MPTRAC

Generated by Doxygen 1.8.11

Contents

1 Main Page

Massive-Parallel Trajectory Calculations (MPTRAC) is a Lagrangian particle dispersion model for the troposphere and stratosphere.This reference manual provides information on the algorithms and data structures used in the code. Further information can be found at:

https://github.com/slcs-jsc/mptrac

2 Data Structure Index

2.1 Data Structures

Here are the data structures with brief descriptions:

3 File Index

3.1 File List

Here is a list of all files with brief descriptions:

4 Data Structure Documentation

4.1 atm_t Struct Reference

Atmospheric data.

```
#include <libtrac.h>
```

Data Fields

- int np
  Number of air pacels.
- double time [NP]
  Time [s].
- double p [NP]
  Pressure [hPa].

- double lon [NP]

  Longitude [deg].
- double lat [NP]

  Latitude [deg].
- double q [NQ][NP]

  Quantity data (for various, user-defined attributes).
- float up [NP]

  Zonal wind perturbation [m/s].
- float vp [NP]

  Meridional wind perturbation [m/s].
- float wp [NP]

  Vertical velocity perturbation [hPa/s].
- double cache_time [EX][EY][EP]

  Cache for reference time of wind standard deviations.
- float cache_usig [EX][EY][EP]

  Cache for zonal wind standard deviations.
- float cache_vsig [EX][EY][EP]

  Cache for meridional wind standard deviations.
- float cache_wsig [EX][EY][EP]

  Cache for vertical velocity standard deviations.

4.1.1 Detailed Description

Atmospheric data.

Definition at line 592 of file libtrac.h.

4.1.2 Field Documentation

4.1.2.1 int atm_t::np

Number of air pacels.

Definition at line 595 of file libtrac.h.

4.1.2.2 double atm_t::time[NP]

Time [s].

Definition at line 598 of file libtrac.h.

4.1.2.3 double atm_t::p[NP]

Pressure [hPa].

Definition at line 601 of file libtrac.h.

4.1.2.4 double atm_t::lon[NP]

Longitude [deg].

Definition at line 604 of file libtrac.h.

4.1.2.5 double atm_t::lat[NP]

Latitude [deg].

Definition at line 607 of file libtrac.h.

4.1.2.6 double atm_t::q[NQ][NP]

Quantity data (for various, user-defined attributes).

Definition at line 610 of file libtrac.h.

4.1.2.7 float atm_t::up[NP]

Zonal wind perturbation [m/s].

Definition at line 613 of file libtrac.h.

4.1.2.8 float atm_t::vp[NP]

Meridional wind perturbation [m/s].

Definition at line 616 of file libtrac.h.

4.1.2.9 float atm_t::wp[NP]

Vertical velocity perturbation [hPa/s].

Definition at line 619 of file libtrac.h.

4.1.2.10 double atm_t::cache_time[EX][EY][EP]

Cache for reference time of wind standard deviations.

Definition at line 622 of file libtrac.h.

4.1.2.11 float atm_t::cache_usig[EX][EY][EP]

Cache for zonal wind standard deviations.

Definition at line 625 of file libtrac.h.

4.1.2.12 float atm_t::cache_vsig[EX][EY][EP]

Cache for meridional wind standard deviations.

Definition at line 628 of file libtrac.h.

4.1.2.13 float atm_t::cache_wsig[EX][EY][EP]

Cache for vertical velocity standard deviations.

Definition at line 631 of file libtrac.h.

The documentation for this struct was generated from the following file:

- libtrac.h

4.2 ctl_t Struct Reference

Control parameters.

`#include <libtrac.h>`

Data Fields

- int nq
  Number of quantities.
- char qnt_name [NQ][LEN]
  Quantity names.
- char qnt_unit [NQ][LEN]
  Quantity units.
- char qnt_format [NQ][LEN]
  Quantity output format.
- int qnt_ens
  Quantity array index for ensemble IDs.
- int qnt_m
  Quantity array index for mass.
- int qnt_rho
  Quantity array index for particle density.
- int qnt_r
  Quantity array index for particle radius.
- int qnt_ps
  Quantity array index for surface pressure.
- int qnt_pt
  Quantity array index for tropopause pressure.
- int qnt_z
  Quantity array index for geopotential height.
- int qnt_p
  Quantity array index for pressure.
- int qnt_t
  Quantity array index for temperature.
- int qnt_u
  Quantity array index for zonal wind.
- int qnt_v
  Quantity array index for meridional wind.
- int qnt_w
  Quantity array index for vertical velocity.

- int qnt_h2o
  Quantity array index for water vapor vmr.
- int qnt_o3
  Quantity array index for ozone vmr.
- int qnt_theta
  Quantity array index for potential temperature.
- int qnt_vh
  Quantity array index for horizontal wind.
- int qnt_vz
  Quantity array index for vertical velocity.
- int qnt_pv
  Quantity array index for potential vorticity.
- int qnt_tice
  Quantity array index for T_ice.
- int qnt_tsts
  Quantity array index for T_STS.
- int qnt_tnat
  Quantity array index for T_NAT.
- int qnt_stat
  Quantity array index for station flag.
- int direction
  Direction flag (1=forward calculation, -1=backward calculation).
- double t_start
  Start time of simulation [s].
- double t_stop
  Stop time of simulation [s].
- double dt_mod
  Time step of simulation [s].
- double dt_met
  Time step of meteorological data [s].
- int met_dx
  Stride for longitudes.
- int met_dy
  Stride for latitudes.
- int met_dp
  Stride for pressure levels.
- int met_sx
  Smoothing for longitudes.
- int met_sy
  Smoothing for latitudes.
- int met_sp
  Smoothing for pressure levels.
- int met_np
  Number of target pressure levels.
- double met_p [EP]
  Target pressure levels [hPa].
- int met_tropo
  Tropopause definition (0=none, 1=clim, 2=cold point, 3=WMO_1st, 4=WMO_2nd).
- char met_geopot [LEN]
  Surface geopotential data file.
- double met_dt_out

Time step for sampling of meteo data along trajectories [s].

- char met_stage [LEN]

  Command to stage meteo data.
- int isosurf

  Isosurface parameter (0=none, 1=pressure, 2=density, 3=theta, 4=balloon).
- char balloon [LEN]

  Balloon position filename.
- double turb_dx_trop

  Horizontal turbulent diffusion coefficient (troposphere) [m^2/s].
- double turb_dx_strat

  Horizontal turbulent diffusion coefficient (stratosphere) [m^2/s].
- double turb_dz_trop

  Vertical turbulent diffusion coefficient (troposphere) [m^2/s].
- double turb_dz_strat

  Vertical turbulent diffusion coefficient (stratosphere) [m^2/s].
- double turb_mesox

  Horizontal scaling factor for mesoscale wind fluctuations.
- double turb_mesoz

  Vertical scaling factor for mesoscale wind fluctuations.
- double molmass

  Molar mass [g/mol].
- double tdec_trop

  Life time of particles (troposphere) [s].
- double tdec_strat

  Life time of particles (stratosphere) [s].
- double psc_h2o

  H2O volume mixing ratio for PSC analysis.
- double psc_hno3

  HNO3 volume mixing ratio for PSC analysis.
- char atm_basename [LEN]

  Basename of atmospheric data files.
- char atm_gpfile [LEN]

  Gnuplot file for atmospheric data.
- double atm_dt_out

  Time step for atmospheric data output [s].
- int atm_filter

  Time filter for atmospheric data output (0=no, 1=yes).
- int atm_type

  Type of atmospheric data files (0=ASCII, 1=binary, 2=netCDF).
- char csi_basename [LEN]

  Basename of CSI data files.
- double csi_dt_out

  Time step for CSI data output [s].
- char csi_obsfile [LEN]

  Observation data file for CSI analysis.
- double csi_obsmin

  Minimum observation index to trigger detection.
- double csi_modmin

  Minimum column density to trigger detection [kg/m^2].
- int csi_nz

  Number of altitudes of gridded CSI data.

- double csi_z0
  Lower altitude of gridded CSI data [km].
- double csi_z1
  Upper altitude of gridded CSI data [km].
- int csi_nx
  Number of longitudes of gridded CSI data.
- double csi_lon0
  Lower longitude of gridded CSI data [deg].
- double csi_lon1
  Upper longitude of gridded CSI data [deg].
- int csi_ny
  Number of latitudes of gridded CSI data.
- double csi_lat0
  Lower latitude of gridded CSI data [deg].
- double csi_lat1
  Upper latitude of gridded CSI data [deg].
- char grid_basename [LEN]
  Basename of grid data files.
- char grid_gpfile [LEN]
  Gnuplot file for gridded data.
- double grid_dt_out
  Time step for gridded data output [s].
- int grid_sparse
  Sparse output in grid data files (0=no, 1=yes).
- int grid_nz
  Number of altitudes of gridded data.
- double grid_z0
  Lower altitude of gridded data [km].
- double grid_z1
  Upper altitude of gridded data [km].
- int grid_nx
  Number of longitudes of gridded data.
- double grid_lon0
  Lower longitude of gridded data [deg].
- double grid_lon1
  Upper longitude of gridded data [deg].
- int grid_ny
  Number of latitudes of gridded data.
- double grid_lat0
  Lower latitude of gridded data [deg].
- double grid_lat1
  Upper latitude of gridded data [deg].
- char prof_basename [LEN]
  Basename for profile output file.
- char prof_obsfile [LEN]
  Observation data file for profile output.
- int prof_nz
  Number of altitudes of gridded profile data.
- double prof_z0
  Lower altitude of gridded profile data [km].
- double prof_z1

Upper altitude of gridded profile data [km].

- int prof_nx

  Number of longitudes of gridded profile data.
- double prof_lon0

  Lower longitude of gridded profile data [deg].
- double prof_lon1

  Upper longitude of gridded profile data [deg].
- int prof_ny

  Number of latitudes of gridded profile data.
- double prof_lat0

  Lower latitude of gridded profile data [deg].
- double prof_lat1

  Upper latitude of gridded profile data [deg].
- char ens_basename [LEN]

  Basename of ensemble data file.
- char stat_basename [LEN]

  Basename of station data file.
- double stat_lon

  Longitude of station [deg].
- double stat_lat

  Latitude of station [deg].
- double stat_r

  Search radius around station [km].

4.2.1 Detailed Description

Control parameters.

Definition at line 273 of file libtrac.h.

4.2.2 Field Documentation

4.2.2.1 int ctl_t::nq

Number of quantities.

Definition at line 276 of file libtrac.h.

4.2.2.2 char ctl_t::qnt_name[NQ][LEN]

Quantity names.

Definition at line 279 of file libtrac.h.

4.2.2.3 char ctl_t::qnt_unit[NQ][LEN]

Quantity units.

Definition at line 282 of file libtrac.h.

4.2.2.4 char ctl_t::qnt_format[NQ][LEN]

Quantity output format.

Definition at line 285 of file libtrac.h.

4.2.2.5 int ctl_t::qnt_ens

Quantity array index for ensemble IDs.

Definition at line 288 of file libtrac.h.

4.2.2.6 int ctl_t::qnt_m

Quantity array index for mass.

Definition at line 291 of file libtrac.h.

4.2.2.7 int ctl_t::qnt_rho

Quantity array index for particle density.

Definition at line 294 of file libtrac.h.

4.2.2.8 int ctl_t::qnt_r

Quantity array index for particle radius.

Definition at line 297 of file libtrac.h.

4.2.2.9 int ctl_t::qnt_ps

Quantity array index for surface pressure.

Definition at line 300 of file libtrac.h.

4.2.2.10 int ctl_t::qnt_pt

Quantity array index for tropopause pressure.

Definition at line 303 of file libtrac.h.

4.2.2.11 int ctl_t::qnt_z

Quantity array index for geopotential height.

Definition at line 306 of file libtrac.h.

4.2.2.12 int ctl_t::qnt_p

Quantity array index for pressure.

Definition at line 309 of file libtrac.h.

4.2.2.13 int ctl_t::qnt_t

Quantity array index for temperature.

Definition at line 312 of file libtrac.h.

4.2.2.14 int ctl_t::qnt_u

Quantity array index for zonal wind.

Definition at line 315 of file libtrac.h.

4.2.2.15 int ctl_t::qnt_v

Quantity array index for meridional wind.

Definition at line 318 of file libtrac.h.

4.2.2.16 int ctl_t::qnt_w

Quantity array index for vertical velocity.

Definition at line 321 of file libtrac.h.

4.2.2.17 int ctl_t::qnt_h2o

Quantity array index for water vapor vmr.

Definition at line 324 of file libtrac.h.

4.2.2.18 int ctl_t::qnt_o3

Quantity array index for ozone vmr.

Definition at line 327 of file libtrac.h.

4.2.2.19 int ctl_t::qnt_theta

Quantity array index for potential temperature.

Definition at line 330 of file libtrac.h.

4.2.2.20 int ctl_t::qnt_vh

Quantity array index for horizontal wind.

Definition at line 333 of file libtrac.h.

4.2.2.21 int ctl_t::qnt_vz

Quantity array index for vertical velocity.

Definition at line 336 of file libtrac.h.

4.2.2.22 int ctl_t::qnt_pv

Quantity array index for potential vorticity.

Definition at line 339 of file libtrac.h.

4.2.2.23 int ctl_t::qnt_tice

Quantity array index for T_ice.

Definition at line 342 of file libtrac.h.

4.2.2.24 int ctl_t::qnt_tsts

Quantity array index for T_STS.

Definition at line 345 of file libtrac.h.

4.2.2.25 int ctl_t::qnt_tnat

Quantity array index for T_NAT.

Definition at line 348 of file libtrac.h.

4.2.2.26 int ctl_t::qnt_stat

Quantity array index for station flag.

Definition at line 351 of file libtrac.h.

4.2.2.27 int ctl_t::direction

Direction flag (1=forward calculation, -1=backward calculation).

Definition at line 354 of file libtrac.h.

4.2.2.28 double ctl_t::t_start

Start time of simulation [s].

Definition at line 357 of file libtrac.h.

4.2.2.29 double ctl_t::t_stop

Stop time of simulation [s].

Definition at line 360 of file libtrac.h.

4.2.2.30 double ctl_t::dt_mod

Time step of simulation [s].

Definition at line 363 of file libtrac.h.

4.2.2.31 double ctl_t::dt_met

Time step of meteorological data [s].

Definition at line 366 of file libtrac.h.

4.2.2.32 int ctl_t::met_dx

Stride for longitudes.

Definition at line 369 of file libtrac.h.

4.2.2.33 int ctl_t::met_dy

Stride for latitudes.

Definition at line 372 of file libtrac.h.

4.2.2.34 int ctl_t::met_dp

Stride for pressure levels.

Definition at line 375 of file libtrac.h.

4.2.2.35 int ctl_t::met_sx

Smoothing for longitudes.

Definition at line 378 of file libtrac.h.

4.2.2.36 int ctl_t::met_sy

Smoothing for latitudes.

Definition at line 381 of file libtrac.h.

4.2.2.37 int ctl_t::met_sp

Smoothing for pressure levels.

Definition at line 384 of file libtrac.h.

4.2.2.38 int ctl_t::met_np

Number of target pressure levels.

Definition at line 387 of file libtrac.h.

4.2.2.39 double ctl_t::met_p[EP]

Target pressure levels [hPa].

Definition at line 390 of file libtrac.h.

4.2.2.40 int ctl_t::met_tropo

Tropopause definition (0=none, 1=clim, 2=cold point, 3=WMO_1st, 4=WMO_2nd).

Definition at line 394 of file libtrac.h.

4.2.2.41 char ctl_t::met_geopot[LEN]

Surface geopotential data file.

Definition at line 397 of file libtrac.h.

4.2.2.42 double ctl_t::met_dt_out

Time step for sampling of meteo data along trajectories [s].

Definition at line 400 of file libtrac.h.

4.2.2.43 char ctl_t::met_stage[LEN]

Command to stage meteo data.

Definition at line 403 of file libtrac.h.

4.2.2.44 int ctl_t::isosurf

Isosurface parameter (0=none, 1=pressure, 2=density, 3=theta, 4=balloon).

Definition at line 407 of file libtrac.h.

4.2.2.45 char ctl_t::balloon[LEN]

Balloon position filename.

Definition at line 410 of file libtrac.h.

4.2.2.46 double ctl_t::turb_dx_trop

Horizontal turbulent diffusion coefficient (troposphere) [m^2/s].

Definition at line 413 of file libtrac.h.

4.2.2.47 double ctl_t::turb_dx_strat

Horizontal turbulent diffusion coefficient (stratosphere) [m^2/s].

Definition at line 416 of file libtrac.h.

4.2.2.48 double ctl_t::turb_dz_trop

Vertical turbulent diffusion coefficient (troposphere) [m^2/s].

Definition at line 419 of file libtrac.h.

4.2.2.49 double ctl_t::turb_dz_strat

Vertical turbulent diffusion coefficient (stratosphere) [m^2/s].

Definition at line 422 of file libtrac.h.

4.2.2.50 double ctl_t::turb_mesox

Horizontal scaling factor for mesoscale wind fluctuations.

Definition at line 425 of file libtrac.h.

4.2.2.51 double ctl_t::turb_mesoz

Vertical scaling factor for mesoscale wind fluctuations.

Definition at line 428 of file libtrac.h.

4.2.2.52 double ctl_t::molmass

Molar mass [g/mol].

Definition at line 431 of file libtrac.h.

4.2.2.53 double ctl_t::tdec_trop

Life time of particles (troposphere) [s].

Definition at line 434 of file libtrac.h.

4.2.2.54 double ctl_t::tdec_strat

Life time of particles (stratosphere) [s].

Definition at line 437 of file libtrac.h.

4.2.2.55 double ctl_t::psc_h2o

H2O volume mixing ratio for PSC analysis.

Definition at line 440 of file libtrac.h.

4.2.2.56 double ctl_t::psc_hno3

HNO3 volume mixing ratio for PSC analysis.

Definition at line 443 of file libtrac.h.

4.2.2.57 char ctl_t::atm_basename[LEN]

Basename of atmospheric data files.

Definition at line 446 of file libtrac.h.

4.2.2.58 char ctl_t::atm_gpfile[LEN]

Gnuplot file for atmospheric data.

Definition at line 449 of file libtrac.h.

4.2.2.59 double ctl_t::atm_dt_out

Time step for atmospheric data output [s].

Definition at line 452 of file libtrac.h.

4.2.2.60 int ctl_t::atm_filter

Time filter for atmospheric data output (0=no, 1=yes).

Definition at line 455 of file libtrac.h.

4.2.2.61 int ctl_t::atm_type

Type of atmospheric data files (0=ASCII, 1=binary, 2=netCDF).

Definition at line 458 of file libtrac.h.

4.2.2.62 char ctl_t::csi_basename[LEN]

Basename of CSI data files.

Definition at line 461 of file libtrac.h.

4.2.2.63 double ctl_t::csi_dt_out

Time step for CSI data output [s].

Definition at line 464 of file libtrac.h.

4.2.2.64 char ctl_t::csi_obsfile[LEN]

Observation data file for CSI analysis.

Definition at line 467 of file libtrac.h.

4.2.2.65 double ctl_t::csi_obsmin

Minimum observation index to trigger detection.

Definition at line 470 of file libtrac.h.

4.2.2.66 double ctl_t::csi_modmin

Minimum column density to trigger detection [kg/m^2].

Definition at line 473 of file libtrac.h.

4.2.2.67 int ctl_t::csi_nz

Number of altitudes of gridded CSI data.

Definition at line 476 of file libtrac.h.

4.2.2.68 double ctl_t::csi_z0

Lower altitude of gridded CSI data [km].

Definition at line 479 of file libtrac.h.

4.2.2.69 double ctl_t::csi_z1

Upper altitude of gridded CSI data [km].

Definition at line 482 of file libtrac.h.

4.2.2.70 int ctl_t::csi_nx

Number of longitudes of gridded CSI data.

Definition at line 485 of file libtrac.h.

4.2.2.71 double ctl_t::csi_lon0

Lower longitude of gridded CSI data [deg].

Definition at line 488 of file libtrac.h.

4.2.2.72 double ctl_t::csi_lon1

Upper longitude of gridded CSI data [deg].

Definition at line 491 of file libtrac.h.

4.2.2.73 int ctl_t::csi_ny

Number of latitudes of gridded CSI data.

Definition at line 494 of file libtrac.h.

4.2.2.74 double ctl_t::csi_lat0

Lower latitude of gridded CSI data [deg].

Definition at line 497 of file libtrac.h.

4.2.2.75 double ctl_t::csi_lat1

Upper latitude of gridded CSI data [deg].

Definition at line 500 of file libtrac.h.

4.2.2.76 char ctl_t::grid_basename[LEN]

Basename of grid data files.

Definition at line 503 of file libtrac.h.

4.2.2.77 char ctl_t::grid_gpfile[LEN]

Gnuplot file for gridded data.

Definition at line 506 of file libtrac.h.

4.2.2.78 double ctl_t::grid_dt_out

Time step for gridded data output [s].

Definition at line 509 of file libtrac.h.

4.2.2.79 int ctl_t::grid_sparse

Sparse output in grid data files (0=no, 1=yes).

Definition at line 512 of file libtrac.h.

4.2.2.80 int ctl_t::grid_nz

Number of altitudes of gridded data.

Definition at line 515 of file libtrac.h.

4.2.2.81 double ctl_t::grid_z0

Lower altitude of gridded data [km].

Definition at line 518 of file libtrac.h.

4.2.2.82 double ctl_t::grid_z1

Upper altitude of gridded data [km].

Definition at line 521 of file libtrac.h.

4.2.2.83 int ctl_t::grid_nx

Number of longitudes of gridded data.

Definition at line 524 of file libtrac.h.

4.2.2.84 double ctl_t::grid_lon0

Lower longitude of gridded data [deg].

Definition at line 527 of file libtrac.h.

4.2.2.85 double ctl_t::grid_lon1

Upper longitude of gridded data [deg].

Definition at line 530 of file libtrac.h.

4.2.2.86 int ctl_t::grid_ny

Number of latitudes of gridded data.

Definition at line 533 of file libtrac.h.

4.2.2.87 double ctl_t::grid_lat0

Lower latitude of gridded data [deg].

Definition at line 536 of file libtrac.h.

4.2.2.88 double ctl_t::grid_lat1

Upper latitude of gridded data [deg].

Definition at line 539 of file libtrac.h.

4.2.2.89 char ctl_t::prof_basename[LEN]

Basename for profile output file.

Definition at line 542 of file libtrac.h.

4.2.2.90 char ctl_t::prof_obsfile[LEN]

Observation data file for profile output.

Definition at line 545 of file libtrac.h.

4.2.2.91 int ctl_t::prof_nz

Number of altitudes of gridded profile data.

Definition at line 548 of file libtrac.h.

4.2.2.92 double ctl_t::prof_z0

Lower altitude of gridded profile data [km].

Definition at line 551 of file libtrac.h.

4.2.2.93 double ctl_t::prof_z1

Upper altitude of gridded profile data [km].

Definition at line 554 of file libtrac.h.

4.2.2.94 int ctl_t::prof_nx

Number of longitudes of gridded profile data.

Definition at line 557 of file libtrac.h.

4.2.2.95 double ctl_t::prof_lon0

Lower longitude of gridded profile data [deg].

Definition at line 560 of file libtrac.h.

4.2.2.96 double ctl_t::prof_lon1

Upper longitude of gridded profile data [deg].

Definition at line 563 of file libtrac.h.

4.2.2.97 int ctl_t::prof_ny

Number of latitudes of gridded profile data.

Definition at line 566 of file libtrac.h.

4.2.2.98 double ctl_t::prof_lat0

Lower latitude of gridded profile data [deg].

Definition at line 569 of file libtrac.h.

4.2.2.99 double ctl_t::prof_lat1

Upper latitude of gridded profile data [deg].

Definition at line 572 of file libtrac.h.

4.2.2.100 char ctl_t::ens_basename[LEN]

Basename of ensemble data file.

Definition at line 575 of file libtrac.h.

4.2.2.101 char ctl_t::stat_basename[LEN]

Basename of station data file.

Definition at line 578 of file libtrac.h.

4.2.2.102 double ctl_t::stat_lon

Longitude of station [deg].

Definition at line 581 of file libtrac.h.

4.2.2.103 double ctl_t::stat_lat

Latitude of station [deg].

Definition at line 584 of file libtrac.h.

4.2.2.104 double ctl_t::stat_r

Search radius around station [km].

Definition at line 587 of file libtrac.h.

The documentation for this struct was generated from the following file:

- libtrac.h

4.3 met_t Struct Reference

Meteorological data.

`#include <libtrac.h>`

Data Fields

- double time
  Time [s].
- int nx
  Number of longitudes.
- int ny
  Number of latitudes.
- int np
  Number of pressure levels.
- double lon [EX]
  Longitude [deg].
- double lat [EY]
  Latitude [deg].
- double p [EP]
  Pressure [hPa].
- double ps [EX][EY]
  Surface pressure [hPa].
- double pt [EX][EY]
  Tropopause pressure [hPa].
- float z [EX][EY][EP]
  Geopotential height [km].
- float t [EX][EY][EP]
  Temperature [K].
- float u [EX][EY][EP]
  Zonal wind [m/s].
- float v [EX][EY][EP]
  Meridional wind [m/s].

- float w [EX][EY][EP]

  Vertical wind [hPa/s].
- float pv [EX][EY][EP]

  Potential vorticity [PVU].
- float h2o [EX][EY][EP]

  Water vapor volume mixing ratio [1].
- float o3 [EX][EY][EP]

  Ozone volume mixing ratio [1].
- float pl [EX][EY][EP]

  Pressure on model levels [hPa].

4.3.1 Detailed Description

Meteorological data.

Definition at line 636 of file libtrac.h.

4.3.2 Field Documentation

4.3.2.1 double met_t::time

Time [s].

Definition at line 639 of file libtrac.h.

4.3.2.2 int met_t::nx

Number of longitudes.

Definition at line 642 of file libtrac.h.

4.3.2.3 int met_t::ny

Number of latitudes.

Definition at line 645 of file libtrac.h.

4.3.2.4 int met_t::np

Number of pressure levels.

Definition at line 648 of file libtrac.h.

4.3.2.5 double met_t::lon[EX]

Longitude [deg].

Definition at line 651 of file libtrac.h.

4.3.2.6 double met_t::lat[EY]

Latitude [deg].

Definition at line 654 of file libtrac.h.

4.3.2.7 double met_t::p[EP]

Pressure [hPa].

Definition at line 657 of file libtrac.h.

4.3.2.8 double met_t::ps[EX][EY]

Surface pressure [hPa].

Definition at line 660 of file libtrac.h.

4.3.2.9 double met_t::pt[EX][EY]

Tropopause pressure [hPa].

Definition at line 663 of file libtrac.h.

4.3.2.10 float met_t::z[EX][EY][EP]

Geopotential height [km].

Definition at line 666 of file libtrac.h.

4.3.2.11 float met_t::t[EX][EY][EP]

Temperature [K].

Definition at line 669 of file libtrac.h.

4.3.2.12 float met_t::u[EX][EY][EP]

Zonal wind [m/s].

Definition at line 672 of file libtrac.h.

4.3.2.13 float met_t::v[EX][EY][EP]

Meridional wind [m/s].

Definition at line 675 of file libtrac.h.

4.3.2.14 float met_t::w[EX][EY][EP]

Vertical wind [hPa/s].

Definition at line 678 of file libtrac.h.

4.3.2.15 float met_t::pv[EX][EY][EP]

Potential vorticity [PVU].

Definition at line 681 of file libtrac.h.

4.3.2.16 float met_t::h2o[EX][EY][EP]

Water vapor volume mixing ratio [1].

Definition at line 684 of file libtrac.h.

4.3.2.17 float met_t::o3[EX][EY][EP]

Ozone volume mixing ratio [1].

Definition at line 687 of file libtrac.h.

4.3.2.18 float met_t::pl[EX][EY][EP]

Pressure on model levels [hPa].

Definition at line 690 of file libtrac.h.

The documentation for this struct was generated from the following file:

- libtrac.h

5 File Documentation

5.1 atm_conv.c File Reference

Convert file format of atmospheric data files.

Functions

- int main (int argc, char *argv[])

5.1.1 Detailed Description

Convert file format of atmospheric data files.

Definition in file atm_conv.c.

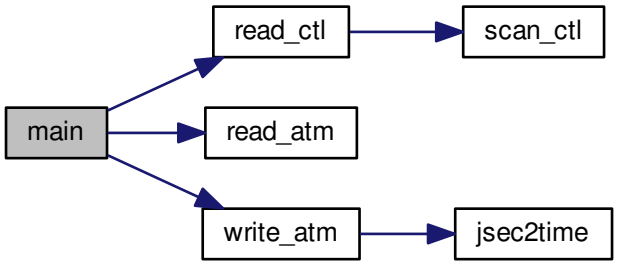
5.1.2 Function Documentation

5.1.2.1 int main (int *argc*, char * *argv[]*)

Definition at line 27 of file atm_conv.c.

```
00029                 {
00030
00031   ctl_t ctl;
00032
00033   atm_t *atm;
00034
00035   /* Check arguments... */
00036   if (argc < 6)
00037     ERRMSG("Give parameters: <ctl> <atm_in> <atm_in_type>"
00038            " <atm_out> <atm_out_type>");
00039
00040   /* Allocate... */
00041   ALLOC(atm, atm_t, 1);
00042
00043   /* Read control parameters... */
00044   read_ctl(argv[1], argc, argv, &ctl);
00045
00046   /* Read atmospheric data... */
00047   ctl.atm_type = atoi(argv[3]);
00048   read_atm(argv[2], &ctl, atm);
00049
00050   /* Write atmospheric data... */
00051   ctl.atm_type = atoi(argv[5]);
00052   write_atm(argv[4], &ctl, atm, 0);
00053
00054   /* Free... */
00055   free(atm);
00056
00057   return EXIT_SUCCESS;
00058 }
```

Here is the call graph for this function:



5.2 atm_conv.c

```
00001 /*
00002   This file is part of MPTRAC.
00003
00004   MPTRAC is free software: you can redistribute it and/or modify
00005   it under the terms of the GNU General Public License as published by
00006   the Free Software Foundation, either version 3 of the License, or
00007   (at your option) any later version.
00008
00009   MPTRAC is distributed in the hope that it will be useful,
00010   but WITHOUT ANY WARRANTY; without even the implied warranty of
```

```
00011   MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
00012   GNU General Public License for more details.
00013
00014   You should have received a copy of the GNU General Public License
00015   along with MPTRAC. If not, see <http://www.gnu.org/licenses/>.
00016
00017   Copyright (C) 2013-2019 Forschungszentrum Juelich GmbH
00018 */
00019
00025 #include "libtrac.h"
00026
00027 int main(
00028   int argc,
00029   char *argv[]) {
00030
00031   ctl_t ctl;
00032
00033   atm_t *atm;
00034
00035   /* Check arguments... */
00036   if (argc < 6)
00037     ERRMSG("Give parameters: <ctl> <atm_in> <atm_in_type>"
00038            " <atm_out> <atm_out_type>");
00039
00040   /* Allocate... */
00041   ALLOC(atm, atm_t, 1);
00042
00043   /* Read control parameters... */
00044   read_ctl(argv[1], argc, argv, &ctl);
00045
00046   /* Read atmospheric data... */
00047   ctl.atm_type = atoi(argv[3]);
00048   read_atm(argv[2], &ctl, atm);
00049
00050   /* Write atmospheric data... */
00051   ctl.atm_type = atoi(argv[5]);
00052   write_atm(argv[4], &ctl, atm, 0);
00053
00054   /* Free... */
00055   free(atm);
00056
00057   return EXIT_SUCCESS;
00058 }
```

5.3 atm_dist.c File Reference

Calculate transport deviations of trajectories.

Functions

- int main (int argc, char *argv[])

5.3.1 Detailed Description

Calculate transport deviations of trajectories.

Definition in file atm_dist.c.

5.3.2 Function Documentation

5.3.2.1 int main (int *argc*, char * *argv[]*)

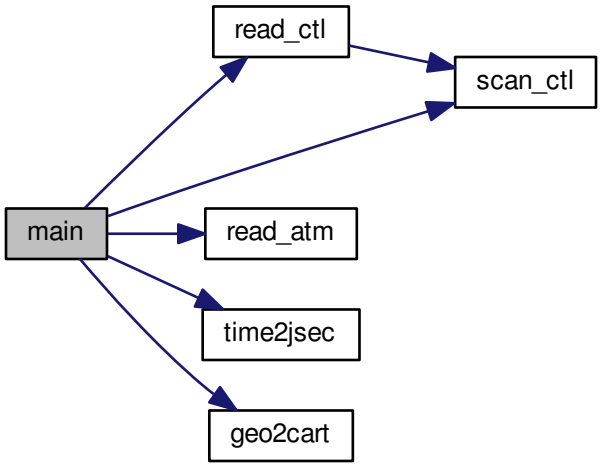
Definition at line 27 of file atm_dist.c.

```
00029                {
00030
00031   ctl_t ctl;
00032
00033   atm_t *atm1, *atm2;
00034
00035   FILE *out;
00036
00037   char tstr[LEN];
00038
00039   double ahtd, aqtd[NQ], atce1[NQ], atce2[NQ], avtd, lat0, lat1,
00040     *lat1_old, *lat2_old, *lh1, *lh2, lon0, lon1, *lon1_old, *lon2_old,
00041     *lv1, *lv2, p0, p1, *q1, *q2, rhtd, rqtd[NQ], rtce1[NQ], rtce2[NQ], rvtd,
00042     t, t0 = 0, x0[3], x1[3], x2[3], z1, *z1_old, z2, *z2_old;
00043
00044   int ens, f, ip, iq, np, year, mon, day, hour, min;
00045
00046   /* Allocate... */
00047   ALLOC(atm1, atm_t, 1);
00048   ALLOC(atm2, atm_t, 1);
00049   ALLOC(lon1_old, double,
00050         NP);
00051   ALLOC(lat1_old, double,
00052         NP);
00053   ALLOC(z1_old, double,
00054         NP);
00055   ALLOC(lh1, double,
00056         NP);
00057   ALLOC(lv1, double,
00058         NP);
00059   ALLOC(lon2_old, double,
00060         NP);
00061   ALLOC(lat2_old, double,
00062         NP);
00063   ALLOC(z2_old, double,
00064         NP);
00065   ALLOC(lh2, double,
00066         NP);
00067   ALLOC(lv2, double,
00068         NP);
00069   ALLOC(q1, double,
00070         NQ * NP);
00071   ALLOC(q2, double,
00072         NQ * NP);
00073
00074   /* Check arguments... */
00075   if (argc < 5)
00076     ERRMSG("Give parameters: <ctl> <outfile> <atm1a> <atm1b>"
00077            " [<atm2a> <atm2b> ...]");
00078
00079   /* Read control parameters... */
00080   read_ctl(argv[1], argc, argv, &ctl);
00081   ens = (int) scan_ctl(argv[1], argc, argv, "DIST_ENS", -1, "-1", NULL);
00082   p0 = P(scan_ctl(argv[1], argc, argv, "DIST_Z0", -1, "-1000", NULL));
00083   p1 = P(scan_ctl(argv[1], argc, argv, "DIST_Z1", -1, "1000", NULL));
00084   lat0 = scan_ctl(argv[1], argc, argv, "DIST_LAT0", -1, "-1000", NULL);
00085   lat1 = scan_ctl(argv[1], argc, argv, "DIST_LAT1", -1, "1000", NULL);
00086   lon0 = scan_ctl(argv[1], argc, argv, "DIST_LON0", -1, "-1000", NULL);
00087   lon1 = scan_ctl(argv[1], argc, argv, "DIST_LON1", -1, "1000", NULL);
00088
00089   /* Write info... */
00090   printf("Write transport deviations: %s\n", argv[2]);
00091
00092   /* Create output file... */
00093   if (!(out = fopen(argv[2], "w")))
00094     ERRMSG("Cannot create file!");
00095
00096   /* Write header... */
00097   fprintf(out,
00098           "# $1 = time [s]\n"
00099           "# $2 = trajectory time [s]\n"
00100           "# $3 = AHTD [km]\n"
00101           "# $4 = RHTD [%%]\n" "# $5 = AVTD [km]\n" "# $6 = RVTD [%%]\n");
00102   for (iq = 0; iq < ctl.nq; iq++)
00103     fprintf(out,
00104             "# $%d = AQTD (%s) [%s]\n"
00105             "# $%d = RQTD (%s) [%%]\n",
00106             7 + 2 * iq, ctl.qnt_name[iq], ctl.qnt_unit[iq],
00107             8 + 2 * iq, ctl.qnt_name[iq]);
00108   for (iq = 0; iq < ctl.nq; iq++)
00109     fprintf(out,
00110             "# $%d = ATCE_1 (%s) [%s]\n"
00111             "# $%d = RTCE_1 (%s) [%%]\n",
00112             7 + 2 * ctl.nq + 2 * iq, ctl.qnt_name[iq], ctl.qnt_unit[iq],
00113             8 + 2 * ctl.nq + 2 * iq, ctl.qnt_name[iq]);
00114   for (iq = 0; iq < ctl.nq; iq++)
00115     fprintf(out,
```

```
00116             "# $%d = ATCE_2 (%s) [%s]\n"
00117             "# $%d = RTCE_2 (%s) [%%]\n",
00118             7 + 4 * ctl.nq + 2 * iq, ctl.qnt_name[iq], ctl.qnt_unit[iq],
00119             8 + 4 * ctl.nq + 2 * iq, ctl.qnt_name[iq]);
00120   fprintf(out, "# $%d = number of particles\n\n", 7 + 6 * ctl.nq);
00121
00122   /* Loop over file pairs... */
00123   for (f = 3; f < argc; f += 2) {
00124
00125     /* Read atmopheric data... */
00126     read_atm(argv[f], &ctl, atm1);
00127     read_atm(argv[f + 1], &ctl, atm2);
00128
00129     /* Check if structs match... */
00130     if (atm1->np != atm2->np)
00131       ERRMSG("Different numbers of parcels!");
00132     for (ip = 0; ip < atm1->np; ip++)
00133       if (gsl_finite(atm1->time[ip]) && gsl_finite(atm2->time[ip])
00134           && atm1->time[ip] != atm2->time[ip])
00135         ERRMSG("Times do not match!");
00136
00137     /* Get time from filename... */
00138     sprintf(tstr, "%.4s", &argv[f][strlen(argv[f]) - 20]);
00139     year = atoi(tstr);
00140     sprintf(tstr, "%.2s", &argv[f][strlen(argv[f]) - 15]);
00141     mon = atoi(tstr);
00142     sprintf(tstr, "%.2s", &argv[f][strlen(argv[f]) - 12]);
00143     day = atoi(tstr);
00144     sprintf(tstr, "%.2s", &argv[f][strlen(argv[f]) - 9]);
00145     hour = atoi(tstr);
00146     sprintf(tstr, "%.2s", &argv[f][strlen(argv[f]) - 6]);
00147     min = atoi(tstr);
00148     time2jsec(year, mon, day, hour, min, 0, 0, &t);
00149
00150     /* Save initial data... */
00151     if (f == 3) {
00152       t0 = t;
00153       for (iq = 0; iq < ctl.nq; iq++)
00154         for (ip = 0; ip < atm1->np; ip++) {
00155           q1[iq * NP + ip] = atm1->q[iq][ip];
00156           q2[iq * NP + ip] = atm2->q[iq][ip];
00157         }
00158     }
00159
00160     /* Init... */
00161     np = 0;
00162     ahtd = avtd = rhtd = rvtd = 0;
00163     for (iq = 0; iq < ctl.nq; iq++)
00164       aqtd[iq] = atce1[iq] = atce2[iq] = rqtd[iq] = rtce1[iq] = rtce2[iq] = 0;
00165
00166     /* Loop over air parcels... */
00167     for (ip = 0; ip < atm1->np; ip++) {
00168
00169       /* Check data... */
00170       if (!gsl_finite(atm1->time[ip]) || !gsl_finite(atm2->time[ip]))
00171         continue;
00172
00173       /* Check ensemble ID... */
00174       if (ens >= 0 && ctl.qnt_ens >= 0 && atm1->q[ctl.qnt_ens][ip] != ens)
00175         continue;
00176       if (ens >= 0 && ctl.qnt_ens >= 0 && atm2->q[ctl.qnt_ens][ip] != ens)
00177         continue;
00178
00179       /* Check spatial range... */
00180       if (atm1->p[ip] > p0 || atm1->p[ip] < p1
00181           || atm1->lon[ip] < lon0 || atm1->lon[ip] > lon1
00182           || atm1->lat[ip] < lat0 || atm1->lat[ip] > lat1)
00183         continue;
00184       if (atm2->p[ip] > p0 || atm2->p[ip] < p1
00185           || atm2->lon[ip] < lon0 || atm2->lon[ip] > lon1
00186           || atm2->lat[ip] < lat0 || atm2->lat[ip] > lat1)
00187         continue;
00188
00189       /* Convert coordinates... */
00190       geo2cart(0, atm1->lon[ip], atm1->lat[ip], x1);
00191       geo2cart(0, atm2->lon[ip], atm2->lat[ip], x2);
00192       z1 = Z(atm1->p[ip]);
00193       z2 = Z(atm2->p[ip]);
00194
00195       /* Calculate absolute transport deviations... */
00196       ahtd += DIST(x1, x2);
00197       avtd += fabs(z1 - z2);
00198       for (iq = 0; iq < ctl.nq; iq++)
00199         aqtd[iq] += fabs(atm1->q[iq][ip] - atm2->q[iq][ip]);
00200
00201       /* Calculate relative transport deviations... */
00202       if (f > 3) {
```

```
00203
00204         /* Get trajectory lengths... */
00205         geo2cart(0, lon1_old[ip], lat1_old[ip], x0);
00206         lh1[ip] += DIST(x0, x1);
00207         lv1[ip] += fabs(z1_old[ip] - z1);
00208
00209         geo2cart(0, lon2_old[ip], lat2_old[ip], x0);
00210         lh2[ip] += DIST(x0, x2);
00211         lv2[ip] += fabs(z2_old[ip] - z2);
00212
00213         /* Get relative transport deviations... */
00214         if (lh1[ip] + lh2[ip] > 0)
00215           rhtd += 200. * DIST(x1, x2) / (lh1[ip] + lh2[ip]);
00216         if (lv1[ip] + lv2[ip] > 0)
00217           rvtd += 200. * fabs(z1 - z2) / (lv1[ip] + lv2[ip]);
00218         for (iq = 0; iq < ctl.nq; iq++)
00219           rqtd[iq] += 200. * fabs(atm1->q[iq][ip] - atm2->q[iq][ip])
00220             / (fabs(atm1->q[iq][ip]) + fabs(atm2->q[iq][ip]));
00221
00222         /* Get tracer conservation errors... */
00223         for (iq = 0; iq < ctl.nq; iq++) {
00224           atce1[iq] += fabs(atm1->q[iq][ip] - q1[iq * NP + ip]);
00225           rtce1[iq] += 200. * fabs(atm1->q[iq][ip] - q1[iq * NP + ip])
00226             / (fabs(atm1->q[iq][ip]) + fabs(q1[iq * NP + ip]));
00227           atce2[iq] += fabs(atm2->q[iq][ip] - q2[iq * NP + ip]);
00228           rtce2[iq] += 200. * fabs(atm2->q[iq][ip] - q2[iq * NP + ip])
00229             / (fabs(atm2->q[iq][ip]) + fabs(q2[iq * NP + ip]));
00230         }
00231       }
00232
00233       /* Save positions of air parcels... */
00234       lon1_old[ip] = atm1->lon[ip];
00235       lat1_old[ip] = atm1->lat[ip];
00236       z1_old[ip] = z1;
00237
00238       lon2_old[ip] = atm2->lon[ip];
00239       lat2_old[ip] = atm2->lat[ip];
00240       z2_old[ip] = z2;
00241
00242       /* Increment air parcel counter... */
00243       np++;
00244     }
00245
00246     /* Write output... */
00247     fprintf(out, "%.2f %.2f %g %g %g %g", t, t - t0,
00248             ahtd / np, rhtd / np, avtd / np, rvtd / np);
00249     for (iq = 0; iq < ctl.nq; iq++) {
00250       fprintf(out, " ");
00251       fprintf(out, ctl.qnt_format[iq], aqtd[iq] / np);
00252       fprintf(out, " ");
00253       fprintf(out, ctl.qnt_format[iq], rqtd[iq] / np);
00254     }
00255     for (iq = 0; iq < ctl.nq; iq++) {
00256       fprintf(out, " ");
00257       fprintf(out, ctl.qnt_format[iq], atce1[iq] / np);
00258       fprintf(out, " ");
00259       fprintf(out, ctl.qnt_format[iq], rtce1[iq] / np);
00260     }
00261     for (iq = 0; iq < ctl.nq; iq++) {
00262       fprintf(out, " ");
00263       fprintf(out, ctl.qnt_format[iq], atce2[iq] / np);
00264       fprintf(out, " ");
00265       fprintf(out, ctl.qnt_format[iq], rtce2[iq] / np);
00266     }
00267     fprintf(out, " %d\n", np);
00268   }
00269
00270   /* Close file... */
00271   fclose(out);
00272
00273   /* Free... */
00274   free(atm1);
00275   free(atm2);
00276   free(lon1_old);
00277   free(lat1_old);
00278   free(z1_old);
00279   free(lh1);
00280   free(lv1);
00281   free(lon2_old);
00282   free(lat2_old);
00283   free(z2_old);
00284   free(lh2);
00285   free(lv2);
00286
00287   return EXIT_SUCCESS;
00288 }
```

Here is the call graph for this function:



5.4 atm_dist.c

```
00001 /*
00002   This file is part of MPTRAC.
00003
00004   MPTRAC is free software: you can redistribute it and/or modify
00005   it under the terms of the GNU General Public License as published by
00006   the Free Software Foundation, either version 3 of the License, or
00007   (at your option) any later version.
00008
00009   MPTRAC is distributed in the hope that it will be useful,
00010   but WITHOUT ANY WARRANTY; without even the implied warranty of
00011   MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
00012   GNU General Public License for more details.
00013
00014   You should have received a copy of the GNU General Public License
00015   along with MPTRAC. If not, see <http://www.gnu.org/licenses/>.
00016
00017   Copyright (C) 2013-2019 Forschungszentrum Juelich GmbH
00018 */
00019
00025 #include "libtrac.h"
00026
00027 int main(
00028   int argc,
00029   char *argv[]) {
00030
00031   ctl_t ctl;
00032
00033   atm_t *atm1, *atm2;
00034
00035   FILE *out;
00036
00037   char tstr[LEN];
00038
00039   double ahtd, aqtd[NQ], atce1[NQ], atce2[NQ], avtd, lat0, lat1,
00040     *lat1_old, *lat2_old, *lh1, *lh2, lon0, lon1, *lon1_old, *lon2_old,
00041     *lv1, *lv2, p0, p1, *q1, *q2, rhtd, rqtd[NQ], rtce1[NQ], rtce2[NQ], rvtd,
00042     t, t0 = 0, x0[3], x1[3], x2[3], z1, *z1_old, z2, *z2_old;
00043
00044   int ens, f, ip, iq, np, year, mon, day, hour, min;
00045
00046   /* Allocate... */
00047   ALLOC(atm1, atm_t, 1);
00048   ALLOC(atm2, atm_t, 1);
00049   ALLOC(lon1_old, double,
```

```
00050         NP);
00051   ALLOC(lat1_old, double,
00052         NP);
00053   ALLOC(z1_old, double,
00054         NP);
00055   ALLOC(lh1, double,
00056         NP);
00057   ALLOC(lv1, double,
00058         NP);
00059   ALLOC(lon2_old, double,
00060         NP);
00061   ALLOC(lat2_old, double,
00062         NP);
00063   ALLOC(z2_old, double,
00064         NP);
00065   ALLOC(lh2, double,
00066         NP);
00067   ALLOC(lv2, double,
00068         NP);
00069   ALLOC(q1, double,
00070         NQ * NP);
00071   ALLOC(q2, double,
00072         NQ * NP);
00073
00074   /* Check arguments... */
00075   if (argc < 5)
00076     ERRMSG("Give parameters: <ctl> <outfile> <atm1a> <atm1b>"
00077            " [<atm2a> <atm2b> ...]");
00078
00079   /* Read control parameters... */
00080   read_ctl(argv[1], argc, argv, &ctl);
00081   ens = (int) scan_ctl(argv[1], argc, argv, "DIST_ENS", -1, "-1", NULL);
00082   p0 = P(scan_ctl(argv[1], argc, argv, "DIST_Z0", -1, "-1000", NULL));
00083   p1 = P(scan_ctl(argv[1], argc, argv, "DIST_Z1", -1, "1000", NULL));
00084   lat0 = scan_ctl(argv[1], argc, argv, "DIST_LAT0", -1, "-1000", NULL);
00085   lat1 = scan_ctl(argv[1], argc, argv, "DIST_LAT1", -1, "1000", NULL);
00086   lon0 = scan_ctl(argv[1], argc, argv, "DIST_LON0", -1, "-1000", NULL);
00087   lon1 = scan_ctl(argv[1], argc, argv, "DIST_LON1", -1, "1000", NULL);
00088
00089   /* Write info... */
00090   printf("Write transport deviations: %s\n", argv[2]);
00091
00092   /* Create output file... */
00093   if (!(out = fopen(argv[2], "w")))
00094     ERRMSG("Cannot create file!");
00095
00096   /* Write header... */
00097   fprintf(out,
00098           "# $1 = time [s]\n"
00099           "# $2 = trajectory time [s]\n"
00100           "# $3 = AHTD [km]\n"
00101           "# $4 = RHTD [%%]\n" "# $5 = AVTD [km]\n" "# $6 = RVTD [%%]\n");
00102   for (iq = 0; iq < ctl.nq; iq++)
00103     fprintf(out,
00104             "# $%d = AQTD (%s) [%s]\n"
00105             "# $%d = RQTD (%s) [%%]\n",
00106             7 + 2 * iq, ctl.qnt_name[iq], ctl.qnt_unit[iq],
00107             8 + 2 * iq, ctl.qnt_name[iq]);
00108   for (iq = 0; iq < ctl.nq; iq++)
00109     fprintf(out,
00110             "# $%d = ATCE_1 (%s) [%s]\n"
00111             "# $%d = RTCE_1 (%s) [%%]\n",
00112             7 + 2 * ctl.nq + 2 * iq, ctl.qnt_name[iq], ctl.qnt_unit[iq],
00113             8 + 2 * ctl.nq + 2 * iq, ctl.qnt_name[iq]);
00114   for (iq = 0; iq < ctl.nq; iq++)
00115     fprintf(out,
00116             "# $%d = ATCE_2 (%s) [%s]\n"
00117             "# $%d = RTCE_2 (%s) [%%]\n",
00118             7 + 4 * ctl.nq + 2 * iq, ctl.qnt_name[iq], ctl.qnt_unit[iq],
00119             8 + 4 * ctl.nq + 2 * iq, ctl.qnt_name[iq]);
00120   fprintf(out, "# $%d = number of particles\n\n", 7 + 6 * ctl.nq);
00121
00122   /* Loop over file pairs... */
00123   for (f = 3; f < argc; f += 2) {
00124
00125     /* Read atmopheric data... */
00126     read_atm(argv[f], &ctl, atm1);
00127     read_atm(argv[f + 1], &ctl, atm2);
00128
00129     /* Check if structs match... */
00130     if (atm1->np != atm2->np)
00131       ERRMSG("Different numbers of parcels!");
00132     for (ip = 0; ip < atm1->np; ip++)
00133       if (gsl_finite(atm1->time[ip]) && gsl_finite(atm2->time[ip])
00134           && atm1->time[ip] != atm2->time[ip])
00135         ERRMSG("Times do not match!");
00136
```

```
00137     /* Get time from filename... */
00138     sprintf(tstr, "%.4s", &argv[f][strlen(argv[f]) - 20]);
00139     year = atoi(tstr);
00140     sprintf(tstr, "%.2s", &argv[f][strlen(argv[f]) - 15]);
00141     mon = atoi(tstr);
00142     sprintf(tstr, "%.2s", &argv[f][strlen(argv[f]) - 12]);
00143     day = atoi(tstr);
00144     sprintf(tstr, "%.2s", &argv[f][strlen(argv[f]) - 9]);
00145     hour = atoi(tstr);
00146     sprintf(tstr, "%.2s", &argv[f][strlen(argv[f]) - 6]);
00147     min = atoi(tstr);
00148     time2jsec(year, mon, day, hour, min, 0, 0, &t);
00149
00150     /* Save initial data... */
00151     if (f == 3) {
00152       t0 = t;
00153       for (iq = 0; iq < ctl.nq; iq++)
00154         for (ip = 0; ip < atm1->np; ip++) {
00155           q1[iq * NP + ip] = atm1->q[iq][ip];
00156           q2[iq * NP + ip] = atm2->q[iq][ip];
00157         }
00158     }
00159
00160     /* Init... */
00161     np = 0;
00162     ahtd = avtd = rhtd = rvtd = 0;
00163     for (iq = 0; iq < ctl.nq; iq++)
00164       aqtd[iq] = atce1[iq] = atce2[iq] = rqtd[iq] = rtce1[iq] = rtce2[iq] = 0;
00165
00166     /* Loop over air parcels... */
00167     for (ip = 0; ip < atm1->np; ip++) {
00168
00169       /* Check data... */
00170       if (!gsl_finite(atm1->time[ip]) || !gsl_finite(atm2->time[ip]))
00171         continue;
00172
00173       /* Check ensemble ID... */
00174       if (ens >= 0 && ctl.qnt_ens >= 0 && atm1->q[ctl.qnt_ens][ip] != ens)
00175         continue;
00176       if (ens >= 0 && ctl.qnt_ens >= 0 && atm2->q[ctl.qnt_ens][ip] != ens)
00177         continue;
00178
00179       /* Check spatial range... */
00180       if (atm1->p[ip] > p0 || atm1->p[ip] < p1
00181           || atm1->lon[ip] < lon0 || atm1->lon[ip] > lon1
00182           || atm1->lat[ip] < lat0 || atm1->lat[ip] > lat1)
00183         continue;
00184       if (atm2->p[ip] > p0 || atm2->p[ip] < p1
00185           || atm2->lon[ip] < lon0 || atm2->lon[ip] > lon1
00186           || atm2->lat[ip] < lat0 || atm2->lat[ip] > lat1)
00187         continue;
00188
00189       /* Convert coordinates... */
00190       geo2cart(0, atm1->lon[ip], atm1->lat[ip], x1);
00191       geo2cart(0, atm2->lon[ip], atm2->lat[ip], x2);
00192       z1 = Z(atm1->p[ip]);
00193       z2 = Z(atm2->p[ip]);
00194
00195       /* Calculate absolute transport deviations... */
00196       ahtd += DIST(x1, x2);
00197       avtd += fabs(z1 - z2);
00198       for (iq = 0; iq < ctl.nq; iq++)
00199         aqtd[iq] += fabs(atm1->q[iq][ip] - atm2->q[iq][ip]);
00200
00201       /* Calculate relative transport deviations... */
00202       if (f > 3) {
00203
00204         /* Get trajectory lengths... */
00205         geo2cart(0, lon1_old[ip], lat1_old[ip], x0);
00206         lh1[ip] += DIST(x0, x1);
00207         lv1[ip] += fabs(z1_old[ip] - z1);
00208
00209         geo2cart(0, lon2_old[ip], lat2_old[ip], x0);
00210         lh2[ip] += DIST(x0, x2);
00211         lv2[ip] += fabs(z2_old[ip] - z2);
00212
00213         /* Get relative transport deviations... */
00214         if (lh1[ip] + lh2[ip] > 0)
00215           rhtd += 200. * DIST(x1, x2) / (lh1[ip] + lh2[ip]);
00216         if (lv1[ip] + lv2[ip] > 0)
00217           rvtd += 200. * fabs(z1 - z2) / (lv1[ip] + lv2[ip]);
00218         for (iq = 0; iq < ctl.nq; iq++)
00219           rqtd[iq] += 200. * fabs(atm1->q[iq][ip] - atm2->q[iq][ip])
00220             / (fabs(atm1->q[iq][ip]) + fabs(atm2->q[iq][ip]));
00221
00222         /* Get tracer conservation errors... */
00223         for (iq = 0; iq < ctl.nq; iq++) {
```

```
00224           atce1[iq] += fabs(atm1->q[iq][ip] - q1[iq * NP + ip]);
00225           rtce1[iq] += 200. * fabs(atm1->q[iq][ip] - q1[iq * NP + ip])
00226             / (fabs(atm1->q[iq][ip]) + fabs(q1[iq * NP + ip]));
00227           atce2[iq] += fabs(atm2->q[iq][ip] - q2[iq * NP + ip]);
00228           rtce2[iq] += 200. * fabs(atm2->q[iq][ip] - q2[iq * NP + ip])
00229             / (fabs(atm2->q[iq][ip]) + fabs(q2[iq * NP + ip]));
00230         }
00231       }
00232
00233       /* Save positions of air parcels... */
00234       lon1_old[ip] = atm1->lon[ip];
00235       lat1_old[ip] = atm1->lat[ip];
00236       z1_old[ip] = z1;
00237
00238       lon2_old[ip] = atm2->lon[ip];
00239       lat2_old[ip] = atm2->lat[ip];
00240       z2_old[ip] = z2;
00241
00242       /* Increment air parcel counter... */
00243       np++;
00244     }
00245
00246     /* Write output... */
00247     fprintf(out, "%.2f %.2f %g %g %g %g", t, t - t0,
00248             ahtd / np, rhtd / np, avtd / np, rvtd / np);
00249     for (iq = 0; iq < ctl.nq; iq++) {
00250       fprintf(out, " ");
00251       fprintf(out, ctl.qnt_format[iq], aqtd[iq] / np);
00252       fprintf(out, " ");
00253       fprintf(out, ctl.qnt_format[iq], rqtd[iq] / np);
00254     }
00255     for (iq = 0; iq < ctl.nq; iq++) {
00256       fprintf(out, " ");
00257       fprintf(out, ctl.qnt_format[iq], atce1[iq] / np);
00258       fprintf(out, " ");
00259       fprintf(out, ctl.qnt_format[iq], rtce1[iq] / np);
00260     }
00261     for (iq = 0; iq < ctl.nq; iq++) {
00262       fprintf(out, " ");
00263       fprintf(out, ctl.qnt_format[iq], atce2[iq] / np);
00264       fprintf(out, " ");
00265       fprintf(out, ctl.qnt_format[iq], rtce2[iq] / np);
00266     }
00267     fprintf(out, " %d\n", np);
00268   }
00269
00270   /* Close file... */
00271   fclose(out);
00272
00273   /* Free... */
00274   free(atm1);
00275   free(atm2);
00276   free(lon1_old);
00277   free(lat1_old);
00278   free(z1_old);
00279   free(lh1);
00280   free(lv1);
00281   free(lon2_old);
00282   free(lat2_old);
00283   free(z2_old);
00284   free(lh2);
00285   free(lv2);
00286
00287   return EXIT_SUCCESS;
00288 }
```

5.5 atm_init.c File Reference

Create atmospheric data file with initial air parcel positions.

Functions

- int main (int argc, char ∗argv[ ])

5.5.1 Detailed Description

Create atmospheric data file with initial air parcel positions.

Definition in file atm_init.c.

5.5.2 Function Documentation

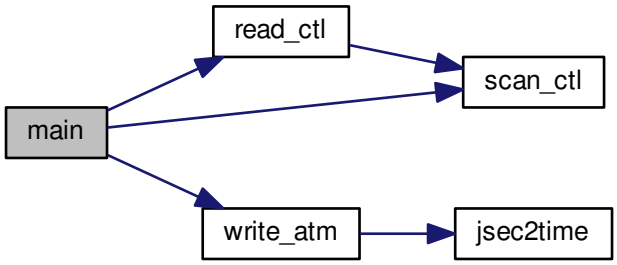
5.5.2.1 int main (int *argc*, char * *argv[]*)

Definition at line 27 of file atm_init.c.

```
00029                {
00030
00031   atm_t *atm;
00032
00033   ctl_t ctl;
00034
00035   gsl_rng *rng;
00036
00037   double dt, dz, dlon, dlat, lat0, lat1, lon0, lon1, t0, t1, z0, z1,
00038     t, z, lon, lat, st, sz, slon, slat, sx, ut, uz, ulon, ulat, m;
00039
00040   int even, ip, irep, rep;
00041
00042   /* Allocate... */
00043   ALLOC(atm, atm_t, 1);
00044
00045   /* Check arguments... */
00046   if (argc < 3)
00047     ERRMSG("Give parameters: <ctl> <atm_out>");
00048
00049   /* Read control parameters... */
00050   read_ctl(argv[1], argc, argv, &ctl);
00051   t0 = scan_ctl(argv[1], argc, argv, "INIT_T0", -1, "0", NULL);
00052   t1 = scan_ctl(argv[1], argc, argv, "INIT_T1", -1, "0", NULL);
00053   dt = scan_ctl(argv[1], argc, argv, "INIT_DT", -1, "1", NULL);
00054   z0 = scan_ctl(argv[1], argc, argv, "INIT_Z0", -1, "0", NULL);
00055   z1 = scan_ctl(argv[1], argc, argv, "INIT_Z1", -1, "0", NULL);
00056   dz = scan_ctl(argv[1], argc, argv, "INIT_DZ", -1, "1", NULL);
00057   lon0 = scan_ctl(argv[1], argc, argv, "INIT_LON0", -1, "0", NULL);
00058   lon1 = scan_ctl(argv[1], argc, argv, "INIT_LON1", -1, "0", NULL);
00059   dlon = scan_ctl(argv[1], argc, argv, "INIT_DLON", -1, "1", NULL);
00060   lat0 = scan_ctl(argv[1], argc, argv, "INIT_LAT0", -1, "0", NULL);
00061   lat1 = scan_ctl(argv[1], argc, argv, "INIT_LAT1", -1, "0", NULL);
00062   dlat = scan_ctl(argv[1], argc, argv, "INIT_DLAT", -1, "1", NULL);
00063   st = scan_ctl(argv[1], argc, argv, "INIT_ST", -1, "0", NULL);
00064   sz = scan_ctl(argv[1], argc, argv, "INIT_SZ", -1, "0", NULL);
00065   slon = scan_ctl(argv[1], argc, argv, "INIT_SLON", -1, "0", NULL);
00066   slat = scan_ctl(argv[1], argc, argv, "INIT_SLAT", -1, "0", NULL);
00067   sx = scan_ctl(argv[1], argc, argv, "INIT_SX", -1, "0", NULL);
00068   ut = scan_ctl(argv[1], argc, argv, "INIT_UT", -1, "0", NULL);
00069   uz = scan_ctl(argv[1], argc, argv, "INIT_UZ", -1, "0", NULL);
00070   ulon = scan_ctl(argv[1], argc, argv, "INIT_ULON", -1, "0", NULL);
00071   ulat = scan_ctl(argv[1], argc, argv, "INIT_ULAT", -1, "0", NULL);
00072   even = (int) scan_ctl(argv[1], argc, argv, "INIT_EVENLY", -1, "1", NULL);
00073   rep = (int) scan_ctl(argv[1], argc, argv, "INIT_REP", -1, "1", NULL);
00074   m = scan_ctl(argv[1], argc, argv, "INIT_MASS", -1, "0", NULL);
00075
00076   /* Initialize random number generator... */
00077   gsl_rng_env_setup();
00078   rng = gsl_rng_alloc(gsl_rng_default);
00079
00080   /* Create grid... */
00081   for (t = t0; t <= t1; t += dt)
00082     for (z = z0; z <= z1; z += dz)
00083       for (lon = lon0; lon <= lon1; lon += dlon)
00084         for (lat = lat0; lat <= lat1; lat += dlat)
00085           for (irep = 0; irep < rep; irep++) {
00086
00087             /* Set position... */
00088             atm->time[atm->np]
00089               = (t + gsl_ran_gaussian_ziggurat(rng, st / 2.3548)
00090                  + ut * (gsl_rng_uniform(rng) - 0.5));
00091             atm->p[atm->np]
00092               = P(z + gsl_ran_gaussian_ziggurat(rng, sz / 2.3548)
00093                   + uz * (gsl_rng_uniform(rng) - 0.5));
00094             atm->lon[atm->np]
00095               = (lon + gsl_ran_gaussian_ziggurat(rng, slon / 2.3548)
00096                  + gsl_ran_gaussian_ziggurat(rng, DX2DEG(sx, lat) / 2.3548)
00097                  + ulon * (gsl_rng_uniform(rng) - 0.5));
00098             do {
00099               atm->lat[atm->np]
00100                 = (lat + gsl_ran_gaussian_ziggurat(rng, slat / 2.3548)
00101                    + gsl_ran_gaussian_ziggurat(rng, DY2DEG(sx) / 2.3548)
00102                    + ulat * (gsl_rng_uniform(rng) - 0.5));
00103             } while (even && gsl_rng_uniform(rng) >
00104                      fabs(cos(atm->lat[atm->np] * M_PI / 180.)));
```

```
00105
00106             /* Set particle counter... */
00107             if ((++atm->np) >= NP)
00108               ERRMSG("Too many particles!");
00109           }
00110
00111   /* Check number of air parcels... */
00112   if (atm->np <= 0)
00113     ERRMSG("Did not create any air parcels!");
00114
00115   /* Initialize mass... */
00116   if (ctl.qnt_m >= 0)
00117     for (ip = 0; ip < atm->np; ip++)
00118       atm->q[ctl.qnt_m][ip] = m / atm->np;
00119
00120   /* Save data... */
00121   write_atm(argv[2], &ctl, atm, t0);
00122
00123   /* Free... */
00124   gsl_rng_free(rng);
00125   free(atm);
00126
00127   return EXIT_SUCCESS;
00128 }
```

Here is the call graph for this function:



5.6 atm_init.c

```
00001 /*
00002   This file is part of MPTRAC.
00003
00004   MPTRAC is free software: you can redistribute it and/or modify
00005   it under the terms of the GNU General Public License as published by
00006   the Free Software Foundation, either version 3 of the License, or
00007   (at your option) any later version.
00008
00009   MPTRAC is distributed in the hope that it will be useful,
00010   but WITHOUT ANY WARRANTY; without even the implied warranty of
00011   MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
00012   GNU General Public License for more details.
00013
00014   You should have received a copy of the GNU General Public License
00015   along with MPTRAC. If not, see <http://www.gnu.org/licenses/>.
00016
00017   Copyright (C) 2013-2019 Forschungszentrum Juelich GmbH
00018 */
00019
00025 #include "libtrac.h"
00026
00027 int main(
00028   int argc,
00029   char *argv[]) {
00030
00031   atm_t *atm;
00032
```

```
00033   ctl_t ctl;
00034
00035   gsl_rng *rng;
00036
00037   double dt, dz, dlon, dlat, lat0, lat1, lon0, lon1, t0, t1, z0, z1,
00038     t, z, lon, lat, st, sz, slon, slat, sx, ut, uz, ulon, ulat, m;
00039
00040   int even, ip, irep, rep;
00041
00042   /* Allocate... */
00043   ALLOC(atm, atm_t, 1);
00044
00045   /* Check arguments... */
00046   if (argc < 3)
00047     ERRMSG("Give parameters: <ctl> <atm_out>");
00048
00049   /* Read control parameters... */
00050   read_ctl(argv[1], argc, argv, &ctl);
00051   t0 = scan_ctl(argv[1], argc, argv, "INIT_T0", -1, "0", NULL);
00052   t1 = scan_ctl(argv[1], argc, argv, "INIT_T1", -1, "0", NULL);
00053   dt = scan_ctl(argv[1], argc, argv, "INIT_DT", -1, "1", NULL);
00054   z0 = scan_ctl(argv[1], argc, argv, "INIT_Z0", -1, "0", NULL);
00055   z1 = scan_ctl(argv[1], argc, argv, "INIT_Z1", -1, "0", NULL);
00056   dz = scan_ctl(argv[1], argc, argv, "INIT_DZ", -1, "1", NULL);
00057   lon0 = scan_ctl(argv[1], argc, argv, "INIT_LON0", -1, "0", NULL);
00058   lon1 = scan_ctl(argv[1], argc, argv, "INIT_LON1", -1, "0", NULL);
00059   dlon = scan_ctl(argv[1], argc, argv, "INIT_DLON", -1, "1", NULL);
00060   lat0 = scan_ctl(argv[1], argc, argv, "INIT_LAT0", -1, "0", NULL);
00061   lat1 = scan_ctl(argv[1], argc, argv, "INIT_LAT1", -1, "0", NULL);
00062   dlat = scan_ctl(argv[1], argc, argv, "INIT_DLAT", -1, "1", NULL);
00063   st = scan_ctl(argv[1], argc, argv, "INIT_ST", -1, "0", NULL);
00064   sz = scan_ctl(argv[1], argc, argv, "INIT_SZ", -1, "0", NULL);
00065   slon = scan_ctl(argv[1], argc, argv, "INIT_SLON", -1, "0", NULL);
00066   slat = scan_ctl(argv[1], argc, argv, "INIT_SLAT", -1, "0", NULL);
00067   sx = scan_ctl(argv[1], argc, argv, "INIT_SX", -1, "0", NULL);
00068   ut = scan_ctl(argv[1], argc, argv, "INIT_UT", -1, "0", NULL);
00069   uz = scan_ctl(argv[1], argc, argv, "INIT_UZ", -1, "0", NULL);
00070   ulon = scan_ctl(argv[1], argc, argv, "INIT_ULON", -1, "0", NULL);
00071   ulat = scan_ctl(argv[1], argc, argv, "INIT_ULAT", -1, "0", NULL);
00072   even = (int) scan_ctl(argv[1], argc, argv, "INIT_EVENLY", -1, "1", NULL);
00073   rep = (int) scan_ctl(argv[1], argc, argv, "INIT_REP", -1, "1", NULL);
00074   m = scan_ctl(argv[1], argc, argv, "INIT_MASS", -1, "0", NULL);
00075
00076   /* Initialize random number generator... */
00077   gsl_rng_env_setup();
00078   rng = gsl_rng_alloc(gsl_rng_default);
00079
00080   /* Create grid... */
00081   for (t = t0; t <= t1; t += dt)
00082     for (z = z0; z <= z1; z += dz)
00083       for (lon = lon0; lon <= lon1; lon += dlon)
00084         for (lat = lat0; lat <= lat1; lat += dlat)
00085           for (irep = 0; irep < rep; irep++) {
00086
00087             /* Set position... */
00088             atm->time[atm->np]
00089               = (t + gsl_ran_gaussian_ziggurat(rng, st / 2.3548)
00090                  + ut * (gsl_rng_uniform(rng) - 0.5));
00091             atm->p[atm->np]
00092               = P(z + gsl_ran_gaussian_ziggurat(rng, sz / 2.3548)
00093                   + uz * (gsl_rng_uniform(rng) - 0.5));
00094             atm->lon[atm->np]
00095               = (lon + gsl_ran_gaussian_ziggurat(rng, slon / 2.3548)
00096                  + gsl_ran_gaussian_ziggurat(rng, DX2DEG(sx, lat) / 2.3548)
00097                  + ulon * (gsl_rng_uniform(rng) - 0.5));
00098             do {
00099               atm->lat[atm->np]
00100                 = (lat + gsl_ran_gaussian_ziggurat(rng, slat / 2.3548)
00101                    + gsl_ran_gaussian_ziggurat(rng, DY2DEG(sx) / 2.3548)
00102                    + ulat * (gsl_rng_uniform(rng) - 0.5));
00103             } while (even && gsl_rng_uniform(rng) >
00104                      fabs(cos(atm->lat[atm->np] * M_PI / 180.)));
00105
00106             /* Set particle counter... */
00107             if ((++atm->np) >= NP)
00108               ERRMSG("Too many particles!");
00109           }
00110
00111   /* Check number of air parcels... */
00112   if (atm->np <= 0)
00113     ERRMSG("Did not create any air parcels!");
00114
00115   /* Initialize mass... */
00116   if (ctl.qnt_m >= 0)
00117     for (ip = 0; ip < atm->np; ip++)
00118       atm->q[ctl.qnt_m][ip] = m / atm->np;
00119
```

```
00120   /* Save data... */
00121   write_atm(argv[2], &ctl, atm, t0);
00122
00123   /* Free... */
00124   gsl_rng_free(rng);
00125   free(atm);
00126
00127   return EXIT_SUCCESS;
00128 }
```

5.7 atm_split.c File Reference

Split air parcels into a larger number of parcels.

Functions

- int main (int argc, char ∗argv[ ])

5.7.1 Detailed Description

Split air parcels into a larger number of parcels.

Definition in file atm_split.c.

5.7.2 Function Documentation

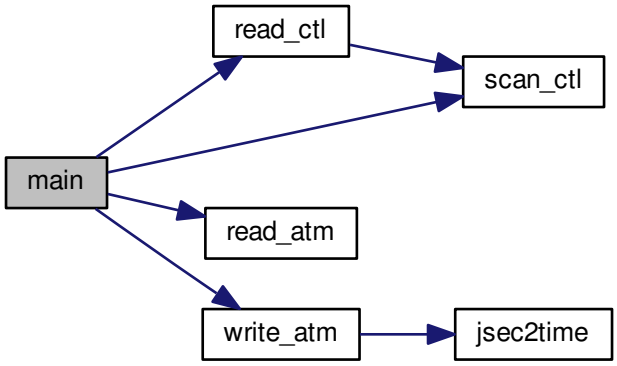
5.7.2.1 int main (int *argc,* char ∗ *argv[ ]*)

Definition at line 27 of file atm_split.c.

```
00029                {
00030
00031   atm_t *atm, *atm2;
00032
00033   ctl_t ctl;
00034
00035   gsl_rng *rng;
00036
00037   double m, mtot = 0, dt, dx, dz, mmax = 0,
00038     t0, t1, z0, z1, lon0, lon1, lat0, lat1;
00039
00040   int i, ip, iq, n;
00041
00042   /* Allocate... */
00043   ALLOC(atm, atm_t, 1);
00044   ALLOC(atm2, atm_t, 1);
00045
00046   /* Check arguments... */
00047   if (argc < 4)
00048     ERRMSG("Give parameters: <ctl> <atm_in> <atm_out>");
00049
00050   /* Read control parameters... */
00051   read_ctl(argv[1], argc, argv, &ctl);
00052   n = (int) scan_ctl(argv[1], argc, argv, "SPLIT_N", -1, "", NULL);
00053   m = scan_ctl(argv[1], argc, argv, "SPLIT_M", -1, "-999", NULL);
00054   dt = scan_ctl(argv[1], argc, argv, "SPLIT_DT", -1, "0", NULL);
00055   t0 = scan_ctl(argv[1], argc, argv, "SPLIT_T0", -1, "0", NULL);
00056   t1 = scan_ctl(argv[1], argc, argv, "SPLIT_T1", -1, "0", NULL);
00057   dz = scan_ctl(argv[1], argc, argv, "SPLIT_DZ", -1, "0", NULL);
00058   z0 = scan_ctl(argv[1], argc, argv, "SPLIT_Z0", -1, "0", NULL);
00059   z1 = scan_ctl(argv[1], argc, argv, "SPLIT_Z1", -1, "0", NULL);
00060   dx = scan_ctl(argv[1], argc, argv, "SPLIT_DX", -1, "0", NULL);
00061   lon0 = scan_ctl(argv[1], argc, argv, "SPLIT_LON0", -1, "0", NULL);
00062   lon1 = scan_ctl(argv[1], argc, argv, "SPLIT_LON1", -1, "0", NULL);
00063   lat0 = scan_ctl(argv[1], argc, argv, "SPLIT_LAT0", -1, "0", NULL);
```

```
00064   lat1 = scan_ctl(argv[1], argc, argv, "SPLIT_LAT1", -1, "0", NULL);
00065
00066   /* Init random number generator... */
00067   gsl_rng_env_setup();
00068   rng = gsl_rng_alloc(gsl_rng_default);
00069
00070   /* Read atmospheric data... */
00071   read_atm(argv[2], &ctl, atm);
00072
00073   /* Get total and maximum mass... */
00074   if (ctl.qnt_m >= 0)
00075     for (ip = 0; ip < atm->np; ip++) {
00076       mtot += atm->q[ctl.qnt_m][ip];
00077       mmax = GSL_MAX(mmax, atm->q[ctl.qnt_m][ip]);
00078     }
00079   if (m > 0)
00080     mtot = m;
00081
00082   /* Loop over air parcels... */
00083   for (i = 0; i < n; i++) {
00084
00085     /* Select air parcel... */
00086     if (ctl.qnt_m >= 0)
00087       do {
00088         ip = (int) gsl_rng_uniform_int(rng, (long unsigned int) atm->np);
00089       } while (gsl_rng_uniform(rng) > atm->q[ctl.qnt_m][ip] / mmax);
00090     else
00091       ip = (int) gsl_rng_uniform_int(rng, (long unsigned int) atm->np);
00092
00093     /* Set time... */
00094     if (t1 > t0)
00095       atm2->time[atm2->np] = t0 + (t1 - t0) * gsl_rng_uniform_pos(rng);
00096     else
00097       atm2->time[atm2->np] = atm->time[ip]
00098         + gsl_ran_gaussian_ziggurat(rng, dt / 2.3548);
00099
00100    /* Set vertical position... */
00101    if (z1 > z0)
00102      atm2->p[atm2->np] = P(z0 + (z1 - z0) * gsl_rng_uniform_pos(rng));
00103    else
00104      atm2->p[atm2->np] = atm->p[ip]
00105        + DZ2DP(gsl_ran_gaussian_ziggurat(rng, dz / 2.3548), atm->p[ip]);
00106
00107    /* Set horizontal position... */
00108    if (lon1 > lon0 && lat1 > lat0) {
00109      atm2->lon[atm2->np] = lon0 + (lon1 - lon0) * gsl_rng_uniform_pos(rng);
00110      atm2->lat[atm2->np] = lat0 + (lat1 - lat0) * gsl_rng_uniform_pos(rng);
00111    } else {
00112      atm2->lon[atm2->np] = atm->lon[ip]
00113        + gsl_ran_gaussian_ziggurat(rng, DX2DEG(dx, atm->lat[ip]) / 2.3548);
00114      atm2->lat[atm2->np] = atm->lat[ip]
00115        + gsl_ran_gaussian_ziggurat(rng, DY2DEG(dx) / 2.3548);
00116    }
00117
00118    /* Copy quantities... */
00119    for (iq = 0; iq < ctl.nq; iq++)
00120      atm2->q[iq][atm2->np] = atm->q[iq][ip];
00121
00122    /* Adjust mass... */
00123    if (ctl.qnt_m >= 0)
00124      atm2->q[ctl.qnt_m][atm2->np] = mtot / n;
00125
00126    /* Increment particle counter... */
00127    if ((++atm2->np) >= NP)
00128      ERRMSG("Too many air parcels!");
00129  }
00130
00131  /* Save data and close file... */
00132  write_atm(argv[3], &ctl, atm2, atm->time[0]);
00133
00134  /* Free... */
00135  free(atm);
00136  free(atm2);
00137
00138  return EXIT_SUCCESS;
00139 }
```

Here is the call graph for this function:



5.8 atm_split.c

```
00001 /*
00002   This file is part of MPTRAC.
00003
00004   MPTRAC is free software: you can redistribute it and/or modify
00005   it under the terms of the GNU General Public License as published by
00006   the Free Software Foundation, either version 3 of the License, or
00007   (at your option) any later version.
00008
00009   MPTRAC is distributed in the hope that it will be useful,
00010   but WITHOUT ANY WARRANTY; without even the implied warranty of
00011   MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
00012   GNU General Public License for more details.
00013
00014   You should have received a copy of the GNU General Public License
00015   along with MPTRAC. If not, see <http://www.gnu.org/licenses/>.
00016
00017   Copyright (C) 2013-2019 Forschungszentrum Juelich GmbH
00018 */
00019
00025 #include "libtrac.h"
00026
00027 int main(
00028   int argc,
00029   char *argv[]) {
00030
00031   atm_t *atm, *atm2;
00032
00033   ctl_t ctl;
00034
00035   gsl_rng *rng;
00036
00037   double m, mtot = 0, dt, dx, dz, mmax = 0,
00038     t0, t1, z0, z1, lon0, lon1, lat0, lat1;
00039
00040   int i, ip, iq, n;
00041
00042   /* Allocate... */
00043   ALLOC(atm, atm_t, 1);
00044   ALLOC(atm2, atm_t, 1);
00045
00046   /* Check arguments... */
00047   if (argc < 4)
00048     ERRMSG("Give parameters: <ctl> <atm_in> <atm_out>");
00049
00050   /* Read control parameters... */
00051   read_ctl(argv[1], argc, argv, &ctl);
00052   n = (int) scan_ctl(argv[1], argc, argv, "SPLIT_N", -1, "", NULL);
00053   m = scan_ctl(argv[1], argc, argv, "SPLIT_M", -1, "-999", NULL);
00054   dt = scan_ctl(argv[1], argc, argv, "SPLIT_DT", -1, "0", NULL);
```

```
00055   t0 = scan_ctl(argv[1], argc, argv, "SPLIT_T0", -1, "0", NULL);
00056   t1 = scan_ctl(argv[1], argc, argv, "SPLIT_T1", -1, "0", NULL);
00057   dz = scan_ctl(argv[1], argc, argv, "SPLIT_DZ", -1, "0", NULL);
00058   z0 = scan_ctl(argv[1], argc, argv, "SPLIT_Z0", -1, "0", NULL);
00059   z1 = scan_ctl(argv[1], argc, argv, "SPLIT_Z1", -1, "0", NULL);
00060   dx = scan_ctl(argv[1], argc, argv, "SPLIT_DX", -1, "0", NULL);
00061   lon0 = scan_ctl(argv[1], argc, argv, "SPLIT_LON0", -1, "0", NULL);
00062   lon1 = scan_ctl(argv[1], argc, argv, "SPLIT_LON1", -1, "0", NULL);
00063   lat0 = scan_ctl(argv[1], argc, argv, "SPLIT_LAT0", -1, "0", NULL);
00064   lat1 = scan_ctl(argv[1], argc, argv, "SPLIT_LAT1", -1, "0", NULL);
00065
00066   /* Init random number generator... */
00067   gsl_rng_env_setup();
00068   rng = gsl_rng_alloc(gsl_rng_default);
00069
00070   /* Read atmospheric data... */
00071   read_atm(argv[2], &ctl, atm);
00072
00073   /* Get total and maximum mass... */
00074   if (ctl.qnt_m >= 0)
00075     for (ip = 0; ip < atm->np; ip++) {
00076       mtot += atm->q[ctl.qnt_m][ip];
00077       mmax = GSL_MAX(mmax, atm->q[ctl.qnt_m][ip]);
00078     }
00079   if (m > 0)
00080     mtot = m;
00081
00082   /* Loop over air parcels... */
00083   for (i = 0; i < n; i++) {
00084
00085     /* Select air parcel... */
00086     if (ctl.qnt_m >= 0)
00087       do {
00088         ip = (int) gsl_rng_uniform_int(rng, (long unsigned int) atm->np);
00089       } while (gsl_rng_uniform(rng) > atm->q[ctl.qnt_m][ip] / mmax);
00090     else
00091       ip = (int) gsl_rng_uniform_int(rng, (long unsigned int) atm->np);
00092
00093     /* Set time... */
00094     if (t1 > t0)
00095       atm2->time[atm2->np] = t0 + (t1 - t0) * gsl_rng_uniform_pos(rng);
00096     else
00097       atm2->time[atm2->np] = atm->time[ip]
00098         + gsl_ran_gaussian_ziggurat(rng, dt / 2.3548);
00099
00100    /* Set vertical position... */
00101    if (z1 > z0)
00102      atm2->p[atm2->np] = P(z0 + (z1 - z0) * gsl_rng_uniform_pos(rng));
00103    else
00104      atm2->p[atm2->np] = atm->p[ip]
00105        + DZ2DP(gsl_ran_gaussian_ziggurat(rng, dz / 2.3548), atm->p[ip]);
00106
00107    /* Set horizontal position... */
00108    if (lon1 > lon0 && lat1 > lat0) {
00109      atm2->lon[atm2->np] = lon0 + (lon1 - lon0) * gsl_rng_uniform_pos(rng);
00110      atm2->lat[atm2->np] = lat0 + (lat1 - lat0) * gsl_rng_uniform_pos(rng);
00111    } else {
00112      atm2->lon[atm2->np] = atm->lon[ip]
00113        + gsl_ran_gaussian_ziggurat(rng, DX2DEG(dx, atm->lat[ip]) / 2.3548);
00114      atm2->lat[atm2->np] = atm->lat[ip]
00115        + gsl_ran_gaussian_ziggurat(rng, DY2DEG(dx) / 2.3548);
00116    }
00117
00118    /* Copy quantities... */
00119    for (iq = 0; iq < ctl.nq; iq++)
00120      atm2->q[iq][atm2->np] = atm->q[iq][ip];
00121
00122    /* Adjust mass... */
00123    if (ctl.qnt_m >= 0)
00124      atm2->q[ctl.qnt_m][atm2->np] = mtot / n;
00125
00126    /* Increment particle counter... */
00127    if ((++atm2->np) >= NP)
00128      ERRMSG("Too many air parcels!");
00129  }
00130
00131  /* Save data and close file... */
00132  write_atm(argv[3], &ctl, atm2, atm->time[0]);
00133
00134  /* Free... */
00135  free(atm);
00136  free(atm2);
00137
00138  return EXIT_SUCCESS;
00139 }
```

5.9 atm_stat.c File Reference

Calculate air parcel statistics.

Functions

- int main (int argc, char ∗argv[ ])

5.9.1 Detailed Description

Calculate air parcel statistics.

Definition in file atm_stat.c.

5.9.2 Function Documentation

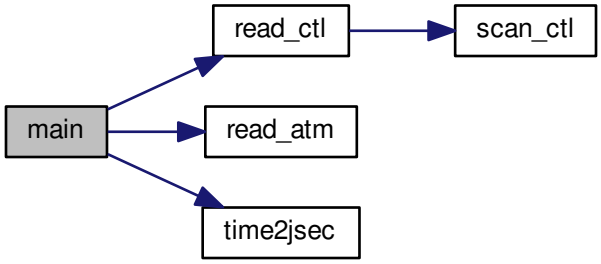
5.9.2.1 int main (int *argc,* char ∗ *argv[ ]*)

Definition at line 27 of file atm_stat.c.

```
00029                {
00030
00031   ctl_t ctl;
00032
00033   atm_t *atm;
00034
00035   FILE *out;
00036
00037   char tstr[LEN];
00038
00039   double latm, lats, lonm, lons, t, zm, zs;
00040
00041   int f, ip, year, mon, day, hour, min;
00042
00043   /* Allocate... */
00044   ALLOC(atm, atm_t, 1);
00045
00046   /* Check arguments... */
00047   if (argc < 4)
00048     ERRMSG("Give parameters: <ctl> <outfile> <atm1> [<atm2> ...]");
00049
00050   /* Read control parameters... */
00051   read_ctl(argv[1], argc, argv, &ctl);
00052
00053   /* Write info... */
00054   printf("Write center of mass data: %s\n", argv[2]);
00055
00056   /* Create output file... */
00057   if (!(out = fopen(argv[2], "w")))
00058     ERRMSG("Cannot create file!");
00059
00060   /* Write header... */
00061   fprintf(out,
00062           "# $1  = time [s]\n"
00063           "# $2  = altitude (mean) [km]\n"
00064           "# $3  = altitude (sigma) [km]\n"
00065           "# $4  = altitude (minimum) [km]\n"
00066           "# $5  = altitude (10%% percentile) [km]\n"
00067           "# $6  = altitude (1st quarter) [km]\n"
00068           "# $7  = altitude (median) [km]\n"
00069           "# $8  = altitude (3rd quarter) [km]\n"
00070           "# $9  = altitude (90%% percentile) [km]\n"
00071           "# $10 = altitude (maximum) [km]\n");
00072   fprintf(out,
00073           "# $11 = longitude (mean) [deg]\n"
00074           "# $12 = longitude (sigma) [deg]\n"
00075           "# $13 = longitude (minimum) [deg]\n"
00076           "# $14 = longitude (10%% percentile) [deg]\n"
```

```
          "# $15 = longitude (1st quarter) [deg]\n"
          "# $16 = longitude (median) [deg]\n"
          "# $17 = longitude (3rd quarter) [deg]\n"
          "# $18 = longitude (90%% percentile) [deg]\n"
          "# $19 = longitude (maximum) [deg]\n");
  fprintf(out,
          "# $20 = latitude (mean) [deg]\n"
          "# $21 = latitude (sigma) [deg]\n"
          "# $22 = latitude (minimum) [deg]\n"
          "# $23 = latitude (10%% percentile) [deg]\n"
          "# $24 = latitude (1st quarter) [deg]\n"
          "# $25 = latitude (median) [deg]\n"
          "# $26 = latitude (3rd quarter) [deg]\n"
          "# $27 = latitude (90%% percentile) [deg]\n"
          "# $28 = latitude (maximum) [deg]\n\n");

  /* Loop over files... */
  for (f = 3; f < argc; f++) {

    /* Read atmopheric data... */
    read_atm(argv[f], &ctl, atm);

    /* Initialize... */
    zm = zs = 0;
    lonm = lons = 0;
    latm = lats = 0;

    /* Calculate mean and standard deviation... */
    for (ip = 0; ip < atm->np; ip++) {
      zm += Z(atm->p[ip]) / atm->np;
      lonm += atm->lon[ip] / atm->np;
      latm += atm->lat[ip] / atm->np;
      zs += SQR(Z(atm->p[ip])) / atm->np;
      lons += SQR(atm->lon[ip]) / atm->np;
      lats += SQR(atm->lat[ip]) / atm->np;
    }

    /* Normalize... */
    zs = sqrt(zs - SQR(zm));
    lons = sqrt(lons - SQR(lonm));
    lats = sqrt(lats - SQR(latm));

    /* Sort arrays... */
    gsl_sort(atm->p, 1, (size_t) atm->np);
    gsl_sort(atm->lon, 1, (size_t) atm->np);
    gsl_sort(atm->lat, 1, (size_t) atm->np);

    /* Get time from filename... */
    sprintf(tstr, "%.4s", &argv[f][strlen(argv[f]) - 20]);
    year = atoi(tstr);
    sprintf(tstr, "%.2s", &argv[f][strlen(argv[f]) - 15]);
    mon = atoi(tstr);
    sprintf(tstr, "%.2s", &argv[f][strlen(argv[f]) - 12]);
    day = atoi(tstr);
    sprintf(tstr, "%.2s", &argv[f][strlen(argv[f]) - 9]);
    hour = atoi(tstr);
    sprintf(tstr, "%.2s", &argv[f][strlen(argv[f]) - 6]);
    min = atoi(tstr);
    time2jsec(year, mon, day, hour, min, 0, 0, &t);

    /* Write data... */
    fprintf(out, "%.2f %g %g %g %g %g %g %g %g %g "
            "%g %g %g %g %g %g %g %g %g %g %g %g %g %g %g %g %g %g\n",
            t, zm, zs, Z(atm->p[atm->np - 1]),
            Z(atm->p[atm->np - atm->np / 10]),
            Z(atm->p[atm->np - atm->np / 4]),
            Z(atm->p[atm->np / 2]), Z(atm->p[atm->np / 4]),
            Z(atm->p[atm->np / 10]), Z(atm->p[0]),
            lonm, lons, atm->lon[0], atm->lon[atm->np / 10],
            atm->lon[atm->np / 4], atm->lon[atm->np / 2],
            atm->lon[atm->np - atm->np / 4],
            atm->lon[atm->np - atm->np / 10],
            atm->lon[atm->np - 1],
            latm, lats, atm->lat[0], atm->lat[atm->np / 10],
            atm->lat[atm->np / 4], atm->lat[atm->np / 2],
            atm->lat[atm->np - atm->np / 4],
            atm->lat[atm->np - atm->np / 10], atm->lat[atm->np - 1]);
  }

  /* Close file... */
  fclose(out);

  /* Free... */
  free(atm);

  return EXIT_SUCCESS;
}
```

Here is the call graph for this function:



5.10 atm_stat.c

```
00001 /*
00002   This file is part of MPTRAC.
00003
00004   MPTRAC is free software: you can redistribute it and/or modify
00005   it under the terms of the GNU General Public License as published by
00006   the Free Software Foundation, either version 3 of the License, or
00007   (at your option) any later version.
00008
00009   MPTRAC is distributed in the hope that it will be useful,
00010   but WITHOUT ANY WARRANTY; without even the implied warranty of
00011   MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
00012   GNU General Public License for more details.
00013
00014   You should have received a copy of the GNU General Public License
00015   along with MPTRAC. If not, see <http://www.gnu.org/licenses/>.
00016
00017   Copyright (C) 2013-2019 Forschungszentrum Juelich GmbH
00018 */
00019
00025 #include "libtrac.h"
00026
00027 int main(
00028   int argc,
00029   char *argv[]) {
00030
00031   ctl_t ctl;
00032
00033   atm_t *atm;
00034
00035   FILE *out;
00036
00037   char tstr[LEN];
00038
00039   double latm, lats, lonm, lons, t, zm, zs;
00040
00041   int f, ip, year, mon, day, hour, min;
00042
00043   /* Allocate... */
00044   ALLOC(atm, atm_t, 1);
00045
00046   /* Check arguments... */
00047   if (argc < 4)
00048     ERRMSG("Give parameters: <ctl> <outfile> <atm1> [<atm2> ...]");
00049
00050   /* Read control parameters... */
00051   read_ctl(argv[1], argc, argv, &ctl);
00052
00053   /* Write info... */
00054   printf("Write center of mass data: %s\n", argv[2]);
00055
00056   /* Create output file... */
00057   if (!(out = fopen(argv[2], "w")))
00058     ERRMSG("Cannot create file!");
00059
```

```
  /* Write header... */
  fprintf(out,
          "# $1  = time [s]\n"
          "# $2  = altitude (mean) [km]\n"
          "# $3  = altitude (sigma) [km]\n"
          "# $4  = altitude (minimum) [km]\n"
          "# $5  = altitude (10%% percentile) [km]\n"
          "# $6  = altitude (1st quarter) [km]\n"
          "# $7  = altitude (median) [km]\n"
          "# $8  = altitude (3rd quarter) [km]\n"
          "# $9  = altitude (90%% percentile) [km]\n"
          "# $10 = altitude (maximum) [km]\n");
  fprintf(out,
          "# $11 = longitude (mean) [deg]\n"
          "# $12 = longitude (sigma) [deg]\n"
          "# $13 = longitude (minimum) [deg]\n"
          "# $14 = longitude (10%% percentile) [deg]\n"
          "# $15 = longitude (1st quarter) [deg]\n"
          "# $16 = longitude (median) [deg]\n"
          "# $17 = longitude (3rd quarter) [deg]\n"
          "# $18 = longitude (90%% percentile) [deg]\n"
          "# $19 = longitude (maximum) [deg]\n");
  fprintf(out,
          "# $20 = latitude (mean) [deg]\n"
          "# $21 = latitude (sigma) [deg]\n"
          "# $22 = latitude (minimum) [deg]\n"
          "# $23 = latitude (10%% percentile) [deg]\n"
          "# $24 = latitude (1st quarter) [deg]\n"
          "# $25 = latitude (median) [deg]\n"
          "# $26 = latitude (3rd quarter) [deg]\n"
          "# $27 = latitude (90%% percentile) [deg]\n"
          "# $28 = latitude (maximum) [deg]\n\n");

  /* Loop over files... */
  for (f = 3; f < argc; f++) {

    /* Read atmopheric data... */
    read_atm(argv[f], &ctl, atm);

    /* Initialize... */
    zm = zs = 0;
    lonm = lons = 0;
    latm = lats = 0;

    /* Calculate mean and standard deviation... */
    for (ip = 0; ip < atm->np; ip++) {
      zm += Z(atm->p[ip]) / atm->np;
      lonm += atm->lon[ip] / atm->np;
      latm += atm->lat[ip] / atm->np;
      zs += SQR(Z(atm->p[ip])) / atm->np;
      lons += SQR(atm->lon[ip]) / atm->np;
      lats += SQR(atm->lat[ip]) / atm->np;
    }

    /* Normalize... */
    zs = sqrt(zs - SQR(zm));
    lons = sqrt(lons - SQR(lonm));
    lats = sqrt(lats - SQR(latm));

    /* Sort arrays... */
    gsl_sort(atm->p, 1, (size_t) atm->np);
    gsl_sort(atm->lon, 1, (size_t) atm->np);
    gsl_sort(atm->lat, 1, (size_t) atm->np);

    /* Get time from filename... */
    sprintf(tstr, "%.4s", &argv[f][strlen(argv[f]) - 20]);
    year = atoi(tstr);
    sprintf(tstr, "%.2s", &argv[f][strlen(argv[f]) - 15]);
    mon = atoi(tstr);
    sprintf(tstr, "%.2s", &argv[f][strlen(argv[f]) - 12]);
    day = atoi(tstr);
    sprintf(tstr, "%.2s", &argv[f][strlen(argv[f]) - 9]);
    hour = atoi(tstr);
    sprintf(tstr, "%.2s", &argv[f][strlen(argv[f]) - 6]);
    min = atoi(tstr);
    time2jsec(year, mon, day, hour, min, 0, 0, &t);

    /* Write data... */
    fprintf(out, "%.2f %g %g %g %g %g %g %g %g %g "
            "%g %g %g %g %g %g %g %g %g %g %g %g %g %g %g %g %g %g\n",
            t, zm, zs, Z(atm->p[atm->np - 1]),
            Z(atm->p[atm->np - atm->np / 10]),
            Z(atm->p[atm->np - atm->np / 4]),
            Z(atm->p[atm->np / 2]), Z(atm->p[atm->np / 4]),
            Z(atm->p[atm->np / 10]), Z(atm->p[0]),
            lonm, lons, atm->lon[0], atm->lon[atm->np / 10],
            atm->lon[atm->np / 4], atm->lon[atm->np / 2],
```

```
00147             atm->lon[atm->np - atm->np / 4],
00148             atm->lon[atm->np - atm->np / 10],
00149             atm->lon[atm->np - 1],
00150             latm, lats, atm->lat[0], atm->lat[atm->np / 10],
00151             atm->lat[atm->np / 4], atm->lat[atm->np / 2],
00152             atm->lat[atm->np - atm->np / 4],
00153             atm->lat[atm->np - atm->np / 10], atm->lat[atm->np - 1]);
00154   }
00155
00156   /* Close file... */
00157   fclose(out);
00158
00159   /* Free... */
00160   free(atm);
00161
00162   return EXIT_SUCCESS;
00163 }
```

5.11 day2doy.c File Reference

Convert date to day of year.

Functions

- int main (int argc, char ∗argv[ ])

5.11.1 Detailed Description

Convert date to day of year.

Definition in file day2doy.c.

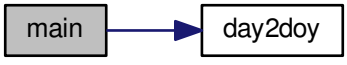
5.11.2 Function Documentation

5.11.2.1 int main (int *argc*, char ∗ *argv[ ]*)

Definition at line 27 of file day2doy.c.

```
00029                 {
00030
00031   int day, doy, mon, year;
00032
00033   /* Check arguments... */
00034   if (argc < 4)
00035     ERRMSG("Give parameters: <year> <mon> <day>");
00036
00037   /* Read arguments... */
00038   year = atoi(argv[1]);
00039   mon = atoi(argv[2]);
00040   day = atoi(argv[3]);
00041
00042   /* Convert... */
00043   day2doy(year, mon, day, &doy);
00044   printf("%d %d\n", year, doy);
00045
00046   return EXIT_SUCCESS;
00047 }
```

Here is the call graph for this function:



5.12 day2doy.c

```
00001 /*
00002   This file is part of MPTRAC.
00003
00004   MPTRAC is free software: you can redistribute it and/or modify
00005   it under the terms of the GNU General Public License as published by
00006   the Free Software Foundation, either version 3 of the License, or
00007   (at your option) any later version.
00008
00009   MPTRAC is distributed in the hope that it will be useful,
00010   but WITHOUT ANY WARRANTY; without even the implied warranty of
00011   MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
00012   GNU General Public License for more details.
00013
00014   You should have received a copy of the GNU General Public License
00015   along with MPTRAC. If not, see <http://www.gnu.org/licenses/>.
00016
00017   Copyright (C) 2013-2019 Forschungszentrum Juelich GmbH
00018 */
00019
00025 #include "libtrac.h"
00026
00027 int main(
00028   int argc,
00029   char *argv[]) {
00030
00031   int day, doy, mon, year;
00032
00033   /* Check arguments... */
00034   if (argc < 4)
00035     ERRMSG("Give parameters: <year> <mon> <day>");
00036
00037   /* Read arguments... */
00038   year = atoi(argv[1]);
00039   mon = atoi(argv[2]);
00040   day = atoi(argv[3]);
00041
00042   /* Convert... */
00043   day2doy(year, mon, day, &doy);
00044   printf("%d %d\n", year, doy);
00045
00046   return EXIT_SUCCESS;
00047 }
```

5.13 doy2day.c File Reference

Convert day of year to date.

Functions

- int main (int argc, char *argv[])

5.13.1 Detailed Description

Convert day of year to date.

Definition in file doy2day.c.

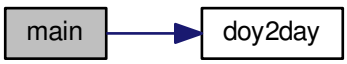
5.13.2 Function Documentation

5.13.2.1 int main (int *argc*, char * *argv[]*)

Definition at line 27 of file doy2day.c.

```
00029                {
00030
00031   int day, doy, mon, year;
00032
00033   /* Check arguments... */
00034   if (argc < 3)
00035     ERRMSG("Give parameters: <year> <doy>");
00036
00037   /* Read arguments... */
00038   year = atoi(argv[1]);
00039   doy = atoi(argv[2]);
00040
00041   /* Convert... */
00042   doy2day(year, doy, &mon, &day);
00043   printf("%d %d %d\n", year, mon, day);
00044
00045   return EXIT_SUCCESS;
00046 }
```

Here is the call graph for this function:



5.14 doy2day.c

```
00001 /*
00002   This file is part of MPTRAC.
00003
00004   MPTRAC is free software: you can redistribute it and/or modify
00005   it under the terms of the GNU General Public License as published by
00006   the Free Software Foundation, either version 3 of the License, or
00007   (at your option) any later version.
00008
00009   MPTRAC is distributed in the hope that it will be useful,
00010   but WITHOUT ANY WARRANTY; without even the implied warranty of
00011   MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
00012   GNU General Public License for more details.
00013
00014   You should have received a copy of the GNU General Public License
00015   along with MPTRAC. If not, see <http://www.gnu.org/licenses/>.
00016
00017   Copyright (C) 2013-2019 Forschungszentrum Juelich GmbH
00018 */
00019
00025 #include "libtrac.h"
00026
00027 int main(
00028   int argc,
00029   char *argv[]) {
00030
00031   int day, doy, mon, year;
00032
00033   /* Check arguments... */
00034   if (argc < 3)
00035     ERRMSG("Give parameters: <year> <doy>");
00036
```

```
00037   /* Read arguments... */
00038   year = atoi(argv[1]);
00039   doy = atoi(argv[2]);
00040
00041   /* Convert... */
00042   doy2day(year, doy, &mon, &day);
00043   printf("%d %d %d\n", year, mon, day);
00044
00045   return EXIT_SUCCESS;
00046 }
```

5.15 extract.c File Reference

Extract single trajectory from atmospheric data files.

Functions

- int main (int argc, char ∗argv[ ])

5.15.1 Detailed Description

Extract single trajectory from atmospheric data files.

Definition in file extract.c.

5.15.2 Function Documentation

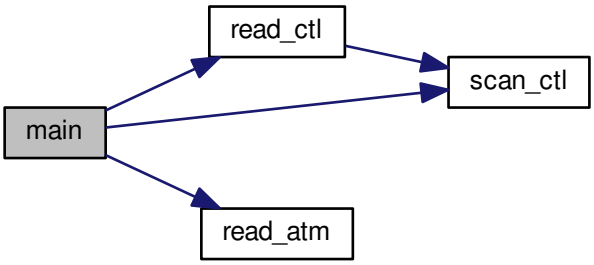
5.15.2.1 int main (int *argc*, char ∗ *argv[ ]*)

Definition at line 27 of file extract.c.

```
00029                {
00030
00031   ctl_t ctl;
00032
00033   atm_t *atm;
00034
00035   FILE *in, *out;
00036
00037   int f, ip, iq;
00038
00039   /* Allocate... */
00040   ALLOC(atm, atm_t, 1);
00041
00042   /* Check arguments... */
00043   if (argc < 4)
00044     ERRMSG("Give parameters: <ctl> <outfile> <atm1> [<atm2> ...]");
00045
00046   /* Read control parameters... */
00047   read_ctl(argv[1], argc, argv, &ctl);
00048   ip = (int) scan_ctl(argv[1], argc, argv, "EXTRACT_IP", -1, "0", NULL);
00049
00050   /* Write info... */
00051   printf("Write trajectory data: %s\n", argv[2]);
00052
00053   /* Create output file... */
00054   if (!(out = fopen(argv[2], "w")))
00055     ERRMSG("Cannot create file!");
00056
00057   /* Write header... */
00058   fprintf(out,
00059           "# $1 = time [s]\n"
00060           "# $2 = altitude [km]\n"
00061           "# $3 = longitude [deg]\n" "# $4 = latitude [deg]\n");
00062   for (iq = 0; iq < ctl.nq; iq++)
```

```
00063     fprintf(out, "# $%i = %s [%s]\n", iq + 5, ctl.qnt_name[iq],
00064             ctl.qnt_unit[iq]);
00065   fprintf(out, "\n");
00066
00067   /* Loop over files... */
00068   for (f = 3; f < argc; f++) {
00069
00070     /* Read atmopheric data... */
00071     if (!(in = fopen(argv[f], "r")))
00072       continue;
00073     else
00074       fclose(in);
00075     read_atm(argv[f], &ctl, atm);
00076
00077     /* Write data... */
00078     fprintf(out, "%.2f %g %g %g", atm->time[ip],
00079             Z(atm->p[ip]), atm->lon[ip], atm->lat[ip]);
00080     for (iq = 0; iq < ctl.nq; iq++) {
00081       fprintf(out, " ");
00082       fprintf(out, ctl.qnt_format[iq], atm->q[iq][ip]);
00083     }
00084     fprintf(out, "\n");
00085   }
00086
00087   /* Close file... */
00088   fclose(out);
00089
00090   /* Free... */
00091   free(atm);
00092
00093   return EXIT_SUCCESS;
00094 }
```

Here is the call graph for this function:



5.16 extract.c

```
00001 /*
00002   This file is part of MPTRAC.
00003
00004   MPTRAC is free software: you can redistribute it and/or modify
00005   it under the terms of the GNU General Public License as published by
00006   the Free Software Foundation, either version 3 of the License, or
00007   (at your option) any later version.
00008
00009   MPTRAC is distributed in the hope that it will be useful,
00010   but WITHOUT ANY WARRANTY; without even the implied warranty of
00011   MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
00012   GNU General Public License for more details.
00013
00014   You should have received a copy of the GNU General Public License
00015   along with MPTRAC. If not, see <http://www.gnu.org/licenses/>.
00016
00017   Copyright (C) 2013-2019 Forschungszentrum Juelich GmbH
00018 */
00019
```

```
00025 #include "libtrac.h"
00026
00027 int main(
00028   int argc,
00029   char *argv[]) {
00030
00031   ctl_t ctl;
00032
00033   atm_t *atm;
00034
00035   FILE *in, *out;
00036
00037   int f, ip, iq;
00038
00039   /* Allocate... */
00040   ALLOC(atm, atm_t, 1);
00041
00042   /* Check arguments... */
00043   if (argc < 4)
00044     ERRMSG("Give parameters: <ctl> <outfile> <atm1> [<atm2> ...]");
00045
00046   /* Read control parameters... */
00047   read_ctl(argv[1], argc, argv, &ctl);
00048   ip = (int) scan_ctl(argv[1], argc, argv, "EXTRACT_IP", -1, "0", NULL);
00049
00050   /* Write info... */
00051   printf("Write trajectory data: %s\n", argv[2]);
00052
00053   /* Create output file... */
00054   if (!(out = fopen(argv[2], "w")))
00055     ERRMSG("Cannot create file!");
00056
00057   /* Write header... */
00058   fprintf(out,
00059           "# $1 = time [s]\n"
00060           "# $2 = altitude [km]\n"
00061           "# $3 = longitude [deg]\n" "# $4 = latitude [deg]\n");
00062   for (iq = 0; iq < ctl.nq; iq++)
00063     fprintf(out, "# $%i = %s [%s]\n", iq + 5, ctl.qnt_name[iq],
00064             ctl.qnt_unit[iq]);
00065   fprintf(out, "\n");
00066
00067   /* Loop over files... */
00068   for (f = 3; f < argc; f++) {
00069
00070     /* Read atmopheric data... */
00071     if (!(in = fopen(argv[f], "r")))
00072       continue;
00073     else
00074       fclose(in);
00075     read_atm(argv[f], &ctl, atm);
00076
00077     /* Write data... */
00078     fprintf(out, "%.2f %g %g %g", atm->time[ip],
00079             Z(atm->p[ip]), atm->lon[ip], atm->lat[ip]);
00080     for (iq = 0; iq < ctl.nq; iq++) {
00081       fprintf(out, " ");
00082       fprintf(out, ctl.qnt_format[iq], atm->q[iq][ip]);
00083     }
00084     fprintf(out, "\n");
00085   }
00086
00087   /* Close file... */
00088   fclose(out);
00089
00090   /* Free... */
00091   free(atm);
00092
00093   return EXIT_SUCCESS;
00094 }
```

5.17 jsec2time.c File Reference

Convert Julian seconds to date.

Functions

- int main (int argc, char *argv[])

5.17.1 Detailed Description

Convert Julian seconds to date.

Definition in file jsec2time.c.

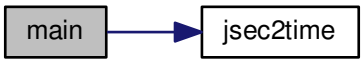
5.17.2 Function Documentation

5.17.2.1 int main (int *argc*, char * *argv[]*)

Definition at line 27 of file jsec2time.c.

```
00029                {
00030
00031   double jsec, remain;
00032
00033   int day, hour, min, mon, sec, year;
00034
00035   /* Check arguments... */
00036   if (argc < 2)
00037     ERRMSG("Give parameters: <jsec>");
00038
00039   /* Read arguments... */
00040   jsec = atof(argv[1]);
00041
00042   /* Convert time... */
00043   jsec2time(jsec, &year, &mon, &day, &hour, &min, &sec, &remain);
00044   printf("%d %d %d %d %d %d %g\n", year, mon, day, hour, min, sec, remain);
00045
00046   return EXIT_SUCCESS;
00047 }
```

Here is the call graph for this function:



5.18 jsec2time.c

```
00001 /*
00002   This file is part of MPTRAC.
00003
00004   MPTRAC is free software: you can redistribute it and/or modify
00005   it under the terms of the GNU General Public License as published by
00006   the Free Software Foundation, either version 3 of the License, or
00007   (at your option) any later version.
00008
00009   MPTRAC is distributed in the hope that it will be useful,
00010   but WITHOUT ANY WARRANTY; without even the implied warranty of
00011   MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
00012   GNU General Public License for more details.
00013
00014   You should have received a copy of the GNU General Public License
00015   along with MPTRAC. If not, see <http://www.gnu.org/licenses/>.
00016
00017   Copyright (C) 2013-2019 Forschungszentrum Juelich GmbH
00018 */
00019
```

```
00025 #include "libtrac.h"
00026
00027 int main(
00028   int argc,
00029   char *argv[]) {
00030
00031   double jsec, remain;
00032
00033   int day, hour, min, mon, sec, year;
00034
00035   /* Check arguments... */
00036   if (argc < 2)
00037     ERRMSG("Give parameters: <jsec>");
00038
00039   /* Read arguments... */
00040   jsec = atof(argv[1]);
00041
00042   /* Convert time... */
00043   jsec2time(jsec, &year, &mon, &day, &hour, &min, &sec, &remain);
00044   printf("%d %d %d %d %d %d %g\n", year, mon, day, hour, min, sec, remain);
00045
00046   return EXIT_SUCCESS;
00047 }
```

5.19 libtrac.c File Reference

MPTRAC library definitions.

Functions

- void cart2geo (double *x, double *z, double *lon, double *lat)

  Convert Cartesian coordinates to geolocation.
- double clim_hno3 (double t, double lat, double p)

  Climatology of HNO3 volume mixing ratios.
- double clim_tropo (double t, double lat)

  Climatology of tropopause pressure.
- void day2doy (int year, int mon, int day, int *doy)

  Get day of year from date.
- void doy2day (int year, int doy, int *mon, int *day)

  Get date from day of year.
- void geo2cart (double z, double lon, double lat, double *x)

  Convert geolocation to Cartesian coordinates.
- void get_met (ctl_t *ctl, char *metbase, double t, met_t **met0, met_t **met1)

  Get meteorological data for given timestep.
- void get_met_help (double t, int direct, char *metbase, double dt_met, char *filename)

  Get meteorological data for timestep.
- void intpol_met_2d (double array[EX][EY], int ix, int iy, double wx, double wy, double *var)

  Linear interpolation of 2-D meteorological data.
- void intpol_met_3d (float array[EX][EY][EP], int ip, int ix, int iy, double wp, double wx, double wy, double *var)

  Linear interpolation of 3-D meteorological data.
- void intpol_met_space (met_t *met, double p, double lon, double lat, double *ps, double *pt, double *z, double *t, double *u, double *v, double *w, double *pv, double *h2o, double *o3)

  Spatial interpolation of meteorological data.
- void intpol_met_time (met_t *met0, met_t *met1, double ts, double p, double lon, double lat, double *ps, double *pt, double *z, double *t, double *u, double *v, double *w, double *pv, double *h2o, double *o3)

  Temporal interpolation of meteorological data.
- void jsec2time (double jsec, int *year, int *mon, int *day, int *hour, int *min, int *sec, double *remain)

  Convert seconds to date.
- int locate_irr (double *xx, int n, double x)

Find array index for irregular grid.

- int locate_reg (double *xx, int n, double x)

  Find array index for regular grid.
- void read_atm (const char *filename, ctl_t *ctl, atm_t *atm)

  Read atmospheric data.
- void read_ctl (const char *filename, int argc, char *argv[ ], ctl_t *ctl)

  Read control parameters.
- void read_met (ctl_t *ctl, char *filename, met_t *met)

  Read meteorological data file.
- void read_met_extrapolate (met_t *met)

  Extrapolate meteorological data at lower boundary.
- void read_met_geopot (ctl_t *ctl, met_t *met)

  Calculate geopotential heights.
- void read_met_help (int ncid, char *varname, char *varname2, met_t *met, float dest[EX][EY][EP], float scl)

  Read and convert variable from meteorological data file.
- void read_met_ml2pl (ctl_t *ctl, met_t *met, float var[EX][EY][EP])

  Convert meteorological data from model levels to pressure levels.
- void read_met_periodic (met_t *met)

  Create meteorological data with periodic boundary conditions.
- void read_met_pv (met_t *met)

  Calculate potential vorticity.
- void read_met_sample (ctl_t *ctl, met_t *met)

  Downsampling of meteorological data.
- void read_met_tropo (ctl_t *ctl, met_t *met)

  Calculate tropopause pressure.
- double scan_ctl (const char *filename, int argc, char *argv[ ], const char *varname, int arridx, const char *defvalue, char *value)

  Read a control parameter from file or command line.
- void time2jsec (int year, int mon, int day, int hour, int min, int sec, double remain, double *jsec)

  Convert date to seconds.
- void timer (const char *name, int id, int mode)

  Measure wall-clock time.
- void write_atm (const char *filename, ctl_t *ctl, atm_t *atm, double t)

  Write atmospheric data.
- void write_csi (const char *filename, ctl_t *ctl, atm_t *atm, double t)

  Write CSI data.
- void write_ens (const char *filename, ctl_t *ctl, atm_t *atm, double t)

  Write ensemble data.
- void write_grid (const char *filename, ctl_t *ctl, met_t *met0, met_t *met1, atm_t *atm, double t)

  Write gridded data.
- void write_prof (const char *filename, ctl_t *ctl, met_t *met0, met_t *met1, atm_t *atm, double t)

  Write profile data.
- void write_station (const char *filename, ctl_t *ctl, atm_t *atm, double t)

  Write station data.

5.19.1 Detailed Description

MPTRAC library definitions.

Definition in file libtrac.c.

5.19.2 Function Documentation

5.19.2.1 void cart2geo (double * x, double * z, double * lon, double * lat)

Convert Cartesian coordinates to geolocation.

Definition at line 29 of file libtrac.c.

```
00033               {
00034
00035   double radius;
00036
00037   radius = NORM(x);
00038   *lat = asin(x[2] / radius) * 180 / M_PI;
00039   *lon = atan2(x[1], x[0]) * 180 / M_PI;
00040   *z = radius - RE;
00041 }
```

5.19.2.2 double clim_hno3 (double t, double lat, double p)

Climatology of HNO3 volume mixing ratios.

Definition at line 45 of file libtrac.c.

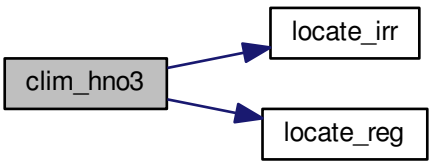
```
00048            {
00049
00050   static double secs[12] = { 1209600.00, 3888000.00, 6393600.00,
00051     9072000.00, 11664000.00, 14342400.00,
00052     16934400.00, 19612800.00, 22291200.00,
00053     24883200.00, 27561600.00, 30153600.00
00054   };
00055
00056   static double lats[18] = { -85, -75, -65, -55, -45, -35, -25, -15, -5,
00057     5, 15, 25, 35, 45, 55, 65, 75, 85
00058   };
00059
00060   static double ps[10] = { 4.64159, 6.81292, 10, 14.678, 21.5443,
00061     31.6228, 46.4159, 68.1292, 100, 146.78
00062   };
00063
00064   static double hno3[12][18][10] = {
00065     {{0.782, 1.65, 2.9, 4.59, 6.71, 8.25, 7.16, 5.75, 2.9, 1.74},
00066      {0.529, 1.64, 2.76, 4.55, 6.58, 8, 6.99, 5.55, 2.68, 1.57},
00067      {0.723, 1.55, 2.73, 4.48, 6.32, 7.58, 7.05, 5.16, 2.49, 1.54},
00068      {0.801, 1.56, 2.74, 4.52, 6.23, 7.35, 6.68, 4.4, 1.97, 1.23},
00069      {0.818, 1.62, 2.77, 4.38, 5.98, 6.84, 5.83, 3.05, 1.15, 0.709},
00070      {0.901, 1.73, 2.78, 4.21, 5.63, 6.16, 4.68, 1.87, 0.617, 0.37},
00071      {0.997, 1.8, 2.79, 4.09, 4.88, 4.96, 3.12, 1.22, 0.311, 0.244},
00072      {1, 1.71, 2.51, 3.4, 3.74, 3.39, 2.25, 0.845, 0.204, 0.222},
00073      {0.997, 1.7, 2.36, 2.88, 3.01, 2.25, 1.77, 0.608, 0.163, 0.181},
00074      {0.991, 1.79, 2.57, 3.06, 3.08, 2.15, 1.81, 0.59, 0.168, 0.104},
00075      {0.974, 1.86, 2.84, 3.8, 3.93, 3.79, 2.91, 1.02, 0.152, 0.0985},
00076      {0.85, 1.86, 3.3, 5.24, 6.55, 6.86, 5.12, 1.93, 0.378, 0.185},
00077      {0.783, 1.89, 3.85, 6.6, 8.56, 8.66, 6.95, 3.95, 1.47, 0.745},
00078      {0.883, 2.05, 4.34, 7.54, 9.68, 9.77, 8.19, 5.72, 3.15, 1.77},
00079      {1.4, 2.44, 4.72, 8.07, 10.5, 10.9, 9.28, 6.95, 4.47, 2.49},
00080      {1.7, 2.43, 4.24, 7.43, 10.4, 11.2, 9.72, 8.15, 5.7, 2.97},
00081      {2.06, 2.27, 3.68, 6.77, 10.3, 10.3, 9.05, 9.1, 6.73, 3.14},
00082      {2.33, 2.39, 3.51, 6.45, 10.3, 9.88, 8.57, 9.42, 7.22, 3.19}},
00083     {{0.947, 2.21, 3.81, 5.69, 7.55, 8.63, 7.53, 5.98, 3.03, 1.64},
00084      {0.642, 2, 3.4, 5.49, 7.5, 8.52, 7.53, 5.83, 2.74, 1.42},
00085      {0.756, 1.83, 3.18, 5.11, 7.24, 8.63, 7.66, 5.5, 2.45, 1.33},
00086      {0.837, 1.75, 3.06, 5, 6.79, 8.08, 7.05, 4.42, 1.81, 1.05},
00087      {0.86, 1.73, 2.96, 4.68, 6.38, 7.38, 6.09, 2.92, 1.06, 0.661},
00088      {0.926, 1.78, 2.89, 4.37, 5.74, 6.14, 4.59, 1.78, 0.561, 0.332},
00089      {0.988, 1.78, 2.75, 3.95, 4.64, 4.49, 2.85, 1.13, 0.271, 0.184},
00090      {0.999, 1.7, 2.44, 3.27, 3.57, 3.03, 2.06, 0.736, 0.181, 0.189},
00091      {0.971, 1.67, 2.23, 2.63, 2.83, 2.15, 1.74, 0.554, 0.157, 0.167},
00092      {0.985, 1.72, 2.34, 2.69, 2.81, 2.11, 1.78, 0.592, 0.152, 0.101},
00093      {0.95, 1.72, 2.57, 3.44, 3.84, 3.89, 2.91, 0.976, 0.135, 0.114},
00094      {0.819, 1.64, 2.93, 4.75, 6.02, 6.93, 5.2, 1.83, 0.347, 0.191},
00095      {0.731, 1.58, 3.3, 5.95, 7.81, 8.32, 6.93, 3.83, 1.47, 0.875},
00096      {0.77, 1.75, 3.74, 6.67, 8.76, 9.41, 8.19, 5.78, 3.32, 2.11},
00097      {1.08, 2.17, 4.24, 7.13, 9.2, 10.3, 9.03, 6.87, 4.65, 3.01},
00098      {1.43, 2.49, 4.31, 7, 9.14, 10.6, 9.34, 7.6, 5.86, 3.64},
```

```
00099      {1.5, 2.68, 4.32, 6.75, 8.78, 10.6, 9.05, 7.65, 6.27, 4.07},
00100      {1.73, 2.91, 4.33, 6.67, 8.73, 10.6, 8.5, 7.54, 6.63, 4.17}},
00101     {{1.43, 3.07, 5.22, 7.54, 9.78, 10.4, 10.1, 7.26, 3.61, 1.69},
00102      {0.989, 2.69, 4.76, 7.19, 9.44, 9.94, 9.5, 6.74, 3.24, 1.52},
00103      {0.908, 2.23, 4.11, 6.48, 8.74, 9.41, 8.58, 5.8, 2.66, 1.3},
00104      {0.923, 1.99, 3.61, 5.83, 7.84, 8.6, 7.55, 4.57, 1.87, 0.98},
00105      {0.933, 1.9, 3.31, 5.28, 7.1, 7.84, 6.44, 3.18, 1.1, 0.642},
00106      {0.982, 1.88, 3.1, 4.76, 6.16, 6.57, 5.16, 2.04, 0.598, 0.33},
00107      {1.02, 1.82, 2.88, 4.12, 4.71, 4.54, 3.03, 1.22, 0.268, 0.174},
00108      {0.992, 1.7, 2.51, 3.33, 3.62, 2.87, 2.05, 0.705, 0.161, 0.169},
00109      {0.969, 1.69, 2.2, 2.62, 2.84, 2.13, 1.78, 0.529, 0.146, 0.186},
00110      {0.945, 1.69, 2.27, 2.64, 2.83, 2.2, 1.83, 0.561, 0.139, 0.121},
00111      {0.922, 1.65, 2.48, 3.33, 3.83, 4.09, 2.92, 0.973, 0.117, 0.135},
00112      {0.886, 1.59, 2.66, 4.26, 5.51, 6.57, 5.09, 1.79, 0.342, 0.194},
00113      {0.786, 1.5, 2.78, 5.01, 6.8, 7.83, 6.65, 3.62, 1.45, 1},
00114      {0.745, 1.55, 3.05, 5.49, 7.44, 8.6, 7.8, 5.28, 2.95, 2.12},
00115      {0.938, 1.76, 3.4, 5.82, 7.8, 9.04, 8.43, 6.15, 3.85, 2.82},
00116      {0.999, 2, 3.66, 5.95, 7.94, 9.27, 8.8, 6.93, 4.87, 3.54},
00117      {1.13, 2.23, 3.86, 5.82, 7.65, 9, 8.82, 7.17, 5.72, 4.08},
00118      {1.23, 2.33, 3.94, 5.74, 7.48, 8.9, 8.84, 7.35, 6.3, 4.42}},
00119     {{1.55, 3.2, 6.25, 10, 12.9, 12.9, 11.9, 7.96, 3.96, 1.75},
00120      {1.32, 3.27, 6.32, 9.99, 12.7, 12.4, 11.3, 7.51, 3.66, 1.58},
00121      {1.25, 3.08, 5.77, 8.71, 11.2, 11.2, 9.84, 6.52, 3.23, 1.5},
00122      {1.18, 2.59, 4.76, 7.46, 9.61, 9.66, 8.42, 5.06, 2.25, 1.09},
00123      {1.09, 2.24, 3.99, 6.4, 8.33, 8.54, 7.08, 3.69, 1.36, 0.727},
00124      {1.06, 2.07, 3.52, 5.52, 7.06, 7.26, 5.83, 2.46, 0.732, 0.409},
00125      {1.07, 1.91, 3.09, 4.63, 5.21, 4.9, 3.68, 1.43, 0.326, 0.198},
00126      {1.03, 1.74, 2.63, 3.54, 3.78, 2.89, 2.09, 0.743, 0.175, 0.12},
00127      {0.959, 1.71, 2.32, 2.77, 2.99, 2.24, 1.76, 0.519, 0.149, 0.172},
00128      {0.931, 1.68, 2.32, 2.74, 2.99, 2.46, 1.88, 0.578, 0.156, 0.157},
00129      {0.933, 1.66, 2.49, 3.42, 3.99, 4.12, 2.93, 1.02, 0.181, 0.138},
00130      {0.952, 1.64, 2.6, 4, 5.15, 6.07, 4.84, 1.78, 0.407, 0.286},
00131      {0.84, 1.54, 2.68, 4.47, 5.97, 7.13, 6.23, 3.25, 1.38, 1.02},
00132      {0.714, 1.44, 2.73, 4.68, 6.28, 7.68, 7.21, 4.82, 2.55, 1.96},
00133      {0.838, 1.57, 2.96, 4.93, 6.55, 8.08, 7.74, 5.77, 3.32, 2.52},
00134      {0.823, 1.65, 3.11, 5.09, 6.89, 8.36, 8.31, 6.59, 4.1, 3.04},
00135      {0.886, 1.83, 3.42, 5.33, 6.92, 8.36, 8.63, 7.21, 4.82, 3.46},
00136      {1.07, 2.12, 3.74, 5.54, 6.98, 8.41, 8.75, 7.41, 5.16, 3.62}},
00137     {{1.13, 2.59, 7.49, 13.5, 15.4, 12.9, 11.3, 8.62, 4.18, 1.63},
00138      {0.973, 2.79, 7.23, 12.8, 15.2, 13.3, 11.6, 8.42, 4.06, 1.57},
00139      {1.46, 3.44, 6.78, 10.4, 12.7, 12.1, 10.5, 7.04, 3.59, 1.63},
00140      {1.52, 3.38, 6.04, 9.08, 11, 10.3, 8.9, 5.7, 2.77, 1.37},
00141      {1.32, 2.65, 4.75, 7.49, 9.32, 8.89, 7.42, 4.27, 1.7, 0.88},
00142      {1.19, 2.2, 3.88, 6.36, 8.03, 7.81, 6.19, 2.94, 0.948, 0.527},
00143      {1.14, 1.96, 3.28, 5.26, 6.12, 5.8, 4.47, 1.66, 0.388, 0.229},
00144      {1.07, 1.82, 2.82, 3.92, 4.03, 3.15, 2.31, 0.871, 0.183, 0.0972},
00145      {0.978, 1.77, 2.53, 3.04, 3.1, 2.36, 1.76, 0.575, 0.16, 0.126},
00146      {0.962, 1.72, 2.49, 3.01, 3.22, 2.72, 2, 0.716, 0.162, 0.183},
00147      {0.968, 1.7, 2.6, 3.57, 4.28, 4.35, 3.09, 1.2, 0.262, 0.18},
00148      {0.977, 1.68, 2.71, 4.03, 5.17, 6.01, 4.81, 1.81, 0.473, 0.343},
00149      {0.819, 1.58, 2.75, 4.37, 5.8, 6.9, 5.96, 2.95, 1.19, 0.964},
00150      {0.672, 1.44, 2.69, 4.42, 5.92, 7.26, 6.79, 4.32, 2.22, 1.83},
00151      {0.783, 1.42, 2.65, 4.45, 6.04, 7.57, 7.39, 5.4, 2.94, 2.25},
00152      {0.757, 1.43, 2.7, 4.54, 6.14, 7.65, 7.51, 5.95, 3.42, 2.39},
00153      {0.758, 1.57, 3.04, 4.88, 6.24, 7.85, 7.58, 6.35, 3.81, 2.52},
00154      {0.835, 1.72, 3.35, 5.24, 6.5, 8.1, 7.67, 6.51, 4, 2.6}},
00155     {{1.5, 2.12, 7.64, 10.5, 5.59, 2.14, 2.2, 3.5, 4.71, 3.26},
00156      {1.32, 2.14, 7.23, 12, 9.3, 5.3, 5.11, 5.37, 5.12, 3.05},
00157      {1.53, 2.92, 6.9, 11.9, 13.5, 11.3, 9.91, 7.18, 4.75, 2.65},
00158      {1.66, 3.48, 6.25, 9.53, 11.3, 10.3, 9.01, 5.76, 2.99, 1.67},
00159      {1.54, 3.03, 5.21, 8.03, 9.66, 8.98, 7.5, 4.64, 2.11, 1.13},
00160      {1.32, 2.39, 4.03, 6.74, 8.52, 8.05, 6.4, 3.48, 1.2, 0.639},
00161      {1.17, 2.08, 3.35, 5.52, 6.86, 6.54, 5.08, 1.97, 0.462, 0.217},
00162      {1.07, 1.92, 3.01, 4.24, 4.47, 3.77, 2.77, 1.07, 0.213, 0.0694},
00163      {0.992, 1.88, 2.76, 3.39, 3.32, 2.52, 1.8, 0.713, 0.192, 0.136},
00164      {0.992, 1.8, 2.63, 3.34, 3.46, 2.95, 2.09, 0.9, 0.242, 0.194},
00165      {0.987, 1.77, 2.67, 3.64, 4.37, 4.36, 3, 1.27, 0.354, 0.229},
00166      {0.979, 1.74, 2.77, 3.99, 5.12, 5.75, 4.53, 1.75, 0.555, 0.302},
00167      {0.832, 1.6, 2.78, 4.32, 5.53, 6.67, 5.69, 2.59, 0.982, 0.66},
00168      {0.696, 1.41, 2.64, 4.31, 5.65, 7.14, 6.56, 3.8, 1.75, 1.41},
00169      {0.788, 1.36, 2.59, 4.3, 5.73, 7.35, 7.04, 4.82, 2.41, 1.8},
00170      {0.761, 1.43, 2.61, 4.28, 5.64, 7.37, 7.11, 5.37, 2.68, 1.9},
00171      {0.701, 1.44, 2.82, 4.64, 5.76, 7.63, 7.07, 5.74, 2.98, 1.88},
00172      {0.763, 1.5, 2.95, 4.97, 6.08, 7.88, 7.12, 5.98, 3.21, 1.91}},
00173     {{3.58, 2.59, 6.49, 5.84, 1.63, 0.282, 0.647, 0.371, 1.36, 2.33},
00174      {3.09, 2.38, 6.37, 7.66, 4.06, 1.23, 1.8, 1.65, 2.32, 2.78},
00175      {2.31, 2.84, 5.58, 9.63, 11, 9.02, 8.2, 6.23, 4.17, 3.08},
00176      {1.61, 3.16, 5.72, 9.13, 11.4, 10.4, 9.15, 6.18, 3.52, 2.3},
00177      {1.32, 2.8, 4.79, 7.44, 9.43, 8.83, 7.41, 4.9, 2.38, 1.38},
00178      {1.14, 2.36, 3.94, 6.41, 8.38, 8.17, 6.53, 3.76, 1.31, 0.656},
00179      {1.05, 2.1, 3.36, 5.45, 7.07, 6.98, 5.44, 2.22, 0.52, 0.176},
00180      {1.02, 2, 3.05, 4.33, 4.74, 4.21, 3.2, 1.26, 0.277, 0.0705},
00181      {1.01, 1.96, 2.9, 3.53, 3.46, 2.69, 1.89, 0.859, 0.254, 0.12},
00182      {1.01, 1.86, 2.7, 3.46, 3.59, 3.03, 2.14, 1, 0.34, 0.199},
00183      {1.02, 1.81, 2.67, 3.68, 4.39, 4.3, 2.93, 1.35, 0.477, 0.25},
00184      {0.991, 1.79, 2.82, 4.05, 5.08, 5.5, 4.21, 1.74, 0.605, 0.259},
00185      {0.844, 1.73, 2.87, 4.38, 5.49, 6.47, 5.5, 2.44, 0.85, 0.422},
```

```
00186       {0.729, 1.57, 2.76, 4.43, 5.73, 7.13, 6.43, 3.52, 1.38, 0.913},
00187       {0.819, 1.46, 2.69, 4.45, 5.92, 7.47, 7.05, 4.52, 2, 1.4},
00188       {0.783, 1.47, 2.71, 4.48, 5.92, 7.46, 7.16, 5.08, 2.35, 1.56},
00189       {0.735, 1.51, 2.96, 4.84, 5.92, 7.77, 7.2, 5.54, 2.56, 1.61},
00190       {0.8, 1.61, 3.14, 5.2, 6.26, 8.08, 7.27, 5.72, 2.75, 1.62}},
00191      {{5, 4.43, 5.53, 5.35, 2.33, 0.384, 0.663, 0.164, 0.692, 1.4},
00192       {3.62, 3.79, 4.77, 5.94, 4.12, 1.36, 1.3, 0.973, 1.37, 1.73},
00193       {2.11, 2.7, 4.12, 7.14, 9.03, 7.74, 7.12, 5.44, 3.73, 2.6},
00194       {1.13, 2.32, 4.12, 6.97, 9.86, 9.69, 8.85, 6.22, 3.59, 2.14},
00195       {0.957, 2.28, 4.11, 6.47, 8.66, 8.78, 7.33, 4.94, 2.44, 1.38},
00196       {0.881, 2.1, 3.65, 5.94, 7.98, 8.29, 6.69, 3.95, 1.36, 0.672},
00197       {0.867, 1.96, 3.26, 5.23, 6.94, 7.2, 5.63, 2.41, 0.578, 0.19},
00198       {0.953, 1.94, 2.98, 4.23, 4.83, 4.52, 3.38, 1.34, 0.293, 0.181},
00199       {1.01, 1.91, 2.77, 3.35, 3.3, 2.62, 1.99, 0.905, 0.245, 0.107},
00200       {1.03, 1.81, 2.57, 3.29, 3.43, 2.87, 2.13, 0.988, 0.306, 0.185},
00201       {1.02, 1.78, 2.58, 3.59, 4.19, 4, 2.72, 1.29, 0.389, 0.224},
00202       {1.01, 1.84, 2.84, 4.06, 4.9, 5.08, 3.71, 1.64, 0.529, 0.232},
00203       {0.902, 1.84, 2.98, 4.43, 5.5, 6.28, 5.18, 2.35, 0.734, 0.341},
00204       {0.785, 1.68, 2.93, 4.67, 5.95, 7.3, 6.52, 3.48, 1.24, 0.754},
00205       {0.847, 1.62, 2.94, 4.86, 6.38, 7.99, 7.5, 4.64, 1.93, 1.23},
00206       {0.8, 1.6, 2.94, 4.95, 6.62, 8.16, 7.91, 5.43, 2.43, 1.45},
00207       {0.82, 1.76, 3.37, 5.47, 6.82, 8.24, 7.73, 5.79, 2.69, 1.5},
00208       {0.988, 2.05, 3.87, 6.01, 7.18, 8.41, 7.7, 5.93, 2.89, 1.55}},
00209      {{1.52, 2.7, 3.79, 4.95, 3.8, 1.51, 1.11, 0.784, 1.1, 1.56},
00210       {1.19, 2.16, 3.34, 4.76, 4.61, 2.93, 2.07, 1.65, 1.63, 1.74},
00211       {0.804, 1.65, 2.79, 4.63, 6.64, 6.95, 6.68, 5.11, 3.3, 2.09},
00212       {0.86, 1.8, 3.25, 5.3, 7.91, 8.76, 8.28, 6.01, 3.39, 1.83},
00213       {0.859, 1.95, 3.54, 5.64, 7.88, 8.55, 7.3, 4.88, 2.3, 1.22},
00214       {0.809, 1.88, 3.38, 5.45, 7.47, 8.02, 6.69, 3.98, 1.35, 0.646},
00215       {0.822, 1.81, 3.11, 4.9, 6.62, 6.96, 5.63, 2.47, 0.614, 0.169},
00216       {0.92, 1.83, 2.8, 3.93, 4.56, 4.4, 3.25, 1.31, 0.295, 0.0587},
00217       {0.986, 1.83, 2.6, 3.13, 3.08, 2.53, 1.94, 0.886, 0.244, 0.0815},
00218       {0.997, 1.74, 2.5, 3.16, 3.24, 2.67, 2.05, 0.939, 0.281, 0.147},
00219       {1.01, 1.75, 2.57, 3.55, 4.1, 3.81, 2.53, 1.21, 0.354, 0.197},
00220       {1.04, 1.88, 2.9, 4.16, 4.95, 4.96, 3.48, 1.63, 0.502, 0.163},
00221       {0.967, 1.95, 3.17, 4.72, 5.85, 6.5, 5.34, 2.53, 0.748, 0.303},
00222       {0.846, 1.83, 3.23, 5.15, 6.62, 7.82, 6.85, 3.79, 1.36, 0.714},
00223       {0.91, 1.81, 3.35, 5.55, 7.32, 8.55, 7.88, 5.03, 2.13, 1.1},
00224       {0.87, 1.94, 3.6, 5.97, 7.98, 9.14, 8.71, 6.04, 2.73, 1.41},
00225       {1.04, 2.36, 4.22, 6.57, 8.5, 9.53, 9.22, 6.71, 3.2, 1.56},
00226       {1.36, 2.84, 4.72, 6.94, 8.81, 9.87, 9.59, 7.1, 3.43, 1.65}},
00227      {{0.704, 1.4, 2.03, 3.08, 4.64, 4.24, 2.55, 1.57, 1.99, 1.91},
00228       {0.484, 1.38, 2.08, 3.54, 5.11, 4.98, 3.73, 2.57, 2.29, 1.84},
00229       {0.749, 1.57, 2.63, 4.17, 6.15, 6.97, 6.64, 5.11, 3.35, 1.97},
00230       {0.864, 1.69, 3.16, 4.87, 7.13, 8.33, 7.87, 5.9, 3.17, 1.56},
00231       {0.861, 1.79, 3.28, 5.2, 7.29, 8.32, 7.38, 4.9, 2.23, 1.11},
00232       {0.835, 1.79, 3.19, 4.99, 6.72, 7.58, 6.45, 3.68, 1.25, 0.616},
00233       {0.847, 1.8, 3.07, 4.66, 6.12, 6.6, 5.21, 2.18, 0.554, 0.21},
00234       {0.941, 1.78, 2.68, 3.68, 4.28, 4.18, 2.97, 1.15, 0.238, 0.0968},
00235       {0.98, 1.78, 2.48, 2.99, 2.96, 2.35, 1.88, 0.747, 0.207, 0.105},
00236       {0.978, 1.74, 2.51, 3.07, 3.12, 2.36, 1.95, 0.777, 0.216, 0.146},
00237       {1.01, 1.79, 2.63, 3.53, 3.95, 3.47, 2.38, 1.08, 0.265, 0.178},
00238       {1.06, 1.94, 3.02, 4.43, 5.19, 5.01, 3.68, 1.71, 0.429, 0.14},
00239       {0.99, 2.02, 3.38, 5.22, 6.56, 6.91, 5.56, 2.75, 0.816, 0.353},
00240       {0.923, 2.05, 3.66, 5.98, 7.78, 8.5, 7.23, 4.26, 1.67, 0.802},
00241       {1.08, 2.27, 4.17, 6.8, 8.89, 9.55, 8.59, 5.64, 2.58, 1.2},
00242       {1.12, 2.5, 4.52, 7.22, 9.76, 10.3, 9.72, 6.79, 3.32, 1.52},
00243       {1.2, 2.64, 4.81, 7.64, 10.5, 11.4, 10.6, 7.65, 3.87, 1.73},
00244       {1.4, 2.91, 5.01, 7.75, 10.7, 11.6, 11.1, 8.02, 4.04, 1.8}},
00245      {{0.75, 1.49, 2.39, 3.39, 4.93, 5.94, 5.03, 2.75, 2.27, 1.78},
00246       {0.508, 1.52, 2.38, 3.82, 5.34, 6.13, 5.6, 3.31, 2.42, 1.73},
00247       {0.715, 1.56, 2.7, 4.39, 6.18, 6.96, 7.1, 5.04, 3.01, 1.75},
00248       {0.813, 1.62, 2.94, 4.65, 6.53, 7.65, 7.52, 5.49, 2.75, 1.41},
00249       {0.802, 1.68, 2.97, 4.64, 6.37, 7.53, 7.01, 4.56, 1.9, 0.955},
00250       {0.816, 1.75, 3.01, 4.59, 6.15, 7.06, 6.15, 3.38, 1.11, 0.61},
00251       {0.867, 1.78, 2.92, 4.35, 5.69, 6.05, 4.73, 1.91, 0.519, 0.269},
00252       {0.932, 1.7, 2.55, 3.44, 4.03, 3.98, 2.74, 1.08, 0.247, 0.132},
00253       {0.937, 1.74, 2.51, 3.09, 3.11, 2.34, 1.84, 0.67, 0.189, 0.121},
00254       {0.942, 1.75, 2.63, 3.3, 3.27, 2.21, 1.87, 0.663, 0.171, 0.147},
00255       {0.959, 1.8, 2.82, 3.78, 4.03, 3.37, 2.53, 1.04, 0.199, 0.146},
00256       {1.01, 1.9, 3.13, 4.76, 5.63, 5.6, 4.31, 1.83, 0.367, 0.172},
00257       {0.989, 2.04, 3.64, 6, 7.62, 7.6, 6, 3.35, 1.05, 0.448},
00258       {1.02, 2.28, 4.32, 7.19, 9.21, 9.16, 7.64, 4.97, 2.2, 0.948},
00259       {1.26, 2.77, 5.2, 8.31, 10.5, 10.4, 9.01, 6.37, 3.46, 1.56},
00260       {1.31, 2.76, 5.23, 8.49, 11.2, 11.3, 10.1, 7.27, 3.98, 1.76},
00261       {1.26, 2.5, 5.14, 8.85, 12.3, 12.3, 11.2, 8.13, 4.45, 1.97},
00262       {1.35, 2.49, 5.26, 9.16, 13, 12.8, 11.8, 8.57, 4.72, 2.05}},
00263      {{0.759, 1.54, 2.54, 4.22, 6.26, 7.44, 7.14, 4.99, 2.84, 1.89},
00264       {0.508, 1.55, 2.5, 4.29, 6.29, 7.29, 7.07, 5.03, 2.77, 1.74},
00265       {0.699, 1.56, 2.62, 4.17, 6.08, 7.38, 7.04, 5.17, 2.81, 1.65},
00266       {0.778, 1.5, 2.65, 4.35, 6.07, 7.28, 6.84, 4.8, 2.28, 1.28},
00267       {0.772, 1.55, 2.71, 4.3, 5.76, 6.91, 6.2, 3.69, 1.45, 0.837},
00268       {0.836, 1.67, 2.78, 4.21, 5.56, 6.41, 5.33, 2.47, 0.807, 0.488},
00269       {0.937, 1.79, 2.78, 4.12, 5.17, 5.38, 3.89, 1.47, 0.392, 0.256},
00270       {0.97, 1.75, 2.52, 3.39, 3.83, 3.63, 2.48, 0.968, 0.212, 0.198},
00271       {0.968, 1.74, 2.5, 3.11, 3.2, 2.34, 1.79, 0.629, 0.169, 0.173},
00272       {0.98, 1.8, 2.69, 3.42, 3.4, 2.18, 1.81, 0.606, 0.164, 0.138},
```

```
00273       {0.975, 1.84, 2.96, 4.08, 4.12, 3.5, 2.79, 1.02, 0.145, 0.133},
00274       {0.96, 1.94, 3.27, 5.17, 6.26, 6.35, 4.88, 1.91, 0.329, 0.189},
00275       {0.954, 2.06, 3.8, 6.53, 8.46, 8.32, 6.53, 3.83, 1.32, 0.6},
00276       {1, 2.34, 4.58, 7.71, 9.68, 9.75, 7.96, 5.45, 2.84, 1.39},
00277       {1.24, 2.65, 5.14, 8.51, 10.7, 10.6, 8.96, 6.51, 3.83, 1.85},
00278       {1.34, 2.44, 4.99, 8.63, 11.6, 11.4, 10.1, 7.84, 4.77, 2.24},
00279       {1.33, 2.1, 4.76, 8.78, 12.2, 11.7, 10.8, 8.68, 5.15, 2.35},
00280       {1.42, 2.04, 4.68, 8.92, 12.7, 12, 11.2, 8.99, 5.32, 2.33}}
00281    };
00282
00283    double aux00, aux01, aux10, aux11, sec;
00284
00285    int ilat, ip, isec;
00286
00287    /* Get seconds since begin of year... */
00288    sec = fmod(t, 365.25 * 86400.);
00289
00290    /* Get indices... */
00291    isec = locate_irr(secs, 12, sec);
00292    ilat = locate_reg(lats, 18, lat);
00293    ip = locate_irr(ps, 10, p);
00294
00295    /* Interpolate... */
00296    aux00 = LIN(ps[ip], hno3[isec][ilat][ip],
00297                ps[ip + 1], hno3[isec][ilat][ip + 1], p);
00298    aux01 = LIN(ps[ip], hno3[isec][ilat + 1][ip],
00299                ps[ip + 1], hno3[isec][ilat + 1][ip + 1], p);
00300    aux10 = LIN(ps[ip], hno3[isec + 1][ilat][ip],
00301                ps[ip + 1], hno3[isec + 1][ilat][ip + 1], p);
00302    aux11 = LIN(ps[ip], hno3[isec + 1][ilat + 1][ip],
00303                ps[ip + 1], hno3[isec + 1][ilat + 1][ip + 1], p);
00304    aux00 = LIN(lats[ilat], aux00, lats[ilat + 1], aux01, lat);
00305    aux11 = LIN(lats[ilat], aux10, lats[ilat + 1], aux11, lat);
00306    return LIN(secs[isec], aux00, secs[isec + 1], aux11, sec);
00307 }
```

Here is the call graph for this function:



5.19.2.3 double clim_tropo (double *t*, double *lat*)

Climatology of tropopause pressure.

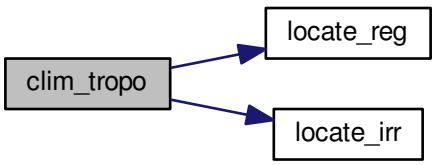
Definition at line 311 of file libtrac.c.

```
00313               {
00314
00315    static double doys[12]
00316    = { 1, 32, 60, 91, 121, 152, 182, 213, 244, 274, 305, 335 };
00317
00318    static double lats[73]
00319      = { -90, -87.5, -85, -82.5, -80, -77.5, -75, -72.5, -70, -67.5,
00320      -65, -62.5, -60, -57.5, -55, -52.5, -50, -47.5, -45, -42.5,
00321      -40, -37.5, -35, -32.5, -30, -27.5, -25, -22.5, -20, -17.5,
00322      -15, -12.5, -10, -7.5, -5, -2.5, 0, 2.5, 5, 7.5, 10, 12.5,
00323      15, 17.5, 20, 22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5,
00324      45, 47.5, 50, 52.5, 55, 57.5, 60, 62.5, 65, 67.5, 70, 72.5,
00325      75, 77.5, 80, 82.5, 85, 87.5, 90
00326    };
```

```
00327
00328   static double tps[12][73]
00329     = { {324.1, 325.6, 325, 324.3, 322.5, 319.7, 314, 307.2, 301.8, 299.6,
00330          297.1, 292.2, 285.6, 276.1, 264, 248.9, 231.9, 213.5, 194.4,
00331          175.3, 157, 140.4, 126.7, 116.3, 109.5, 105.4, 103, 101.4, 100.4,
00332          99.69, 99.19, 98.84, 98.56, 98.39, 98.39, 98.42, 98.44, 98.54,
00333          98.68, 98.81, 98.89, 98.96, 99.12, 99.65, 101.4, 105.4, 113.5, 128,
00334          152.1, 184.7, 214, 234.1, 247.3, 255.8, 262.6, 267.7, 271.7, 275,
00335          277.2, 279, 280.1, 280.4, 280.6, 280.1, 279.3, 278.3, 276.8, 275.8,
00336          275.3, 275.6, 275.4, 274.1, 273.5},
00337    {337.3, 338.7, 337.8, 336.4, 333, 328.8, 321.1, 312.6, 306.6, 303.7,
00338     300.2, 293.8, 285.4, 273.8, 259.6, 242.7, 224.4, 205.2, 186, 167.5,
00339     150.3, 135, 122.8, 113.9, 108.2, 104.7, 102.5, 101.1, 100.2, 99.42,
00340     98.88, 98.52, 98.25, 98.09, 98.07, 98.1, 98.12, 98.2, 98.25, 98.27,
00341     98.26, 98.27, 98.36, 98.79, 100.2, 104.2, 113.7, 131.2, 159.5, 193,
00342     220.4, 238.1, 250.2, 258.1, 264.7, 269.7, 273.7, 277.3, 280.2, 282.8,
00343     284.9, 286.5, 288.1, 288.8, 289, 288.5, 287.2, 286.3, 286.1, 287.2,
00344     287.5, 286.2, 285.8},
00345    {335, 336, 335.7, 335.1, 332.3, 328.1, 320.6, 311.8, 305.1, 301.9,
00346     297.6, 290, 280.4, 268.3, 254.6, 239.6, 223.9, 207.9, 192.2, 176.9,
00347     161.7, 146.4, 132.2, 120.6, 112.3, 107.2, 104.3, 102.4, 101.3,
00348     100.4, 99.86, 99.47, 99.16, 98.97, 98.94, 98.97, 99, 99.09, 99.2,
00349     99.31, 99.35, 99.41, 99.51, 99.86, 101.1, 104.9, 114.3, 131, 156.8,
00350     186.3, 209.3, 224.6, 236.8, 246.3, 254.9, 262.3, 268.8, 274.8,
00351     279.9, 284.6, 288.6, 291.6, 294.9, 297.5, 299.8, 301.8, 303.1,
00352     304.3, 304.9, 306, 306.6, 306.2, 306},
00353    {306.2, 306.7, 305.7, 307.1, 307.3, 306.4, 301.8, 296.2, 292.4,
00354     290.3, 287.1, 280.9, 273.4, 264.3, 254.1, 242.8, 231, 219, 207.2,
00355     195.5, 183.3, 169.7, 154.7, 138.7, 124.1, 113.6, 107.8, 104.7,
00356     102.8, 101.7, 100.9, 100.4, 100, 99.79, 99.7, 99.66, 99.68, 99.79,
00357     99.94, 100.2, 100.5, 100.9, 101.4, 102.1, 103.4, 107, 115.2, 129.1,
00358     148.7, 171, 190.8, 205.6, 218.4, 229.4, 239.6, 248.6, 256.5,
00359     263.7, 270.3, 276.6, 282.6, 288.1, 294.5, 300.4, 306.3, 311.4,
00360     315.1, 318.3, 320.3, 322.2, 322.8, 321.5, 321.1},
00361    {266.5, 264.9, 260.8, 261, 262, 263, 261.3, 259.7, 259.2, 259.8,
00362     260.1, 258.6, 256.7, 253.6, 249.5, 243.9, 237.4, 230, 222.1, 213.9,
00363     205, 194.4, 180.4, 161.8, 140.7, 122.9, 112.1, 106.7, 104.1, 102.7,
00364     101.8, 101.4, 101.1, 101, 101, 101, 101.1, 101.2, 101.5, 101.9,
00365     102.4, 103, 103.8, 104.9, 106.8, 110.1, 115.6, 124, 135.2, 148.9,
00366     165.2, 181.3, 198, 211.8, 223.5, 233.8, 242.9, 251.5, 259, 266.2,
00367     273.1, 279.2, 286.2, 292.8, 299.6, 306, 311.1, 315.5, 318.8, 322.6,
00368     325.3, 325.8, 325.8},
00369    {220.1, 218.1, 210.8, 207.2, 207.6, 210.5, 211.4, 213.5, 217.3,
00370     222.4, 227.9, 232.8, 237.4, 240.8, 242.8, 243, 241.5, 238.6, 234.2,
00371     228.5, 221, 210.7, 195.1, 172.9, 147.8, 127.6, 115.6, 109.9, 107.1,
00372     105.7, 105, 104.8, 104.8, 104.9, 105, 105.1, 105.3, 105.5, 105.8,
00373     106.4, 107, 107.6, 108.1, 108.8, 110, 111.8, 114.2, 117.4, 121.6,
00374     127.9, 137.3, 151.2, 169.5, 189, 205.8, 218.9, 229.1, 237.8, 245,
00375     251.5, 257.1, 262.3, 268.2, 274, 280.4, 286.7, 292.4, 297.9, 302.9,
00376     308.5, 312.2, 313.1, 313.3},
00377    {187.4, 184.5, 173.3, 166.1, 165.4, 167.8, 169.6, 173.6, 179.6,
00378     187.9, 198.9, 210, 220.5, 229.2, 235.7, 239.9, 241.8, 241.6, 239.6,
00379     235.8, 229.4, 218.6, 200.9, 175.9, 149.4, 129.4, 118.3, 113.1,
00380     110.8, 109.7, 109.3, 109.4, 109.7, 110, 110.2, 110.4, 110.5, 110.7,
00381     111, 111.4, 111.8, 112.1, 112.3, 112.7, 113.2, 113.9, 115, 116.4,
00382     117.9, 120.4, 124.1, 130.9, 142.2, 159.6, 179.6, 198.5, 212.9,
00383     224.2, 232.7, 239.1, 243.8, 247.7, 252.4, 257.3, 263.2, 269.5,
00384     275.4, 281.1, 286.3, 292, 296.3, 298.2, 298.8},
00385    {166, 166.4, 155.7, 148.3, 147.1, 149, 152.1, 157, 163.6, 172.4,
00386     185.3, 199.2, 212.6, 224, 233.2, 239.6, 243.3, 244.6, 243.6, 240.3,
00387     233.9, 222.6, 203.7, 177, 149.5, 129.7, 119, 114, 111.7, 110.7,
00388     110.3, 110.3, 110.6, 110.9, 111.1, 111.3, 111.5, 111.6, 111.9,
00389     112.2, 112.5, 112.6, 112.8, 113, 113.4, 114, 115.1, 116.5, 118.3,
00390     120.9, 124.4, 130.2, 139.4, 154.6, 173.8, 193.1, 208.1, 220.4,
00391     230.1, 238.2, 244.7, 249.5, 254.5, 259.3, 264.5, 269.4, 273.7,
00392     278.2, 282.6, 287.4, 290.9, 292.5, 293},
00393    {171.9, 172.8, 166.2, 162.3, 161.4, 162.5, 165.2, 169.6, 175.3,
00394     183.1, 193.8, 205.9, 218.3, 229.6, 238.5, 244.3, 246.9, 246.7,
00395     243.8, 238.4, 230.2, 217.9, 199.6, 174.9, 148.9, 129.8, 119.5,
00396     114.8, 112.3, 110.9, 110.3, 110.1, 110.2, 110.3, 110.4, 110.5,
00397     110.6, 110.8, 111, 111.4, 111.8, 112, 112.2, 112.4, 112.9, 113.6,
00398     114.7, 116.3, 118.4, 121.9, 127.1, 136.1, 149.8, 168.4, 186.9,
00399     203.3, 217, 229.1, 238.7, 247, 254, 259.3, 264.3, 268.3, 272.5,
00400     276.6, 280.4, 284.4, 288.4, 293.3, 297.2, 298.7, 299.1},
00401    {191.6, 192.2, 189, 188.1, 190.2, 193.7, 197.8, 202.9, 208.5,
00402     215.6, 224.2, 233.1, 241.2, 247.3, 250.8, 251.3, 248.9, 244.2,
00403     237.3, 228.4, 217.2, 202.9, 184.5, 162.5, 140.7, 124.8, 116.2,
00404     111.8, 109.4, 107.9, 107, 106.7, 106.6, 106.6, 106.7, 106.7,
00405     106.8, 107, 107.4, 108, 108.7, 109.3, 109.8, 110.4, 111.2,
00406     112.4, 114.2, 116.9, 121.1, 127.9, 139.3, 155.2, 173.6, 190.7,
00407     206.1, 220.1, 232.3, 243, 251.8, 259.2, 265.7, 270.6, 275.3,
00408     279.3, 283.3, 286.9, 289.7, 292.8, 296.1, 300.5, 303.9, 304.8,
00409     305.1},
00410    {241.5, 239.6, 236.8, 237.4, 239.4, 242.3, 244.2, 246.4, 249.2,
00411     253.6, 258.6, 262.7, 264.8, 264.2, 260.6, 254.1, 245.5, 235.3,
00412     223.9, 211.7, 198.3, 183.1, 165.6, 147.1, 130.5, 118.7, 111.9,
00413     108.1, 105.8, 104.3, 103.4, 102.8, 102.5, 102.4, 102.5, 102.5,
```

```
00414    102.5, 102.7, 103.1, 103.8, 104.6, 105.4, 106.1, 107, 108.2,
00415    109.9, 112.8, 117.5, 126, 140.4, 161, 181.9, 201.2, 216.8, 230.4,
00416    241.8, 251.4, 259.9, 266.9, 272.8, 277.4, 280.4, 282.9, 284.6,
00417    286.1, 287.4, 288.3, 289.5, 290.9, 294.2, 296.9, 297.5, 297.6},
00418   {301.2, 300.3, 296.6, 295.4, 295, 294.3, 291.2, 287.4, 284.9, 284.7,
00419    284.1, 281.5, 277.1, 270.4, 261.7, 250.6, 237.6, 223.1, 207.9, 192,
00420    175.8, 158.8, 142.1, 127.6, 116.8, 109.9, 106, 103.6, 102.1, 101.1,
00421    100.4, 99.96, 99.6, 99.37, 99.32, 99.32, 99.31, 99.46, 99.77, 100.2,
00422    100.7, 101.3, 101.8, 102.7, 104.1, 106.8, 111.9, 121, 136.7, 160,
00423    186.9, 209.9, 228.1, 241.2, 251.5, 259.5, 265.7, 270.9, 274.8, 278,
00424    280.3, 281.8, 283, 283.3, 283.7, 283.8, 283, 282.2, 281.2, 281.4,
00425    281.7, 281.1, 281.2}
00426   };
00427
00428   double doy, p0, p1;
00429
00430   int imon, ilat;
00431
00432   /* Get day of year... */
00433   doy = fmod(t / 86400., 365.25);
00434   while (doy < 0)
00435     doy += 365.25;
00436
00437   /* Get indices... */
00438   ilat = locate_reg(lats, 73, lat);
00439   imon = locate_irr(doys, 12, doy);
00440
00441   /* Interpolate... */
00442   p0 = LIN(lats[ilat], tps[imon][ilat],
00443            lats[ilat + 1], tps[imon][ilat + 1], lat);
00444   p1 = LIN(lats[ilat], tps[imon + 1][ilat],
00445            lats[ilat + 1], tps[imon + 1][ilat + 1], lat);
00446   return LIN(doys[imon], p0, doys[imon + 1], p1, doy);
00447 }
```

Here is the call graph for this function:



5.19.2.4 void day2doy (int *year*, int *mon*, int *day*, int * *doy*)

Get day of year from date.

Definition at line 451 of file libtrac.c.

```
00455            {
00456
00457   int d0[12] = { 1, 32, 60, 91, 121, 152, 182, 213, 244, 274, 305, 335 };
00458   int d01[12] = { 1, 32, 61, 92, 122, 153, 183, 214, 245, 275, 306, 336 };
00459
00460   /* Get day of year... */
00461   if (year % 400 == 0 || (year % 100 != 0 && year % 4 == 0))
00462     *doy = d01[mon - 1] + day - 1;
00463   else
00464     *doy = d0[mon - 1] + day - 1;
00465 }
```

5.19.2.5 void doy2day (int *year*, int *doy*, int * *mon*, int * *day*)

Get date from day of year.

Definition at line 469 of file libtrac.c.

```
00473            {
00474
00475   int d0[12] = { 1, 32, 60, 91, 121, 152, 182, 213, 244, 274, 305, 335 };
00476   int d0l[12] = { 1, 32, 61, 92, 122, 153, 183, 214, 245, 275, 306, 336 };
00477   int i;
00478
00479   /* Get month and day... */
00480   if (year % 400 == 0 || (year % 100 != 0 && year % 4 == 0)) {
00481     for (i = 11; i >= 0; i--)
00482       if (d0l[i] <= doy)
00483         break;
00484     *mon = i + 1;
00485     *day = doy - d0l[i] + 1;
00486   } else {
00487     for (i = 11; i >= 0; i--)
00488       if (d0[i] <= doy)
00489         break;
00490     *mon = i + 1;
00491     *day = doy - d0[i] + 1;
00492   }
00493 }
```

5.19.2.6 void geo2cart (double *z*, double *lon*, double *lat*, double * *x*)

Convert geolocation to Cartesian coordinates.

Definition at line 497 of file libtrac.c.

```
00501             {
00502
00503   double radius;
00504
00505   radius = z + RE;
00506   x[0] = radius * cos(lat / 180 * M_PI) * cos(lon / 180 * M_PI);
00507   x[1] = radius * cos(lat / 180 * M_PI) * sin(lon / 180 * M_PI);
00508   x[2] = radius * sin(lat / 180 * M_PI);
00509 }
```

5.19.2.7 void get_met (ctl_t * *ctl*, char * *metbase*, double *t*, met_t ** *met0*, met_t ** *met1*)

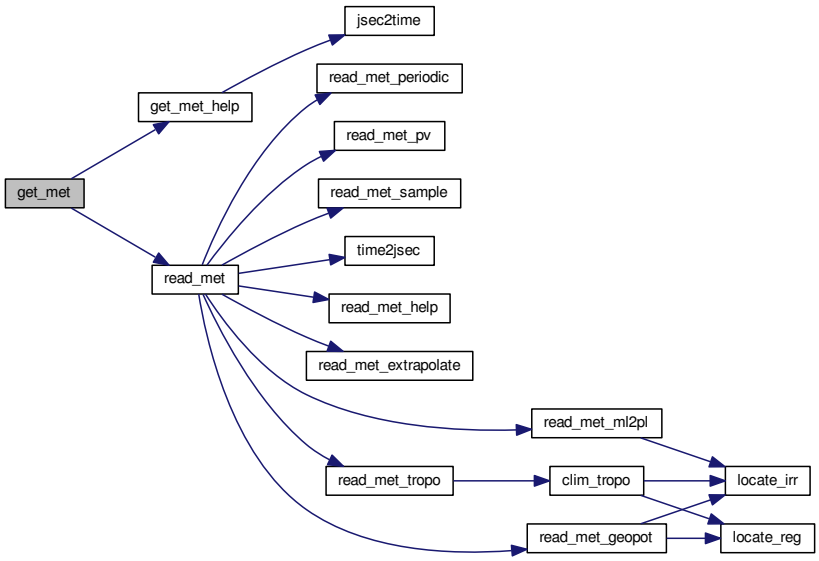
Get meteorological data for given timestep.

Definition at line 513 of file libtrac.c.

```
00518                 {
00519
00520   static int init, ip, ix, iy;
00521
00522   met_t *mets;
00523
00524   char filename[LEN];
00525
00526   /* Init... */
00527   if (t == ctl->t_start || !init) {
00528     init = 1;
00529
00530     get_met_help(t, -1, metbase, ctl->dt_met, filename);
00531     read_met(ctl, filename, *met0);
00532
00533     get_met_help(t + 1.0 * ctl->direction, 1, metbase, ctl->
    dt_met, filename);
00534     read_met(ctl, filename, *met1);
00535   }
00536
```

```
00537   /* Read new data for forward trajectories... */
00538   if (t > (*met1)->time && ctl->direction == 1) {
00539     mets = *met1;
00540     *met1 = *met0;
00541     *met0 = mets;
00542     get_met_help(t, 1, metbase, ctl->dt_met, filename);
00543     read_met(ctl, filename, *met1);
00544   }
00545
00546   /* Read new data for backward trajectories... */
00547   if (t < (*met0)->time && ctl->direction == -1) {
00548     mets = *met1;
00549     *met1 = *met0;
00550     *met0 = mets;
00551     get_met_help(t, -1, metbase, ctl->dt_met, filename);
00552     read_met(ctl, filename, *met0);
00553   }
00554
00555   /* Check that grids are consistent... */
00556   if ((*met0)->nx != (*met1)->nx
00557       || (*met0)->ny != (*met1)->ny || (*met0)->np != (*met1)->np)
00558     ERRMSG("Meteo grid dimensions do not match!");
00559   for (ix = 0; ix < (*met0)->nx; ix++)
00560     if ((*met0)->lon[ix] != (*met1)->lon[ix])
00561       ERRMSG("Meteo grid longitudes do not match!");
00562   for (iy = 0; iy < (*met0)->ny; iy++)
00563     if ((*met0)->lat[iy] != (*met1)->lat[iy])
00564       ERRMSG("Meteo grid latitudes do not match!");
00565   for (ip = 0; ip < (*met0)->np; ip++)
00566     if ((*met0)->p[ip] != (*met1)->p[ip])
00567       ERRMSG("Meteo grid pressure levels do not match!");
00568 }
```

Here is the call graph for this function:



5.19.2.8 void get_met_help (double *t*, int *direct*, char * *metbase*, double *dt_met*, char * *filename*)

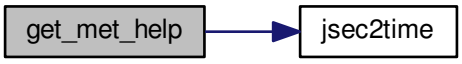
Get meteorological data for timestep.

Definition at line 572 of file libtrac.c.

```
00577                   {
00578
00579   double t6, r;
```

```
00580
00581   int year, mon, day, hour, min, sec;
00582
00583   /* Round time to fixed intervals... */
00584   if (direct == -1)
00585     t6 = floor(t / dt_met) * dt_met;
00586   else
00587     t6 = ceil(t / dt_met) * dt_met;
00588
00589   /* Decode time... */
00590   jsec2time(t6, &year, &mon, &day, &hour, &min, &sec, &r);
00591
00592   /* Set filename... */
00593   sprintf(filename, "%s_%d_%02d_%02d_%02d.nc", metbase, year, mon, day, hour);
00594 }
```

Here is the call graph for this function:



5.19.2.9 void intpol_met_2d (double *array[EX][EY]*, int *ix*, int *iy*, double *wx*, double *wy*, double * *var*)

Linear interpolation of 2-D meteorological data.

Definition at line 598 of file libtrac.c.

```
00604               {
00605
00606   double aux00, aux01, aux10, aux11;
00607
00608   /* Set variables... */
00609   aux00 = array[ix][iy];
00610   aux01 = array[ix][iy + 1];
00611   aux10 = array[ix + 1][iy];
00612   aux11 = array[ix + 1][iy + 1];
00613
00614   /* Interpolate horizontally... */
00615   aux00 = wy * (aux00 - aux01) + aux01;
00616   aux11 = wy * (aux10 - aux11) + aux11;
00617   *var = wx * (aux00 - aux11) + aux11;
00618 }
```

5.19.2.10 void intpol_met_3d (float *array[EX][EY][EP]*, int *ip*, int *ix*, int *iy*, double *wp*, double *wx*, double *wy*, double * *var*)

Linear interpolation of 3-D meteorological data.

Definition at line 622 of file libtrac.c.

```
00630               {
00631
00632   double aux00, aux01, aux10, aux11;
00633
00634   /* Interpolate vertically... */
00635   aux00 = wp * (array[ix][iy][ip] - array[ix][iy][ip + 1])
00636     + array[ix][iy][ip + 1];
00637   aux01 = wp * (array[ix][iy + 1][ip] - array[ix][iy + 1][ip + 1])
00638     + array[ix][iy + 1][ip + 1];
00639   aux10 = wp * (array[ix + 1][iy][ip] - array[ix + 1][iy][ip + 1])
00640     + array[ix + 1][iy][ip + 1];
00641   aux11 = wp * (array[ix + 1][iy + 1][ip] - array[ix + 1][iy + 1][ip + 1])
00642     + array[ix + 1][iy + 1][ip + 1];
00643
00644   /* Interpolate horizontally... */
00645   aux00 = wy * (aux00 - aux01) + aux01;
00646   aux11 = wy * (aux10 - aux11) + aux11;
00647   *var = wx * (aux00 - aux11) + aux11;
00648 }
```

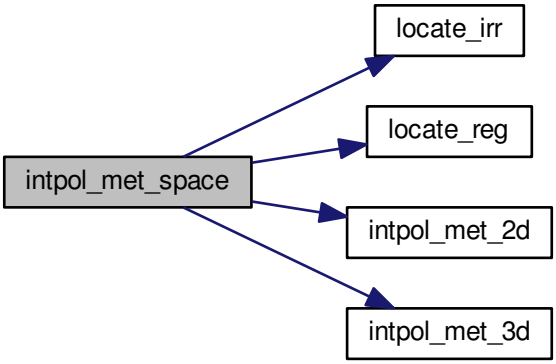
5.19.2.11 void intpol_met_space (met_t * *met*, double *p*, double *lon*, double *lat*, double * *ps*, double * *pt*, double * *z*, double * *t*, double * *u*, double * *v*, double * *w*, double * *pv*, double * *h2o*, double * *o3*)

Spatial interpolation of meteorological data.

Definition at line 652 of file libtrac.c.

```
00666               {
00667
00668   double wp, wx, wy;
00669
00670   int ip, ix, iy;
00671
00672   /* Check longitude... */
00673   if (met->lon[met->nx - 1] > 180 && lon < 0)
00674     lon += 360;
00675
00676   /* Get indices... */
00677   ip = locate_irr(met->p, met->np, p);
00678   ix = locate_reg(met->lon, met->nx, lon);
00679   iy = locate_reg(met->lat, met->ny, lat);
00680
00681   /* Get weights... */
00682   wp = (met->p[ip + 1] - p) / (met->p[ip + 1] - met->p[ip]);
00683   wx = (met->lon[ix + 1] - lon) / (met->lon[ix + 1] - met->lon[ix]);
00684   wy = (met->lat[iy + 1] - lat) / (met->lat[iy + 1] - met->lat[iy]);
00685
00686   /* Interpolate... */
00687   if (ps != NULL)
00688     intpol_met_2d(met->ps, ix, iy, wx, wy, ps);
00689   if (pt != NULL)
00690     intpol_met_2d(met->pt, ix, iy, wx, wy, pt);
00691   if (z != NULL)
00692     intpol_met_3d(met->z, ip, ix, iy, wp, wx, wy, z);
00693   if (t != NULL)
00694     intpol_met_3d(met->t, ip, ix, iy, wp, wx, wy, t);
00695   if (u != NULL)
00696     intpol_met_3d(met->u, ip, ix, iy, wp, wx, wy, u);
00697   if (v != NULL)
00698     intpol_met_3d(met->v, ip, ix, iy, wp, wx, wy, v);
00699   if (w != NULL)
00700     intpol_met_3d(met->w, ip, ix, iy, wp, wx, wy, w);
00701   if (pv != NULL)
00702     intpol_met_3d(met->pv, ip, ix, iy, wp, wx, wy, pv);
00703   if (h2o != NULL)
00704     intpol_met_3d(met->h2o, ip, ix, iy, wp, wx, wy, h2o);
00705   if (o3 != NULL)
00706     intpol_met_3d(met->o3, ip, ix, iy, wp, wx, wy, o3);
00707 }
```

Here is the call graph for this function:



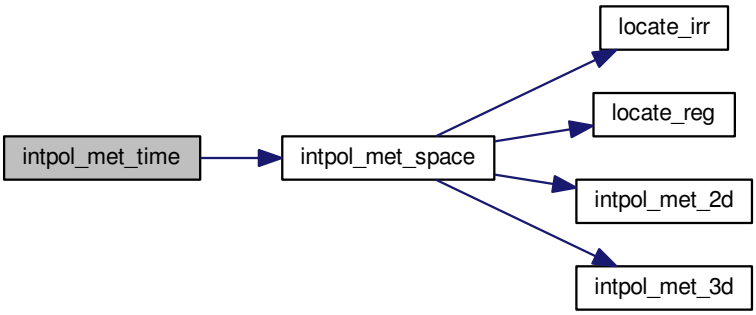
5.19.2.12 void intpol_met_time (met_t * *met0*, met_t * *met1*, double *ts*, double *p*, double *lon*, double *lat*, double * *ps*, double * *pt*, double * *z*, double * *t*, double * *u*, double * *v*, double * *w*, double * *pv*, double * *h2o*, double * *o3*)

Temporal interpolation of meteorological data.

Definition at line 711 of file libtrac.c.

```
00727              {
00728
00729   double h2o0, h2o1, o30, o31, ps0, ps1, pt0, pt1, pv0, pv1, t0, t1, u0, u1,
00730     v0, v1, w0, w1, wt, z0, z1;
00731
00732   /* Spatial interpolation... */
00733   intpol_met_space(met0, p, lon, lat,
00734                    ps == NULL ? NULL : &ps0,
00735                    pt == NULL ? NULL : &pt0,
00736                    z == NULL ? NULL : &z0,
00737                    t == NULL ? NULL : &t0,
00738                    u == NULL ? NULL : &u0,
00739                    v == NULL ? NULL : &v0,
00740                    w == NULL ? NULL : &w0,
00741                    pv == NULL ? NULL : &pv0,
00742                    h2o == NULL ? NULL : &h2o0, o3 == NULL ? NULL : &o30);
00743   intpol_met_space(met1, p, lon, lat,
00744                    ps == NULL ? NULL : &ps1,
00745                    pt == NULL ? NULL : &pt1,
00746                    z == NULL ? NULL : &z1,
00747                    t == NULL ? NULL : &t1,
00748                    u == NULL ? NULL : &u1,
00749                    v == NULL ? NULL : &v1,
00750                    w == NULL ? NULL : &w1,
00751                    pv == NULL ? NULL : &pv1,
00752                    h2o == NULL ? NULL : &h2o1, o3 == NULL ? NULL : &o31);
00753
00754   /* Get weighting factor... */
00755   wt = (met1->time - ts) / (met1->time - met0->time);
00756
00757   /* Interpolate... */
00758   if (ps != NULL)
00759     *ps = wt * (ps0 - ps1) + ps1;
00760   if (pt != NULL)
00761     *pt = wt * (pt0 - pt1) + pt1;
00762   if (z != NULL)
00763     *z = wt * (z0 - z1) + z1;
00764   if (t != NULL)
00765     *t = wt * (t0 - t1) + t1;
00766   if (u != NULL)
00767     *u = wt * (u0 - u1) + u1;
00768   if (v != NULL)
00769     *v = wt * (v0 - v1) + v1;
00770   if (w != NULL)
00771     *w = wt * (w0 - w1) + w1;
00772   if (pv != NULL)
00773     *pv = wt * (pv0 - pv1) + pv1;
00774   if (h2o != NULL)
00775     *h2o = wt * (h2o0 - h2o1) + h2o1;
00776   if (o3 != NULL)
00777     *o3 = wt * (o30 - o31) + o31;
00778 }
```

Here is the call graph for this function:



5.19.2.13 void jsec2time (double *jsec*, int * *year*, int * *mon*, int * *day*, int * *hour*, int * *min*, int * *sec*, double * *remain*)

Convert seconds to date.

Definition at line 782 of file libtrac.c.

```
00790                   {
00791
00792   struct tm t0, *t1;
00793
00794   time_t jsec0;
00795
00796   t0.tm_year = 100;
00797   t0.tm_mon = 0;
00798   t0.tm_mday = 1;
00799   t0.tm_hour = 0;
00800   t0.tm_min = 0;
00801   t0.tm_sec = 0;
00802
00803   jsec0 = (time_t) jsec + timegm(&t0);
00804   t1 = gmtime(&jsec0);
00805
00806   *year = t1->tm_year + 1900;
00807   *mon = t1->tm_mon + 1;
00808   *day = t1->tm_mday;
00809   *hour = t1->tm_hour;
00810   *min = t1->tm_min;
00811   *sec = t1->tm_sec;
00812   *remain = jsec - floor(jsec);
00813 }
```

5.19.2.14 int locate_irr (double * *xx*, int *n*, double *x*)

Find array index for irregular grid.

Definition at line 817 of file libtrac.c.

```
00820             {
00821
00822   int i, ilo, ihi;
00823
00824   ilo = 0;
00825   ihi = n - 1;
00826   i = (ihi + ilo) >> 1;
00827
```

```
00828   if (xx[i] < xx[i + 1])
00829     while (ihi > ilo + 1) {
00830       i = (ihi + ilo) >> 1;
00831       if (xx[i] > x)
00832         ihi = i;
00833       else
00834         ilo = i;
00835   } else
00836     while (ihi > ilo + 1) {
00837       i = (ihi + ilo) >> 1;
00838       if (xx[i] <= x)
00839         ihi = i;
00840       else
00841         ilo = i;
00842     }
00843
00844   return ilo;
00845 }
```

5.19.2.15 int locate_reg (double * *xx*, int *n*, double *x*)

Find array index for regular grid.

Definition at line 849 of file libtrac.c.

```
00852             {
00853
00854   int i;
00855
00856   /* Calculate index... */
00857   i = (int) ((x - xx[0]) / (xx[1] - xx[0]));
00858
00859   /* Check range... */
00860   if (i < 0)
00861     i = 0;
00862   else if (i >= n - 2)
00863     i = n - 2;
00864
00865   return i;
00866 }
```

5.19.2.16 void read_atm (const char * *filename*, ctl_t * *ctl*, atm_t * *atm*)

Read atmospheric data.

Definition at line 870 of file libtrac.c.

```
00873               {
00874
00875   FILE *in;
00876
00877   char line[LEN], *tok;
00878
00879   double t0;
00880
00881   int dimid, ip, iq, ncid, varid;
00882
00883   size_t nparts;
00884
00885   /* Init... */
00886   atm->np = 0;
00887
00888   /* Write info... */
00889   printf("Read atmospheric data: %s\n", filename);
00890
00891   /* Read ASCII data... */
00892   if (ctl->atm_type == 0) {
00893
00894     /* Open file... */
00895     if (!(in = fopen(filename, "r")))
00896       ERRMSG("Cannot open file!");
00897
00898     /* Read line... */
00899     while (fgets(line, LEN, in)) {
```

```
00900
00901       /* Read data... */
00902       TOK(line, tok, "%lg", atm->time[atm->np]);
00903       TOK(NULL, tok, "%lg", atm->p[atm->np]);
00904       TOK(NULL, tok, "%lg", atm->lon[atm->np]);
00905       TOK(NULL, tok, "%lg", atm->lat[atm->np]);
00906       for (iq = 0; iq < ctl->nq; iq++)
00907         TOK(NULL, tok, "%lg", atm->q[iq][atm->np]);
00908
00909       /* Convert altitude to pressure... */
00910       atm->p[atm->np] = P(atm->p[atm->np]);
00911
00912       /* Increment data point counter... */
00913       if ((++atm->np) > NP)
00914         ERRMSG("Too many data points!");
00915     }
00916
00917     /* Close file... */
00918     fclose(in);
00919   }
00920
00921   /* Read binary data... */
00922   else if (ctl->atm_type == 1) {
00923
00924     /* Open file... */
00925     if (!(in = fopen(filename, "r")))
00926       ERRMSG("Cannot open file!");
00927
00928     /* Read data... */
00929     FREAD(&atm->np, int,
00930           1,
00931           in);
00932     FREAD(atm->time, double,
00933             (size_t) atm->np,
00934           in);
00935     FREAD(atm->p, double,
00936             (size_t) atm->np,
00937           in);
00938     FREAD(atm->lon, double,
00939             (size_t) atm->np,
00940           in);
00941     FREAD(atm->lat, double,
00942             (size_t) atm->np,
00943           in);
00944     for (iq = 0; iq < ctl->nq; iq++)
00945       FREAD(atm->q[iq], double,
00946               (size_t) atm->np,
00947             in);
00948
00949     /* Close file... */
00950     fclose(in);
00951   }
00952
00953   /* Read netCDF data... */
00954   else if (ctl->atm_type == 2) {
00955
00956     /* Open file... */
00957     NC(nc_open(filename, NC_NOWRITE, &ncid));
00958
00959     /* Get dimensions... */
00960     NC(nc_inq_dimid(ncid, "NPARTS", &dimid));
00961     NC(nc_inq_dimlen(ncid, dimid, &nparts));
00962     atm->np = (int) nparts;
00963     if (atm->np > NP)
00964       ERRMSG("Too many particles!");
00965
00966     /* Get time... */
00967     NC(nc_inq_varid(ncid, "time", &varid));
00968     NC(nc_get_var_double(ncid, varid, &t0));
00969     for (ip = 0; ip < atm->np; ip++)
00970       atm->time[ip] = t0;
00971
00972     /* Read geolocations... */
00973     NC(nc_inq_varid(ncid, "PRESS", &varid));
00974     NC(nc_get_var_double(ncid, varid, atm->p));
00975     NC(nc_inq_varid(ncid, "LON", &varid));
00976     NC(nc_get_var_double(ncid, varid, atm->lon));
00977     NC(nc_inq_varid(ncid, "LAT", &varid));
00978     NC(nc_get_var_double(ncid, varid, atm->lat));
00979
00980     /* Read variables... */
00981     if (ctl->qnt_p >= 0)
00982       if (nc_inq_varid(ncid, "PRESS", &varid) == NC_NOERR)
00983         NC(nc_get_var_double(ncid, varid, atm->q[ctl->qnt_p]));
00984     if (ctl->qnt_t >= 0)
00985       if (nc_inq_varid(ncid, "TEMP", &varid) == NC_NOERR)
00986         NC(nc_get_var_double(ncid, varid, atm->q[ctl->qnt_t]));
```

```
00987     if (ctl->qnt_u >= 0)
00988       if (nc_inq_varid(ncid, "U", &varid) == NC_NOERR)
00989         NC(nc_get_var_double(ncid, varid, atm->q[ctl->qnt_u]));
00990     if (ctl->qnt_v >= 0)
00991       if (nc_inq_varid(ncid, "V", &varid) == NC_NOERR)
00992         NC(nc_get_var_double(ncid, varid, atm->q[ctl->qnt_v]));
00993     if (ctl->qnt_w >= 0)
00994       if (nc_inq_varid(ncid, "W", &varid) == NC_NOERR)
00995         NC(nc_get_var_double(ncid, varid, atm->q[ctl->qnt_w]));
00996     if (ctl->qnt_h2o >= 0)
00997       if (nc_inq_varid(ncid, "SH", &varid) == NC_NOERR)
00998         NC(nc_get_var_double(ncid, varid, atm->q[ctl->qnt_h2o]));
00999     if (ctl->qnt_o3 >= 0)
01000       if (nc_inq_varid(ncid, "O3", &varid) == NC_NOERR)
01001         NC(nc_get_var_double(ncid, varid, atm->q[ctl->qnt_o3]));
01002     if (ctl->qnt_theta >= 0)
01003       if (nc_inq_varid(ncid, "THETA", &varid) == NC_NOERR)
01004         NC(nc_get_var_double(ncid, varid, atm->q[ctl->qnt_theta]));
01005     if (ctl->qnt_pv >= 0)
01006       if (nc_inq_varid(ncid, "PV", &varid) == NC_NOERR)
01007         NC(nc_get_var_double(ncid, varid, atm->q[ctl->qnt_pv]));
01008
01009     /* Check data... */
01010     for (ip = 0; ip < atm->np; ip++)
01011       if (fabs(atm->lon[ip]) > 360 || fabs(atm->lat[ip]) > 90
01012           || (ctl->qnt_t >= 0 && fabs(atm->q[ctl->qnt_t][ip]) > 350)
01013           || (ctl->qnt_h2o >= 0 && fabs(atm->q[ctl->qnt_h2o][ip]) > 1)
01014           || (ctl->qnt_theta >= 0 && fabs(atm->q[ctl->qnt_theta][ip]) > 1e10)
01015           || (ctl->qnt_pv >= 0 && fabs(atm->q[ctl->qnt_pv][ip]) > 1e10)) {
01016         atm->time[ip] = GSL_NAN;
01017         atm->p[ip] = GSL_NAN;
01018         atm->lon[ip] = GSL_NAN;
01019         atm->lat[ip] = GSL_NAN;
01020         for (iq = 0; iq < ctl->nq; iq++)
01021           atm->q[iq][ip] = GSL_NAN;
01022       } else {
01023         if (ctl->qnt_h2o >= 0)
01024           atm->q[ctl->qnt_h2o][ip] *= 1.608;
01025         if (ctl->qnt_pv >= 0)
01026           atm->q[ctl->qnt_pv][ip] *= 1e6;
01027         if (atm->lon[ip] > 180)
01028           atm->lon[ip] -= 360;
01029       }
01030
01031     /* Close file... */
01032     NC(nc_close(ncid));
01033   }
01034
01035   /* Error... */
01036   else
01037     ERRMSG("Atmospheric data type not supported!");
01038
01039   /* Check number of points... */
01040   if (atm->np < 1)
01041     ERRMSG("Can not read any data!");
01042 }
```

5.19.2.17 void read_ctl (const char * *filename*, int *argc*, char * *argv[]*, ctl_t * *ctl*)

Read control parameters.

Definition at line 1046 of file libtrac.c.

```
01050                {
01051
01052   int ip, iq;
01053
01054   /* Write info... */
01055   printf("\nMassive-Parallel Trajectory Calculations (MPTRAC)\n"
01056          "(executable: %s | compiled: %s, %s)\n\n",
01057          argv[0], __DATE__, __TIME__);
01058
01059   /* Initialize quantity indices... */
01060   ctl->qnt_ens = -1;
01061   ctl->qnt_m = -1;
01062   ctl->qnt_r = -1;
01063   ctl->qnt_rho = -1;
01064   ctl->qnt_ps = -1;
01065   ctl->qnt_pt = -1;
01066   ctl->qnt_z = -1;
```

```
01067   ctl->qnt_p = -1;
01068   ctl->qnt_t = -1;
01069   ctl->qnt_u = -1;
01070   ctl->qnt_v = -1;
01071   ctl->qnt_w = -1;
01072   ctl->qnt_h2o = -1;
01073   ctl->qnt_o3 = -1;
01074   ctl->qnt_theta = -1;
01075   ctl->qnt_vh = -1;
01076   ctl->qnt_vz = -1;
01077   ctl->qnt_pv = -1;
01078   ctl->qnt_tice = -1;
01079   ctl->qnt_tsts = -1;
01080   ctl->qnt_tnat = -1;
01081   ctl->qnt_stat = -1;
01082
01083   /* Read quantities... */
01084   ctl->nq = (int) scan_ctl(filename, argc, argv, "NQ", -1, "0", NULL);
01085   if (ctl->nq > NQ)
01086     ERRMSG("Too many quantities!");
01087   for (iq = 0; iq < ctl->nq; iq++) {
01088
01089     /* Read quantity name and format... */
01090     scan_ctl(filename, argc, argv, "QNT_NAME", iq, "", ctl->qnt_name[iq]);
01091     scan_ctl(filename, argc, argv, "QNT_FORMAT", iq, "%g",
01092              ctl->qnt_format[iq]);
01093
01094     /* Try to identify quantity... */
01095     if (strcmp(ctl->qnt_name[iq], "ens") == 0) {
01096       ctl->qnt_ens = iq;
01097       sprintf(ctl->qnt_unit[iq], "-");
01098     } else if (strcmp(ctl->qnt_name[iq], "m") == 0) {
01099       ctl->qnt_m = iq;
01100       sprintf(ctl->qnt_unit[iq], "kg");
01101     } else if (strcmp(ctl->qnt_name[iq], "r") == 0) {
01102       ctl->qnt_r = iq;
01103       sprintf(ctl->qnt_unit[iq], "m");
01104     } else if (strcmp(ctl->qnt_name[iq], "rho") == 0) {
01105       ctl->qnt_rho = iq;
01106       sprintf(ctl->qnt_unit[iq], "kg/m^3");
01107     } else if (strcmp(ctl->qnt_name[iq], "ps") == 0) {
01108       ctl->qnt_ps = iq;
01109       sprintf(ctl->qnt_unit[iq], "hPa");
01110     } else if (strcmp(ctl->qnt_name[iq], "pt") == 0) {
01111       ctl->qnt_pt = iq;
01112       sprintf(ctl->qnt_unit[iq], "hPa");
01113     } else if (strcmp(ctl->qnt_name[iq], "z") == 0) {
01114       ctl->qnt_z = iq;
01115       sprintf(ctl->qnt_unit[iq], "km");
01116     } else if (strcmp(ctl->qnt_name[iq], "p") == 0) {
01117       ctl->qnt_p = iq;
01118       sprintf(ctl->qnt_unit[iq], "hPa");
01119     } else if (strcmp(ctl->qnt_name[iq], "t") == 0) {
01120       ctl->qnt_t = iq;
01121       sprintf(ctl->qnt_unit[iq], "K");
01122     } else if (strcmp(ctl->qnt_name[iq], "u") == 0) {
01123       ctl->qnt_u = iq;
01124       sprintf(ctl->qnt_unit[iq], "m/s");
01125     } else if (strcmp(ctl->qnt_name[iq], "v") == 0) {
01126       ctl->qnt_v = iq;
01127       sprintf(ctl->qnt_unit[iq], "m/s");
01128     } else if (strcmp(ctl->qnt_name[iq], "w") == 0) {
01129       ctl->qnt_w = iq;
01130       sprintf(ctl->qnt_unit[iq], "hPa/s");
01131     } else if (strcmp(ctl->qnt_name[iq], "h2o") == 0) {
01132       ctl->qnt_h2o = iq;
01133       sprintf(ctl->qnt_unit[iq], "1");
01134     } else if (strcmp(ctl->qnt_name[iq], "o3") == 0) {
01135       ctl->qnt_o3 = iq;
01136       sprintf(ctl->qnt_unit[iq], "1");
01137     } else if (strcmp(ctl->qnt_name[iq], "theta") == 0) {
01138       ctl->qnt_theta = iq;
01139       sprintf(ctl->qnt_unit[iq], "K");
01140     } else if (strcmp(ctl->qnt_name[iq], "vh") == 0) {
01141       ctl->qnt_vh = iq;
01142       sprintf(ctl->qnt_unit[iq], "m/s");
01143     } else if (strcmp(ctl->qnt_name[iq], "vz") == 0) {
01144       ctl->qnt_vz = iq;
01145       sprintf(ctl->qnt_unit[iq], "m/s");
01146     } else if (strcmp(ctl->qnt_name[iq], "pv") == 0) {
01147       ctl->qnt_pv = iq;
01148       sprintf(ctl->qnt_unit[iq], "PVU");
01149     } else if (strcmp(ctl->qnt_name[iq], "tice") == 0) {
01150       ctl->qnt_tice = iq;
01151       sprintf(ctl->qnt_unit[iq], "K");
01152     } else if (strcmp(ctl->qnt_name[iq], "tsts") == 0) {
01153       ctl->qnt_tsts = iq;
```

```
01154       sprintf(ctl->qnt_unit[iq], "K");
01155     } else if (strcmp(ctl->qnt_name[iq], "tnat") == 0) {
01156       ctl->qnt_tnat = iq;
01157       sprintf(ctl->qnt_unit[iq], "K");
01158     } else if (strcmp(ctl->qnt_name[iq], "stat") == 0) {
01159       ctl->qnt_stat = iq;
01160       sprintf(ctl->qnt_unit[iq], "-");
01161     } else
01162       scan_ctl(filename, argc, argv, "QNT_UNIT", iq, "", ctl->qnt_unit[iq]);
01163   }
01164
01165   /* Time steps of simulation... */
01166   ctl->direction =
01167     (int) scan_ctl(filename, argc, argv, "DIRECTION", -1, "1", NULL);
01168   if (ctl->direction != -1 && ctl->direction != 1)
01169     ERRMSG("Set DIRECTION to -1 or 1!");
01170   ctl->t_stop = scan_ctl(filename, argc, argv, "T_STOP", -1, "1e100", NULL);
01171   ctl->dt_mod = scan_ctl(filename, argc, argv, "DT_MOD", -1, "600", NULL);
01172
01173   /* Meteorological data... */
01174   ctl->dt_met = scan_ctl(filename, argc, argv, "DT_MET", -1, "21600", NULL);
01175   ctl->met_dx = (int) scan_ctl(filename, argc, argv, "MET_DX", -1, "1", NULL);
01176   ctl->met_dy = (int) scan_ctl(filename, argc, argv, "MET_DY", -1, "1", NULL);
01177   ctl->met_dp = (int) scan_ctl(filename, argc, argv, "MET_DP", -1, "1", NULL);
01178   ctl->met_sx = (int) scan_ctl(filename, argc, argv, "MET_SX", -1, "1", NULL);
01179   ctl->met_sy = (int) scan_ctl(filename, argc, argv, "MET_SY", -1, "1", NULL);
01180   ctl->met_sp = (int) scan_ctl(filename, argc, argv, "MET_SP", -1, "1", NULL);
01181   ctl->met_np = (int) scan_ctl(filename, argc, argv, "MET_NP", -1, "0", NULL);
01182   if (ctl->met_np > EP)
01183     ERRMSG("Too many levels!");
01184   for (ip = 0; ip < ctl->met_np; ip++)
01185     ctl->met_p[ip] = scan_ctl(filename, argc, argv, "MET_P", ip, "", NULL);
01186   ctl->met_tropo
01187     = (int) scan_ctl(filename, argc, argv, "MET_TROPO", -1, "0", NULL);
01188   scan_ctl(filename, argc, argv, "MET_GEOPOT", -1, "-", ctl->met_geopot);
01189   scan_ctl(filename, argc, argv, "MET_STAGE", -1, "-", ctl->met_stage);
01190   ctl->met_dt_out =
01191     scan_ctl(filename, argc, argv, "MET_DT_OUT", -1, "0.1", NULL);
01192
01193   /* Isosurface parameters... */
01194   ctl->isosurf
01195     = (int) scan_ctl(filename, argc, argv, "ISOSURF", -1, "0", NULL);
01196   scan_ctl(filename, argc, argv, "BALLOON", -1, "-", ctl->balloon);
01197
01198   /* Diffusion parameters... */
01199   ctl->turb_dx_trop
01200     = scan_ctl(filename, argc, argv, "TURB_DX_TROP", -1, "50", NULL);
01201   ctl->turb_dx_strat
01202     = scan_ctl(filename, argc, argv, "TURB_DX_STRAT", -1, "0", NULL);
01203   ctl->turb_dz_trop
01204     = scan_ctl(filename, argc, argv, "TURB_DZ_TROP", -1, "0", NULL);
01205   ctl->turb_dz_strat
01206     = scan_ctl(filename, argc, argv, "TURB_DZ_STRAT", -1, "0.1", NULL);
01207   ctl->turb_mesox =
01208     scan_ctl(filename, argc, argv, "TURB_MESOX", -1, "0.16", NULL);
01209   ctl->turb_mesoz =
01210     scan_ctl(filename, argc, argv, "TURB_MESOZ", -1, "0.16", NULL);
01211
01212   /* Mass and life time... */
01213   ctl->molmass = scan_ctl(filename, argc, argv, "MOLMASS", -1, "1", NULL);
01214   ctl->tdec_trop = scan_ctl(filename, argc, argv, "TDEC_TROP", -1, "0", NULL);
01215   ctl->tdec_strat =
01216     scan_ctl(filename, argc, argv, "TDEC_STRAT", -1, "0", NULL);
01217
01218   /* PSC analysis... */
01219   ctl->psc_h2o = scan_ctl(filename, argc, argv, "PSC_H2O", -1, "4e-6", NULL);
01220   ctl->psc_hno3 =
01221     scan_ctl(filename, argc, argv, "PSC_HNO3", -1, "9e-9", NULL);
01222
01223   /* Output of atmospheric data... */
01224   scan_ctl(filename, argc, argv, "ATM_BASENAME", -1, "-", ctl->
      atm_basename);
01225   scan_ctl(filename, argc, argv, "ATM_GPFILE", -1, "-", ctl->atm_gpfile);
01226   ctl->atm_dt_out =
01227     scan_ctl(filename, argc, argv, "ATM_DT_OUT", -1, "86400", NULL);
01228   ctl->atm_filter =
01229     (int) scan_ctl(filename, argc, argv, "ATM_FILTER", -1, "0", NULL);
01230   ctl->atm_type =
01231     (int) scan_ctl(filename, argc, argv, "ATM_TYPE", -1, "0", NULL);
01232
01233   /* Output of CSI data... */
01234   scan_ctl(filename, argc, argv, "CSI_BASENAME", -1, "-", ctl->
      csi_basename);
01235   ctl->csi_dt_out =
01236     scan_ctl(filename, argc, argv, "CSI_DT_OUT", -1, "86400", NULL);
01237   scan_ctl(filename, argc, argv, "CSI_OBSFILE", -1, "-", ctl->
      csi_obsfile);
```

```
01238   ctl->csi_obsmin =
01239     scan_ctl(filename, argc, argv, "CSI_OBSMIN", -1, "0", NULL);
01240   ctl->csi_modmin =
01241     scan_ctl(filename, argc, argv, "CSI_MODMIN", -1, "0", NULL);
01242   ctl->csi_z0 = scan_ctl(filename, argc, argv, "CSI_Z0", -1, "0", NULL);
01243   ctl->csi_z1 = scan_ctl(filename, argc, argv, "CSI_Z1", -1, "100", NULL);
01244   ctl->csi_nz = (int) scan_ctl(filename, argc, argv, "CSI_NZ", -1, "1", NULL);
01245   ctl->csi_lon0 =
01246     scan_ctl(filename, argc, argv, "CSI_LON0", -1, "-180", NULL);
01247   ctl->csi_lon1 = scan_ctl(filename, argc, argv, "CSI_LON1", -1, "180", NULL);
01248   ctl->csi_nx =
01249     (int) scan_ctl(filename, argc, argv, "CSI_NX", -1, "360", NULL);
01250   ctl->csi_lat0 = scan_ctl(filename, argc, argv, "CSI_LAT0", -1, "-90", NULL);
01251   ctl->csi_lat1 = scan_ctl(filename, argc, argv, "CSI_LAT1", -1, "90", NULL);
01252   ctl->csi_ny =
01253     (int) scan_ctl(filename, argc, argv, "CSI_NY", -1, "180", NULL);
01254
01255   /* Output of ensemble data... */
01256   scan_ctl(filename, argc, argv, "ENS_BASENAME", -1, "-", ctl->
      ens_basename);
01257
01258   /* Output of grid data... */
01259   scan_ctl(filename, argc, argv, "GRID_BASENAME", -1, "-",
01260            ctl->grid_basename);
01261   scan_ctl(filename, argc, argv, "GRID_GPFILE", -1, "-", ctl->
      grid_gpfile);
01262   ctl->grid_dt_out =
01263     scan_ctl(filename, argc, argv, "GRID_DT_OUT", -1, "86400", NULL);
01264   ctl->grid_sparse =
01265     (int) scan_ctl(filename, argc, argv, "GRID_SPARSE", -1, "0", NULL);
01266   ctl->grid_z0 = scan_ctl(filename, argc, argv, "GRID_Z0", -1, "0", NULL);
01267   ctl->grid_z1 = scan_ctl(filename, argc, argv, "GRID_Z1", -1, "100", NULL);
01268   ctl->grid_nz =
01269     (int) scan_ctl(filename, argc, argv, "GRID_NZ", -1, "1", NULL);
01270   ctl->grid_lon0 =
01271     scan_ctl(filename, argc, argv, "GRID_LON0", -1, "-180", NULL);
01272   ctl->grid_lon1 =
01273     scan_ctl(filename, argc, argv, "GRID_LON1", -1, "180", NULL);
01274   ctl->grid_nx =
01275     (int) scan_ctl(filename, argc, argv, "GRID_NX", -1, "360", NULL);
01276   ctl->grid_lat0 =
01277     scan_ctl(filename, argc, argv, "GRID_LAT0", -1, "-90", NULL);
01278   ctl->grid_lat1 =
01279     scan_ctl(filename, argc, argv, "GRID_LAT1", -1, "90", NULL);
01280   ctl->grid_ny =
01281     (int) scan_ctl(filename, argc, argv, "GRID_NY", -1, "180", NULL);
01282
01283   /* Output of profile data... */
01284   scan_ctl(filename, argc, argv, "PROF_BASENAME", -1, "-",
01285            ctl->prof_basename);
01286   scan_ctl(filename, argc, argv, "PROF_OBSFILE", -1, "-", ctl->
      prof_obsfile);
01287   ctl->prof_z0 = scan_ctl(filename, argc, argv, "PROF_Z0", -1, "0", NULL);
01288   ctl->prof_z1 = scan_ctl(filename, argc, argv, "PROF_Z1", -1, "60", NULL);
01289   ctl->prof_nz =
01290     (int) scan_ctl(filename, argc, argv, "PROF_NZ", -1, "60", NULL);
01291   ctl->prof_lon0 =
01292     scan_ctl(filename, argc, argv, "PROF_LON0", -1, "-180", NULL);
01293   ctl->prof_lon1 =
01294     scan_ctl(filename, argc, argv, "PROF_LON1", -1, "180", NULL);
01295   ctl->prof_nx =
01296     (int) scan_ctl(filename, argc, argv, "PROF_NX", -1, "360", NULL);
01297   ctl->prof_lat0 =
01298     scan_ctl(filename, argc, argv, "PROF_LAT0", -1, "-90", NULL);
01299   ctl->prof_lat1 =
01300     scan_ctl(filename, argc, argv, "PROF_LAT1", -1, "90", NULL);
01301   ctl->prof_ny =
01302     (int) scan_ctl(filename, argc, argv, "PROF_NY", -1, "180", NULL);
01303
01304   /* Output of station data... */
01305   scan_ctl(filename, argc, argv, "STAT_BASENAME", -1, "-",
01306            ctl->stat_basename);
01307   ctl->stat_lon = scan_ctl(filename, argc, argv, "STAT_LON", -1, "0", NULL);
01308   ctl->stat_lat = scan_ctl(filename, argc, argv, "STAT_LAT", -1, "0", NULL);
01309   ctl->stat_r = scan_ctl(filename, argc, argv, "STAT_R", -1, "50", NULL);
01310 }
```

Here is the call graph for this function:

5.19.2.18 void read_met (ctl_t * *ctl*, char * *filename*, met_t * *met*)

Read meteorological data file.

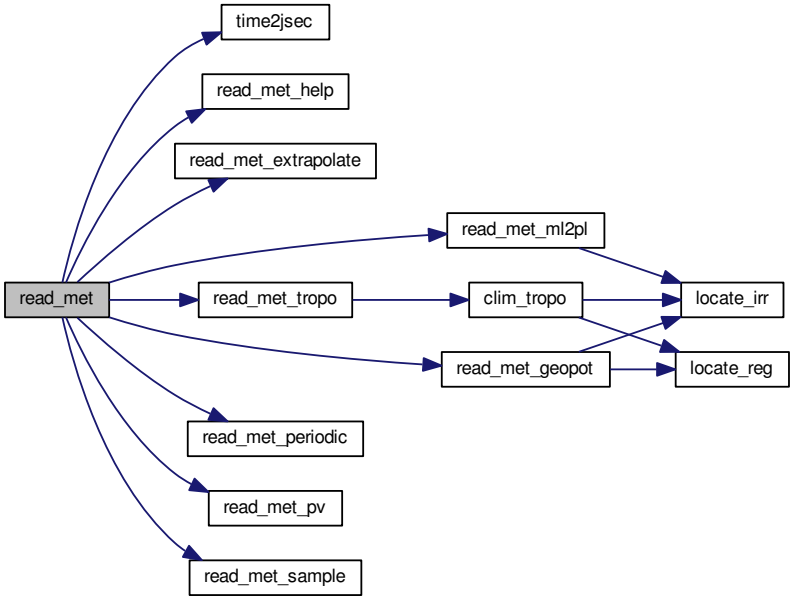
Definition at line 1314 of file libtrac.c.

```
01317               {
01318
01319   char cmd[2 * LEN], levname[LEN], tstr[10];
01320
01321   static float help[EX * EY];
01322
01323   int ix, iy, ip, dimid, ncid, varid, year, mon, day, hour;
01324
01325   size_t np, nx, ny;
01326
01327   /* Write info... */
01328   printf("Read meteorological data: %s\n", filename);
01329
01330   /* Get time from filename... */
01331   sprintf(tstr, "%.4s", &filename[strlen(filename) - 16]);
01332   year = atoi(tstr);
01333   sprintf(tstr, "%.2s", &filename[strlen(filename) - 11]);
01334   mon = atoi(tstr);
01335   sprintf(tstr, "%.2s", &filename[strlen(filename) - 8]);
01336   day = atoi(tstr);
01337   sprintf(tstr, "%.2s", &filename[strlen(filename) - 5]);
01338   hour = atoi(tstr);
01339   time2jsec(year, mon, day, hour, 0, 0, 0, &met->time);
01340
01341   /* Open netCDF file... */
01342   if (nc_open(filename, NC_NOWRITE, &ncid) != NC_NOERR) {
01343
01344     /* Try to stage meteo file... */
01345     if (ctl->met_stage[0] != '-') {
01346       sprintf(cmd, "%s %d %02d %02d %02d %s", ctl->met_stage,
01347               year, mon, day, hour, filename);
01348       if (system(cmd) != 0)
01349         ERRMSG("Error while staging meteo data!");
01350     }
01351
01352     /* Try to open again... */
01353     NC(nc_open(filename, NC_NOWRITE, &ncid));
01354   }
01355
01356   /* Get dimensions... */
01357   NC(nc_inq_dimid(ncid, "lon", &dimid));
01358   NC(nc_inq_dimlen(ncid, dimid, &nx));
01359   if (nx < 2 || nx > EX)
01360     ERRMSG("Number of longitudes out of range!");
01361
01362   NC(nc_inq_dimid(ncid, "lat", &dimid));
01363   NC(nc_inq_dimlen(ncid, dimid, &ny));
01364   if (ny < 2 || ny > EY)
01365     ERRMSG("Number of latitudes out of range!");
01366
01367   sprintf(levname, "lev");
01368   NC(nc_inq_dimid(ncid, levname, &dimid));
01369   NC(nc_inq_dimlen(ncid, dimid, &np));
01370   if (np == 1) {
01371     sprintf(levname, "lev_2");
01372     NC(nc_inq_dimid(ncid, levname, &dimid));
01373     NC(nc_inq_dimlen(ncid, dimid, &np));
```

```
01374   }
01375   if (np < 2 || np > EP)
01376     ERRMSG("Number of levels out of range!");
01377
01378   /* Store dimensions... */
01379   met->np = (int) np;
01380   met->nx = (int) nx;
01381   met->ny = (int) ny;
01382
01383   /* Get horizontal grid... */
01384   NC(nc_inq_varid(ncid, "lon", &varid));
01385   NC(nc_get_var_double(ncid, varid, met->lon));
01386   NC(nc_inq_varid(ncid, "lat", &varid));
01387   NC(nc_get_var_double(ncid, varid, met->lat));
01388
01389   /* Read meteorological data... */
01390   read_met_help(ncid, "t", "T", met, met->t, 1.0);
01391   read_met_help(ncid, "u", "U", met, met->u, 1.0);
01392   read_met_help(ncid, "v", "V", met, met->v, 1.0);
01393   read_met_help(ncid, "w", "W", met, met->w, 0.01f);
01394   read_met_help(ncid, "q", "Q", met, met->h2o, (float) (MA / 18.01528));
01395   read_met_help(ncid, "o3", "O3", met, met->o3, (float) (MA / 48.00));
01396
01397   /* Meteo data on pressure levels... */
01398   if (ctl->met_np <= 0) {
01399
01400     /* Read pressure levels from file... */
01401     NC(nc_inq_varid(ncid, levname, &varid));
01402     NC(nc_get_var_double(ncid, varid, met->p));
01403     for (ip = 0; ip < met->np; ip++)
01404       met->p[ip] /= 100.;
01405
01406     /* Extrapolate data for lower boundary... */
01407     read_met_extrapolate(met);
01408   }
01409
01410   /* Meteo data on model levels... */
01411   else {
01412
01413     /* Read pressure data from file... */
01414     read_met_help(ncid, "pl", "PL", met, met->pl, 0.01f);
01415
01416     /* Interpolate from model levels to pressure levels... */
01417     read_met_ml2pl(ctl, met, met->t);
01418     read_met_ml2pl(ctl, met, met->u);
01419     read_met_ml2pl(ctl, met, met->v);
01420     read_met_ml2pl(ctl, met, met->w);
01421     read_met_ml2pl(ctl, met, met->h2o);
01422     read_met_ml2pl(ctl, met, met->o3);
01423
01424     /* Set pressure levels... */
01425     met->np = ctl->met_np;
01426     for (ip = 0; ip < met->np; ip++)
01427       met->p[ip] = ctl->met_p[ip];
01428   }
01429
01430   /* Check ordering of pressure levels... */
01431   for (ip = 1; ip < met->np; ip++)
01432     if (met->p[ip - 1] < met->p[ip])
01433       ERRMSG("Pressure levels must be descending!");
01434
01435   /* Read surface pressure... */
01436   if (nc_inq_varid(ncid, "ps", &varid) == NC_NOERR
01437       || nc_inq_varid(ncid, "PS", &varid) == NC_NOERR) {
01438     NC(nc_get_var_float(ncid, varid, help));
01439     for (iy = 0; iy < met->ny; iy++)
01440       for (ix = 0; ix < met->nx; ix++)
01441         met->ps[ix][iy] = help[iy * met->nx + ix] / 100.;
01442   } else if (nc_inq_varid(ncid, "lnsp", &varid) == NC_NOERR
01443              || nc_inq_varid(ncid, "LNSP", &varid) == NC_NOERR) {
01444     NC(nc_get_var_float(ncid, varid, help));
01445     for (iy = 0; iy < met->ny; iy++)
01446       for (ix = 0; ix < met->nx; ix++)
01447         met->ps[ix][iy] = exp(help[iy * met->nx + ix]) / 100.;
01448   } else
01449     for (ix = 0; ix < met->nx; ix++)
01450       for (iy = 0; iy < met->ny; iy++)
01451         met->ps[ix][iy] = met->p[0];
01452
01453   /* Create periodic boundary conditions... */
01454   read_met_periodic(met);
01455
01456   /* Calculate geopotential heights... */
01457   read_met_geopot(ctl, met);
01458
01459   /* Calculate potential vorticity... */
01460   read_met_pv(met);
```

```
01461
01462   /* Calculate tropopause pressure... */
01463   read_met_tropo(ctl, met);
01464
01465   /* Downsampling... */
01466   read_met_sample(ctl, met);
01467
01468   /* Close file... */
01469   NC(nc_close(ncid));
01470 }
```

Here is the call graph for this function:



5.19.2.19 void read_met_extrapolate (met_t * *met*)

Extrapolate meteorological data at lower boundary.

Definition at line 1474 of file libtrac.c.

```
01475               {
01476
01477   int ip, ip0, ix, iy;
01478
01479   /* Loop over columns... */
01480 #pragma omp parallel for default(shared) private(ix,iy,ip0,ip)
01481   for (ix = 0; ix < met->nx; ix++)
01482     for (iy = 0; iy < met->ny; iy++) {
01483
01484       /* Find lowest valid data point... */
01485       for (ip0 = met->np - 1; ip0 >= 0; ip0--)
01486         if (!gsl_finite(met->t[ix][iy][ip0])
01487             || !gsl_finite(met->u[ix][iy][ip0])
01488             || !gsl_finite(met->v[ix][iy][ip0])
01489             || !gsl_finite(met->w[ix][iy][ip0]))
01490           break;
01491
01492       /* Extrapolate... */
01493       for (ip = ip0; ip >= 0; ip--) {
01494         met->t[ix][iy][ip] = met->t[ix][iy][ip + 1];
01495         met->u[ix][iy][ip] = met->u[ix][iy][ip + 1];
```

```
01496         met->v[ix][iy][ip] = met->v[ix][iy][ip + 1];
01497         met->w[ix][iy][ip] = met->w[ix][iy][ip + 1];
01498         met->h2o[ix][iy][ip] = met->h2o[ix][iy][ip + 1];
01499         met->o3[ix][iy][ip] = met->o3[ix][iy][ip + 1];
01500       }
01501     }
01502 }
```

5.19.2.20 void read_met_geopot (ctl_t * *ctl*, met_t * *met*)

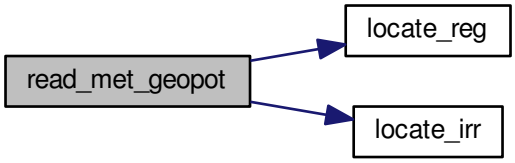
Calculate geopotential heights.

Definition at line 1506 of file libtrac.c.

```
01508               {
01509
01510   static double topo_lat[EY], topo_lon[EX], topo_z[EX][EY];
01511
01512   static int init, topo_nx = -1, topo_ny;
01513
01514   FILE *in;
01515
01516   char line[LEN];
01517
01518   double data[30], lat, lon, rlat, rlon, rlon_old = -999, rz, ts, z0, z1;
01519
01520   float help[EX][EY];
01521
01522   int ip, ip0, ix, ix2, ix3, iy, iy2, n, tx, ty;
01523
01524   /* Initialize geopotential heights... */
01525 #pragma omp parallel for default(shared) private(ix,iy,ip)
01526   for (ix = 0; ix < met->nx; ix++)
01527     for (iy = 0; iy < met->ny; iy++)
01528       for (ip = 0; ip < met->np; ip++)
01529         met->z[ix][iy][ip] = GSL_NAN;
01530
01531   /* Check filename... */
01532   if (ctl->met_geopot[0] == '-')
01533     return;
01534
01535   /* Read surface geopotential... */
01536   if (!init) {
01537     init = 1;
01538
01539     /* Write info... */
01540     printf("Read surface geopotential: %s\n", ctl->met_geopot);
01541
01542     /* Open file... */
01543     if (!(in = fopen(ctl->met_geopot, "r")))
01544       ERRMSG("Cannot open file!");
01545
01546     /* Read data... */
01547     while (fgets(line, LEN, in))
01548       if (sscanf(line, "%lg %lg %lg", &rlon, &rlat, &rz) == 3) {
01549         if (rlon != rlon_old) {
01550           if ((++topo_nx) >= EX)
01551             ERRMSG("Too many longitudes!");
01552           topo_ny = 0;
01553         }
01554         rlon_old = rlon;
01555         topo_lon[topo_nx] = rlon;
01556         topo_lat[topo_ny] = rlat;
01557         topo_z[topo_nx][topo_ny] = rz;
01558         if ((++topo_ny) >= EY)
01559           ERRMSG("Too many latitudes!");
01560       }
01561     if ((++topo_nx) >= EX)
01562       ERRMSG("Too many longitudes!");
01563
01564     /* Close file... */
01565     fclose(in);
01566
01567     /* Check grid spacing... */
01568     if (fabs(met->lon[0] - met->lon[1]) != fabs(topo_lon[0] - topo_lon[1])
01569         || fabs(met->lat[0] - met->lat[1]) != fabs(topo_lat[0] - topo_lat[1]))
01570       printf("Warning: Grid spacing does not match!\n");
01571   }
01572
01573   /* Apply hydrostatic equation to calculate geopotential heights... */
```

```
01574 #pragma omp parallel for default(shared) private(ix,iy,lon,lat,tx,ty,z0,z1,ip0,ts,ip)
01575   for (ix = 0; ix < met->nx; ix++)
01576     for (iy = 0; iy < met->ny; iy++) {
01577
01578       /* Get surface height... */
01579       lon = met->lon[ix];
01580       if (lon < topo_lon[0])
01581         lon += 360;
01582       else if (lon > topo_lon[topo_nx - 1])
01583         lon -= 360;
01584       lat = met->lat[iy];
01585       tx = locate_reg(topo_lon, topo_nx, lon);
01586       ty = locate_reg(topo_lat, topo_ny, lat);
01587       z0 = LIN(topo_lon[tx], topo_z[tx][ty],
01588                topo_lon[tx + 1], topo_z[tx + 1][ty], lon);
01589       z1 = LIN(topo_lon[tx], topo_z[tx][ty + 1],
01590                topo_lon[tx + 1], topo_z[tx + 1][ty + 1], lon);
01591       z0 = LIN(topo_lat[ty], z0, topo_lat[ty + 1], z1, lat);
01592
01593       /* Find surface pressure level... */
01594       ip0 = locate_irr(met->p, met->np, met->ps[ix][iy]);
01595
01596       /* Get surface temperature... */
01597       ts = LIN(met->p[ip0], met->t[ix][iy][ip0],
01598                met->p[ip0 + 1], met->t[ix][iy][ip0 + 1], met->ps[ix][iy]);
01599
01600       /* Upper part of profile... */
01601       met->z[ix][iy][ip0 + 1]
01602         = (float) (z0 + RI / MA / G0 * 0.5 * (ts + met->t[ix][iy][ip0 + 1])
01603                    * log(met->ps[ix][iy] / met->p[ip0 + 1]));
01604       for (ip = ip0 + 2; ip < met->np; ip++)
01605         met->z[ix][iy][ip]
01606           = (float) (met->z[ix][iy][ip - 1] + RI / MA / G0
01607                      * 0.5 * (met->t[ix][iy][ip - 1] + met->t[ix][iy][ip])
01608                      * log(met->p[ip - 1] / met->p[ip]));
01609     }
01610
01611   /* Smooth fields... */
01612 #pragma omp parallel for default(shared) private(ip,ix,iy,n,ix2,ix3,iy2,data)
01613   for (ip = 0; ip < met->np; ip++) {
01614
01615     /* Median filter... */
01616     for (ix = 0; ix < met->nx; ix++)
01617       for (iy = 0; iy < met->nx; iy++) {
01618         n = 0;
01619         for (ix2 = ix - 2; ix2 <= ix + 2; ix2++) {
01620           ix3 = ix2;
01621           if (ix3 < 0)
01622             ix3 += met->nx;
01623           if (ix3 >= met->nx)
01624             ix3 -= met->nx;
01625           for (iy2 = GSL_MAX(iy - 2, 0); iy2 <= GSL_MIN(iy + 2, met->ny - 1);
01626                iy2++)
01627             if (gsl_finite(met->z[ix3][iy2][ip])) {
01628               data[n] = met->z[ix3][iy2][ip];
01629               n++;
01630             }
01631         }
01632         if (n > 0) {
01633           gsl_sort(data, 1, (size_t) n);
01634           help[ix][iy] = (float)
01635             gsl_stats_median_from_sorted_data(data, 1, (size_t) n);
01636         } else
01637           help[ix][iy] = GSL_NAN;
01638       }
01639
01640     /* Copy data... */
01641     for (ix = 0; ix < met->nx; ix++)
01642       for (iy = 0; iy < met->nx; iy++)
01643         met->z[ix][iy][ip] = help[ix][iy];
01644   }
01645 }
```

Here is the call graph for this function:



5.19.2.21 void read_met_help (int *ncid*, char * *varname*, char * *varname2*, met_t * *met*, float *dest[EX][EY][EP]*, float *scl*)

Read and convert variable from meteorological data file.

Definition at line 1649 of file libtrac.c.

```
01655             {
01656
01657   static float help[EX * EY * EP];
01658
01659   int ip, ix, iy, varid;
01660
01661   /* Check if variable exists... */
01662   if (nc_inq_varid(ncid, varname, &varid) != NC_NOERR)
01663     if (nc_inq_varid(ncid, varname2, &varid) != NC_NOERR)
01664       return;
01665
01666   /* Read data... */
01667   NC(nc_get_var_float(ncid, varid, help));
01668
01669   /* Copy and check data... */
01670 #pragma omp parallel for default(shared) private(ix,iy,ip)
01671   for (ix = 0; ix < met->nx; ix++)
01672     for (iy = 0; iy < met->ny; iy++)
01673       for (ip = 0; ip < met->np; ip++) {
01674         dest[ix][iy][ip] = help[(ip * met->ny + iy) * met->nx + ix];
01675         if (fabsf(dest[ix][iy][ip]) < 1e14f)
01676           dest[ix][iy][ip] *= scl;
01677         else
01678           dest[ix][iy][ip] = GSL_NAN;
01679       }
01680 }
```

5.19.2.22 void read_met_ml2pl (ctl_t * *ctl*, met_t * *met*, float *var[EX][EY][EP]*)

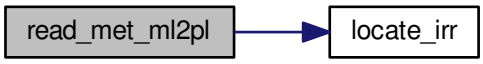
Convert meteorological data from model levels to pressure levels.

Definition at line 1684 of file libtrac.c.

```
01687                         {
01688
01689   double aux[EP], p[EP], pt;
01690
01691   int ip, ip2, ix, iy;
01692
01693   /* Loop over columns... */
01694 #pragma omp parallel for default(shared) private(ix,iy,ip,p,pt,ip2,aux)
01695   for (ix = 0; ix < met->nx; ix++)
01696     for (iy = 0; iy < met->ny; iy++) {
01697
01698       /* Copy pressure profile... */
```

```
01699       for (ip = 0; ip < met->np; ip++)
01700         p[ip] = met->pl[ix][iy][ip];
01701
01702       /* Interpolate... */
01703       for (ip = 0; ip < ctl->met_np; ip++) {
01704         pt = ctl->met_p[ip];
01705         if ((pt > p[0] && p[0] > p[1]) || (pt < p[0] && p[0] < p[1]))
01706           pt = p[0];
01707         else if ((pt > p[met->np - 1] && p[1] > p[0])
01708                  || (pt < p[met->np - 1] && p[1] < p[0]))
01709           pt = p[met->np - 1];
01710         ip2 = locate_irr(p, met->np, pt);
01711         aux[ip] = LIN(p[ip2], var[ix][iy][ip2],
01712                       p[ip2 + 1], var[ix][iy][ip2 + 1], pt);
01713       }
01714
01715       /* Copy data... */
01716       for (ip = 0; ip < ctl->met_np; ip++)
01717         var[ix][iy][ip] = (float) aux[ip];
01718     }
01719 }
```

Here is the call graph for this function:



5.19.2.23 void read_met_periodic (met_t * *met*)

Create meteorological data with periodic boundary conditions.

Definition at line 1723 of file libtrac.c.

```
01724               {
01725
01726   int ip, iy;
01727
01728   /* Check longitudes... */
01729   if (!(fabs(met->lon[met->nx - 1] - met->lon[0]
01730              + met->lon[1] - met->lon[0] - 360) < 0.01))
01731     return;
01732
01733   /* Increase longitude counter... */
01734   if ((++met->nx) > EX)
01735     ERRMSG("Cannot create periodic boundary conditions!");
01736
01737   /* Set longitude... */
01738   met->lon[met->nx - 1] = met->lon[met->nx - 2] + met->lon[1] - met->
      lon[0];
01739
01740   /* Loop over latitudes and pressure levels... */
01741 #pragma omp parallel for default(shared) private(iy,ip)
01742   for (iy = 0; iy < met->ny; iy++) {
01743     met->ps[met->nx - 1][iy] = met->ps[0][iy];
01744     met->pt[met->nx - 1][iy] = met->pt[0][iy];
01745     for (ip = 0; ip < met->np; ip++) {
01746       met->z[met->nx - 1][iy][ip] = met->z[0][iy][ip];
01747       met->t[met->nx - 1][iy][ip] = met->t[0][iy][ip];
01748       met->u[met->nx - 1][iy][ip] = met->u[0][iy][ip];
01749       met->v[met->nx - 1][iy][ip] = met->v[0][iy][ip];
01750       met->w[met->nx - 1][iy][ip] = met->w[0][iy][ip];
01751       met->pv[met->nx - 1][iy][ip] = met->pv[0][iy][ip];
01752       met->h2o[met->nx - 1][iy][ip] = met->h2o[0][iy][ip];
01753       met->o3[met->nx - 1][iy][ip] = met->o3[0][iy][ip];
01754     }
01755   }
01756 }
```

5.19.2.24 void read_met_pv (met_t * *met*)

Calculate potential vorticity.

Definition at line 1760 of file libtrac.c.

```
01761               {
01762
01763   double c0, c1, cr, dx, dy, dp0, dp1, denom, dtdx, dvdx, dtdy, dudy,
01764     dtdp, dudp, dvdp, latr, vort, pows[EP];
01765
01766   int ip, ip0, ip1, ix, ix0, ix1, iy, iy0, iy1;
01767
01768   /* Set powers... */
01769   for (ip = 0; ip < met->np; ip++)
01770     pows[ip] = pow(1000. / met->p[ip], 0.286);
01771
01772   /* Loop over grid points... */
01773 #pragma omp parallel for default(shared)
      private(ix,ix0,ix1,iy,iy0,iy1,latr,dx,dy,c0,c1,cr,vort,ip,ip0,ip1,dp0,dp1,denom,dtdx,dvdx,dtdy,dudy,dtdp,dudp,dvdp)
01774   for (ix = 0; ix < met->nx; ix++) {
01775
01776     /* Set indices... */
01777     ix0 = GSL_MAX(ix - 1, 0);
01778     ix1 = GSL_MIN(ix + 1, met->nx - 1);
01779
01780     /* Loop over grid points... */
01781     for (iy = 0; iy < met->ny; iy++) {
01782
01783       /* Set indices... */
01784       iy0 = GSL_MAX(iy - 1, 0);
01785       iy1 = GSL_MIN(iy + 1, met->ny - 1);
01786
01787       /* Set auxiliary variables... */
01788       latr = GSL_MIN(GSL_MAX(met->lat[iy], -89.), 89.);
01789       dx = 1000. * DEG2DX(met->lon[ix1] - met->lon[ix0], latr);
01790       dy = 1000. * DEG2DY(met->lat[iy1] - met->lat[iy0]);
01791       c0 = cos(met->lat[iy0] / 180. * M_PI);
01792       c1 = cos(met->lat[iy1] / 180. * M_PI);
01793       cr = cos(latr / 180. * M_PI);
01794       vort = 2 * 7.2921e-5 * sin(latr * M_PI / 180.);
01795
01796       /* Loop over grid points... */
01797       for (ip = 0; ip < met->np; ip++) {
01798
01799         /* Get gradients in longitude... */
01800         dtdx = (met->t[ix1][iy][ip] - met->t[ix0][iy][ip]) * pows[ip] / dx;
01801         dvdx = (met->v[ix1][iy][ip] - met->v[ix0][iy][ip]) / dx;
01802
01803         /* Get gradients in latitude... */
01804         dtdy = (met->t[ix][iy1][ip] - met->t[ix][iy0][ip]) * pows[ip] / dy;
01805         dudy = (met->u[ix][iy1][ip] * c1 - met->u[ix][iy0][ip] * c0) / dy;
01806
01807         /* Set indices... */
01808         ip0 = GSL_MAX(ip - 1, 0);
01809         ip1 = GSL_MIN(ip + 1, met->np - 1);
01810
01811         /* Get gradients in pressure... */
01812         dp0 = 100. * (met->p[ip] - met->p[ip0]);
01813         dp1 = 100. * (met->p[ip1] - met->p[ip]);
01814         if (ip != ip0 && ip != ip1) {
01815           denom = dp0 * dp1 * (dp0 + dp1);
01816           dtdp = (dp0 * dp0 * met->t[ix][iy][ip1] * pows[ip1]
01817                   - dp1 * dp1 * met->t[ix][iy][ip0] * pows[ip0]
01818                   + (dp1 * dp1 - dp0 * dp0) * met->t[ix][iy][ip] * pows[ip])
01819             / denom;
01820           dudp = (dp0 * dp0 * met->u[ix][iy][ip1]
01821                   - dp1 * dp1 * met->u[ix][iy][ip0]
01822                   + (dp1 * dp1 - dp0 * dp0) * met->u[ix][iy][ip])
01823             / denom;
01824           dvdp = (dp0 * dp0 * met->v[ix][iy][ip1]
01825                   - dp1 * dp1 * met->v[ix][iy][ip0]
01826                   + (dp1 * dp1 - dp0 * dp0) * met->v[ix][iy][ip])
01827             / denom;
01828         } else {
01829           denom = dp0 + dp1;
01830           dtdp =
01831             (met->t[ix][iy][ip1] * pows[ip1] -
01832              met->t[ix][iy][ip0] * pows[ip0]) / denom;
01833           dudp = (met->u[ix][iy][ip1] - met->u[ix][iy][ip0]) / denom;
01834           dvdp = (met->v[ix][iy][ip1] - met->v[ix][iy][ip0]) / denom;
01835         }
01836
```

```
01837         /* Calculate PV... */
01838         met->pv[ix][iy][ip] = (float)
01839           (1e6 * G0 *
01840            (-dtdp * (dvdx - dudy / cr + vort) + dvdp * dtdx - dudp * dtdy));
01841       }
01842     }
01843   }
01844 }
```

5.19.2.25 void read_met_sample (ctl_t * *ctl*, met_t * *met*)

Downsampling of meteorological data.

Definition at line 1848 of file libtrac.c.

```
01850               {
01851
01852   met_t *help;
01853
01854   float w, wsum;
01855
01856   int ip, ip2, ix, ix2, ix3, iy, iy2;
01857
01858   /* Check parameters... */
01859   if (ctl->met_dp <= 1 && ctl->met_dx <= 1 && ctl->met_dy <= 1
01860       && ctl->met_sp <= 1 && ctl->met_sx <= 1 && ctl->met_sy <= 1)
01861     return;
01862
01863   /* Allocate... */
01864   ALLOC(help, met_t, 1);
01865
01866   /* Copy data... */
01867   help->nx = met->nx;
01868   help->ny = met->ny;
01869   help->np = met->np;
01870   memcpy(help->lon, met->lon, sizeof(met->lon));
01871   memcpy(help->lat, met->lat, sizeof(met->lat));
01872   memcpy(help->p, met->p, sizeof(met->p));
01873
01874   /* Smoothing... */
01875   for (ix = 0; ix < met->nx; ix += ctl->met_dx) {
01876     for (iy = 0; iy < met->ny; iy += ctl->met_dy) {
01877       for (ip = 0; ip < met->np; ip += ctl->met_dp) {
01878         help->ps[ix][iy] = 0;
01879         help->pt[ix][iy] = 0;
01880         help->z[ix][iy][ip] = 0;
01881         help->t[ix][iy][ip] = 0;
01882         help->u[ix][iy][ip] = 0;
01883         help->v[ix][iy][ip] = 0;
01884         help->w[ix][iy][ip] = 0;
01885         help->pv[ix][iy][ip] = 0;
01886         help->h2o[ix][iy][ip] = 0;
01887         help->o3[ix][iy][ip] = 0;
01888         wsum = 0;
01889         for (ix2 = ix - ctl->met_sx + 1; ix2 <= ix + ctl->met_sx - 1; ix2++) {
01890           ix3 = ix2;
01891           if (ix3 < 0)
01892             ix3 += met->nx;
01893           else if (ix3 >= met->nx)
01894             ix3 -= met->nx;
01895
01896           for (iy2 = GSL_MAX(iy - ctl->met_sy + 1, 0);
01897                iy2 <= GSL_MIN(iy + ctl->met_sy - 1, met->ny - 1); iy2++)
01898             for (ip2 = GSL_MAX(ip - ctl->met_sp + 1, 0);
01899                  ip2 <= GSL_MIN(ip + ctl->met_sp - 1, met->np - 1); ip2++) {
01900               w = (float) (1.0 - fabs(ix - ix2) / ctl->met_sx)
01901                 * (float) (1.0 - fabs(iy - iy2) / ctl->met_sy)
01902                 * (float) (1.0 - fabs(ip - ip2) / ctl->met_sp);
01903               help->ps[ix][iy] += w * met->ps[ix3][iy2];
01904               help->pt[ix][iy] += w * met->pt[ix3][iy2];
01905               help->z[ix][iy][ip] += w * met->z[ix3][iy2][ip2];
01906               help->t[ix][iy][ip] += w * met->t[ix3][iy2][ip2];
01907               help->u[ix][iy][ip] += w * met->u[ix3][iy2][ip2];
01908               help->v[ix][iy][ip] += w * met->v[ix3][iy2][ip2];
01909               help->w[ix][iy][ip] += w * met->w[ix3][iy2][ip2];
01910               help->pv[ix][iy][ip] += w * met->pv[ix3][iy2][ip2];
01911               help->h2o[ix][iy][ip] += w * met->h2o[ix3][iy2][ip2];
01912               help->o3[ix][iy][ip] += w * met->o3[ix3][iy2][ip2];
01913               wsum += w;
01914             }
```

```
01915         }
01916         help->ps[ix][iy] /= wsum;
01917         help->pt[ix][iy] /= wsum;
01918         help->t[ix][iy][ip] /= wsum;
01919         help->z[ix][iy][ip] /= wsum;
01920         help->u[ix][iy][ip] /= wsum;
01921         help->v[ix][iy][ip] /= wsum;
01922         help->w[ix][iy][ip] /= wsum;
01923         help->pv[ix][iy][ip] /= wsum;
01924         help->h2o[ix][iy][ip] /= wsum;
01925         help->o3[ix][iy][ip] /= wsum;
01926       }
01927     }
01928   }
01929
01930   /* Downsampling... */
01931   met->nx = 0;
01932   for (ix = 0; ix < help->nx; ix += ctl->met_dx) {
01933     met->lon[met->nx] = help->lon[ix];
01934     met->ny = 0;
01935     for (iy = 0; iy < help->ny; iy += ctl->met_dy) {
01936       met->lat[met->ny] = help->lat[iy];
01937       met->ps[met->nx][met->ny] = help->ps[ix][iy];
01938       met->pt[met->nx][met->ny] = help->pt[ix][iy];
01939       met->np = 0;
01940       for (ip = 0; ip < help->np; ip += ctl->met_dp) {
01941         met->p[met->np] = help->p[ip];
01942         met->z[met->nx][met->ny][met->np] = help->z[ix][iy][ip];
01943         met->t[met->nx][met->ny][met->np] = help->t[ix][iy][ip];
01944         met->u[met->nx][met->ny][met->np] = help->u[ix][iy][ip];
01945         met->v[met->nx][met->ny][met->np] = help->v[ix][iy][ip];
01946         met->w[met->nx][met->ny][met->np] = help->w[ix][iy][ip];
01947         met->pv[met->nx][met->ny][met->np] = help->pv[ix][iy][ip];
01948         met->h2o[met->nx][met->ny][met->np] = help->h2o[ix][iy][ip];
01949         met->o3[met->nx][met->ny][met->np] = help->o3[ix][iy][ip];
01950         met->np++;
01951       }
01952       met->ny++;
01953     }
01954     met->nx++;
01955   }
01956
01957   /* Free... */
01958   free(help);
01959 }
```

5.19.2.26 void read_met_tropo (ctl_t * *ctl*, met_t * *met*)

Calculate tropopause pressure.

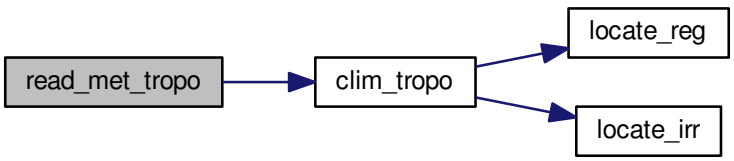
Definition at line 1963 of file libtrac.c.

```
01965               {
01966
01967   gsl_interp_accel *acc;
01968
01969   gsl_spline *spline;
01970
01971   double p2[400], pv[400], pv2[400], t[400], t2[400], th[400], th2[400],
01972     z[400], z2[400];
01973
01974   int found, ix, iy, iz, iz2;
01975
01976   /* Allocate... */
01977   acc = gsl_interp_accel_alloc();
01978   spline = gsl_spline_alloc(gsl_interp_cspline, (size_t) met->np);
01979
01980   /* Get altitude and pressure profiles... */
01981   for (iz = 0; iz < met->np; iz++)
01982     z[iz] = Z(met->p[iz]);
01983   for (iz = 0; iz <= 170; iz++) {
01984     z2[iz] = 4.5 + 0.1 * iz;
01985     p2[iz] = P(z2[iz]);
01986   }
01987
01988   /* Do not calculate tropopause... */
01989   if (ctl->met_tropo == 0)
01990     for (ix = 0; ix < met->nx; ix++)
01991       for (iy = 0; iy < met->ny; iy++)
01992         met->pt[ix][iy] = GSL_NAN;
```

```
01993
01994   /* Use tropopause climatology... */
01995   else if (ctl->met_tropo == 1)
01996     for (ix = 0; ix < met->nx; ix++)
01997       for (iy = 0; iy < met->ny; iy++)
01998         met->pt[ix][iy] = clim_tropo(met->time, met->lat[iy]);
01999
02000   /* Use cold point... */
02001   else if (ctl->met_tropo == 2) {
02002
02003     /* Loop over grid points... */
02004     for (ix = 0; ix < met->nx; ix++)
02005       for (iy = 0; iy < met->ny; iy++) {
02006
02007         /* Interpolate temperature profile... */
02008         for (iz = 0; iz < met->np; iz++)
02009           t[iz] = met->t[ix][iy][iz];
02010         gsl_spline_init(spline, z, t, (size_t) met->np);
02011         for (iz = 0; iz <= 170; iz++)
02012           t2[iz] = gsl_spline_eval(spline, z2[iz], acc);
02013
02014         /* Find minimum... */
02015         iz = (int) gsl_stats_min_index(t2, 1, 171);
02016         if (iz <= 0 || iz >= 170)
02017           met->pt[ix][iy] = GSL_NAN;
02018         else
02019           met->pt[ix][iy] = p2[iz];
02020       }
02021   }
02022
02023   /* Use WMO definition... */
02024   else if (ctl->met_tropo == 3 || ctl->met_tropo == 4) {
02025
02026     /* Loop over grid points... */
02027     for (ix = 0; ix < met->nx; ix++)
02028       for (iy = 0; iy < met->ny; iy++) {
02029
02030         /* Interpolate temperature profile... */
02031         for (iz = 0; iz < met->np; iz++)
02032           t[iz] = met->t[ix][iy][iz];
02033         gsl_spline_init(spline, z, t, (size_t) met->np);
02034         for (iz = 0; iz <= 160; iz++)
02035           t2[iz] = gsl_spline_eval(spline, z2[iz], acc);
02036
02037         /* Find 1st tropopause... */
02038         met->pt[ix][iy] = GSL_NAN;
02039         for (iz = 0; iz <= 140; iz++) {
02040           found = 1;
02041           for (iz2 = iz + 1; iz2 <= iz + 20; iz2++)
02042             if (1000. * G0 / RA * log(t2[iz2] / t2[iz])
02043                 / log(p2[iz2] / p2[iz]) > 2.0) {
02044               found = 0;
02045               break;
02046             }
02047           if (found) {
02048             if (iz > 0 && iz < 140)
02049               met->pt[ix][iy] = p2[iz];
02050             break;
02051           }
02052         }
02053
02054         /* Find 2nd tropopause... */
02055         if (ctl->met_tropo == 4) {
02056           met->pt[ix][iy] = GSL_NAN;
02057           for (; iz <= 140; iz++) {
02058             found = 1;
02059             for (iz2 = iz + 1; iz2 <= iz + 10; iz2++)
02060               if (1000. * G0 / RA * log(t2[iz2] / t2[iz])
02061                   / log(p2[iz2] / p2[iz]) < 3.0) {
02062                 found = 0;
02063                 break;
02064               }
02065             if (found)
02066               break;
02067           }
02068           for (; iz <= 140; iz++) {
02069             found = 1;
02070             for (iz2 = iz + 1; iz2 <= iz + 20; iz2++)
02071               if (1000. * G0 / RA * log(t2[iz2] / t2[iz])
02072                   / log(p2[iz2] / p2[iz]) > 2.0) {
02073                 found = 0;
02074                 break;
02075               }
02076             if (found) {
02077               if (iz > 0 && iz < 140)
02078                 met->pt[ix][iy] = p2[iz];
02079               break;
```

```
02080             }
02081           }
02082         }
02083       }
02084   }
02085
02086   /* Use dynamical tropopause... */
02087   else if (ctl->met_tropo == 5) {
02088
02089     /* Loop over grid points... */
02090     for (ix = 0; ix < met->nx; ix++)
02091       for (iy = 0; iy < met->ny; iy++) {
02092
02093         /* Interpolate potential vorticity profile... */
02094         for (iz = 0; iz < met->np; iz++)
02095           pv[iz] = met->pv[ix][iy][iz];
02096         gsl_spline_init(spline, z, pv, (size_t) met->np);
02097         for (iz = 0; iz <= 160; iz++)
02098           pv2[iz] = gsl_spline_eval(spline, z2[iz], acc);
02099
02100         /* Interpolate potential temperature profile... */
02101         for (iz = 0; iz < met->np; iz++)
02102           th[iz] = THETA(met->p[iz], met->t[ix][iy][iz]);
02103         gsl_spline_init(spline, z, th, (size_t) met->np);
02104         for (iz = 0; iz <= 160; iz++)
02105           th2[iz] = gsl_spline_eval(spline, z2[iz], acc);
02106
02107         /* Find dynamical tropopause 3.5 PVU + 380 K */
02108         met->pt[ix][iy] = GSL_NAN;
02109         for (iz = 0; iz <= 160; iz++)
02110           if (fabs(pv2[iz]) >= 3.5 || th2[iz] >= 380.) {
02111             if (iz > 0 && iz < 160)
02112               met->pt[ix][iy] = p2[iz];
02113             break;
02114           }
02115       }
02116   }
02117
02118   else
02119     ERRMSG("Cannot calculate tropopause!");
02120
02121   /* Free... */
02122   gsl_spline_free(spline);
02123   gsl_interp_accel_free(acc);
02124 }
```

Here is the call graph for this function:



5.19.2.27 double scan_ctl (const char * *filename*, int *argc*, char * *argv[]*, const char * *varname*, int *arridx*, const char * *defvalue*, char * *value*)

Read a control parameter from file or command line.

Definition at line 2128 of file libtrac.c.

```
02135               {
02136
02137   FILE *in = NULL;
```

```
02138
02139   char dummy[LEN], fullname1[LEN], fullname2[LEN], line[LEN],
02140     msg[2 * LEN], rvarname[LEN], rval[LEN];
02141
02142   int contain = 0, i;
02143
02144   /* Open file... */
02145   if (filename[strlen(filename) - 1] != '-')
02146     if (!(in = fopen(filename, "r")))
02147       ERRMSG("Cannot open file!");
02148
02149   /* Set full variable name... */
02150   if (arridx >= 0) {
02151     sprintf(fullname1, "%s[%d]", varname, arridx);
02152     sprintf(fullname2, "%s[*]", varname);
02153   } else {
02154     sprintf(fullname1, "%s", varname);
02155     sprintf(fullname2, "%s", varname);
02156   }
02157
02158   /* Read data... */
02159   if (in != NULL)
02160     while (fgets(line, LEN, in))
02161       if (sscanf(line, "%s %s %s", rvarname, dummy, rval) == 3)
02162         if (strcasecmp(rvarname, fullname1) == 0 ||
02163             strcasecmp(rvarname, fullname2) == 0) {
02164           contain = 1;
02165           break;
02166         }
02167   for (i = 1; i < argc - 1; i++)
02168     if (strcasecmp(argv[i], fullname1) == 0 ||
02169         strcasecmp(argv[i], fullname2) == 0) {
02170       sprintf(rval, "%s", argv[i + 1]);
02171       contain = 1;
02172       break;
02173     }
02174
02175   /* Close file... */
02176   if (in != NULL)
02177     fclose(in);
02178
02179   /* Check for missing variables... */
02180   if (!contain) {
02181     if (strlen(defvalue) > 0)
02182       sprintf(rval, "%s", defvalue);
02183     else {
02184       sprintf(msg, "Missing variable %s!\n", fullname1);
02185       ERRMSG(msg);
02186     }
02187   }
02188
02189   /* Write info... */
02190   printf("%s = %s\n", fullname1, rval);
02191
02192   /* Return values... */
02193   if (value != NULL)
02194     sprintf(value, "%s", rval);
02195   return atof(rval);
02196 }
```

5.19.2.28 void time2jsec (int *year*, int *mon*, int *day*, int *hour*, int *min*, int *sec*, double *remain*, double * *jsec*)

Convert date to seconds.

Definition at line 2200 of file libtrac.c.

```
02208                 {
02209
02210   struct tm t0, t1;
02211
02212   t0.tm_year = 100;
02213   t0.tm_mon = 0;
02214   t0.tm_mday = 1;
02215   t0.tm_hour = 0;
02216   t0.tm_min = 0;
02217   t0.tm_sec = 0;
02218
02219   t1.tm_year = year - 1900;
02220   t1.tm_mon = mon - 1;
02221   t1.tm_mday = day;
```

```
02222   t1.tm_hour = hour;
02223   t1.tm_min = min;
02224   t1.tm_sec = sec;
02225
02226   *jsec = (double) timegm(&t1) - (double) timegm(&t0) + remain;
02227 }
```

5.19.2.29 void timer (const char * *name*, int *id*, int *mode*)

Measure wall-clock time.

Definition at line 2231 of file libtrac.c.

```
02234             {
02235
02236   static double starttime[NTIMER], runtime[NTIMER];
02237
02238   /* Check id... */
02239   if (id < 0 || id >= NTIMER)
02240     ERRMSG("Too many timers!");
02241
02242   /* Start timer... */
02243   if (mode == 1) {
02244     if (starttime[id] <= 0)
02245       starttime[id] = omp_get_wtime();
02246     else
02247       ERRMSG("Timer already started!");
02248   }
02249
02250   /* Stop timer... */
02251   else if (mode == 2) {
02252     if (starttime[id] > 0) {
02253       runtime[id] = runtime[id] + omp_get_wtime() - starttime[id];
02254       starttime[id] = -1;
02255     }
02256   }
02257
02258   /* Print timer... */
02259   else if (mode == 3) {
02260     printf("%s = %.3f s\n", name, runtime[id]);
02261     runtime[id] = 0;
02262   }
02263 }
```

5.19.2.30 void write_atm (const char * *filename*, ctl_t * *ctl*, atm_t * *atm*, double *t*)

Write atmospheric data.

Definition at line 2267 of file libtrac.c.

```
02271             {
02272
02273   FILE *in, *out;
02274
02275   char line[LEN];
02276
02277   double r, t0, t1;
02278
02279   int ip, iq, year, mon, day, hour, min, sec;
02280
02281   /* Set time interval for output... */
02282   t0 = t - 0.5 * ctl->dt_mod;
02283   t1 = t + 0.5 * ctl->dt_mod;
02284
02285   /* Write info... */
02286   printf("Write atmospheric data: %s\n", filename);
02287
02288   /* Write ASCII data... */
02289   if (ctl->atm_type == 0) {
02290
02291     /* Check if gnuplot output is requested... */
02292     if (ctl->atm_gpfile[0] != '-') {
02293
02294       /* Create gnuplot pipe... */
```

```
02295       if (!(out = popen("gnuplot", "w")))
02296         ERRMSG("Cannot create pipe to gnuplot!");
02297
02298       /* Set plot filename... */
02299       fprintf(out, "set out \"%s.png\"\n", filename);
02300
02301       /* Set time string... */
02302       jsec2time(t, &year, &mon, &day, &hour, &min, &sec, &r);
02303       fprintf(out, "timestr=\"%d-%02d-%02d, %02d:%02d UTC\"\n",
02304               year, mon, day, hour, min);
02305
02306       /* Dump gnuplot file to pipe... */
02307       if (!(in = fopen(ctl->atm_gpfile, "r")))
02308         ERRMSG("Cannot open file!");
02309       while (fgets(line, LEN, in))
02310         fprintf(out, "%s", line);
02311       fclose(in);
02312     }
02313
02314     else {
02315
02316       /* Create file... */
02317       if (!(out = fopen(filename, "w")))
02318         ERRMSG("Cannot create file!");
02319     }
02320
02321     /* Write header... */
02322     fprintf(out,
02323             "# $1 = time [s]\n"
02324             "# $2 = altitude [km]\n"
02325             "# $3 = longitude [deg]\n" "# $4 = latitude [deg]\n");
02326     for (iq = 0; iq < ctl->nq; iq++)
02327       fprintf(out, "# $%i = %s [%s]\n", iq + 5, ctl->qnt_name[iq],
02328               ctl->qnt_unit[iq]);
02329     fprintf(out, "\n");
02330
02331     /* Write data... */
02332     for (ip = 0; ip < atm->np; ip++) {
02333
02334       /* Check time... */
02335       if (ctl->atm_filter && (atm->time[ip] < t0 || atm->time[ip] > t1))
02336         continue;
02337
02338       /* Write output... */
02339       fprintf(out, "%.2f %g %g %g", atm->time[ip], Z(atm->p[ip]),
02340               atm->lon[ip], atm->lat[ip]);
02341       for (iq = 0; iq < ctl->nq; iq++) {
02342         fprintf(out, " ");
02343         fprintf(out, ctl->qnt_format[iq], atm->q[iq][ip]);
02344       }
02345       fprintf(out, "\n");
02346     }
02347
02348     /* Close file... */
02349     fclose(out);
02350   }
02351
02352   /* Write binary data... */
02353   else if (ctl->atm_type == 1) {
02354
02355     /* Create file... */
02356     if (!(out = fopen(filename, "w")))
02357       ERRMSG("Cannot create file!");
02358
02359     /* Write data... */
02360     FWRITE(&atm->np, int,
02361            1,
02362            out);
02363     FWRITE(atm->time, double,
02364              (size_t) atm->np,
02365            out);
02366     FWRITE(atm->p, double,
02367              (size_t) atm->np,
02368            out);
02369     FWRITE(atm->lon, double,
02370              (size_t) atm->np,
02371            out);
02372     FWRITE(atm->lat, double,
02373              (size_t) atm->np,
02374            out);
02375     for (iq = 0; iq < ctl->nq; iq++)
02376       FWRITE(atm->q[iq], double,
02377                (size_t) atm->np,
02378              out);
02379
02380     /* Close file... */
02381     fclose(out);
```

```
02382   }
02383
02384   /* Error... */
02385   else
02386     ERRMSG("Atmospheric data type not supported!");
02387 }
```

Here is the call graph for this function:

5.19.2.31 void write_csi (const char * *filename*, ctl_t * *ctl*, atm_t * *atm*, double *t*)

Write CSI data.

Definition at line 2391 of file libtrac.c.

```
02395             {
02396
02397   static FILE *in, *out;
02398
02399   static char line[LEN];
02400
02401   static double modmean[GX][GY][GZ], obsmean[GX][GY][GZ],
02402     rt, rz, rlon, rlat, robs, t0, t1, area, dlon, dlat, lat;
02403
02404   static int obscount[GX][GY][GZ], cx, cy, cz, ip, ix, iy, iz;
02405
02406   /* Init... */
02407   if (t == ctl->t_start) {
02408
02409     /* Check quantity index for mass... */
02410     if (ctl->qnt_m < 0)
02411       ERRMSG("Need quantity mass!");
02412
02413     /* Open observation data file... */
02414     printf("Read CSI observation data: %s\n", ctl->csi_obsfile);
02415     if (!(in = fopen(ctl->csi_obsfile, "r")))
02416       ERRMSG("Cannot open file!");
02417
02418     /* Create new file... */
02419     printf("Write CSI data: %s\n", filename);
02420     if (!(out = fopen(filename, "w")))
02421       ERRMSG("Cannot create file!");
02422
02423     /* Write header... */
02424     fprintf(out,
02425             "# $1 = time [s]\n"
02426             "# $2 = number of hits (cx)\n"
02427             "# $3 = number of misses (cy)\n"
02428             "# $4 = number of false alarms (cz)\n"
02429             "# $5 = number of observations (cx + cy)\n"
02430             "# $6 = number of forecasts (cx + cz)\n"
02431             "# $7 = bias (forecasts/observations) [%%]\n"
02432             "# $8 = probability of detection (POD) [%%]\n"
02433             "# $9 = false alarm rate (FAR) [%%]\n"
02434             "# $10 = critical success index (CSI) [%%]\n\n");
02435   }
02436
02437   /* Set time interval... */
02438   t0 = t - 0.5 * ctl->dt_mod;
02439   t1 = t + 0.5 * ctl->dt_mod;
02440
02441   /* Initialize grid cells... */
```

```
02442 #pragma omp parallel for default(shared) private(ix,iy,iz)
02443   for (ix = 0; ix < ctl->csi_nx; ix++)
02444     for (iy = 0; iy < ctl->csi_ny; iy++)
02445       for (iz = 0; iz < ctl->csi_nz; iz++)
02446         modmean[ix][iy][iz] = obsmean[ix][iy][iz] = obscount[ix][iy][iz] = 0;
02447
02448   /* Read observation data... */
02449   while (fgets(line, LEN, in)) {
02450
02451     /* Read data... */
02452     if (sscanf(line, "%lg %lg %lg %lg %lg", &rt, &rz, &rlon, &rlat, &robs) !=
02453         5)
02454       continue;
02455
02456     /* Check time... */
02457     if (rt < t0)
02458       continue;
02459     if (rt > t1)
02460       break;
02461
02462     /* Calculate indices... */
02463     ix = (int) ((rlon - ctl->csi_lon0)
02464                 / (ctl->csi_lon1 - ctl->csi_lon0) * ctl->csi_nx);
02465     iy = (int) ((rlat - ctl->csi_lat0)
02466                 / (ctl->csi_lat1 - ctl->csi_lat0) * ctl->csi_ny);
02467     iz = (int) ((rz - ctl->csi_z0)
02468                 / (ctl->csi_z1 - ctl->csi_z0) * ctl->csi_nz);
02469
02470     /* Check indices... */
02471     if (ix < 0 || ix >= ctl->csi_nx ||
02472         iy < 0 || iy >= ctl->csi_ny || iz < 0 || iz >= ctl->csi_nz)
02473       continue;
02474
02475     /* Get mean observation index... */
02476     obsmean[ix][iy][iz] += robs;
02477     obscount[ix][iy][iz]++;
02478   }
02479
02480   /* Analyze model data... */
02481 #pragma omp parallel for default(shared) private(ip,ix,iy,iz)
02482   for (ip = 0; ip < atm->np; ip++) {
02483
02484     /* Check time... */
02485     if (atm->time[ip] < t0 || atm->time[ip] > t1)
02486       continue;
02487
02488     /* Get indices... */
02489     ix = (int) ((atm->lon[ip] - ctl->csi_lon0)
02490                 / (ctl->csi_lon1 - ctl->csi_lon0) * ctl->csi_nx);
02491     iy = (int) ((atm->lat[ip] - ctl->csi_lat0)
02492                 / (ctl->csi_lat1 - ctl->csi_lat0) * ctl->csi_ny);
02493     iz = (int) ((Z(atm->p[ip]) - ctl->csi_z0)
02494                 / (ctl->csi_z1 - ctl->csi_z0) * ctl->csi_nz);
02495
02496     /* Check indices... */
02497     if (ix < 0 || ix >= ctl->csi_nx ||
02498         iy < 0 || iy >= ctl->csi_ny || iz < 0 || iz >= ctl->csi_nz)
02499       continue;
02500
02501     /* Get total mass in grid cell... */
02502     modmean[ix][iy][iz] += atm->q[ctl->qnt_m][ip];
02503   }
02504
02505   /* Analyze all grid cells... */
02506 #pragma omp parallel for default(shared) private(ix,iy,iz,dlon,dlat,lat,area)
02507   for (ix = 0; ix < ctl->csi_nx; ix++)
02508     for (iy = 0; iy < ctl->csi_ny; iy++)
02509       for (iz = 0; iz < ctl->csi_nz; iz++) {
02510
02511         /* Calculate mean observation index... */
02512         if (obscount[ix][iy][iz] > 0)
02513           obsmean[ix][iy][iz] /= obscount[ix][iy][iz];
02514
02515         /* Calculate column density... */
02516         if (modmean[ix][iy][iz] > 0) {
02517           dlon = (ctl->csi_lon1 - ctl->csi_lon0) / ctl->csi_nx;
02518           dlat = (ctl->csi_lat1 - ctl->csi_lat0) / ctl->csi_ny;
02519           lat = ctl->csi_lat0 + dlat * (iy + 0.5);
02520           area = dlat * M_PI * RE / 180. * dlon * M_PI * RE / 180.
02521             * cos(lat * M_PI / 180.);
02522           modmean[ix][iy][iz] /= (1e6 * area);
02523         }
02524
02525         /* Calculate CSI... */
02526         if (obscount[ix][iy][iz] > 0) {
02527           if (obsmean[ix][iy][iz] >= ctl->csi_obsmin &&
02528               modmean[ix][iy][iz] >= ctl->csi_modmin)
```

```
02529             cx++;
02530           else if (obsmean[ix][iy][iz] >= ctl->csi_obsmin &&
02531                    modmean[ix][iy][iz] < ctl->csi_modmin)
02532             cy++;
02533           else if (obsmean[ix][iy][iz] < ctl->csi_obsmin &&
02534                    modmean[ix][iy][iz] >= ctl->csi_modmin)
02535             cz++;
02536         }
02537       }
02538
02539   /* Write output... */
02540   if (fmod(t, ctl->csi_dt_out) == 0) {
02541
02542     /* Write... */
02543     fprintf(out, "%.2f %d %d %d %d %d %g %g %g %g\n",
02544             t, cx, cy, cz, cx + cy, cx + cz,
02545             (cx + cy > 0) ? 100. * (cx + cz) / (cx + cy) : GSL_NAN,
02546             (cx + cy > 0) ? (100. * cx) / (cx + cy) : GSL_NAN,
02547             (cx + cz > 0) ? (100. * cz) / (cx + cz) : GSL_NAN,
02548             (cx + cy + cz > 0) ? (100. * cx) / (cx + cy + cz) : GSL_NAN);
02549
02550     /* Set counters to zero... */
02551     cx = cy = cz = 0;
02552   }
02553
02554   /* Close file... */
02555   if (t == ctl->t_stop)
02556     fclose(out);
02557 }
```

5.19.2.32 void write_ens (const char * *filename*, ctl_t * *ctl*, atm_t * *atm*, double *t*)

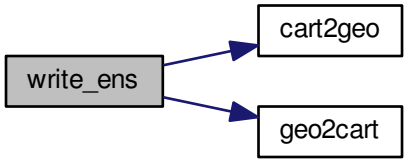
Write ensemble data.

Definition at line 2561 of file libtrac.c.

```
02565             {
02566
02567   static FILE *out;
02568
02569   static double dummy, ens, lat, lon, p[NENS], q[NQ][NENS],
02570     t0, t1, x[NENS][3], xm[3];
02571
02572   static int ip, iq;
02573
02574   static size_t i, n;
02575
02576   /* Init... */
02577   if (t == ctl->t_start) {
02578
02579     /* Check quantities... */
02580     if (ctl->qnt_ens < 0)
02581       ERRMSG("Missing ensemble IDs!");
02582
02583     /* Create new file... */
02584     printf("Write ensemble data: %s\n", filename);
02585     if (!(out = fopen(filename, "w")))
02586       ERRMSG("Cannot create file!");
02587
02588     /* Write header... */
02589     fprintf(out,
02590             "# $1 = time [s]\n"
02591             "# $2 = altitude [km]\n"
02592             "# $3 = longitude [deg]\n" "# $4 = latitude [deg]\n");
02593     for (iq = 0; iq < ctl->nq; iq++)
02594       fprintf(out, "# $%d = %s (mean) [%s]\n", 5 + iq,
02595               ctl->qnt_name[iq], ctl->qnt_unit[iq]);
02596     for (iq = 0; iq < ctl->nq; iq++)
02597       fprintf(out, "# $%d = %s (sigma) [%s]\n", 5 + ctl->nq + iq,
02598               ctl->qnt_name[iq], ctl->qnt_unit[iq]);
02599     fprintf(out, "# $%d = number of members\n\n", 5 + 2 * ctl->nq);
02600   }
02601
02602   /* Set time interval... */
02603   t0 = t - 0.5 * ctl->dt_mod;
02604   t1 = t + 0.5 * ctl->dt_mod;
02605
02606   /* Init... */
02607   ens = GSL_NAN;
02608   n = 0;
```

```
02609
02610   /* Loop over air parcels... */
02611   for (ip = 0; ip < atm->np; ip++) {
02612
02613     /* Check time... */
02614     if (atm->time[ip] < t0 || atm->time[ip] > t1)
02615       continue;
02616
02617     /* Check ensemble id... */
02618     if (atm->q[ctl->qnt_ens][ip] != ens) {
02619
02620       /* Write results... */
02621       if (n > 0) {
02622
02623         /* Get mean position... */
02624         xm[0] = xm[1] = xm[2] = 0;
02625         for (i = 0; i < n; i++) {
02626           xm[0] += x[i][0] / (double) n;
02627           xm[1] += x[i][1] / (double) n;
02628           xm[2] += x[i][2] / (double) n;
02629         }
02630         cart2geo(xm, &dummy, &lon, &lat);
02631         fprintf(out, "%.2f %g %g %g", t, Z(gsl_stats_mean(p, 1, n)), lon,
02632                 lat);
02633
02634         /* Get quantity statistics... */
02635         for (iq = 0; iq < ctl->nq; iq++) {
02636           fprintf(out, " ");
02637           fprintf(out, ctl->qnt_format[iq], gsl_stats_mean(q[iq], 1, n));
02638         }
02639         for (iq = 0; iq < ctl->nq; iq++) {
02640           fprintf(out, " ");
02641           fprintf(out, ctl->qnt_format[iq], gsl_stats_sd(q[iq], 1, n));
02642         }
02643         fprintf(out, " %lu\n", n);
02644       }
02645
02646       /* Init new ensemble... */
02647       ens = atm->q[ctl->qnt_ens][ip];
02648       n = 0;
02649     }
02650
02651     /* Save data... */
02652     p[n] = atm->p[ip];
02653     geo2cart(0, atm->lon[ip], atm->lat[ip], x[n]);
02654     for (iq = 0; iq < ctl->nq; iq++)
02655       q[iq][n] = atm->q[iq][ip];
02656     if ((++n) >= NENS)
02657       ERRMSG("Too many data points!");
02658   }
02659
02660   /* Write results... */
02661   if (n > 0) {
02662
02663     /* Get mean position... */
02664     xm[0] = xm[1] = xm[2] = 0;
02665     for (i = 0; i < n; i++) {
02666       xm[0] += x[i][0] / (double) n;
02667       xm[1] += x[i][1] / (double) n;
02668       xm[2] += x[i][2] / (double) n;
02669     }
02670     cart2geo(xm, &dummy, &lon, &lat);
02671     fprintf(out, "%.2f %g %g %g", t, Z(gsl_stats_mean(p, 1, n)), lon, lat);
02672
02673     /* Get quantity statistics... */
02674     for (iq = 0; iq < ctl->nq; iq++) {
02675       fprintf(out, " ");
02676       fprintf(out, ctl->qnt_format[iq], gsl_stats_mean(q[iq], 1, n));
02677     }
02678     for (iq = 0; iq < ctl->nq; iq++) {
02679       fprintf(out, " ");
02680       fprintf(out, ctl->qnt_format[iq], gsl_stats_sd(q[iq], 1, n));
02681     }
02682     fprintf(out, " %lu\n", n);
02683   }
02684
02685   /* Close file... */
02686   if (t == ctl->t_stop)
02687     fclose(out);
02688 }
```

Here is the call graph for this function:



5.19.2.33 void write_grid (const char * *filename*, ctl_t * *ctl*, met_t * *met0*, met_t * *met1*, atm_t * *atm*, double *t*)

Write gridded data.

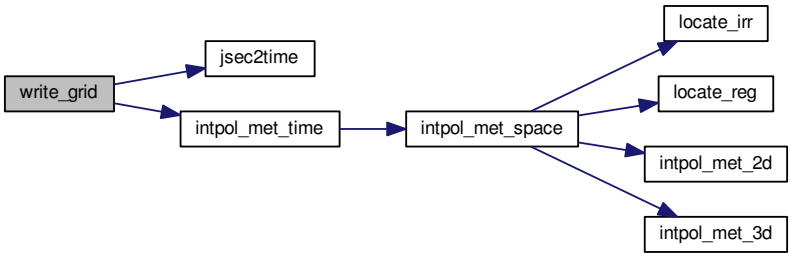
Definition at line 2692 of file libtrac.c.

```
02698            {
02699
02700   FILE *in, *out;
02701
02702   char line[LEN];
02703
02704   static double mass[GX][GY][GZ], z, dz, lon, dlon, lat, dlat,
02705     area, rho_air, press, temp, cd, vmr, t0, t1, r;
02706
02707   static int ip, ix, iy, iz, year, mon, day, hour, min, sec;
02708
02709   /* Check dimensions... */
02710   if (ctl->grid_nx > GX || ctl->grid_ny > GY || ctl->grid_nz > GZ)
02711     ERRMSG("Grid dimensions too large!");
02712
02713   /* Check quantity index for mass... */
02714   if (ctl->qnt_m < 0)
02715     ERRMSG("Need quantity mass!");
02716
02717   /* Set time interval for output... */
02718   t0 = t - 0.5 * ctl->dt_mod;
02719   t1 = t + 0.5 * ctl->dt_mod;
02720
02721   /* Set grid box size... */
02722   dz = (ctl->grid_z1 - ctl->grid_z0) / ctl->grid_nz;
02723   dlon = (ctl->grid_lon1 - ctl->grid_lon0) / ctl->grid_nx;
02724   dlat = (ctl->grid_lat1 - ctl->grid_lat0) / ctl->grid_ny;
02725
02726   /* Initialize grid... */
02727 #pragma omp parallel for default(shared) private(ix,iy,iz)
02728   for (ix = 0; ix < ctl->grid_nx; ix++)
02729     for (iy = 0; iy < ctl->grid_ny; iy++)
02730       for (iz = 0; iz < ctl->grid_nz; iz++)
02731         mass[ix][iy][iz] = 0;
02732
02733   /* Average data... */
02734 #pragma omp parallel for default(shared) private(ip,ix,iy,iz)
02735   for (ip = 0; ip < atm->np; ip++)
02736     if (atm->time[ip] >= t0 && atm->time[ip] <= t1) {
02737
02738       /* Get index... */
02739       ix = (int) ((atm->lon[ip] - ctl->grid_lon0) / dlon);
02740       iy = (int) ((atm->lat[ip] - ctl->grid_lat0) / dlat);
02741       iz = (int) ((Z(atm->p[ip]) - ctl->grid_z0) / dz);
02742
02743       /* Check indices... */
02744       if (ix < 0 || ix >= ctl->grid_nx ||
02745           iy < 0 || iy >= ctl->grid_ny || iz < 0 || iz >= ctl->grid_nz)
02746         continue;
02747
02748       /* Add mass... */
02749       mass[ix][iy][iz] += atm->q[ctl->qnt_m][ip];
```

```
02750     }
02751
02752   /* Check if gnuplot output is requested... */
02753   if (ctl->grid_gpfile[0] != '-') {
02754
02755     /* Write info... */
02756     printf("Plot grid data: %s.png\n", filename);
02757
02758     /* Create gnuplot pipe... */
02759     if (!(out = popen("gnuplot", "w")))
02760       ERRMSG("Cannot create pipe to gnuplot!");
02761
02762     /* Set plot filename... */
02763     fprintf(out, "set out \"%s.png\"\n", filename);
02764
02765     /* Set time string... */
02766     jsec2time(t, &year, &mon, &day, &hour, &min, &sec, &r);
02767     fprintf(out, "timestr=\"%d-%02d-%02d, %02d:%02d UTC\"\n",
02768             year, mon, day, hour, min);
02769
02770     /* Dump gnuplot file to pipe... */
02771     if (!(in = fopen(ctl->grid_gpfile, "r")))
02772       ERRMSG("Cannot open file!");
02773     while (fgets(line, LEN, in))
02774       fprintf(out, "%s", line);
02775     fclose(in);
02776   }
02777
02778   else {
02779
02780     /* Write info... */
02781     printf("Write grid data: %s\n", filename);
02782
02783     /* Create file... */
02784     if (!(out = fopen(filename, "w")))
02785       ERRMSG("Cannot create file!");
02786   }
02787
02788   /* Write header... */
02789   fprintf(out,
02790           "# $1 = time [s]\n"
02791           "# $2 = altitude [km]\n"
02792           "# $3 = longitude [deg]\n"
02793           "# $4 = latitude [deg]\n"
02794           "# $5 = surface area [km^2]\n"
02795           "# $6 = layer width [km]\n"
02796           "# $7 = temperature [K]\n"
02797           "# $8 = column density [kg/m^2]\n"
02798           "# $9 = volume mixing ratio [1]\n\n");
02799
02800   /* Write data... */
02801   for (ix = 0; ix < ctl->grid_nx; ix++) {
02802     if (ix > 0 && ctl->grid_ny > 1 && !ctl->grid_sparse)
02803       fprintf(out, "\n");
02804     for (iy = 0; iy < ctl->grid_ny; iy++) {
02805       if (iy > 0 && ctl->grid_nz > 1 && !ctl->grid_sparse)
02806         fprintf(out, "\n");
02807       for (iz = 0; iz < ctl->grid_nz; iz++)
02808         if (!ctl->grid_sparse || mass[ix][iy][iz] > 0) {
02809
02810           /* Set coordinates... */
02811           z = ctl->grid_z0 + dz * (iz + 0.5);
02812           lon = ctl->grid_lon0 + dlon * (ix + 0.5);
02813           lat = ctl->grid_lat0 + dlat * (iy + 0.5);
02814
02815           /* Get pressure and temperature... */
02816           press = P(z);
02817           intpol_met_time(met0, met1, t, press, lon, lat, NULL, NULL,
02818                           NULL, &temp, NULL, NULL, NULL, NULL, NULL, NULL);
02819
02820           /* Calculate surface area... */
02821           area = dlat * dlon * SQR(RE * M_PI / 180.)
02822             * cos(lat * M_PI / 180.);
02823
02824           /* Calculate column density... */
02825           cd = mass[ix][iy][iz] / (1e6 * area);
02826
02827           /* Calculate volume mixing ratio... */
02828           rho_air = 100. * press / (RA * temp);
02829           vmr = MA / ctl->molmass * mass[ix][iy][iz]
02830             / (rho_air * 1e6 * area * 1e3 * dz);
02831
02832           /* Write output... */
02833           fprintf(out, "%.2f %g %g %g %g %g %g %g %g\n",
02834                   t, z, lon, lat, area, dz, temp, cd, vmr);
02835         }
02836     }
```

```
02837   }
02838
02839   /* Close file... */
02840   fclose(out);
02841 }
```

Here is the call graph for this function:



5.19.2.34 void write_prof (const char * *filename*, ctl_t * *ctl*, met_t * *met0*, met_t * *met1*, atm_t * *atm*, double *t*)

Write profile data.

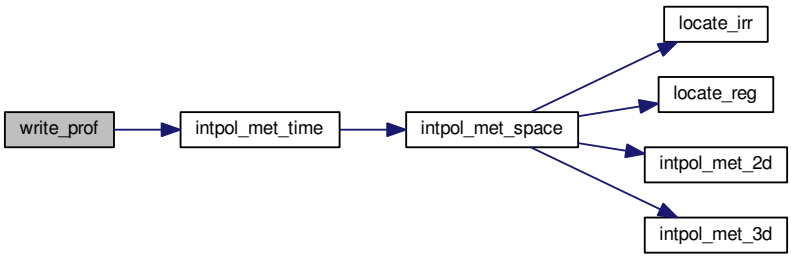
Definition at line 2845 of file libtrac.c.

```
02851           {
02852
02853   static FILE *in, *out;
02854
02855   static char line[LEN];
02856
02857   static double mass[GX][GY][GZ], obsmean[GX][GY], obsmean2[GX][GY], rt, rz,
02858     rlon, rlat, robs, t0, t1, area, dz, dlon, dlat, lon, lat, z, press, temp,
02859     rho_air, vmr, h2o, o3;
02860
02861   static int obscount[GX][GY], ip, ix, iy, iz, okay;
02862
02863   /* Init... */
02864   if (t == ctl->t_start) {
02865
02866     /* Check quantity index for mass... */
02867     if (ctl->qnt_m < 0)
02868       ERRMSG("Need quantity mass!");
02869
02870     /* Check dimensions... */
02871     if (ctl->prof_nx > GX || ctl->prof_ny > GY || ctl->prof_nz > GZ)
02872       ERRMSG("Grid dimensions too large!");
02873
02874     /* Open observation data file... */
02875     printf("Read profile observation data: %s\n", ctl->prof_obsfile);
02876     if (!(in = fopen(ctl->prof_obsfile, "r")))
02877       ERRMSG("Cannot open file!");
02878
02879     /* Create new output file... */
02880     printf("Write profile data: %s\n", filename);
02881     if (!(out = fopen(filename, "w")))
02882       ERRMSG("Cannot create file!");
02883
02884     /* Write header... */
02885     fprintf(out,
02886             "# $1 = time [s]\n"
02887             "# $2 = altitude [km]\n"
02888             "# $3 = longitude [deg]\n"
02889             "# $4 = latitude [deg]\n"
02890             "# $5 = pressure [hPa]\n"
02891             "# $6 = temperature [K]\n"
02892             "# $7 = volume mixing ratio [1]\n"
```

```
02893             "# $8 = H2O volume mixing ratio [1]\n"
02894             "# $9 = O3 volume mixing ratio [1]\n"
02895             "# $10 = observed BT index (mean) [K]\n"
02896             "# $11 = observed BT index (sigma) [K]\n");
02897
02898     /* Set grid box size... */
02899     dz = (ctl->prof_z1 - ctl->prof_z0) / ctl->prof_nz;
02900     dlon = (ctl->prof_lon1 - ctl->prof_lon0) / ctl->prof_nx;
02901     dlat = (ctl->prof_lat1 - ctl->prof_lat0) / ctl->prof_ny;
02902   }
02903
02904   /* Set time interval... */
02905   t0 = t - 0.5 * ctl->dt_mod;
02906   t1 = t + 0.5 * ctl->dt_mod;
02907
02908   /* Initialize... */
02909 #pragma omp parallel for default(shared) private(ix,iy,iz)
02910   for (ix = 0; ix < ctl->prof_nx; ix++)
02911     for (iy = 0; iy < ctl->prof_ny; iy++) {
02912       obsmean[ix][iy] = 0;
02913       obsmean2[ix][iy] = 0;
02914       obscount[ix][iy] = 0;
02915       for (iz = 0; iz < ctl->prof_nz; iz++)
02916         mass[ix][iy][iz] = 0;
02917     }
02918
02919   /* Read observation data... */
02920   while (fgets(line, LEN, in)) {
02921
02922     /* Read data... */
02923     if (sscanf(line, "%lg %lg %lg %lg %lg", &rt, &rz, &rlon, &rlat, &robs) !=
02924         5)
02925       continue;
02926
02927     /* Check time... */
02928     if (rt < t0)
02929       continue;
02930     if (rt > t1)
02931       break;
02932
02933     /* Calculate indices... */
02934     ix = (int) ((rlon - ctl->prof_lon0) / dlon);
02935     iy = (int) ((rlat - ctl->prof_lat0) / dlat);
02936
02937     /* Check indices... */
02938     if (ix < 0 || ix >= ctl->prof_nx || iy < 0 || iy >= ctl->prof_ny)
02939       continue;
02940
02941     /* Get mean observation index... */
02942     obsmean[ix][iy] += robs;
02943     obsmean2[ix][iy] += SQR(robs);
02944     obscount[ix][iy]++;
02945   }
02946
02947   /* Analyze model data... */
02948 #pragma omp parallel for default(shared) private(ip,ix,iy,iz)
02949   for (ip = 0; ip < atm->np; ip++) {
02950
02951     /* Check time... */
02952     if (atm->time[ip] < t0 || atm->time[ip] > t1)
02953       continue;
02954
02955     /* Get indices... */
02956     ix = (int) ((atm->lon[ip] - ctl->prof_lon0) / dlon);
02957     iy = (int) ((atm->lat[ip] - ctl->prof_lat0) / dlat);
02958     iz = (int) ((Z(atm->p[ip]) - ctl->prof_z0) / dz);
02959
02960     /* Check indices... */
02961     if (ix < 0 || ix >= ctl->prof_nx ||
02962         iy < 0 || iy >= ctl->prof_ny || iz < 0 || iz >= ctl->prof_nz)
02963       continue;
02964
02965     /* Get total mass in grid cell... */
02966     mass[ix][iy][iz] += atm->q[ctl->qnt_m][ip];
02967   }
02968
02969   /* Extract profiles... */
02970   for (ix = 0; ix < ctl->prof_nx; ix++)
02971     for (iy = 0; iy < ctl->prof_ny; iy++)
02972       if (obscount[ix][iy] > 0) {
02973
02974         /* Check profile... */
02975         okay = 0;
02976         for (iz = 0; iz < ctl->prof_nz; iz++)
02977           if (mass[ix][iy][iz] > 0) {
02978             okay = 1;
02979             break;
```

```
02980           }
02981         if (!okay)
02982           continue;
02983
02984         /* Write output... */
02985         fprintf(out, "\n");
02986
02987         /* Loop over altitudes... */
02988         for (iz = 0; iz < ctl->prof_nz; iz++) {
02989
02990           /* Set coordinates... */
02991           z = ctl->prof_z0 + dz * (iz + 0.5);
02992           lon = ctl->prof_lon0 + dlon * (ix + 0.5);
02993           lat = ctl->prof_lat0 + dlat * (iy + 0.5);
02994
02995           /* Get pressure and temperature... */
02996           press = P(z);
02997           intpol_met_time(met0, met1, t, press, lon, lat, NULL, NULL,
02998                           NULL, &temp, NULL, NULL, NULL, NULL, &h2o, &o3);
02999
03000           /* Calculate surface area... */
03001           area = dlat * dlon * SQR(M_PI * RE / 180.)
03002             * cos(lat * M_PI / 180.);
03003
03004           /* Calculate volume mixing ratio... */
03005           rho_air = 100. * press / (RA * temp);
03006           vmr = MA / ctl->molmass * mass[ix][iy][iz]
03007             / (rho_air * area * dz * 1e9);
03008
03009           /* Write output... */
03010           fprintf(out, "%.2f %g %g %g %g %g %g %g %g %g %g\n",
03011                   t, z, lon, lat, press, temp, vmr, h2o, o3,
03012                   obsmean[ix][iy] / obscount[ix][iy],
03013                   sqrt(obsmean2[ix][iy] / obscount[ix][iy]
03014                        - SQR(obsmean[ix][iy] / obscount[ix][iy])));
03015         }
03016       }
03017
03018   /* Close file... */
03019   if (t == ctl->t_stop)
03020     fclose(out);
03021 }
```

Here is the call graph for this function:



5.19.2.35 void write_station (const char * *filename*, ctl_t * *ctl*, atm_t * *atm*, double *t*)

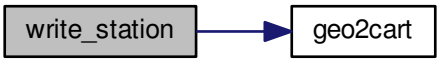
Write station data.

Definition at line 3025 of file libtrac.c.

```
03029             {
03030
03031   static FILE *out;
03032
03033   static double rmax2, t0, t1, x0[3], x1[3];
```

```
03034
03035   static int ip, iq;
03036
03037   /* Init... */
03038   if (t == ctl->t_start) {
03039
03040     /* Write info... */
03041     printf("Write station data: %s\n", filename);
03042
03043     /* Create new file... */
03044     if (!(out = fopen(filename, "w")))
03045       ERRMSG("Cannot create file!");
03046
03047     /* Write header... */
03048     fprintf(out,
03049             "# $1 = time [s]\n"
03050             "# $2 = altitude [km]\n"
03051             "# $3 = longitude [deg]\n" "# $4 = latitude [deg]\n");
03052     for (iq = 0; iq < ctl->nq; iq++)
03053       fprintf(out, "# $%i = %s [%s]\n", (iq + 5),
03054               ctl->qnt_name[iq], ctl->qnt_unit[iq]);
03055     fprintf(out, "\n");
03056
03057     /* Set geolocation and search radius... */
03058     geo2cart(0, ctl->stat_lon, ctl->stat_lat, x0);
03059     rmax2 = SQR(ctl->stat_r);
03060   }
03061
03062   /* Set time interval for output... */
03063   t0 = t - 0.5 * ctl->dt_mod;
03064   t1 = t + 0.5 * ctl->dt_mod;
03065
03066   /* Loop over air parcels... */
03067   for (ip = 0; ip < atm->np; ip++) {
03068
03069     /* Check time... */
03070     if (atm->time[ip] < t0 || atm->time[ip] > t1)
03071       continue;
03072
03073     /* Check station flag... */
03074     if (ctl->qnt_stat >= 0)
03075       if (atm->q[ctl->qnt_stat][ip])
03076         continue;
03077
03078     /* Get Cartesian coordinates... */
03079     geo2cart(0, atm->lon[ip], atm->lat[ip], x1);
03080
03081     /* Check horizontal distance... */
03082     if (DIST2(x0, x1) > rmax2)
03083       continue;
03084
03085     /* Set station flag... */
03086     if (ctl->qnt_stat >= 0)
03087       atm->q[ctl->qnt_stat][ip] = 1;
03088
03089     /* Write data... */
03090     fprintf(out, "%.2f %g %g %g",
03091             atm->time[ip], Z(atm->p[ip]), atm->lon[ip], atm->lat[ip]);
03092     for (iq = 0; iq < ctl->nq; iq++) {
03093       fprintf(out, " ");
03094       fprintf(out, ctl->qnt_format[iq], atm->q[iq][ip]);
03095     }
03096     fprintf(out, "\n");
03097   }
03098
03099   /* Close file... */
03100   if (t == ctl->t_stop)
03101     fclose(out);
03102 }
```

Here is the call graph for this function:



5.20 libtrac.c

```
00001 /*
00002   This file is part of MPTRAC.
00003
00004   MPTRAC is free software: you can redistribute it and/or modify
00005   it under the terms of the GNU General Public License as published by
00006   the Free Software Foundation, either version 3 of the License, or
00007   (at your option) any later version.
00008
00009   MPTRAC is distributed in the hope that it will be useful,
00010   but WITHOUT ANY WARRANTY; without even the implied warranty of
00011   MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
00012   GNU General Public License for more details.
00013
00014   You should have received a copy of the GNU General Public License
00015   along with MPTRAC. If not, see <http://www.gnu.org/licenses/>.
00016
00017   Copyright (C) 2013-2019 Forschungszentrum Juelich GmbH
00018 */
00019
00025 #include "libtrac.h"
00026
00027 /*****************************************************************************/
00028
00029 void cart2geo(
00030   double *x,
00031   double *z,
00032   double *lon,
00033   double *lat) {
00034
00035   double radius;
00036
00037   radius = NORM(x);
00038   *lat = asin(x[2] / radius) * 180 / M_PI;
00039   *lon = atan2(x[1], x[0]) * 180 / M_PI;
00040   *z = radius - RE;
00041 }
00042
00043 /*****************************************************************************/
00044
00045 double clim_hno3(
00046   double t,
00047   double lat,
00048   double p) {
00049
00050   static double secs[12] = { 1209600.00, 3888000.00, 6393600.00,
00051     9072000.00, 11664000.00, 14342400.00,
00052     16934400.00, 19612800.00, 22291200.00,
00053     24883200.00, 27561600.00, 30153600.00
00054   };
00055
00056   static double lats[18] = { -85, -75, -65, -55, -45, -35, -25, -15, -5,
00057     5, 15, 25, 35, 45, 55, 65, 75, 85
00058   };
00059
00060   static double ps[10] = { 4.64159, 6.81292, 10, 14.678, 21.5443,
00061     31.6228, 46.4159, 68.1292, 100, 146.78
00062   };
00063
00064   static double hno3[12][18][10] = {
00065     {{0.782, 1.65, 2.9, 4.59, 6.71, 8.25, 7.16, 5.75, 2.9, 1.74},
00066      {0.529, 1.64, 2.76, 4.55, 6.58, 8, 6.99, 5.55, 2.68, 1.57},
00067      {0.723, 1.55, 2.73, 4.48, 6.32, 7.58, 7.05, 5.16, 2.49, 1.54},
00068      {0.801, 1.56, 2.74, 4.52, 6.23, 7.35, 6.68, 4.4, 1.97, 1.23},
00069      {0.818, 1.62, 2.77, 4.38, 5.98, 6.84, 5.83, 3.05, 1.15, 0.709},
00070      {0.901, 1.73, 2.78, 4.21, 5.63, 6.16, 4.68, 1.87, 0.617, 0.37},
00071      {0.997, 1.8, 2.79, 4.09, 4.88, 4.96, 3.12, 1.22, 0.311, 0.244},
00072      {1, 1.71, 2.51, 3.4, 3.74, 3.39, 2.25, 0.845, 0.204, 0.222},
00073      {0.997, 1.7, 2.36, 2.88, 3.01, 2.25, 1.77, 0.608, 0.163, 0.181},
00074      {0.991, 1.79, 2.57, 3.06, 3.08, 2.15, 1.81, 0.59, 0.168, 0.104},
00075      {0.974, 1.86, 2.84, 3.8, 3.93, 3.79, 2.91, 1.02, 0.152, 0.0985},
00076      {0.85, 1.86, 3.3, 5.24, 6.55, 6.86, 5.12, 1.93, 0.378, 0.185},
00077      {0.783, 1.89, 3.85, 6.6, 8.56, 8.66, 6.95, 3.95, 1.47, 0.745},
00078      {0.883, 2.05, 4.34, 7.54, 9.68, 9.77, 8.19, 5.72, 3.15, 1.77},
00079      {1.4, 2.44, 4.72, 8.07, 10.5, 10.9, 9.28, 6.95, 4.47, 2.49},
00080      {1.7, 2.43, 4.24, 7.43, 10.4, 11.2, 9.72, 8.15, 5.7, 2.97},
00081      {2.06, 2.27, 3.68, 6.77, 10.3, 10.3, 9.05, 9.1, 6.73, 3.14},
00082      {2.33, 2.39, 3.51, 6.45, 10.3, 9.88, 8.57, 9.42, 7.22, 3.19}},
00083     {{0.947, 2.21, 3.81, 5.69, 7.55, 8.63, 7.53, 5.98, 3.03, 1.64},
00084      {0.642, 2, 3.4, 5.49, 7.5, 8.52, 7.53, 5.83, 2.74, 1.42},
00085      {0.756, 1.83, 3.18, 5.11, 7.24, 8.63, 7.66, 5.5, 2.45, 1.33},
00086      {0.837, 1.75, 3.06, 5, 6.79, 8.08, 7.05, 4.42, 1.81, 1.05},
00087      {0.86, 1.73, 2.96, 4.68, 6.38, 7.38, 6.09, 2.92, 1.06, 0.661},
00088      {0.926, 1.78, 2.89, 4.37, 5.74, 6.14, 4.59, 1.78, 0.561, 0.332},
00089      {0.988, 1.78, 2.75, 3.95, 4.64, 4.49, 2.85, 1.13, 0.271, 0.184},
```

```
00090       {0.999, 1.7, 2.44, 3.27, 3.57, 3.03, 2.06, 0.736, 0.181, 0.189},
00091       {0.971, 1.67, 2.23, 2.63, 2.83, 2.15, 1.74, 0.554, 0.157, 0.167},
00092       {0.985, 1.72, 2.34, 2.69, 2.81, 2.11, 1.78, 0.592, 0.152, 0.101},
00093       {0.95, 1.72, 2.57, 3.44, 3.84, 3.89, 2.91, 0.976, 0.135, 0.114},
00094       {0.819, 1.64, 2.93, 4.75, 6.02, 6.93, 5.2, 1.83, 0.347, 0.191},
00095       {0.731, 1.58, 3.3, 5.95, 7.81, 8.32, 6.93, 3.83, 1.47, 0.875},
00096       {0.77, 1.75, 3.74, 6.67, 8.76, 9.41, 8.19, 5.78, 3.32, 2.11},
00097       {1.08, 2.17, 4.24, 7.13, 9.2, 10.3, 9.03, 6.87, 4.65, 3.01},
00098       {1.43, 2.49, 4.31, 7, 9.14, 10.6, 9.34, 7.6, 5.86, 3.64},
00099       {1.5, 2.68, 4.32, 6.75, 8.78, 10.6, 9.05, 7.65, 6.27, 4.07},
00100       {1.73, 2.91, 4.33, 6.67, 8.73, 10.6, 8.5, 7.54, 6.63, 4.17}},
00101      {{1.43, 3.07, 5.22, 7.54, 9.78, 10.4, 10.1, 7.26, 3.61, 1.69},
00102       {0.989, 2.69, 4.76, 7.19, 9.44, 9.94, 9.5, 6.74, 3.24, 1.52},
00103       {0.908, 2.23, 4.11, 6.48, 8.74, 9.41, 8.58, 5.8, 2.66, 1.3},
00104       {0.923, 1.99, 3.61, 5.83, 7.84, 8.6, 7.55, 4.57, 1.87, 0.98},
00105       {0.933, 1.9, 3.31, 5.28, 7.1, 7.84, 6.44, 3.18, 1.1, 0.642},
00106       {0.982, 1.88, 3.1, 4.76, 6.16, 6.57, 5.16, 2.04, 0.598, 0.33},
00107       {1.02, 1.82, 2.88, 4.12, 4.71, 4.54, 3.03, 1.22, 0.268, 0.174},
00108       {0.992, 1.7, 2.51, 3.33, 3.62, 2.87, 2.05, 0.705, 0.161, 0.169},
00109       {0.969, 1.69, 2.2, 2.62, 2.84, 2.13, 1.78, 0.529, 0.146, 0.186},
00110       {0.945, 1.69, 2.27, 2.64, 2.83, 2.2, 1.83, 0.561, 0.139, 0.121},
00111       {0.922, 1.65, 2.48, 3.33, 3.83, 4.09, 2.92, 0.973, 0.117, 0.135},
00112       {0.886, 1.59, 2.66, 4.26, 5.51, 6.57, 5.09, 1.79, 0.342, 0.194},
00113       {0.786, 1.5, 2.78, 5.01, 6.8, 7.83, 6.65, 3.62, 1.45, 1},
00114       {0.745, 1.55, 3.05, 5.49, 7.44, 8.6, 7.8, 5.28, 2.95, 2.12},
00115       {0.938, 1.76, 3.4, 5.82, 7.8, 9.04, 8.43, 6.15, 3.85, 2.82},
00116       {0.999, 2, 3.66, 5.95, 7.94, 9.27, 8.8, 6.93, 4.87, 3.54},
00117       {1.13, 2.23, 3.86, 5.82, 7.65, 9, 8.82, 7.17, 5.72, 4.08},
00118       {1.23, 2.33, 3.94, 5.74, 7.48, 8.9, 8.84, 7.35, 6.3, 4.42}},
00119      {{1.55, 3.2, 6.25, 10, 12.9, 12.9, 11.9, 7.96, 3.96, 1.75},
00120       {1.32, 3.27, 6.32, 9.99, 12.7, 12.4, 11.3, 7.51, 3.66, 1.58},
00121       {1.25, 3.08, 5.77, 8.71, 11.2, 11.2, 9.84, 6.52, 3.23, 1.5},
00122       {1.18, 2.59, 4.76, 7.46, 9.61, 9.66, 8.42, 5.06, 2.25, 1.09},
00123       {1.09, 2.24, 3.99, 6.4, 8.33, 8.54, 7.08, 3.69, 1.36, 0.727},
00124       {1.06, 2.07, 3.52, 5.52, 7.06, 7.26, 5.83, 2.46, 0.732, 0.409},
00125       {1.07, 1.91, 3.09, 4.63, 5.21, 4.9, 3.68, 1.43, 0.326, 0.198},
00126       {1.03, 1.74, 2.63, 3.54, 3.78, 2.89, 2.09, 0.743, 0.175, 0.12},
00127       {0.959, 1.71, 2.32, 2.77, 2.99, 2.24, 1.76, 0.519, 0.149, 0.172},
00128       {0.931, 1.68, 2.32, 2.74, 2.99, 2.46, 1.88, 0.578, 0.156, 0.157},
00129       {0.933, 1.66, 2.49, 3.42, 3.99, 4.12, 2.93, 1.02, 0.181, 0.138},
00130       {0.952, 1.64, 2.6, 4, 5.15, 6.07, 4.84, 1.78, 0.407, 0.286},
00131       {0.84, 1.54, 2.68, 4.47, 5.97, 7.13, 6.23, 3.25, 1.38, 1.02},
00132       {0.714, 1.44, 2.73, 4.68, 6.28, 7.68, 7.21, 4.82, 2.55, 1.96},
00133       {0.838, 1.57, 2.96, 4.93, 6.55, 8.08, 7.74, 5.77, 3.32, 2.52},
00134       {0.823, 1.65, 3.11, 5.09, 6.89, 8.36, 8.31, 6.59, 4.1, 3.04},
00135       {0.886, 1.83, 3.42, 5.33, 6.92, 8.36, 8.63, 7.21, 4.82, 3.46},
00136       {1.07, 2.12, 3.74, 5.54, 6.98, 8.41, 8.75, 7.41, 5.16, 3.62}},
00137      {{1.13, 2.59, 7.49, 13.5, 15.4, 12.9, 11.3, 8.62, 4.18, 1.63},
00138       {0.973, 2.79, 7.23, 12.8, 15.2, 13.3, 11.6, 8.42, 4.06, 1.57},
00139       {1.46, 3.44, 6.78, 10.4, 12.7, 12.1, 10.5, 7.04, 3.59, 1.63},
00140       {1.52, 3.38, 6.04, 9.08, 11, 10.3, 8.9, 5.7, 2.77, 1.37},
00141       {1.32, 2.65, 4.75, 7.49, 9.32, 8.89, 7.42, 4.27, 1.7, 0.88},
00142       {1.19, 2.2, 3.88, 6.36, 8.03, 7.81, 6.19, 2.94, 0.948, 0.527},
00143       {1.14, 1.96, 3.28, 5.26, 6.12, 5.8, 4.47, 1.66, 0.388, 0.229},
00144       {1.07, 1.82, 2.82, 3.92, 4.03, 3.15, 2.31, 0.871, 0.183, 0.0972},
00145       {0.978, 1.77, 2.53, 3.04, 3.1, 2.36, 1.76, 0.575, 0.16, 0.126},
00146       {0.962, 1.72, 2.49, 3.01, 3.22, 2.72, 2, 0.716, 0.162, 0.183},
00147       {0.968, 1.7, 2.6, 3.57, 4.28, 4.35, 3.09, 1.2, 0.262, 0.18},
00148       {0.977, 1.68, 2.71, 4.03, 5.17, 6.01, 4.81, 1.81, 0.473, 0.343},
00149       {0.819, 1.58, 2.75, 4.37, 5.8, 6.9, 5.96, 2.95, 1.19, 0.964},
00150       {0.672, 1.44, 2.69, 4.42, 5.92, 7.26, 6.79, 4.32, 2.22, 1.83},
00151       {0.783, 1.42, 2.65, 4.45, 6.04, 7.57, 7.39, 5.4, 2.94, 2.25},
00152       {0.757, 1.43, 2.7, 4.54, 6.14, 7.65, 7.51, 5.95, 3.42, 2.39},
00153       {0.758, 1.57, 3.04, 4.88, 6.24, 7.85, 7.58, 6.35, 3.81, 2.52},
00154       {0.835, 1.72, 3.35, 5.24, 6.5, 8.1, 7.67, 6.51, 4, 2.6}},
00155      {{1.5, 2.12, 7.64, 10.5, 5.59, 2.14, 2.2, 3.5, 4.71, 3.26},
00156       {1.32, 2.14, 7.23, 12, 9.3, 5.3, 5.11, 5.37, 5.12, 3.05},
00157       {1.53, 2.92, 6.9, 11.9, 13.5, 11.3, 9.91, 7.18, 4.75, 2.65},
00158       {1.66, 3.48, 6.25, 9.53, 11.3, 10.3, 9.01, 5.76, 2.99, 1.67},
00159       {1.54, 3.03, 5.21, 8.03, 9.66, 8.98, 7.5, 4.64, 2.11, 1.13},
00160       {1.32, 2.39, 4.03, 6.74, 8.52, 8.05, 6.4, 3.48, 1.2, 0.639},
00161       {1.17, 2.08, 3.35, 5.52, 6.86, 6.54, 5.08, 1.97, 0.462, 0.217},
00162       {1.07, 1.92, 3.01, 4.24, 4.47, 3.77, 2.77, 1.07, 0.213, 0.0694},
00163       {0.992, 1.88, 2.76, 3.39, 3.32, 2.52, 1.8, 0.713, 0.192, 0.136},
00164       {0.992, 1.8, 2.63, 3.34, 3.46, 2.95, 2.09, 0.9, 0.242, 0.194},
00165       {0.987, 1.77, 2.67, 3.64, 4.37, 4.36, 3, 1.27, 0.354, 0.229},
00166       {0.979, 1.74, 2.77, 3.99, 5.12, 5.75, 4.53, 1.75, 0.555, 0.302},
00167       {0.832, 1.6, 2.78, 4.32, 5.53, 6.67, 5.69, 2.59, 0.982, 0.66},
00168       {0.696, 1.41, 2.64, 4.31, 5.65, 7.14, 6.56, 3.8, 1.75, 1.41},
00169       {0.788, 1.36, 2.59, 4.3, 5.73, 7.35, 7.04, 4.82, 2.41, 1.8},
00170       {0.761, 1.43, 2.61, 4.28, 5.64, 7.37, 7.11, 5.37, 2.68, 1.9},
00171       {0.701, 1.44, 2.82, 4.64, 5.76, 7.63, 7.07, 5.74, 2.98, 1.88},
00172       {0.763, 1.5, 2.95, 4.97, 6.08, 7.88, 7.12, 5.98, 3.21, 1.91}},
00173      {{3.58, 2.59, 6.49, 5.84, 1.63, 0.282, 0.647, 0.371, 1.36, 2.33},
00174       {3.09, 2.38, 6.37, 7.66, 4.06, 1.23, 1.8, 1.65, 2.32, 2.78},
00175       {2.31, 2.84, 5.58, 9.63, 11, 9.02, 8.2, 6.23, 4.17, 3.08},
00176       {1.61, 3.16, 5.72, 9.13, 11.4, 10.4, 9.15, 6.18, 3.52, 2.3},
```

```
00177      {1.32, 2.8, 4.79, 7.44, 9.43, 8.83, 7.41, 4.9, 2.38, 1.38},
00178      {1.14, 2.36, 3.94, 6.41, 8.38, 8.17, 6.53, 3.76, 1.31, 0.656},
00179      {1.05, 2.1, 3.36, 5.45, 7.07, 6.98, 5.44, 2.22, 0.52, 0.176},
00180      {1.02, 2, 3.05, 4.33, 4.74, 4.21, 3.2, 1.26, 0.277, 0.0705},
00181      {1.01, 1.96, 2.9, 3.53, 3.46, 2.69, 1.89, 0.859, 0.254, 0.12},
00182      {1.01, 1.86, 2.7, 3.46, 3.59, 3.03, 2.14, 1, 0.34, 0.199},
00183      {1.02, 1.81, 2.67, 3.68, 4.39, 4.3, 2.93, 1.35, 0.477, 0.25},
00184      {0.991, 1.79, 2.82, 4.05, 5.08, 5.5, 4.21, 1.74, 0.605, 0.259},
00185      {0.844, 1.73, 2.87, 4.38, 5.49, 6.47, 5.5, 2.44, 0.85, 0.422},
00186      {0.729, 1.57, 2.76, 4.43, 5.73, 7.13, 6.43, 3.52, 1.38, 0.913},
00187      {0.819, 1.46, 2.69, 4.45, 5.92, 7.47, 7.05, 4.52, 2, 1.4},
00188      {0.783, 1.47, 2.71, 4.48, 5.92, 7.46, 7.16, 5.08, 2.35, 1.56},
00189      {0.735, 1.51, 2.96, 4.84, 5.92, 7.77, 7.2, 5.54, 2.56, 1.61},
00190      {0.8, 1.61, 3.14, 5.2, 6.26, 8.08, 7.27, 5.72, 2.75, 1.62}},
00191     {{5, 4.43, 5.53, 5.35, 2.33, 0.384, 0.663, 0.164, 0.692, 1.4},
00192      {3.62, 3.79, 4.77, 5.94, 4.12, 1.36, 1.3, 0.973, 1.37, 1.73},
00193      {2.11, 2.7, 4.12, 7.14, 9.03, 7.74, 7.12, 5.44, 3.73, 2.6},
00194      {1.13, 2.32, 4.12, 6.97, 9.86, 9.69, 8.85, 6.22, 3.59, 2.14},
00195      {0.957, 2.28, 4.11, 6.47, 8.66, 8.78, 7.33, 4.94, 2.44, 1.38},
00196      {0.881, 2.1, 3.65, 5.94, 7.98, 8.29, 6.69, 3.95, 1.36, 0.672},
00197      {0.867, 1.96, 3.26, 5.23, 6.94, 7.2, 5.63, 2.41, 0.578, 0.19},
00198      {0.953, 1.94, 2.98, 4.23, 4.83, 4.52, 3.38, 1.34, 0.293, 0.181},
00199      {1.01, 1.91, 2.77, 3.35, 3.3, 2.62, 1.99, 0.905, 0.245, 0.107},
00200      {1.03, 1.81, 2.57, 3.29, 3.43, 2.87, 2.13, 0.988, 0.306, 0.185},
00201      {1.02, 1.78, 2.58, 3.59, 4.19, 4, 2.72, 1.29, 0.389, 0.224},
00202      {1.01, 1.84, 2.84, 4.06, 4.9, 5.08, 3.71, 1.64, 0.529, 0.232},
00203      {0.902, 1.84, 2.98, 4.43, 5.5, 6.28, 5.18, 2.35, 0.734, 0.341},
00204      {0.785, 1.68, 2.93, 4.67, 5.95, 7.3, 6.52, 3.48, 1.24, 0.754},
00205      {0.847, 1.62, 2.94, 4.86, 6.38, 7.99, 7.5, 4.64, 1.93, 1.23},
00206      {0.8, 1.6, 2.94, 4.95, 6.62, 8.16, 7.91, 5.43, 2.43, 1.45},
00207      {0.82, 1.76, 3.37, 5.47, 6.82, 8.24, 7.73, 5.79, 2.69, 1.5},
00208      {0.988, 2.05, 3.87, 6.01, 7.18, 8.41, 7.7, 5.93, 2.89, 1.55}},
00209     {{1.52, 2.7, 3.79, 4.95, 3.8, 1.51, 1.11, 0.784, 1.1, 1.56},
00210      {1.19, 2.16, 3.34, 4.76, 4.61, 2.93, 2.07, 1.65, 1.63, 1.74},
00211      {0.804, 1.65, 2.79, 4.63, 6.64, 6.95, 6.68, 5.11, 3.3, 2.09},
00212      {0.86, 1.8, 3.25, 5.3, 7.91, 8.76, 8.28, 6.01, 3.39, 1.83},
00213      {0.859, 1.95, 3.54, 5.64, 7.88, 8.55, 7.3, 4.88, 2.3, 1.22},
00214      {0.809, 1.88, 3.38, 5.45, 7.47, 8.02, 6.69, 3.98, 1.35, 0.646},
00215      {0.822, 1.81, 3.11, 4.9, 6.62, 6.96, 5.63, 2.47, 0.614, 0.169},
00216      {0.92, 1.83, 2.8, 3.93, 4.56, 4.4, 3.25, 1.31, 0.295, 0.0587},
00217      {0.986, 1.83, 2.6, 3.13, 3.08, 2.53, 1.94, 0.886, 0.244, 0.0815},
00218      {0.997, 1.74, 2.5, 3.16, 3.24, 2.67, 2.05, 0.939, 0.281, 0.147},
00219      {1.01, 1.75, 2.57, 3.55, 4.1, 3.81, 2.53, 1.21, 0.354, 0.197},
00220      {1.04, 1.88, 2.9, 4.16, 4.95, 4.96, 3.48, 1.63, 0.502, 0.163},
00221      {0.967, 1.95, 3.17, 4.72, 5.85, 6.5, 5.34, 2.53, 0.748, 0.303},
00222      {0.846, 1.83, 3.23, 5.15, 6.62, 7.82, 6.85, 3.79, 1.36, 0.714},
00223      {0.91, 1.81, 3.35, 5.55, 7.32, 8.55, 7.88, 5.03, 2.13, 1.1},
00224      {0.87, 1.94, 3.6, 5.97, 7.98, 9.14, 8.71, 6.04, 2.73, 1.41},
00225      {1.04, 2.36, 4.22, 6.57, 8.5, 9.53, 9.22, 6.71, 3.2, 1.56},
00226      {1.36, 2.84, 4.72, 6.94, 8.81, 9.87, 9.59, 7.1, 3.43, 1.65}},
00227     {{0.704, 1.4, 2.03, 3.08, 4.64, 4.24, 2.55, 1.57, 1.99, 1.91},
00228      {0.484, 1.38, 2.08, 3.54, 5.11, 4.98, 3.73, 2.57, 2.29, 1.84},
00229      {0.749, 1.57, 2.63, 4.17, 6.15, 6.97, 6.64, 5.11, 3.35, 1.97},
00230      {0.864, 1.69, 3.16, 4.87, 7.13, 8.33, 7.87, 5.9, 3.17, 1.56},
00231      {0.861, 1.79, 3.28, 5.2, 7.29, 8.32, 7.38, 4.9, 2.23, 1.11},
00232      {0.835, 1.79, 3.19, 4.99, 6.72, 7.58, 6.45, 3.68, 1.25, 0.616},
00233      {0.847, 1.8, 3.07, 4.66, 6.12, 6.6, 5.21, 2.18, 0.554, 0.21},
00234      {0.941, 1.78, 2.68, 3.68, 4.28, 4.18, 2.97, 1.15, 0.238, 0.0968},
00235      {0.98, 1.78, 2.48, 2.99, 2.96, 2.35, 1.88, 0.747, 0.207, 0.105},
00236      {0.978, 1.74, 2.51, 3.07, 3.12, 2.36, 1.95, 0.777, 0.216, 0.146},
00237      {1.01, 1.79, 2.63, 3.53, 3.95, 3.47, 2.38, 1.08, 0.265, 0.178},
00238      {1.06, 1.94, 3.02, 4.43, 5.19, 5.01, 3.68, 1.71, 0.429, 0.14},
00239      {0.99, 2.02, 3.38, 5.22, 6.56, 6.91, 5.56, 2.75, 0.816, 0.353},
00240      {0.923, 2.05, 3.66, 5.98, 7.78, 8.5, 7.23, 4.26, 1.67, 0.802},
00241      {1.08, 2.27, 4.17, 6.8, 8.89, 9.55, 8.59, 5.64, 2.58, 1.2},
00242      {1.12, 2.5, 4.52, 7.22, 9.76, 10.3, 9.72, 6.79, 3.32, 1.52},
00243      {1.2, 2.64, 4.81, 7.64, 10.5, 11.4, 10.6, 7.65, 3.87, 1.73},
00244      {1.4, 2.91, 5.01, 7.75, 10.7, 11.6, 11.1, 8.02, 4.04, 1.8}},
00245     {{0.75, 1.49, 2.39, 3.39, 4.93, 5.94, 5.03, 2.75, 2.27, 1.78},
00246      {0.508, 1.52, 2.38, 3.82, 5.34, 6.13, 5.6, 3.31, 2.42, 1.73},
00247      {0.715, 1.56, 2.7, 4.39, 6.18, 6.96, 7.1, 5.04, 3.01, 1.75},
00248      {0.813, 1.62, 2.94, 4.65, 6.53, 7.65, 7.52, 5.49, 2.75, 1.41},
00249      {0.802, 1.68, 2.97, 4.64, 6.37, 7.53, 7.01, 4.56, 1.9, 0.955},
00250      {0.816, 1.75, 3.01, 4.59, 6.15, 7.06, 6.15, 3.38, 1.11, 0.61},
00251      {0.867, 1.78, 2.92, 4.35, 5.69, 6.05, 4.73, 1.91, 0.519, 0.269},
00252      {0.932, 1.7, 2.55, 3.44, 4.03, 3.98, 2.74, 1.08, 0.247, 0.132},
00253      {0.937, 1.74, 2.51, 3.09, 3.11, 2.34, 1.84, 0.67, 0.189, 0.121},
00254      {0.942, 1.75, 2.63, 3.3, 3.27, 2.21, 1.87, 0.663, 0.171, 0.147},
00255      {0.959, 1.8, 2.82, 3.78, 4.03, 3.37, 2.53, 1.04, 0.199, 0.146},
00256      {1.01, 1.9, 3.13, 4.76, 5.63, 5.6, 4.31, 1.83, 0.367, 0.172},
00257      {0.989, 2.04, 3.64, 6, 7.62, 7.6, 6, 3.35, 1.05, 0.448},
00258      {1.02, 2.28, 4.32, 7.19, 9.21, 9.16, 7.64, 4.97, 2.2, 0.948},
00259      {1.26, 2.77, 5.2, 8.31, 10.5, 10.4, 9.01, 6.37, 3.46, 1.56},
00260      {1.31, 2.76, 5.23, 8.49, 11.2, 11.3, 10.1, 7.27, 3.98, 1.76},
00261      {1.26, 2.5, 5.14, 8.85, 12.3, 12.3, 11.2, 8.13, 4.45, 1.97},
00262      {1.35, 2.49, 5.26, 9.16, 13, 12.8, 11.8, 8.57, 4.72, 2.05}},
00263     {{0.759, 1.54, 2.54, 4.22, 6.26, 7.44, 7.14, 4.99, 2.84, 1.89},
```

```
00264       {0.508, 1.55, 2.5, 4.29, 6.29, 7.29, 7.07, 5.03, 2.77, 1.74},
00265       {0.699, 1.56, 2.62, 4.17, 6.08, 7.38, 7.04, 5.17, 2.81, 1.65},
00266       {0.778, 1.5, 2.65, 4.35, 6.07, 7.28, 6.84, 4.8, 2.28, 1.28},
00267       {0.772, 1.55, 2.71, 4.3, 5.76, 6.91, 6.2, 3.69, 1.45, 0.837},
00268       {0.836, 1.67, 2.78, 4.21, 5.56, 6.41, 5.33, 2.47, 0.807, 0.488},
00269       {0.937, 1.79, 2.78, 4.12, 5.17, 5.38, 3.89, 1.47, 0.392, 0.256},
00270       {0.97, 1.75, 2.52, 3.39, 3.83, 3.63, 2.48, 0.968, 0.212, 0.198},
00271       {0.968, 1.74, 2.5, 3.11, 3.2, 2.34, 1.79, 0.629, 0.169, 0.173},
00272       {0.98, 1.8, 2.69, 3.42, 3.4, 2.18, 1.81, 0.606, 0.164, 0.138},
00273       {0.975, 1.84, 2.96, 4.08, 4.12, 3.5, 2.79, 1.02, 0.145, 0.133},
00274       {0.96, 1.94, 3.27, 5.17, 6.26, 6.35, 4.88, 1.91, 0.329, 0.189},
00275       {0.954, 2.06, 3.8, 6.53, 8.46, 8.32, 6.53, 3.83, 1.32, 0.6},
00276       {1, 2.34, 4.58, 7.71, 9.68, 9.75, 7.96, 5.45, 2.84, 1.39},
00277       {1.24, 2.65, 5.14, 8.51, 10.7, 10.6, 8.96, 6.51, 3.83, 1.85},
00278       {1.34, 2.44, 4.99, 8.63, 11.6, 11.4, 10.1, 7.84, 4.77, 2.24},
00279       {1.33, 2.1, 4.76, 8.78, 12.2, 11.7, 10.8, 8.68, 5.15, 2.35},
00280       {1.42, 2.04, 4.68, 8.92, 12.7, 12, 11.2, 8.99, 5.32, 2.33}}
00281   };
00282
00283   double aux00, aux01, aux10, aux11, sec;
00284
00285   int ilat, ip, isec;
00286
00287   /* Get seconds since begin of year... */
00288   sec = fmod(t, 365.25 * 86400.);
00289
00290   /* Get indices... */
00291   isec = locate_irr(secs, 12, sec);
00292   ilat = locate_reg(lats, 18, lat);
00293   ip = locate_irr(ps, 10, p);
00294
00295   /* Interpolate... */
00296   aux00 = LIN(ps[ip], hno3[isec][ilat][ip],
00297               ps[ip + 1], hno3[isec][ilat][ip + 1], p);
00298   aux01 = LIN(ps[ip], hno3[isec][ilat + 1][ip],
00299               ps[ip + 1], hno3[isec][ilat + 1][ip + 1], p);
00300   aux10 = LIN(ps[ip], hno3[isec + 1][ilat][ip],
00301               ps[ip + 1], hno3[isec + 1][ilat][ip + 1], p);
00302   aux11 = LIN(ps[ip], hno3[isec + 1][ilat + 1][ip],
00303               ps[ip + 1], hno3[isec + 1][ilat + 1][ip + 1], p);
00304   aux00 = LIN(lats[ilat], aux00, lats[ilat + 1], aux01, lat);
00305   aux11 = LIN(lats[ilat], aux10, lats[ilat + 1], aux11, lat);
00306   return LIN(secs[isec], aux00, secs[isec + 1], aux11, sec);
00307 }
00308
00309 /*****************************************************************************/
00310
00311 double clim_tropo(
00312   double t,
00313   double lat) {
00314
00315   static double doys[12]
00316   = { 1, 32, 60, 91, 121, 152, 182, 213, 244, 274, 305, 335 };
00317
00318   static double lats[73]
00319     = { -90, -87.5, -85, -82.5, -80, -77.5, -75, -72.5, -70, -67.5,
00320     -65, -62.5, -60, -57.5, -55, -52.5, -50, -47.5, -45, -42.5,
00321     -40, -37.5, -35, -32.5, -30, -27.5, -25, -22.5, -20, -17.5,
00322     -15, -12.5, -10, -7.5, -5, -2.5, 0, 2.5, 5, 7.5, 10, 12.5,
00323     15, 17.5, 20, 22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5,
00324     45, 47.5, 50, 52.5, 55, 57.5, 60, 62.5, 65, 67.5, 70, 72.5,
00325     75, 77.5, 80, 82.5, 85, 87.5, 90
00326   };
00327
00328   static double tps[12][73]
00329     = { {324.1, 325.6, 325, 324.3, 322.5, 319.7, 314, 307.2, 301.8, 299.6,
00330          297.1, 292.2, 285.6, 276.1, 264, 248.9, 231.9, 213.5, 194.4,
00331          175.3, 157, 140.4, 126.7, 116.3, 109.5, 105.4, 103, 101.4, 100.4,
00332          99.69, 99.19, 98.84, 98.56, 98.39, 98.39, 98.42, 98.44, 98.54,
00333          98.68, 98.81, 98.89, 98.96, 99.12, 99.65, 101.4, 105.4, 113.5, 128,
00334          152.1, 184.7, 214, 234.1, 247.3, 255.8, 262.6, 267.7, 271.7, 275,
00335          277.2, 279, 280.1, 280.4, 280.6, 280.1, 279.3, 278.3, 276.8, 275.8,
00336          275.3, 275.6, 275.4, 274.1, 273.5},
00337   {337.3, 338.7, 337.8, 336.4, 333, 328.8, 321.1, 312.6, 306.6, 303.7,
00338    300.2, 293.8, 285.4, 273.8, 259.6, 242.7, 224.4, 205.2, 186, 167.5,
00339    150.3, 135, 122.8, 113.9, 108.2, 104.7, 102.5, 101.1, 100.2, 99.42,
00340    98.88, 98.52, 98.25, 98.09, 98.07, 98.1, 98.12, 98.2, 98.25, 98.27,
00341    98.26, 98.27, 98.36, 98.79, 100.2, 104.2, 113.7, 131.2, 159.5, 193,
00342    220.4, 238.1, 250.2, 258.1, 264.7, 269.7, 273.7, 277.3, 280.2, 282.8,
00343    284.9, 286.5, 288.1, 288.8, 289, 288.5, 287.2, 286.3, 286.1, 287.2,
00344    287.5, 286.2, 285.8},
00345   {335, 336, 335.7, 335.1, 332.3, 328.1, 320.6, 311.8, 305.1, 301.9,
00346    297.6, 290, 280.4, 268.3, 254.6, 239.6, 223.9, 207.9, 192.2, 176.9,
00347    161.7, 146.4, 132.2, 120.6, 112.3, 107.2, 104.3, 102.4, 101.3,
00348    100.4, 99.86, 99.47, 99.16, 98.97, 98.94, 98.97, 99, 99.09, 99.2,
00349    99.31, 99.35, 99.41, 99.51, 99.86, 101.1, 104.9, 114.3, 131, 156.8,
00350    186.3, 209.3, 224.6, 236.8, 246.3, 254.9, 262.3, 268.8, 274.8,
```

```
00351    279.9, 284.6, 288.6, 291.6, 294.9, 297.5, 299.8, 301.8, 303.1,
00352    304.3, 304.9, 306, 306.6, 306.2, 306},
00353   {306.2, 306.7, 305.7, 307.1, 307.3, 306.4, 301.8, 296.2, 292.4,
00354    290.3, 287.1, 280.9, 273.4, 264.3, 254.1, 242.8, 231, 219, 207.2,
00355    195.5, 183.3, 169.7, 154.7, 138.7, 124.1, 113.6, 107.8, 104.7,
00356    102.8, 101.7, 100.9, 100.4, 100, 99.79, 99.7, 99.66, 99.68, 99.79,
00357    99.94, 100.2, 100.5, 100.9, 101.4, 102.1, 103.4, 107, 115.2, 129.1,
00358    148.7, 171, 190.8, 205.6, 218.4, 229.4, 239.6, 248.6, 256.5,
00359    263.7, 270.3, 276.6, 282.6, 288.1, 294.5, 300.4, 306.3, 311.4,
00360    315.1, 318.3, 320.3, 322.2, 322.8, 321.5, 321.1},
00361   {266.5, 264.9, 260.8, 261, 262, 263, 261.3, 259.7, 259.2, 259.8,
00362    260.1, 258.6, 256.7, 253.6, 249.5, 243.9, 237.4, 230, 222.1, 213.9,
00363    205, 194.4, 180.4, 161.8, 140.7, 122.9, 112.1, 106.7, 104.1, 102.7,
00364    101.8, 101.4, 101.1, 101, 101, 101, 101.1, 101.2, 101.5, 101.9,
00365    102.4, 103, 103.8, 104.9, 106.8, 110.1, 115.6, 124, 135.2, 148.9,
00366    165.2, 181.3, 198, 211.8, 223.5, 233.8, 242.9, 251.5, 259, 266.2,
00367    273.1, 279.2, 286.2, 292.8, 299.6, 306, 311.1, 315.5, 318.8, 322.6,
00368    325.3, 325.8, 325.8},
00369   {220.1, 218.1, 210.8, 207.2, 207.6, 210.5, 211.4, 213.5, 217.3,
00370    222.4, 227.9, 232.8, 237.4, 240.8, 242.8, 243, 241.5, 238.6, 234.2,
00371    228.5, 221, 210.7, 195.1, 172.9, 147.8, 127.6, 115.6, 109.9, 107.1,
00372    105.7, 105, 104.8, 104.8, 104.9, 105, 105.1, 105.3, 105.5, 105.8,
00373    106.4, 107, 107.6, 108.1, 108.8, 110, 111.8, 114.2, 117.4, 121.6,
00374    127.9, 137.3, 151.2, 169.5, 189, 205.8, 218.9, 229.1, 237.8, 245,
00375    251.5, 257.1, 262.3, 268.2, 274, 280.4, 286.7, 292.4, 297.9, 302.9,
00376    308.5, 312.2, 313.1, 313.3},
00377   {187.4, 184.5, 173.3, 166.1, 165.4, 167.8, 169.6, 173.6, 179.6,
00378    187.9, 198.9, 210, 220.5, 229.2, 235.7, 239.9, 241.8, 241.6, 239.6,
00379    235.8, 229.4, 218.6, 200.9, 175.9, 149.4, 129.4, 118.3, 113.1,
00380    110.8, 109.7, 109.3, 109.4, 109.7, 110, 110.2, 110.4, 110.5, 110.7,
00381    111, 111.4, 111.8, 112.1, 112.3, 112.7, 113.2, 113.9, 115, 116.4,
00382    117.9, 120.4, 124.1, 130.9, 142.2, 159.6, 179.6, 198.5, 212.9,
00383    224.2, 232.7, 239.1, 243.8, 247.7, 252.4, 257.3, 263.2, 269.5,
00384    275.4, 281.1, 286.3, 292, 296.3, 298.2, 298.8},
00385   {166, 166.4, 155.7, 148.3, 147.1, 149, 152.1, 157, 163.6, 172.4,
00386    185.3, 199.2, 212.6, 224, 233.2, 239.6, 243.3, 244.6, 243.6, 240.3,
00387    233.9, 222.6, 203.7, 177, 149.5, 129.7, 119, 114, 111.7, 110.7,
00388    110.3, 110.3, 110.6, 110.9, 111.1, 111.3, 111.5, 111.6, 111.9,
00389    112.2, 112.5, 112.6, 112.8, 113, 113.4, 114, 115.1, 116.5, 118.3,
00390    120.9, 124.4, 130.2, 139.4, 154.6, 173.8, 193.1, 208.1, 220.4,
00391    230.1, 238.2, 244.7, 249.5, 254.5, 259.3, 264.5, 269.4, 273.7,
00392    278.2, 282.6, 287.4, 290.9, 292.5, 293},
00393   {171.9, 172.8, 166.2, 162.3, 161.4, 162.5, 165.2, 169.6, 175.3,
00394    183.1, 193.8, 205.9, 218.3, 229.6, 238.5, 244.3, 246.9, 246.7,
00395    243.8, 238.4, 230.2, 217.9, 199.6, 174.9, 148.9, 129.8, 119.5,
00396    114.8, 112.3, 110.9, 110.3, 110.1, 110.2, 110.3, 110.4, 110.5,
00397    110.6, 110.8, 111, 111.4, 111.8, 112, 112.2, 112.4, 112.9, 113.6,
00398    114.7, 116.3, 118.4, 121.9, 127.1, 136.1, 149.8, 168.4, 186.9,
00399    203.3, 217, 229.1, 238.7, 247, 254, 259.3, 264.3, 268.3, 272.5,
00400    276.6, 280.4, 284.4, 288.4, 293.3, 297.2, 298.7, 299.1},
00401   {191.6, 192.2, 189, 188.1, 190.2, 193.7, 197.8, 202.9, 208.5,
00402    215.6, 224.2, 233.1, 241.2, 247.3, 250.8, 251.3, 248.9, 244.2,
00403    237.3, 228.4, 217.2, 202.9, 184.5, 162.5, 140.7, 124.8, 116.2,
00404    111.8, 109.4, 107.9, 107, 106.7, 106.6, 106.6, 106.7, 106.7,
00405    106.8, 107, 107.4, 108, 108.7, 109.3, 109.8, 110.4, 111.2,
00406    112.4, 114.2, 116.9, 121.1, 127.9, 139.3, 155.2, 173.6, 190.7,
00407    206.1, 220.1, 232.3, 243, 251.8, 259.2, 265.7, 270.6, 275.3,
00408    279.3, 283.3, 286.9, 289.7, 292.8, 296.1, 300.5, 303.9, 304.8,
00409    305.1},
00410   {241.5, 239.6, 236.8, 237.4, 239.4, 242.3, 244.2, 246.4, 249.2,
00411    253.6, 258.6, 262.7, 264.8, 264.2, 260.6, 254.1, 245.5, 235.3,
00412    223.9, 211.7, 198.3, 183.1, 165.6, 147.1, 130.5, 118.7, 111.9,
00413    108.1, 105.8, 104.3, 103.4, 102.8, 102.5, 102.4, 102.5, 102.5,
00414    102.5, 102.7, 103.1, 103.8, 104.6, 105.4, 106.1, 107, 108.2,
00415    109.9, 112.8, 117.5, 126, 140.4, 161, 181.9, 201.2, 216.8, 230.4,
00416    241.8, 251.4, 259.9, 266.9, 272.8, 277.4, 280.4, 282.9, 284.6,
00417    286.1, 287.4, 288.3, 289.5, 290.9, 294.2, 296.9, 297.5, 297.6},
00418   {301.2, 300.3, 296.6, 295.4, 295, 294.3, 291.2, 287.4, 284.9, 284.7,
00419    284.1, 281.5, 277.1, 270.4, 261.7, 250.6, 237.6, 223.1, 207.9, 192,
00420    175.8, 158.8, 142.1, 127.6, 116.8, 109.9, 106, 103.6, 102.1, 101.1,
00421    100.4, 99.96, 99.6, 99.37, 99.32, 99.32, 99.31, 99.46, 99.77, 100.2,
00422    100.7, 101.3, 101.8, 102.7, 104.1, 106.8, 111.9, 121, 136.7, 160,
00423    186.9, 209.9, 228.1, 241.2, 251.5, 259.5, 265.7, 270.9, 274.8, 278,
00424    280.3, 281.8, 283, 283.3, 283.7, 283.8, 283, 282.2, 281.2, 281.4,
00425    281.7, 281.1, 281.2}
00426   };
00427
00428   double doy, p0, p1;
00429
00430   int imon, ilat;
00431
00432   /* Get day of year... */
00433   doy = fmod(t / 86400., 365.25);
00434   while (doy < 0)
00435     doy += 365.25;
00436
00437   /* Get indices... */
```

```
00438   ilat = locate_reg(lats, 73, lat);
00439   imon = locate_irr(doys, 12, doy);
00440
00441   /* Interpolate... */
00442   p0 = LIN(lats[ilat], tps[imon][ilat],
00443            lats[ilat + 1], tps[imon][ilat + 1], lat);
00444   p1 = LIN(lats[ilat], tps[imon + 1][ilat],
00445            lats[ilat + 1], tps[imon + 1][ilat + 1], lat);
00446   return LIN(doys[imon], p0, doys[imon + 1], p1, doy);
00447 }
00448
00449 /*****************************************************************************/
00450
00451 void day2doy(
00452   int year,
00453   int mon,
00454   int day,
00455   int *doy) {
00456
00457   int d0[12] = { 1, 32, 60, 91, 121, 152, 182, 213, 244, 274, 305, 335 };
00458   int d0l[12] = { 1, 32, 61, 92, 122, 153, 183, 214, 245, 275, 306, 336 };
00459
00460   /* Get day of year... */
00461   if (year % 400 == 0 || (year % 100 != 0 && year % 4 == 0))
00462     *doy = d0l[mon - 1] + day - 1;
00463   else
00464     *doy = d0[mon - 1] + day - 1;
00465 }
00466
00467 /*****************************************************************************/
00468
00469 void doy2day(
00470   int year,
00471   int doy,
00472   int *mon,
00473   int *day) {
00474
00475   int d0[12] = { 1, 32, 60, 91, 121, 152, 182, 213, 244, 274, 305, 335 };
00476   int d0l[12] = { 1, 32, 61, 92, 122, 153, 183, 214, 245, 275, 306, 336 };
00477   int i;
00478
00479   /* Get month and day... */
00480   if (year % 400 == 0 || (year % 100 != 0 && year % 4 == 0)) {
00481     for (i = 11; i >= 0; i--)
00482       if (d0l[i] <= doy)
00483         break;
00484     *mon = i + 1;
00485     *day = doy - d0l[i] + 1;
00486   } else {
00487     for (i = 11; i >= 0; i--)
00488       if (d0[i] <= doy)
00489         break;
00490     *mon = i + 1;
00491     *day = doy - d0[i] + 1;
00492   }
00493 }
00494
00495 /*****************************************************************************/
00496
00497 void geo2cart(
00498   double z,
00499   double lon,
00500   double lat,
00501   double *x) {
00502
00503   double radius;
00504
00505   radius = z + RE;
00506   x[0] = radius * cos(lat / 180 * M_PI) * cos(lon / 180 * M_PI);
00507   x[1] = radius * cos(lat / 180 * M_PI) * sin(lon / 180 * M_PI);
00508   x[2] = radius * sin(lat / 180 * M_PI);
00509 }
00510
00511 /*****************************************************************************/
00512
00513 void get_met(
00514   ctl_t * ctl,
00515   char *metbase,
00516   double t,
00517   met_t ** met0,
00518   met_t ** met1) {
00519
00520   static int init, ip, ix, iy;
00521
00522   met_t *mets;
00523
00524   char filename[LEN];
```

```
00525
00526   /* Init... */
00527   if (t == ctl->t_start || !init) {
00528     init = 1;
00529
00530     get_met_help(t, -1, metbase, ctl->dt_met, filename);
00531     read_met(ctl, filename, *met0);
00532
00533     get_met_help(t + 1.0 * ctl->direction, 1, metbase, ctl->
      dt_met, filename);
00534     read_met(ctl, filename, *met1);
00535   }
00536
00537   /* Read new data for forward trajectories... */
00538   if (t > (*met1)->time && ctl->direction == 1) {
00539     mets = *met1;
00540     *met1 = *met0;
00541     *met0 = mets;
00542     get_met_help(t, 1, metbase, ctl->dt_met, filename);
00543     read_met(ctl, filename, *met1);
00544   }
00545
00546   /* Read new data for backward trajectories... */
00547   if (t < (*met0)->time && ctl->direction == -1) {
00548     mets = *met1;
00549     *met1 = *met0;
00550     *met0 = mets;
00551     get_met_help(t, -1, metbase, ctl->dt_met, filename);
00552     read_met(ctl, filename, *met0);
00553   }
00554
00555   /* Check that grids are consistent... */
00556   if ((*met0)->nx != (*met1)->nx
00557       || (*met0)->ny != (*met1)->ny || (*met0)->np != (*met1)->np)
00558     ERRMSG("Meteo grid dimensions do not match!");
00559   for (ix = 0; ix < (*met0)->nx; ix++)
00560     if ((*met0)->lon[ix] != (*met1)->lon[ix])
00561       ERRMSG("Meteo grid longitudes do not match!");
00562   for (iy = 0; iy < (*met0)->ny; iy++)
00563     if ((*met0)->lat[iy] != (*met1)->lat[iy])
00564       ERRMSG("Meteo grid latitudes do not match!");
00565   for (ip = 0; ip < (*met0)->np; ip++)
00566     if ((*met0)->p[ip] != (*met1)->p[ip])
00567       ERRMSG("Meteo grid pressure levels do not match!");
00568 }
00569
00570 /*****************************************************************************/
00571
00572 void get_met_help(
00573   double t,
00574   int direct,
00575   char *metbase,
00576   double dt_met,
00577   char *filename) {
00578
00579   double t6, r;
00580
00581   int year, mon, day, hour, min, sec;
00582
00583   /* Round time to fixed intervals... */
00584   if (direct == -1)
00585     t6 = floor(t / dt_met) * dt_met;
00586   else
00587     t6 = ceil(t / dt_met) * dt_met;
00588
00589   /* Decode time... */
00590   jsec2time(t6, &year, &mon, &day, &hour, &min, &sec, &r);
00591
00592   /* Set filename... */
00593   sprintf(filename, "%s_%d_%02d_%02d_%02d.nc", metbase, year, mon, day, hour);
00594 }
00595
00596 /*****************************************************************************/
00597
00598 void intpol_met_2d(
00599   double array[EX][EY],
00600   int ix,
00601   int iy,
00602   double wx,
00603   double wy,
00604   double *var) {
00605
00606   double aux00, aux01, aux10, aux11;
00607
00608   /* Set variables... */
00609   aux00 = array[ix][iy];
00610   aux01 = array[ix][iy + 1];
```

```
00611   aux10 = array[ix + 1][iy];
00612   aux11 = array[ix + 1][iy + 1];
00613
00614   /* Interpolate horizontally... */
00615   aux00 = wy * (aux00 - aux01) + aux01;
00616   aux11 = wy * (aux10 - aux11) + aux11;
00617   *var = wx * (aux00 - aux11) + aux11;
00618 }
00619
00620 /*****************************************************************************/
00621
00622 void intpol_met_3d(
00623   float array[EX][EY][EP],
00624   int ip,
00625   int ix,
00626   int iy,
00627   double wp,
00628   double wx,
00629   double wy,
00630   double *var) {
00631
00632   double aux00, aux01, aux10, aux11;
00633
00634   /* Interpolate vertically... */
00635   aux00 = wp * (array[ix][iy][ip] - array[ix][iy][ip + 1])
00636     + array[ix][iy][ip + 1];
00637   aux01 = wp * (array[ix][iy + 1][ip] - array[ix][iy + 1][ip + 1])
00638     + array[ix][iy + 1][ip + 1];
00639   aux10 = wp * (array[ix + 1][iy][ip] - array[ix + 1][iy][ip + 1])
00640     + array[ix + 1][iy][ip + 1];
00641   aux11 = wp * (array[ix + 1][iy + 1][ip] - array[ix + 1][iy + 1][ip + 1])
00642     + array[ix + 1][iy + 1][ip + 1];
00643
00644   /* Interpolate horizontally... */
00645   aux00 = wy * (aux00 - aux01) + aux01;
00646   aux11 = wy * (aux10 - aux11) + aux11;
00647   *var = wx * (aux00 - aux11) + aux11;
00648 }
00649
00650 /*****************************************************************************/
00651
00652 void intpol_met_space(
00653   met_t * met,
00654   double p,
00655   double lon,
00656   double lat,
00657   double *ps,
00658   double *pt,
00659   double *z,
00660   double *t,
00661   double *u,
00662   double *v,
00663   double *w,
00664   double *pv,
00665   double *h2o,
00666   double *o3) {
00667
00668   double wp, wx, wy;
00669
00670   int ip, ix, iy;
00671
00672   /* Check longitude... */
00673   if (met->lon[met->nx - 1] > 180 && lon < 0)
00674     lon += 360;
00675
00676   /* Get indices... */
00677   ip = locate_irr(met->p, met->np, p);
00678   ix = locate_reg(met->lon, met->nx, lon);
00679   iy = locate_reg(met->lat, met->ny, lat);
00680
00681   /* Get weights... */
00682   wp = (met->p[ip + 1] - p) / (met->p[ip + 1] - met->p[ip]);
00683   wx = (met->lon[ix + 1] - lon) / (met->lon[ix + 1] - met->lon[ix]);
00684   wy = (met->lat[iy + 1] - lat) / (met->lat[iy + 1] - met->lat[iy]);
00685
00686   /* Interpolate... */
00687   if (ps != NULL)
00688     intpol_met_2d(met->ps, ix, iy, wx, wy, ps);
00689   if (pt != NULL)
00690     intpol_met_2d(met->pt, ix, iy, wx, wy, pt);
00691   if (z != NULL)
00692     intpol_met_3d(met->z, ip, ix, iy, wp, wx, wy, z);
00693   if (t != NULL)
00694     intpol_met_3d(met->t, ip, ix, iy, wp, wx, wy, t);
00695   if (u != NULL)
00696     intpol_met_3d(met->u, ip, ix, iy, wp, wx, wy, u);
00697   if (v != NULL)
```

```
00698     intpol_met_3d(met->v, ip, ix, iy, wp, wx, wy, v);
00699   if (w != NULL)
00700     intpol_met_3d(met->w, ip, ix, iy, wp, wx, wy, w);
00701   if (pv != NULL)
00702     intpol_met_3d(met->pv, ip, ix, iy, wp, wx, wy, pv);
00703   if (h2o != NULL)
00704     intpol_met_3d(met->h2o, ip, ix, iy, wp, wx, wy, h2o);
00705   if (o3 != NULL)
00706     intpol_met_3d(met->o3, ip, ix, iy, wp, wx, wy, o3);
00707 }
00708
00709 /*****************************************************************************/
00710
00711 void intpol_met_time(
00712   met_t * met0,
00713   met_t * met1,
00714   double ts,
00715   double p,
00716   double lon,
00717   double lat,
00718   double *ps,
00719   double *pt,
00720   double *z,
00721   double *t,
00722   double *u,
00723   double *v,
00724   double *w,
00725   double *pv,
00726   double *h2o,
00727   double *o3) {
00728
00729   double h2o0, h2o1, o30, o31, ps0, ps1, pt0, pt1, pv0, pv1, t0, t1, u0, u1,
00730     v0, v1, w0, w1, wt, z0, z1;
00731
00732   /* Spatial interpolation... */
00733   intpol_met_space(met0, p, lon, lat,
00734                    ps == NULL ? NULL : &ps0,
00735                    pt == NULL ? NULL : &pt0,
00736                    z == NULL ? NULL : &z0,
00737                    t == NULL ? NULL : &t0,
00738                    u == NULL ? NULL : &u0,
00739                    v == NULL ? NULL : &v0,
00740                    w == NULL ? NULL : &w0,
00741                    pv == NULL ? NULL : &pv0,
00742                    h2o == NULL ? NULL : &h2o0, o3 == NULL ? NULL : &o30);
00743   intpol_met_space(met1, p, lon, lat,
00744                    ps == NULL ? NULL : &ps1,
00745                    pt == NULL ? NULL : &pt1,
00746                    z == NULL ? NULL : &z1,
00747                    t == NULL ? NULL : &t1,
00748                    u == NULL ? NULL : &u1,
00749                    v == NULL ? NULL : &v1,
00750                    w == NULL ? NULL : &w1,
00751                    pv == NULL ? NULL : &pv1,
00752                    h2o == NULL ? NULL : &h2o1, o3 == NULL ? NULL : &o31);
00753
00754   /* Get weighting factor... */
00755   wt = (met1->time - ts) / (met1->time - met0->time);
00756
00757   /* Interpolate... */
00758   if (ps != NULL)
00759     *ps = wt * (ps0 - ps1) + ps1;
00760   if (pt != NULL)
00761     *pt = wt * (pt0 - pt1) + pt1;
00762   if (z != NULL)
00763     *z = wt * (z0 - z1) + z1;
00764   if (t != NULL)
00765     *t = wt * (t0 - t1) + t1;
00766   if (u != NULL)
00767     *u = wt * (u0 - u1) + u1;
00768   if (v != NULL)
00769     *v = wt * (v0 - v1) + v1;
00770   if (w != NULL)
00771     *w = wt * (w0 - w1) + w1;
00772   if (pv != NULL)
00773     *pv = wt * (pv0 - pv1) + pv1;
00774   if (h2o != NULL)
00775     *h2o = wt * (h2o0 - h2o1) + h2o1;
00776   if (o3 != NULL)
00777     *o3 = wt * (o30 - o31) + o31;
00778 }
00779
00780 /*****************************************************************************/
00781
00782 void jsec2time(
00783   double jsec,
00784   int *year,
```

```
00785   int *mon,
00786   int *day,
00787   int *hour,
00788   int *min,
00789   int *sec,
00790   double *remain) {
00791
00792   struct tm t0, *t1;
00793
00794   time_t jsec0;
00795
00796   t0.tm_year = 100;
00797   t0.tm_mon = 0;
00798   t0.tm_mday = 1;
00799   t0.tm_hour = 0;
00800   t0.tm_min = 0;
00801   t0.tm_sec = 0;
00802
00803   jsec0 = (time_t) jsec + timegm(&t0);
00804   t1 = gmtime(&jsec0);
00805
00806   *year = t1->tm_year + 1900;
00807   *mon = t1->tm_mon + 1;
00808   *day = t1->tm_mday;
00809   *hour = t1->tm_hour;
00810   *min = t1->tm_min;
00811   *sec = t1->tm_sec;
00812   *remain = jsec - floor(jsec);
00813 }
00814
00815 /*****************************************************************************/
00816
00817 int locate_irr(
00818   double *xx,
00819   int n,
00820   double x) {
00821
00822   int i, ilo, ihi;
00823
00824   ilo = 0;
00825   ihi = n - 1;
00826   i = (ihi + ilo) >> 1;
00827
00828   if (xx[i] < xx[i + 1])
00829     while (ihi > ilo + 1) {
00830       i = (ihi + ilo) >> 1;
00831       if (xx[i] > x)
00832         ihi = i;
00833       else
00834         ilo = i;
00835   } else
00836     while (ihi > ilo + 1) {
00837       i = (ihi + ilo) >> 1;
00838       if (xx[i] <= x)
00839         ihi = i;
00840       else
00841         ilo = i;
00842     }
00843
00844   return ilo;
00845 }
00846
00847 /*****************************************************************************/
00848
00849 int locate_reg(
00850   double *xx,
00851   int n,
00852   double x) {
00853
00854   int i;
00855
00856   /* Calculate index... */
00857   i = (int) ((x - xx[0]) / (xx[1] - xx[0]));
00858
00859   /* Check range... */
00860   if (i < 0)
00861     i = 0;
00862   else if (i >= n - 2)
00863     i = n - 2;
00864
00865   return i;
00866 }
00867
00868 /*****************************************************************************/
00869
00870 void read_atm(
00871   const char *filename,
```

```
00872   ctl_t * ctl,
00873   atm_t * atm) {
00874
00875   FILE *in;
00876
00877   char line[LEN], *tok;
00878
00879   double t0;
00880
00881   int dimid, ip, iq, ncid, varid;
00882
00883   size_t nparts;
00884
00885   /* Init... */
00886   atm->np = 0;
00887
00888   /* Write info... */
00889   printf("Read atmospheric data: %s\n", filename);
00890
00891   /* Read ASCII data... */
00892   if (ctl->atm_type == 0) {
00893
00894     /* Open file... */
00895     if (!(in = fopen(filename, "r")))
00896       ERRMSG("Cannot open file!");
00897
00898     /* Read line... */
00899     while (fgets(line, LEN, in)) {
00900
00901       /* Read data... */
00902       TOK(line, tok, "%lg", atm->time[atm->np]);
00903       TOK(NULL, tok, "%lg", atm->p[atm->np]);
00904       TOK(NULL, tok, "%lg", atm->lon[atm->np]);
00905       TOK(NULL, tok, "%lg", atm->lat[atm->np]);
00906       for (iq = 0; iq < ctl->nq; iq++)
00907         TOK(NULL, tok, "%lg", atm->q[iq][atm->np]);
00908
00909       /* Convert altitude to pressure... */
00910       atm->p[atm->np] = P(atm->p[atm->np]);
00911
00912       /* Increment data point counter... */
00913       if ((++atm->np) > NP)
00914         ERRMSG("Too many data points!");
00915     }
00916
00917     /* Close file... */
00918     fclose(in);
00919   }
00920
00921   /* Read binary data... */
00922   else if (ctl->atm_type == 1) {
00923
00924     /* Open file... */
00925     if (!(in = fopen(filename, "r")))
00926       ERRMSG("Cannot open file!");
00927
00928     /* Read data... */
00929     FREAD(&atm->np, int,
00930           1,
00931           in);
00932     FREAD(atm->time, double,
00933             (size_t) atm->np,
00934           in);
00935     FREAD(atm->p, double,
00936             (size_t) atm->np,
00937           in);
00938     FREAD(atm->lon, double,
00939             (size_t) atm->np,
00940           in);
00941     FREAD(atm->lat, double,
00942             (size_t) atm->np,
00943           in);
00944     for (iq = 0; iq < ctl->nq; iq++)
00945       FREAD(atm->q[iq], double,
00946               (size_t) atm->np,
00947             in);
00948
00949     /* Close file... */
00950     fclose(in);
00951   }
00952
00953   /* Read netCDF data... */
00954   else if (ctl->atm_type == 2) {
00955
00956     /* Open file... */
00957     NC(nc_open(filename, NC_NOWRITE, &ncid));
00958
```

```
00959     /* Get dimensions... */
00960     NC(nc_inq_dimid(ncid, "NPARTS", &dimid));
00961     NC(nc_inq_dimlen(ncid, dimid, &nparts));
00962     atm->np = (int) nparts;
00963     if (atm->np > NP)
00964       ERRMSG("Too many particles!");
00965
00966     /* Get time... */
00967     NC(nc_inq_varid(ncid, "time", &varid));
00968     NC(nc_get_var_double(ncid, varid, &t0));
00969     for (ip = 0; ip < atm->np; ip++)
00970       atm->time[ip] = t0;
00971
00972     /* Read geolocations... */
00973     NC(nc_inq_varid(ncid, "PRESS", &varid));
00974     NC(nc_get_var_double(ncid, varid, atm->p));
00975     NC(nc_inq_varid(ncid, "LON", &varid));
00976     NC(nc_get_var_double(ncid, varid, atm->lon));
00977     NC(nc_inq_varid(ncid, "LAT", &varid));
00978     NC(nc_get_var_double(ncid, varid, atm->lat));
00979
00980     /* Read variables... */
00981     if (ctl->qnt_p >= 0)
00982       if (nc_inq_varid(ncid, "PRESS", &varid) == NC_NOERR)
00983         NC(nc_get_var_double(ncid, varid, atm->q[ctl->qnt_p]));
00984     if (ctl->qnt_t >= 0)
00985       if (nc_inq_varid(ncid, "TEMP", &varid) == NC_NOERR)
00986         NC(nc_get_var_double(ncid, varid, atm->q[ctl->qnt_t]));
00987     if (ctl->qnt_u >= 0)
00988       if (nc_inq_varid(ncid, "U", &varid) == NC_NOERR)
00989         NC(nc_get_var_double(ncid, varid, atm->q[ctl->qnt_u]));
00990     if (ctl->qnt_v >= 0)
00991       if (nc_inq_varid(ncid, "V", &varid) == NC_NOERR)
00992         NC(nc_get_var_double(ncid, varid, atm->q[ctl->qnt_v]));
00993     if (ctl->qnt_w >= 0)
00994       if (nc_inq_varid(ncid, "W", &varid) == NC_NOERR)
00995         NC(nc_get_var_double(ncid, varid, atm->q[ctl->qnt_w]));
00996     if (ctl->qnt_h2o >= 0)
00997       if (nc_inq_varid(ncid, "SH", &varid) == NC_NOERR)
00998         NC(nc_get_var_double(ncid, varid, atm->q[ctl->qnt_h2o]));
00999     if (ctl->qnt_o3 >= 0)
01000       if (nc_inq_varid(ncid, "O3", &varid) == NC_NOERR)
01001         NC(nc_get_var_double(ncid, varid, atm->q[ctl->qnt_o3]));
01002     if (ctl->qnt_theta >= 0)
01003       if (nc_inq_varid(ncid, "THETA", &varid) == NC_NOERR)
01004         NC(nc_get_var_double(ncid, varid, atm->q[ctl->qnt_theta]));
01005     if (ctl->qnt_pv >= 0)
01006       if (nc_inq_varid(ncid, "PV", &varid) == NC_NOERR)
01007         NC(nc_get_var_double(ncid, varid, atm->q[ctl->qnt_pv]));
01008
01009     /* Check data... */
01010     for (ip = 0; ip < atm->np; ip++)
01011       if (fabs(atm->lon[ip]) > 360 || fabs(atm->lat[ip]) > 90
01012           || (ctl->qnt_t >= 0 && fabs(atm->q[ctl->qnt_t][ip]) > 350)
01013           || (ctl->qnt_h2o >= 0 && fabs(atm->q[ctl->qnt_h2o][ip]) > 1)
01014           || (ctl->qnt_theta >= 0 && fabs(atm->q[ctl->qnt_theta][ip]) > 1e10)
01015           || (ctl->qnt_pv >= 0 && fabs(atm->q[ctl->qnt_pv][ip]) > 1e10)) {
01016         atm->time[ip] = GSL_NAN;
01017         atm->p[ip] = GSL_NAN;
01018         atm->lon[ip] = GSL_NAN;
01019         atm->lat[ip] = GSL_NAN;
01020         for (iq = 0; iq < ctl->nq; iq++)
01021           atm->q[iq][ip] = GSL_NAN;
01022       } else {
01023         if (ctl->qnt_h2o >= 0)
01024           atm->q[ctl->qnt_h2o][ip] *= 1.608;
01025         if (ctl->qnt_pv >= 0)
01026           atm->q[ctl->qnt_pv][ip] *= 1e6;
01027         if (atm->lon[ip] > 180)
01028           atm->lon[ip] -= 360;
01029       }
01030
01031     /* Close file... */
01032     NC(nc_close(ncid));
01033   }
01034
01035   /* Error... */
01036   else
01037     ERRMSG("Atmospheric data type not supported!");
01038
01039   /* Check number of points... */
01040   if (atm->np < 1)
01041     ERRMSG("Can not read any data!");
01042 }
01043
01044 /*****************************************************************************/
01045
```

```
01046 void read_ctl(
01047   const char *filename,
01048   int argc,
01049   char *argv[],
01050   ctl_t * ctl) {
01051
01052   int ip, iq;
01053
01054   /* Write info... */
01055   printf("\nMassive-Parallel Trajectory Calculations (MPTRAC)\n"
01056          "(executable: %s | compiled: %s, %s)\n\n",
01057          argv[0], __DATE__, __TIME__);
01058
01059   /* Initialize quantity indices... */
01060   ctl->qnt_ens = -1;
01061   ctl->qnt_m = -1;
01062   ctl->qnt_r = -1;
01063   ctl->qnt_rho = -1;
01064   ctl->qnt_ps = -1;
01065   ctl->qnt_pt = -1;
01066   ctl->qnt_z = -1;
01067   ctl->qnt_p = -1;
01068   ctl->qnt_t = -1;
01069   ctl->qnt_u = -1;
01070   ctl->qnt_v = -1;
01071   ctl->qnt_w = -1;
01072   ctl->qnt_h2o = -1;
01073   ctl->qnt_o3 = -1;
01074   ctl->qnt_theta = -1;
01075   ctl->qnt_vh = -1;
01076   ctl->qnt_vz = -1;
01077   ctl->qnt_pv = -1;
01078   ctl->qnt_tice = -1;
01079   ctl->qnt_tsts = -1;
01080   ctl->qnt_tnat = -1;
01081   ctl->qnt_stat = -1;
01082
01083   /* Read quantities... */
01084   ctl->nq = (int) scan_ctl(filename, argc, argv, "NQ", -1, "0", NULL);
01085   if (ctl->nq > NQ)
01086     ERRMSG("Too many quantities!");
01087   for (iq = 0; iq < ctl->nq; iq++) {
01088
01089     /* Read quantity name and format... */
01090     scan_ctl(filename, argc, argv, "QNT_NAME", iq, "", ctl->qnt_name[iq]);
01091     scan_ctl(filename, argc, argv, "QNT_FORMAT", iq, "%g",
01092              ctl->qnt_format[iq]);
01093
01094     /* Try to identify quantity... */
01095     if (strcmp(ctl->qnt_name[iq], "ens") == 0) {
01096       ctl->qnt_ens = iq;
01097       sprintf(ctl->qnt_unit[iq], "-");
01098     } else if (strcmp(ctl->qnt_name[iq], "m") == 0) {
01099       ctl->qnt_m = iq;
01100       sprintf(ctl->qnt_unit[iq], "kg");
01101     } else if (strcmp(ctl->qnt_name[iq], "r") == 0) {
01102       ctl->qnt_r = iq;
01103       sprintf(ctl->qnt_unit[iq], "m");
01104     } else if (strcmp(ctl->qnt_name[iq], "rho") == 0) {
01105       ctl->qnt_rho = iq;
01106       sprintf(ctl->qnt_unit[iq], "kg/m^3");
01107     } else if (strcmp(ctl->qnt_name[iq], "ps") == 0) {
01108       ctl->qnt_ps = iq;
01109       sprintf(ctl->qnt_unit[iq], "hPa");
01110     } else if (strcmp(ctl->qnt_name[iq], "pt") == 0) {
01111       ctl->qnt_pt = iq;
01112       sprintf(ctl->qnt_unit[iq], "hPa");
01113     } else if (strcmp(ctl->qnt_name[iq], "z") == 0) {
01114       ctl->qnt_z = iq;
01115       sprintf(ctl->qnt_unit[iq], "km");
01116     } else if (strcmp(ctl->qnt_name[iq], "p") == 0) {
01117       ctl->qnt_p = iq;
01118       sprintf(ctl->qnt_unit[iq], "hPa");
01119     } else if (strcmp(ctl->qnt_name[iq], "t") == 0) {
01120       ctl->qnt_t = iq;
01121       sprintf(ctl->qnt_unit[iq], "K");
01122     } else if (strcmp(ctl->qnt_name[iq], "u") == 0) {
01123       ctl->qnt_u = iq;
01124       sprintf(ctl->qnt_unit[iq], "m/s");
01125     } else if (strcmp(ctl->qnt_name[iq], "v") == 0) {
01126       ctl->qnt_v = iq;
01127       sprintf(ctl->qnt_unit[iq], "m/s");
01128     } else if (strcmp(ctl->qnt_name[iq], "w") == 0) {
01129       ctl->qnt_w = iq;
01130       sprintf(ctl->qnt_unit[iq], "hPa/s");
01131     } else if (strcmp(ctl->qnt_name[iq], "h2o") == 0) {
01132       ctl->qnt_h2o = iq;
```

```
01133       sprintf(ctl->qnt_unit[iq], "1");
01134     } else if (strcmp(ctl->qnt_name[iq], "o3") == 0) {
01135       ctl->qnt_o3 = iq;
01136       sprintf(ctl->qnt_unit[iq], "1");
01137     } else if (strcmp(ctl->qnt_name[iq], "theta") == 0) {
01138       ctl->qnt_theta = iq;
01139       sprintf(ctl->qnt_unit[iq], "K");
01140     } else if (strcmp(ctl->qnt_name[iq], "vh") == 0) {
01141       ctl->qnt_vh = iq;
01142       sprintf(ctl->qnt_unit[iq], "m/s");
01143     } else if (strcmp(ctl->qnt_name[iq], "vz") == 0) {
01144       ctl->qnt_vz = iq;
01145       sprintf(ctl->qnt_unit[iq], "m/s");
01146     } else if (strcmp(ctl->qnt_name[iq], "pv") == 0) {
01147       ctl->qnt_pv = iq;
01148       sprintf(ctl->qnt_unit[iq], "PVU");
01149     } else if (strcmp(ctl->qnt_name[iq], "tice") == 0) {
01150       ctl->qnt_tice = iq;
01151       sprintf(ctl->qnt_unit[iq], "K");
01152     } else if (strcmp(ctl->qnt_name[iq], "tsts") == 0) {
01153       ctl->qnt_tsts = iq;
01154       sprintf(ctl->qnt_unit[iq], "K");
01155     } else if (strcmp(ctl->qnt_name[iq], "tnat") == 0) {
01156       ctl->qnt_tnat = iq;
01157       sprintf(ctl->qnt_unit[iq], "K");
01158     } else if (strcmp(ctl->qnt_name[iq], "stat") == 0) {
01159       ctl->qnt_stat = iq;
01160       sprintf(ctl->qnt_unit[iq], "-");
01161     } else
01162       scan_ctl(filename, argc, argv, "QNT_UNIT", iq, "", ctl->qnt_unit[iq]);
01163   }
01164
01165   /* Time steps of simulation... */
01166   ctl->direction =
01167     (int) scan_ctl(filename, argc, argv, "DIRECTION", -1, "1", NULL);
01168   if (ctl->direction != -1 && ctl->direction != 1)
01169     ERRMSG("Set DIRECTION to -1 or 1!");
01170   ctl->t_stop = scan_ctl(filename, argc, argv, "T_STOP", -1, "1e100", NULL);
01171   ctl->dt_mod = scan_ctl(filename, argc, argv, "DT_MOD", -1, "600", NULL);
01172
01173   /* Meteorological data... */
01174   ctl->dt_met = scan_ctl(filename, argc, argv, "DT_MET", -1, "21600", NULL);
01175   ctl->met_dx = (int) scan_ctl(filename, argc, argv, "MET_DX", -1, "1", NULL);
01176   ctl->met_dy = (int) scan_ctl(filename, argc, argv, "MET_DY", -1, "1", NULL);
01177   ctl->met_dp = (int) scan_ctl(filename, argc, argv, "MET_DP", -1, "1", NULL);
01178   ctl->met_sx = (int) scan_ctl(filename, argc, argv, "MET_SX", -1, "1", NULL);
01179   ctl->met_sy = (int) scan_ctl(filename, argc, argv, "MET_SY", -1, "1", NULL);
01180   ctl->met_sp = (int) scan_ctl(filename, argc, argv, "MET_SP", -1, "1", NULL);
01181   ctl->met_np = (int) scan_ctl(filename, argc, argv, "MET_NP", -1, "0", NULL);
01182   if (ctl->met_np > EP)
01183     ERRMSG("Too many levels!");
01184   for (ip = 0; ip < ctl->met_np; ip++)
01185     ctl->met_p[ip] = scan_ctl(filename, argc, argv, "MET_P", ip, "", NULL);
01186   ctl->met_tropo
01187     = (int) scan_ctl(filename, argc, argv, "MET_TROPO", -1, "0", NULL);
01188   scan_ctl(filename, argc, argv, "MET_GEOPOT", -1, "-", ctl->met_geopot);
01189   scan_ctl(filename, argc, argv, "MET_STAGE", -1, "-", ctl->met_stage);
01190   ctl->met_dt_out =
01191     scan_ctl(filename, argc, argv, "MET_DT_OUT", -1, "0.1", NULL);
01192
01193   /* Isosurface parameters... */
01194   ctl->isosurf
01195     = (int) scan_ctl(filename, argc, argv, "ISOSURF", -1, "0", NULL);
01196   scan_ctl(filename, argc, argv, "BALLOON", -1, "-", ctl->balloon);
01197
01198   /* Diffusion parameters... */
01199   ctl->turb_dx_trop
01200     = scan_ctl(filename, argc, argv, "TURB_DX_TROP", -1, "50", NULL);
01201   ctl->turb_dx_strat
01202     = scan_ctl(filename, argc, argv, "TURB_DX_STRAT", -1, "0", NULL);
01203   ctl->turb_dz_trop
01204     = scan_ctl(filename, argc, argv, "TURB_DZ_TROP", -1, "0", NULL);
01205   ctl->turb_dz_strat
01206     = scan_ctl(filename, argc, argv, "TURB_DZ_STRAT", -1, "0.1", NULL);
01207   ctl->turb_mesox =
01208     scan_ctl(filename, argc, argv, "TURB_MESOX", -1, "0.16", NULL);
01209   ctl->turb_mesoz =
01210     scan_ctl(filename, argc, argv, "TURB_MESOZ", -1, "0.16", NULL);
01211
01212   /* Mass and life time... */
01213   ctl->molmass = scan_ctl(filename, argc, argv, "MOLMASS", -1, "1", NULL);
01214   ctl->tdec_trop = scan_ctl(filename, argc, argv, "TDEC_TROP", -1, "0", NULL);
01215   ctl->tdec_strat =
01216     scan_ctl(filename, argc, argv, "TDEC_STRAT", -1, "0", NULL);
01217
01218   /* PSC analysis... */
01219   ctl->psc_h2o = scan_ctl(filename, argc, argv, "PSC_H2O", -1, "4e-6", NULL);
```

```
01220   ctl->psc_hno3 =
01221     scan_ctl(filename, argc, argv, "PSC_HNO3", -1, "9e-9", NULL);
01222
01223   /* Output of atmospheric data... */
01224   scan_ctl(filename, argc, argv, "ATM_BASENAME", -1, "-", ctl->
      atm_basename);
01225   scan_ctl(filename, argc, argv, "ATM_GPFILE", -1, "-", ctl->atm_gpfile);
01226   ctl->atm_dt_out =
01227     scan_ctl(filename, argc, argv, "ATM_DT_OUT", -1, "86400", NULL);
01228   ctl->atm_filter =
01229     (int) scan_ctl(filename, argc, argv, "ATM_FILTER", -1, "0", NULL);
01230   ctl->atm_type =
01231     (int) scan_ctl(filename, argc, argv, "ATM_TYPE", -1, "0", NULL);
01232
01233   /* Output of CSI data... */
01234   scan_ctl(filename, argc, argv, "CSI_BASENAME", -1, "-", ctl->
      csi_basename);
01235   ctl->csi_dt_out =
01236     scan_ctl(filename, argc, argv, "CSI_DT_OUT", -1, "86400", NULL);
01237   scan_ctl(filename, argc, argv, "CSI_OBSFILE", -1, "-", ctl->
      csi_obsfile);
01238   ctl->csi_obsmin =
01239     scan_ctl(filename, argc, argv, "CSI_OBSMIN", -1, "0", NULL);
01240   ctl->csi_modmin =
01241     scan_ctl(filename, argc, argv, "CSI_MODMIN", -1, "0", NULL);
01242   ctl->csi_z0 = scan_ctl(filename, argc, argv, "CSI_Z0", -1, "0", NULL);
01243   ctl->csi_z1 = scan_ctl(filename, argc, argv, "CSI_Z1", -1, "100", NULL);
01244   ctl->csi_nz = (int) scan_ctl(filename, argc, argv, "CSI_NZ", -1, "1", NULL);
01245   ctl->csi_lon0 =
01246     scan_ctl(filename, argc, argv, "CSI_LON0", -1, "-180", NULL);
01247   ctl->csi_lon1 = scan_ctl(filename, argc, argv, "CSI_LON1", -1, "180", NULL);
01248   ctl->csi_nx =
01249     (int) scan_ctl(filename, argc, argv, "CSI_NX", -1, "360", NULL);
01250   ctl->csi_lat0 = scan_ctl(filename, argc, argv, "CSI_LAT0", -1, "-90", NULL);
01251   ctl->csi_lat1 = scan_ctl(filename, argc, argv, "CSI_LAT1", -1, "90", NULL);
01252   ctl->csi_ny =
01253     (int) scan_ctl(filename, argc, argv, "CSI_NY", -1, "180", NULL);
01254
01255   /* Output of ensemble data... */
01256   scan_ctl(filename, argc, argv, "ENS_BASENAME", -1, "-", ctl->
      ens_basename);
01257
01258   /* Output of grid data... */
01259   scan_ctl(filename, argc, argv, "GRID_BASENAME", -1, "-",
01260            ctl->grid_basename);
01261   scan_ctl(filename, argc, argv, "GRID_GPFILE", -1, "-", ctl->
      grid_gpfile);
01262   ctl->grid_dt_out =
01263     scan_ctl(filename, argc, argv, "GRID_DT_OUT", -1, "86400", NULL);
01264   ctl->grid_sparse =
01265     (int) scan_ctl(filename, argc, argv, "GRID_SPARSE", -1, "0", NULL);
01266   ctl->grid_z0 = scan_ctl(filename, argc, argv, "GRID_Z0", -1, "0", NULL);
01267   ctl->grid_z1 = scan_ctl(filename, argc, argv, "GRID_Z1", -1, "100", NULL);
01268   ctl->grid_nz =
01269     (int) scan_ctl(filename, argc, argv, "GRID_NZ", -1, "1", NULL);
01270   ctl->grid_lon0 =
01271     scan_ctl(filename, argc, argv, "GRID_LON0", -1, "-180", NULL);
01272   ctl->grid_lon1 =
01273     scan_ctl(filename, argc, argv, "GRID_LON1", -1, "180", NULL);
01274   ctl->grid_nx =
01275     (int) scan_ctl(filename, argc, argv, "GRID_NX", -1, "360", NULL);
01276   ctl->grid_lat0 =
01277     scan_ctl(filename, argc, argv, "GRID_LAT0", -1, "-90", NULL);
01278   ctl->grid_lat1 =
01279     scan_ctl(filename, argc, argv, "GRID_LAT1", -1, "90", NULL);
01280   ctl->grid_ny =
01281     (int) scan_ctl(filename, argc, argv, "GRID_NY", -1, "180", NULL);
01282
01283   /* Output of profile data... */
01284   scan_ctl(filename, argc, argv, "PROF_BASENAME", -1, "-",
01285            ctl->prof_basename);
01286   scan_ctl(filename, argc, argv, "PROF_OBSFILE", -1, "-", ctl->
      prof_obsfile);
01287   ctl->prof_z0 = scan_ctl(filename, argc, argv, "PROF_Z0", -1, "0", NULL);
01288   ctl->prof_z1 = scan_ctl(filename, argc, argv, "PROF_Z1", -1, "60", NULL);
01289   ctl->prof_nz =
01290     (int) scan_ctl(filename, argc, argv, "PROF_NZ", -1, "60", NULL);
01291   ctl->prof_lon0 =
01292     scan_ctl(filename, argc, argv, "PROF_LON0", -1, "-180", NULL);
01293   ctl->prof_lon1 =
01294     scan_ctl(filename, argc, argv, "PROF_LON1", -1, "180", NULL);
01295   ctl->prof_nx =
01296     (int) scan_ctl(filename, argc, argv, "PROF_NX", -1, "360", NULL);
01297   ctl->prof_lat0 =
01298     scan_ctl(filename, argc, argv, "PROF_LAT0", -1, "-90", NULL);
01299   ctl->prof_lat1 =
01300     scan_ctl(filename, argc, argv, "PROF_LAT1", -1, "90", NULL);
```

```
01301   ctl->prof_ny =
01302     (int) scan_ctl(filename, argc, argv, "PROF_NY", -1, "180", NULL);
01303
01304   /* Output of station data... */
01305   scan_ctl(filename, argc, argv, "STAT_BASENAME", -1, "-",
01306            ctl->stat_basename);
01307   ctl->stat_lon = scan_ctl(filename, argc, argv, "STAT_LON", -1, "0", NULL);
01308   ctl->stat_lat = scan_ctl(filename, argc, argv, "STAT_LAT", -1, "0", NULL);
01309   ctl->stat_r = scan_ctl(filename, argc, argv, "STAT_R", -1, "50", NULL);
01310 }
01311
01312 /*****************************************************************************/
01313
01314 void read_met(
01315   ctl_t * ctl,
01316   char *filename,
01317   met_t * met) {
01318
01319   char cmd[2 * LEN], levname[LEN], tstr[10];
01320
01321   static float help[EX * EY];
01322
01323   int ix, iy, ip, dimid, ncid, varid, year, mon, day, hour;
01324
01325   size_t np, nx, ny;
01326
01327   /* Write info... */
01328   printf("Read meteorological data: %s\n", filename);
01329
01330   /* Get time from filename... */
01331   sprintf(tstr, "%.4s", &filename[strlen(filename) - 16]);
01332   year = atoi(tstr);
01333   sprintf(tstr, "%.2s", &filename[strlen(filename) - 11]);
01334   mon = atoi(tstr);
01335   sprintf(tstr, "%.2s", &filename[strlen(filename) - 8]);
01336   day = atoi(tstr);
01337   sprintf(tstr, "%.2s", &filename[strlen(filename) - 5]);
01338   hour = atoi(tstr);
01339   time2jsec(year, mon, day, hour, 0, 0, 0, &met->time);
01340
01341   /* Open netCDF file... */
01342   if (nc_open(filename, NC_NOWRITE, &ncid) != NC_NOERR) {
01343
01344     /* Try to stage meteo file... */
01345     if (ctl->met_stage[0] != '-') {
01346       sprintf(cmd, "%s %d %02d %02d %02d %s", ctl->met_stage,
01347               year, mon, day, hour, filename);
01348       if (system(cmd) != 0)
01349         ERRMSG("Error while staging meteo data!");
01350     }
01351
01352     /* Try to open again... */
01353     NC(nc_open(filename, NC_NOWRITE, &ncid));
01354   }
01355
01356   /* Get dimensions... */
01357   NC(nc_inq_dimid(ncid, "lon", &dimid));
01358   NC(nc_inq_dimlen(ncid, dimid, &nx));
01359   if (nx < 2 || nx > EX)
01360     ERRMSG("Number of longitudes out of range!");
01361
01362   NC(nc_inq_dimid(ncid, "lat", &dimid));
01363   NC(nc_inq_dimlen(ncid, dimid, &ny));
01364   if (ny < 2 || ny > EY)
01365     ERRMSG("Number of latitudes out of range!");
01366
01367   sprintf(levname, "lev");
01368   NC(nc_inq_dimid(ncid, levname, &dimid));
01369   NC(nc_inq_dimlen(ncid, dimid, &np));
01370   if (np == 1) {
01371     sprintf(levname, "lev_2");
01372     NC(nc_inq_dimid(ncid, levname, &dimid));
01373     NC(nc_inq_dimlen(ncid, dimid, &np));
01374   }
01375   if (np < 2 || np > EP)
01376     ERRMSG("Number of levels out of range!");
01377
01378   /* Store dimensions... */
01379   met->np = (int) np;
01380   met->nx = (int) nx;
01381   met->ny = (int) ny;
01382
01383   /* Get horizontal grid... */
01384   NC(nc_inq_varid(ncid, "lon", &varid));
01385   NC(nc_get_var_double(ncid, varid, met->lon));
01386   NC(nc_inq_varid(ncid, "lat", &varid));
01387   NC(nc_get_var_double(ncid, varid, met->lat));
```

```
01388
01389   /* Read meteorological data... */
01390   read_met_help(ncid, "t", "T", met, met->t, 1.0);
01391   read_met_help(ncid, "u", "U", met, met->u, 1.0);
01392   read_met_help(ncid, "v", "V", met, met->v, 1.0);
01393   read_met_help(ncid, "w", "W", met, met->w, 0.01f);
01394   read_met_help(ncid, "q", "Q", met, met->h2o, (float) (MA / 18.01528));
01395   read_met_help(ncid, "o3", "O3", met, met->o3, (float) (MA / 48.00));
01396
01397   /* Meteo data on pressure levels... */
01398   if (ctl->met_np <= 0) {
01399
01400     /* Read pressure levels from file... */
01401     NC(nc_inq_varid(ncid, levname, &varid));
01402     NC(nc_get_var_double(ncid, varid, met->p));
01403     for (ip = 0; ip < met->np; ip++)
01404       met->p[ip] /= 100.;
01405
01406     /* Extrapolate data for lower boundary... */
01407     read_met_extrapolate(met);
01408   }
01409
01410   /* Meteo data on model levels... */
01411   else {
01412
01413     /* Read pressure data from file... */
01414     read_met_help(ncid, "pl", "PL", met, met->pl, 0.01f);
01415
01416     /* Interpolate from model levels to pressure levels... */
01417     read_met_ml2pl(ctl, met, met->t);
01418     read_met_ml2pl(ctl, met, met->u);
01419     read_met_ml2pl(ctl, met, met->v);
01420     read_met_ml2pl(ctl, met, met->w);
01421     read_met_ml2pl(ctl, met, met->h2o);
01422     read_met_ml2pl(ctl, met, met->o3);
01423
01424     /* Set pressure levels... */
01425     met->np = ctl->met_np;
01426     for (ip = 0; ip < met->np; ip++)
01427       met->p[ip] = ctl->met_p[ip];
01428   }
01429
01430   /* Check ordering of pressure levels... */
01431   for (ip = 1; ip < met->np; ip++)
01432     if (met->p[ip - 1] < met->p[ip])
01433       ERRMSG("Pressure levels must be descending!");
01434
01435   /* Read surface pressure... */
01436   if (nc_inq_varid(ncid, "ps", &varid) == NC_NOERR
01437       || nc_inq_varid(ncid, "PS", &varid) == NC_NOERR) {
01438     NC(nc_get_var_float(ncid, varid, help));
01439     for (iy = 0; iy < met->ny; iy++)
01440       for (ix = 0; ix < met->nx; ix++)
01441         met->ps[ix][iy] = help[iy * met->nx + ix] / 100.;
01442   } else if (nc_inq_varid(ncid, "lnsp", &varid) == NC_NOERR
01443              || nc_inq_varid(ncid, "LNSP", &varid) == NC_NOERR) {
01444     NC(nc_get_var_float(ncid, varid, help));
01445     for (iy = 0; iy < met->ny; iy++)
01446       for (ix = 0; ix < met->nx; ix++)
01447         met->ps[ix][iy] = exp(help[iy * met->nx + ix]) / 100.;
01448   } else
01449     for (ix = 0; ix < met->nx; ix++)
01450       for (iy = 0; iy < met->ny; iy++)
01451         met->ps[ix][iy] = met->p[0];
01452
01453   /* Create periodic boundary conditions... */
01454   read_met_periodic(met);
01455
01456   /* Calculate geopotential heights... */
01457   read_met_geopot(ctl, met);
01458
01459   /* Calculate potential vorticity... */
01460   read_met_pv(met);
01461
01462   /* Calculate tropopause pressure... */
01463   read_met_tropo(ctl, met);
01464
01465   /* Downsampling... */
01466   read_met_sample(ctl, met);
01467
01468   /* Close file... */
01469   NC(nc_close(ncid));
01470 }
01471
01472 /*****************************************************************************/
01473
01474 void read_met_extrapolate(
```

```
01475   met_t * met) {
01476
01477   int ip, ip0, ix, iy;
01478
01479   /* Loop over columns... */
01480 #pragma omp parallel for default(shared) private(ix,iy,ip0,ip)
01481   for (ix = 0; ix < met->nx; ix++)
01482     for (iy = 0; iy < met->ny; iy++) {
01483
01484       /* Find lowest valid data point... */
01485       for (ip0 = met->np - 1; ip0 >= 0; ip0--)
01486         if (!gsl_finite(met->t[ix][iy][ip0])
01487             || !gsl_finite(met->u[ix][iy][ip0])
01488             || !gsl_finite(met->v[ix][iy][ip0])
01489             || !gsl_finite(met->w[ix][iy][ip0]))
01490           break;
01491
01492       /* Extrapolate... */
01493       for (ip = ip0; ip >= 0; ip--) {
01494         met->t[ix][iy][ip] = met->t[ix][iy][ip + 1];
01495         met->u[ix][iy][ip] = met->u[ix][iy][ip + 1];
01496         met->v[ix][iy][ip] = met->v[ix][iy][ip + 1];
01497         met->w[ix][iy][ip] = met->w[ix][iy][ip + 1];
01498         met->h2o[ix][iy][ip] = met->h2o[ix][iy][ip + 1];
01499         met->o3[ix][iy][ip] = met->o3[ix][iy][ip + 1];
01500       }
01501     }
01502 }
01503
01504 /*****************************************************************************/
01505
01506 void read_met_geopot(
01507   ctl_t * ctl,
01508   met_t * met) {
01509
01510   static double topo_lat[EY], topo_lon[EX], topo_z[EX][EY];
01511
01512   static int init, topo_nx = -1, topo_ny;
01513
01514   FILE *in;
01515
01516   char line[LEN];
01517
01518   double data[30], lat, lon, rlat, rlon, rlon_old = -999, rz, ts, z0, z1;
01519
01520   float help[EX][EY];
01521
01522   int ip, ip0, ix, ix2, ix3, iy, iy2, n, tx, ty;
01523
01524   /* Initialize geopotential heights... */
01525 #pragma omp parallel for default(shared) private(ix,iy,ip)
01526   for (ix = 0; ix < met->nx; ix++)
01527     for (iy = 0; iy < met->ny; iy++)
01528       for (ip = 0; ip < met->np; ip++)
01529         met->z[ix][iy][ip] = GSL_NAN;
01530
01531   /* Check filename... */
01532   if (ctl->met_geopot[0] == '-')
01533     return;
01534
01535   /* Read surface geopotential... */
01536   if (!init) {
01537     init = 1;
01538
01539     /* Write info... */
01540     printf("Read surface geopotential: %s\n", ctl->met_geopot);
01541
01542     /* Open file... */
01543     if (!(in = fopen(ctl->met_geopot, "r")))
01544       ERRMSG("Cannot open file!");
01545
01546     /* Read data... */
01547     while (fgets(line, LEN, in))
01548       if (sscanf(line, "%lg %lg %lg", &rlon, &rlat, &rz) == 3) {
01549         if (rlon != rlon_old) {
01550           if ((++topo_nx) >= EX)
01551             ERRMSG("Too many longitudes!");
01552           topo_ny = 0;
01553         }
01554         rlon_old = rlon;
01555         topo_lon[topo_nx] = rlon;
01556         topo_lat[topo_ny] = rlat;
01557         topo_z[topo_nx][topo_ny] = rz;
01558         if ((++topo_ny) >= EY)
01559           ERRMSG("Too many latitudes!");
01560       }
01561     if ((++topo_nx) >= EX)
```

```
01562       ERRMSG("Too many longitudes!");
01563
01564     /* Close file... */
01565     fclose(in);
01566
01567     /* Check grid spacing... */
01568     if (fabs(met->lon[0] - met->lon[1]) != fabs(topo_lon[0] - topo_lon[1])
01569         || fabs(met->lat[0] - met->lat[1]) != fabs(topo_lat[0] - topo_lat[1]))
01570       printf("Warning: Grid spacing does not match!\n");
01571   }
01572
01573   /* Apply hydrostatic equation to calculate geopotential heights... */
01574 #pragma omp parallel for default(shared) private(ix,iy,lon,lat,tx,ty,z0,z1,ip0,ts,ip)
01575   for (ix = 0; ix < met->nx; ix++)
01576     for (iy = 0; iy < met->ny; iy++) {
01577
01578       /* Get surface height... */
01579       lon = met->lon[ix];
01580       if (lon < topo_lon[0])
01581         lon += 360;
01582       else if (lon > topo_lon[topo_nx - 1])
01583         lon -= 360;
01584       lat = met->lat[iy];
01585       tx = locate_reg(topo_lon, topo_nx, lon);
01586       ty = locate_reg(topo_lat, topo_ny, lat);
01587       z0 = LIN(topo_lon[tx], topo_z[tx][ty],
01588                topo_lon[tx + 1], topo_z[tx + 1][ty], lon);
01589       z1 = LIN(topo_lon[tx], topo_z[tx][ty + 1],
01590                topo_lon[tx + 1], topo_z[tx + 1][ty + 1], lon);
01591       z0 = LIN(topo_lat[ty], z0, topo_lat[ty + 1], z1, lat);
01592
01593       /* Find surface pressure level... */
01594       ip0 = locate_irr(met->p, met->np, met->ps[ix][iy]);
01595
01596       /* Get surface temperature... */
01597       ts = LIN(met->p[ip0], met->t[ix][iy][ip0],
01598                met->p[ip0 + 1], met->t[ix][iy][ip0 + 1], met->ps[ix][iy]);
01599
01600       /* Upper part of profile... */
01601       met->z[ix][iy][ip0 + 1]
01602         = (float) (z0 + RI / MA / G0 * 0.5 * (ts + met->t[ix][iy][ip0 + 1])
01603                    * log(met->ps[ix][iy] / met->p[ip0 + 1]));
01604       for (ip = ip0 + 2; ip < met->np; ip++)
01605         met->z[ix][iy][ip]
01606           = (float) (met->z[ix][iy][ip - 1] + RI / MA / G0
01607                      * 0.5 * (met->t[ix][iy][ip - 1] + met->t[ix][iy][ip])
01608                      * log(met->p[ip - 1] / met->p[ip]));
01609     }
01610
01611   /* Smooth fields... */
01612 #pragma omp parallel for default(shared) private(ip,ix,iy,n,ix2,ix3,iy2,data)
01613   for (ip = 0; ip < met->np; ip++) {
01614
01615     /* Median filter... */
01616     for (ix = 0; ix < met->nx; ix++)
01617       for (iy = 0; iy < met->nx; iy++) {
01618         n = 0;
01619         for (ix2 = ix - 2; ix2 <= ix + 2; ix2++) {
01620           ix3 = ix2;
01621           if (ix3 < 0)
01622             ix3 += met->nx;
01623           if (ix3 >= met->nx)
01624             ix3 -= met->nx;
01625           for (iy2 = GSL_MAX(iy - 2, 0); iy2 <= GSL_MIN(iy + 2, met->ny - 1);
01626                iy2++)
01627             if (gsl_finite(met->z[ix3][iy2][ip])) {
01628               data[n] = met->z[ix3][iy2][ip];
01629               n++;
01630             }
01631         }
01632         if (n > 0) {
01633           gsl_sort(data, 1, (size_t) n);
01634           help[ix][iy] = (float)
01635             gsl_stats_median_from_sorted_data(data, 1, (size_t) n);
01636         } else
01637           help[ix][iy] = GSL_NAN;
01638       }
01639
01640     /* Copy data... */
01641     for (ix = 0; ix < met->nx; ix++)
01642       for (iy = 0; iy < met->nx; iy++)
01643         met->z[ix][iy][ip] = help[ix][iy];
01644   }
01645 }
01646
01647 /*****************************************************************************/
01648
```

```
01649 void read_met_help(
01650   int ncid,
01651   char *varname,
01652   char *varname2,
01653   met_t * met,
01654   float dest[EX][EY][EP],
01655   float scl) {
01656
01657   static float help[EX * EY * EP];
01658
01659   int ip, ix, iy, varid;
01660
01661   /* Check if variable exists... */
01662   if (nc_inq_varid(ncid, varname, &varid) != NC_NOERR)
01663     if (nc_inq_varid(ncid, varname2, &varid) != NC_NOERR)
01664       return;
01665
01666   /* Read data... */
01667   NC(nc_get_var_float(ncid, varid, help));
01668
01669   /* Copy and check data... */
01670 #pragma omp parallel for default(shared) private(ix,iy,ip)
01671   for (ix = 0; ix < met->nx; ix++)
01672     for (iy = 0; iy < met->ny; iy++)
01673       for (ip = 0; ip < met->np; ip++) {
01674         dest[ix][iy][ip] = help[(ip * met->ny + iy) * met->nx + ix];
01675         if (fabsf(dest[ix][iy][ip]) < 1e14f)
01676           dest[ix][iy][ip] *= scl;
01677         else
01678           dest[ix][iy][ip] = GSL_NAN;
01679       }
01680 }
01681
01682 /*****************************************************************************/
01683
01684 void read_met_ml2pl(
01685   ctl_t * ctl,
01686   met_t * met,
01687   float var[EX][EY][EP]) {
01688
01689   double aux[EP], p[EP], pt;
01690
01691   int ip, ip2, ix, iy;
01692
01693   /* Loop over columns... */
01694 #pragma omp parallel for default(shared) private(ix,iy,ip,p,pt,ip2,aux)
01695   for (ix = 0; ix < met->nx; ix++)
01696     for (iy = 0; iy < met->ny; iy++) {
01697
01698       /* Copy pressure profile... */
01699       for (ip = 0; ip < met->np; ip++)
01700         p[ip] = met->pl[ix][iy][ip];
01701
01702       /* Interpolate... */
01703       for (ip = 0; ip < ctl->met_np; ip++) {
01704         pt = ctl->met_p[ip];
01705         if ((pt > p[0] && p[0] > p[1]) || (pt < p[0] && p[0] < p[1]))
01706           pt = p[0];
01707         else if ((pt > p[met->np - 1] && p[1] > p[0])
01708                  || (pt < p[met->np - 1] && p[1] < p[0]))
01709           pt = p[met->np - 1];
01710         ip2 = locate_irr(p, met->np, pt);
01711         aux[ip] = LIN(p[ip2], var[ix][iy][ip2],
01712                       p[ip2 + 1], var[ix][iy][ip2 + 1], pt);
01713       }
01714
01715       /* Copy data... */
01716       for (ip = 0; ip < ctl->met_np; ip++)
01717         var[ix][iy][ip] = (float) aux[ip];
01718     }
01719 }
01720
01721 /*****************************************************************************/
01722
01723 void read_met_periodic(
01724   met_t * met) {
01725
01726   int ip, iy;
01727
01728   /* Check longitudes... */
01729   if (!(fabs(met->lon[met->nx - 1] - met->lon[0]
01730              + met->lon[1] - met->lon[0] - 360) < 0.01))
01731     return;
01732
01733   /* Increase longitude counter... */
01734   if ((++met->nx) > EX)
01735     ERRMSG("Cannot create periodic boundary conditions!");
```

```
01736
01737   /* Set longitude... */
01738   met->lon[met->nx - 1] = met->lon[met->nx - 2] + met->lon[1] - met->
      lon[0];
01739
01740   /* Loop over latitudes and pressure levels... */
01741 #pragma omp parallel for default(shared) private(iy,ip)
01742   for (iy = 0; iy < met->ny; iy++) {
01743     met->ps[met->nx - 1][iy] = met->ps[0][iy];
01744     met->pt[met->nx - 1][iy] = met->pt[0][iy];
01745     for (ip = 0; ip < met->np; ip++) {
01746       met->z[met->nx - 1][iy][ip] = met->z[0][iy][ip];
01747       met->t[met->nx - 1][iy][ip] = met->t[0][iy][ip];
01748       met->u[met->nx - 1][iy][ip] = met->u[0][iy][ip];
01749       met->v[met->nx - 1][iy][ip] = met->v[0][iy][ip];
01750       met->w[met->nx - 1][iy][ip] = met->w[0][iy][ip];
01751       met->pv[met->nx - 1][iy][ip] = met->pv[0][iy][ip];
01752       met->h2o[met->nx - 1][iy][ip] = met->h2o[0][iy][ip];
01753       met->o3[met->nx - 1][iy][ip] = met->o3[0][iy][ip];
01754     }
01755   }
01756 }
01757
01758 /*****************************************************************************/
01759
01760 void read_met_pv(
01761   met_t * met) {
01762
01763   double c0, c1, cr, dx, dy, dp0, dp1, denom, dtdx, dvdx, dtdy, dudy,
01764     dtdp, dudp, dvdp, latr, vort, pows[EP];
01765
01766   int ip, ip0, ip1, ix, ix0, ix1, iy, iy0, iy1;
01767
01768   /* Set powers... */
01769   for (ip = 0; ip < met->np; ip++)
01770     pows[ip] = pow(1000. / met->p[ip], 0.286);
01771
01772   /* Loop over grid points... */
01773 #pragma omp parallel for default(shared)
      private(ix,ix0,ix1,iy,iy0,iy1,latr,dx,dy,c0,c1,cr,vort,ip,ip0,ip1,dp0,dp1,denom,dtdx,dvdx,dtdy,dudy,dtdp,dudp,dvdp)
01774   for (ix = 0; ix < met->nx; ix++) {
01775
01776     /* Set indices... */
01777     ix0 = GSL_MAX(ix - 1, 0);
01778     ix1 = GSL_MIN(ix + 1, met->nx - 1);
01779
01780     /* Loop over grid points... */
01781     for (iy = 0; iy < met->ny; iy++) {
01782
01783       /* Set indices... */
01784       iy0 = GSL_MAX(iy - 1, 0);
01785       iy1 = GSL_MIN(iy + 1, met->ny - 1);
01786
01787       /* Set auxiliary variables... */
01788       latr = GSL_MIN(GSL_MAX(met->lat[iy], -89.), 89.);
01789       dx = 1000. * DEG2DX(met->lon[ix1] - met->lon[ix0], latr);
01790       dy = 1000. * DEG2DY(met->lat[iy1] - met->lat[iy0]);
01791       c0 = cos(met->lat[iy0] / 180. * M_PI);
01792       c1 = cos(met->lat[iy1] / 180. * M_PI);
01793       cr = cos(latr / 180. * M_PI);
01794       vort = 2 * 7.2921e-5 * sin(latr * M_PI / 180.);
01795
01796       /* Loop over grid points... */
01797       for (ip = 0; ip < met->np; ip++) {
01798
01799         /* Get gradients in longitude... */
01800         dtdx = (met->t[ix1][iy][ip] - met->t[ix0][iy][ip]) * pows[ip] / dx;
01801         dvdx = (met->v[ix1][iy][ip] - met->v[ix0][iy][ip]) / dx;
01802
01803         /* Get gradients in latitude... */
01804         dtdy = (met->t[ix][iy1][ip] - met->t[ix][iy0][ip]) * pows[ip] / dy;
01805         dudy = (met->u[ix][iy1][ip] * c1 - met->u[ix][iy0][ip] * c0) / dy;
01806
01807         /* Set indices... */
01808         ip0 = GSL_MAX(ip - 1, 0);
01809         ip1 = GSL_MIN(ip + 1, met->np - 1);
01810
01811         /* Get gradients in pressure... */
01812         dp0 = 100. * (met->p[ip] - met->p[ip0]);
01813         dp1 = 100. * (met->p[ip1] - met->p[ip]);
01814         if (ip != ip0 && ip != ip1) {
01815           denom = dp0 * dp1 * (dp0 + dp1);
01816           dtdp = (dp0 * dp0 * met->t[ix][iy][ip1] * pows[ip1]
01817                   - dp1 * dp1 * met->t[ix][iy][ip0] * pows[ip0]
01818                   + (dp1 * dp1 - dp0 * dp0) * met->t[ix][iy][ip] * pows[ip])
01819             / denom;
01820           dudp = (dp0 * dp0 * met->u[ix][iy][ip1]
```

```
01821                   - dp1 * dp1 * met->u[ix][iy][ip0]
01822                   + (dp1 * dp1 - dp0 * dp0) * met->u[ix][iy][ip]) 
01823             / denom;
01824           dvdp = (dp0 * dp0 * met->v[ix][iy][ip1]
01825                   - dp1 * dp1 * met->v[ix][iy][ip0]
01826                   + (dp1 * dp1 - dp0 * dp0) * met->v[ix][iy][ip])
01827             / denom;
01828         } else {
01829           denom = dp0 + dp1;
01830           dtdp =
01831             (met->t[ix][iy][ip1] * pows[ip1] -
01832              met->t[ix][iy][ip0] * pows[ip0]) / denom;
01833           dudp = (met->u[ix][iy][ip1] - met->u[ix][iy][ip0]) / denom;
01834           dvdp = (met->v[ix][iy][ip1] - met->v[ix][iy][ip0]) / denom;
01835         }
01836 
01837         /* Calculate PV... */
01838         met->pv[ix][iy][ip] = (float)
01839           (1e6 * G0 *
01840            (-dtdp * (dvdx - dudy / cr + vort) + dvdp * dtdx - dudp * dtdy));
01841       }
01842     }
01843   }
01844 }
01845 
01846 /*****************************************************************************/
01847 
01848 void read_met_sample(
01849   ctl_t * ctl,
01850   met_t * met) {
01851 
01852   met_t *help;
01853 
01854   float w, wsum;
01855 
01856   int ip, ip2, ix, ix2, ix3, iy, iy2;
01857 
01858   /* Check parameters... */
01859   if (ctl->met_dp <= 1 && ctl->met_dx <= 1 && ctl->met_dy <= 1
01860       && ctl->met_sp <= 1 && ctl->met_sx <= 1 && ctl->met_sy <= 1)
01861     return;
01862 
01863   /* Allocate... */
01864   ALLOC(help, met_t, 1);
01865 
01866   /* Copy data... */
01867   help->nx = met->nx;
01868   help->ny = met->ny;
01869   help->np = met->np;
01870   memcpy(help->lon, met->lon, sizeof(met->lon));
01871   memcpy(help->lat, met->lat, sizeof(met->lat));
01872   memcpy(help->p, met->p, sizeof(met->p));
01873 
01874   /* Smoothing... */
01875   for (ix = 0; ix < met->nx; ix += ctl->met_dx) {
01876     for (iy = 0; iy < met->ny; iy += ctl->met_dy) {
01877       for (ip = 0; ip < met->np; ip += ctl->met_dp) {
01878         help->ps[ix][iy] = 0;
01879         help->pt[ix][iy] = 0;
01880         help->z[ix][iy][ip] = 0;
01881         help->t[ix][iy][ip] = 0;
01882         help->u[ix][iy][ip] = 0;
01883         help->v[ix][iy][ip] = 0;
01884         help->w[ix][iy][ip] = 0;
01885         help->pv[ix][iy][ip] = 0;
01886         help->h2o[ix][iy][ip] = 0;
01887         help->o3[ix][iy][ip] = 0;
01888         wsum = 0;
01889         for (ix2 = ix - ctl->met_sx + 1; ix2 <= ix + ctl->met_sx - 1; ix2++) {
01890           ix3 = ix2;
01891           if (ix3 < 0)
01892             ix3 += met->nx;
01893           else if (ix3 >= met->nx)
01894             ix3 -= met->nx;
01895 
01896           for (iy2 = GSL_MAX(iy - ctl->met_sy + 1, 0);
01897                iy2 <= GSL_MIN(iy + ctl->met_sy - 1, met->ny - 1); iy2++)
01898             for (ip2 = GSL_MAX(ip - ctl->met_sp + 1, 0);
01899                  ip2 <= GSL_MIN(ip + ctl->met_sp - 1, met->np - 1); ip2++) {
01900               w = (float) (1.0 - fabs(ix - ix2) / ctl->met_sx)
01901                 * (float) (1.0 - fabs(iy - iy2) / ctl->met_sy)
01902                 * (float) (1.0 - fabs(ip - ip2) / ctl->met_sp);
01903               help->ps[ix][iy] += w * met->ps[ix3][iy2];
01904               help->pt[ix][iy] += w * met->pt[ix3][iy2];
01905               help->z[ix][iy][ip] += w * met->z[ix3][iy2][ip2];
01906               help->t[ix][iy][ip] += w * met->t[ix3][iy2][ip2];
01907               help->u[ix][iy][ip] += w * met->u[ix3][iy2][ip2];
```

```
01908               help->v[ix][iy][ip] += w * met->v[ix3][iy2][ip2];
01909               help->w[ix][iy][ip] += w * met->w[ix3][iy2][ip2];
01910               help->pv[ix][iy][ip] += w * met->pv[ix3][iy2][ip2];
01911               help->h2o[ix][iy][ip] += w * met->h2o[ix3][iy2][ip2];
01912               help->o3[ix][iy][ip] += w * met->o3[ix3][iy2][ip2];
01913               wsum += w;
01914             }
01915         }
01916         help->ps[ix][iy] /= wsum;
01917         help->pt[ix][iy] /= wsum;
01918         help->t[ix][iy][ip] /= wsum;
01919         help->z[ix][iy][ip] /= wsum;
01920         help->u[ix][iy][ip] /= wsum;
01921         help->v[ix][iy][ip] /= wsum;
01922         help->w[ix][iy][ip] /= wsum;
01923         help->pv[ix][iy][ip] /= wsum;
01924         help->h2o[ix][iy][ip] /= wsum;
01925         help->o3[ix][iy][ip] /= wsum;
01926       }
01927     }
01928   }
01929
01930   /* Downsampling... */
01931   met->nx = 0;
01932   for (ix = 0; ix < help->nx; ix += ctl->met_dx) {
01933     met->lon[met->nx] = help->lon[ix];
01934     met->ny = 0;
01935     for (iy = 0; iy < help->ny; iy += ctl->met_dy) {
01936       met->lat[met->ny] = help->lat[iy];
01937       met->ps[met->nx][met->ny] = help->ps[ix][iy];
01938       met->pt[met->nx][met->ny] = help->pt[ix][iy];
01939       met->np = 0;
01940       for (ip = 0; ip < help->np; ip += ctl->met_dp) {
01941         met->p[met->np] = help->p[ip];
01942         met->z[met->nx][met->ny][met->np] = help->z[ix][iy][ip];
01943         met->t[met->nx][met->ny][met->np] = help->t[ix][iy][ip];
01944         met->u[met->nx][met->ny][met->np] = help->u[ix][iy][ip];
01945         met->v[met->nx][met->ny][met->np] = help->v[ix][iy][ip];
01946         met->w[met->nx][met->ny][met->np] = help->w[ix][iy][ip];
01947         met->pv[met->nx][met->ny][met->np] = help->pv[ix][iy][ip];
01948         met->h2o[met->nx][met->ny][met->np] = help->h2o[ix][iy][ip];
01949         met->o3[met->nx][met->ny][met->np] = help->o3[ix][iy][ip];
01950         met->np++;
01951       }
01952       met->ny++;
01953     }
01954     met->nx++;
01955   }
01956
01957   /* Free... */
01958   free(help);
01959 }
01960
01961 /*****************************************************************************/
01962
01963 void read_met_tropo(
01964   ctl_t * ctl,
01965   met_t * met) {
01966
01967   gsl_interp_accel *acc;
01968
01969   gsl_spline *spline;
01970
01971   double p2[400], pv[400], pv2[400], t[400], t2[400], th[400], th2[400],
01972     z[400], z2[400];
01973
01974   int found, ix, iy, iz, iz2;
01975
01976   /* Allocate... */
01977   acc = gsl_interp_accel_alloc();
01978   spline = gsl_spline_alloc(gsl_interp_cspline, (size_t) met->np);
01979
01980   /* Get altitude and pressure profiles... */
01981   for (iz = 0; iz < met->np; iz++)
01982     z[iz] = Z(met->p[iz]);
01983   for (iz = 0; iz <= 170; iz++) {
01984     z2[iz] = 4.5 + 0.1 * iz;
01985     p2[iz] = P(z2[iz]);
01986   }
01987
01988   /* Do not calculate tropopause... */
01989   if (ctl->met_tropo == 0)
01990     for (ix = 0; ix < met->nx; ix++)
01991       for (iy = 0; iy < met->ny; iy++)
01992         met->pt[ix][iy] = GSL_NAN;
01993
01994   /* Use tropopause climatology... */
```

```
01995   else if (ctl->met_tropo == 1)
01996     for (ix = 0; ix < met->nx; ix++)
01997       for (iy = 0; iy < met->ny; iy++)
01998         met->pt[ix][iy] = clim_tropo(met->time, met->lat[iy]);
01999
02000   /* Use cold point... */
02001   else if (ctl->met_tropo == 2) {
02002
02003     /* Loop over grid points... */
02004     for (ix = 0; ix < met->nx; ix++)
02005       for (iy = 0; iy < met->ny; iy++) {
02006
02007         /* Interpolate temperature profile... */
02008         for (iz = 0; iz < met->np; iz++)
02009           t[iz] = met->t[ix][iy][iz];
02010         gsl_spline_init(spline, z, t, (size_t) met->np);
02011         for (iz = 0; iz <= 170; iz++)
02012           t2[iz] = gsl_spline_eval(spline, z2[iz], acc);
02013
02014         /* Find minimum... */
02015         iz = (int) gsl_stats_min_index(t2, 1, 171);
02016         if (iz <= 0 || iz >= 170)
02017           met->pt[ix][iy] = GSL_NAN;
02018         else
02019           met->pt[ix][iy] = p2[iz];
02020       }
02021   }
02022
02023   /* Use WMO definition... */
02024   else if (ctl->met_tropo == 3 || ctl->met_tropo == 4) {
02025
02026     /* Loop over grid points... */
02027     for (ix = 0; ix < met->nx; ix++)
02028       for (iy = 0; iy < met->ny; iy++) {
02029
02030         /* Interpolate temperature profile... */
02031         for (iz = 0; iz < met->np; iz++)
02032           t[iz] = met->t[ix][iy][iz];
02033         gsl_spline_init(spline, z, t, (size_t) met->np);
02034         for (iz = 0; iz <= 160; iz++)
02035           t2[iz] = gsl_spline_eval(spline, z2[iz], acc);
02036
02037         /* Find 1st tropopause... */
02038         met->pt[ix][iy] = GSL_NAN;
02039         for (iz = 0; iz <= 140; iz++) {
02040           found = 1;
02041           for (iz2 = iz + 1; iz2 <= iz + 20; iz2++)
02042             if (1000. * G0 / RA * log(t2[iz2] / t2[iz])
02043                 / log(p2[iz2] / p2[iz]) > 2.0) {
02044               found = 0;
02045               break;
02046             }
02047           if (found) {
02048             if (iz > 0 && iz < 140)
02049               met->pt[ix][iy] = p2[iz];
02050             break;
02051           }
02052         }
02053
02054         /* Find 2nd tropopause... */
02055         if (ctl->met_tropo == 4) {
02056           met->pt[ix][iy] = GSL_NAN;
02057           for (; iz <= 140; iz++) {
02058             found = 1;
02059             for (iz2 = iz + 1; iz2 <= iz + 10; iz2++)
02060               if (1000. * G0 / RA * log(t2[iz2] / t2[iz])
02061                   / log(p2[iz2] / p2[iz]) < 3.0) {
02062                 found = 0;
02063                 break;
02064               }
02065             if (found)
02066               break;
02067           }
02068           for (; iz <= 140; iz++) {
02069             found = 1;
02070             for (iz2 = iz + 1; iz2 <= iz + 20; iz2++)
02071               if (1000. * G0 / RA * log(t2[iz2] / t2[iz])
02072                   / log(p2[iz2] / p2[iz]) > 2.0) {
02073                 found = 0;
02074                 break;
02075               }
02076             if (found) {
02077               if (iz > 0 && iz < 140)
02078                 met->pt[ix][iy] = p2[iz];
02079               break;
02080             }
02081           }
```

```
02082         }
02083       }
02084   }
02085
02086   /* Use dynamical tropopause... */
02087   else if (ctl->met_tropo == 5) {
02088
02089     /* Loop over grid points... */
02090     for (ix = 0; ix < met->nx; ix++)
02091       for (iy = 0; iy < met->ny; iy++) {
02092
02093         /* Interpolate potential vorticity profile... */
02094         for (iz = 0; iz < met->np; iz++)
02095           pv[iz] = met->pv[ix][iy][iz];
02096         gsl_spline_init(spline, z, pv, (size_t) met->np);
02097         for (iz = 0; iz <= 160; iz++)
02098           pv2[iz] = gsl_spline_eval(spline, z2[iz], acc);
02099
02100         /* Interpolate potential temperature profile... */
02101         for (iz = 0; iz < met->np; iz++)
02102           th[iz] = THETA(met->p[iz], met->t[ix][iy][iz]);
02103         gsl_spline_init(spline, z, th, (size_t) met->np);
02104         for (iz = 0; iz <= 160; iz++)
02105           th2[iz] = gsl_spline_eval(spline, z2[iz], acc);
02106
02107         /* Find dynamical tropopause 3.5 PVU + 380 K */
02108         met->pt[ix][iy] = GSL_NAN;
02109         for (iz = 0; iz <= 160; iz++)
02110           if (fabs(pv2[iz]) >= 3.5 || th2[iz] >= 380.) {
02111             if (iz > 0 && iz < 160)
02112               met->pt[ix][iy] = p2[iz];
02113             break;
02114           }
02115       }
02116   }
02117
02118   else
02119     ERRMSG("Cannot calculate tropopause!");
02120
02121   /* Free... */
02122   gsl_spline_free(spline);
02123   gsl_interp_accel_free(acc);
02124 }
02125
02126 /*****************************************************************************/
02127
02128 double scan_ctl(
02129   const char *filename,
02130   int argc,
02131   char *argv[],
02132   const char *varname,
02133   int arridx,
02134   const char *defvalue,
02135   char *value) {
02136
02137   FILE *in = NULL;
02138
02139   char dummy[LEN], fullname1[LEN], fullname2[LEN], line[LEN],
02140     msg[2 * LEN], rvarname[LEN], rval[LEN];
02141
02142   int contain = 0, i;
02143
02144   /* Open file... */
02145   if (filename[strlen(filename) - 1] != '-')
02146     if (!(in = fopen(filename, "r")))
02147       ERRMSG("Cannot open file!");
02148
02149   /* Set full variable name... */
02150   if (arridx >= 0) {
02151     sprintf(fullname1, "%s[%d]", varname, arridx);
02152     sprintf(fullname2, "%s[*]", varname);
02153   } else {
02154     sprintf(fullname1, "%s", varname);
02155     sprintf(fullname2, "%s", varname);
02156   }
02157
02158   /* Read data... */
02159   if (in != NULL)
02160     while (fgets(line, LEN, in))
02161       if (sscanf(line, "%s %s %s", rvarname, dummy, rval) == 3)
02162         if (strcasecmp(rvarname, fullname1) == 0 ||
02163             strcasecmp(rvarname, fullname2) == 0) {
02164           contain = 1;
02165           break;
02166         }
02167   for (i = 1; i < argc - 1; i++)
02168     if (strcasecmp(argv[i], fullname1) == 0 ||
```

```
02169         strcasecmp(argv[i], fullname2) == 0) {
02170       sprintf(rval, "%s", argv[i + 1]);
02171       contain = 1;
02172       break;
02173     }
02174
02175   /* Close file... */
02176   if (in != NULL)
02177     fclose(in);
02178
02179   /* Check for missing variables... */
02180   if (!contain) {
02181     if (strlen(defvalue) > 0)
02182       sprintf(rval, "%s", defvalue);
02183     else {
02184       sprintf(msg, "Missing variable %s!\n", fullname1);
02185       ERRMSG(msg);
02186     }
02187   }
02188
02189   /* Write info... */
02190   printf("%s = %s\n", fullname1, rval);
02191
02192   /* Return values... */
02193   if (value != NULL)
02194     sprintf(value, "%s", rval);
02195   return atof(rval);
02196 }
02197
02198 /*****************************************************************************/
02199
02200 void time2jsec(
02201   int year,
02202   int mon,
02203   int day,
02204   int hour,
02205   int min,
02206   int sec,
02207   double remain,
02208   double *jsec) {
02209
02210   struct tm t0, t1;
02211
02212   t0.tm_year = 100;
02213   t0.tm_mon = 0;
02214   t0.tm_mday = 1;
02215   t0.tm_hour = 0;
02216   t0.tm_min = 0;
02217   t0.tm_sec = 0;
02218
02219   t1.tm_year = year - 1900;
02220   t1.tm_mon = mon - 1;
02221   t1.tm_mday = day;
02222   t1.tm_hour = hour;
02223   t1.tm_min = min;
02224   t1.tm_sec = sec;
02225
02226   *jsec = (double) timegm(&t1) - (double) timegm(&t0) + remain;
02227 }
02228
02229 /*****************************************************************************/
02230
02231 void timer(
02232   const char *name,
02233   int id,
02234   int mode) {
02235
02236   static double starttime[NTIMER], runtime[NTIMER];
02237
02238   /* Check id... */
02239   if (id < 0 || id >= NTIMER)
02240     ERRMSG("Too many timers!");
02241
02242   /* Start timer... */
02243   if (mode == 1) {
02244     if (starttime[id] <= 0)
02245       starttime[id] = omp_get_wtime();
02246     else
02247       ERRMSG("Timer already started!");
02248   }
02249
02250   /* Stop timer... */
02251   else if (mode == 2) {
02252     if (starttime[id] > 0) {
02253       runtime[id] = runtime[id] + omp_get_wtime() - starttime[id];
02254       starttime[id] = -1;
02255     }
```

```
02256   }
02257
02258   /* Print timer... */
02259   else if (mode == 3) {
02260     printf("%s = %.3f s\n", name, runtime[id]);
02261     runtime[id] = 0;
02262   }
02263 }
02264
02265 /*****************************************************************************/
02266
02267 void write_atm(
02268   const char *filename,
02269   ctl_t * ctl,
02270   atm_t * atm,
02271   double t) {
02272
02273   FILE *in, *out;
02274
02275   char line[LEN];
02276
02277   double r, t0, t1;
02278
02279   int ip, iq, year, mon, day, hour, min, sec;
02280
02281   /* Set time interval for output... */
02282   t0 = t - 0.5 * ctl->dt_mod;
02283   t1 = t + 0.5 * ctl->dt_mod;
02284
02285   /* Write info... */
02286   printf("Write atmospheric data: %s\n", filename);
02287
02288   /* Write ASCII data... */
02289   if (ctl->atm_type == 0) {
02290
02291     /* Check if gnuplot output is requested... */
02292     if (ctl->atm_gpfile[0] != '-') {
02293
02294       /* Create gnuplot pipe... */
02295       if (!(out = popen("gnuplot", "w")))
02296         ERRMSG("Cannot create pipe to gnuplot!");
02297
02298       /* Set plot filename... */
02299       fprintf(out, "set out \"%s.png\"\n", filename);
02300
02301       /* Set time string... */
02302       jsec2time(t, &year, &mon, &day, &hour, &min, &sec, &r);
02303       fprintf(out, "timestr=\"%d-%02d-%02d, %02d:%02d UTC\"\n",
02304               year, mon, day, hour, min);
02305
02306       /* Dump gnuplot file to pipe... */
02307       if (!(in = fopen(ctl->atm_gpfile, "r")))
02308         ERRMSG("Cannot open file!");
02309       while (fgets(line, LEN, in))
02310         fprintf(out, "%s", line);
02311       fclose(in);
02312     }
02313
02314     else {
02315
02316       /* Create file... */
02317       if (!(out = fopen(filename, "w")))
02318         ERRMSG("Cannot create file!");
02319     }
02320
02321     /* Write header... */
02322     fprintf(out,
02323             "# $1 = time [s]\n"
02324             "# $2 = altitude [km]\n"
02325             "# $3 = longitude [deg]\n" "# $4 = latitude [deg]\n");
02326     for (iq = 0; iq < ctl->nq; iq++)
02327       fprintf(out, "# $%i = %s [%s]\n", iq + 5, ctl->qnt_name[iq],
02328               ctl->qnt_unit[iq]);
02329     fprintf(out, "\n");
02330
02331     /* Write data... */
02332     for (ip = 0; ip < atm->np; ip++) {
02333
02334       /* Check time... */
02335       if (ctl->atm_filter && (atm->time[ip] < t0 || atm->time[ip] > t1))
02336         continue;
02337
02338       /* Write output... */
02339       fprintf(out, "%.2f %g %g %g", atm->time[ip], Z(atm->p[ip]),
02340               atm->lon[ip], atm->lat[ip]);
02341       for (iq = 0; iq < ctl->nq; iq++) {
02342         fprintf(out, " ");
```

```
02343         fprintf(out, ctl->qnt_format[iq], atm->q[iq][ip]);
02344       }
02345       fprintf(out, "\n");
02346     }
02347
02348     /* Close file... */
02349     fclose(out);
02350   }
02351
02352   /* Write binary data... */
02353   else if (ctl->atm_type == 1) {
02354
02355     /* Create file... */
02356     if (!(out = fopen(filename, "w")))
02357       ERRMSG("Cannot create file!");
02358
02359     /* Write data... */
02360     FWRITE(&atm->np, int,
02361            1,
02362            out);
02363     FWRITE(atm->time, double,
02364              (size_t) atm->np,
02365            out);
02366     FWRITE(atm->p, double,
02367              (size_t) atm->np,
02368            out);
02369     FWRITE(atm->lon, double,
02370              (size_t) atm->np,
02371            out);
02372     FWRITE(atm->lat, double,
02373              (size_t) atm->np,
02374            out);
02375     for (iq = 0; iq < ctl->nq; iq++)
02376       FWRITE(atm->q[iq], double,
02377                (size_t) atm->np,
02378              out);
02379
02380     /* Close file... */
02381     fclose(out);
02382   }
02383
02384   /* Error... */
02385   else
02386     ERRMSG("Atmospheric data type not supported!");
02387 }
02388
02389 /*****************************************************************************/
02390
02391 void write_csi(
02392   const char *filename,
02393   ctl_t * ctl,
02394   atm_t * atm,
02395   double t) {
02396
02397   static FILE *in, *out;
02398
02399   static char line[LEN];
02400
02401   static double modmean[GX][GY][GZ], obsmean[GX][GY][GZ],
02402     rt, rz, rlon, rlat, robs, t0, t1, area, dlon, dlat, lat;
02403
02404   static int obscount[GX][GY][GZ], cx, cy, cz, ip, ix, iy, iz;
02405
02406   /* Init... */
02407   if (t == ctl->t_start) {
02408
02409     /* Check quantity index for mass... */
02410     if (ctl->qnt_m < 0)
02411       ERRMSG("Need quantity mass!");
02412
02413     /* Open observation data file... */
02414     printf("Read CSI observation data: %s\n", ctl->csi_obsfile);
02415     if (!(in = fopen(ctl->csi_obsfile, "r")))
02416       ERRMSG("Cannot open file!");
02417
02418     /* Create new file... */
02419     printf("Write CSI data: %s\n", filename);
02420     if (!(out = fopen(filename, "w")))
02421       ERRMSG("Cannot create file!");
02422
02423     /* Write header... */
02424     fprintf(out,
02425             "# $1 = time [s]\n"
02426             "# $2 = number of hits (cx)\n"
02427             "# $3 = number of misses (cy)\n"
02428             "# $4 = number of false alarms (cz)\n"
02429             "# $5 = number of observations (cx + cy)\n"
```

```
02430             "# $6 = number of forecasts (cx + cz)\n"
02431             "# $7 = bias (forecasts/observations) [%%]\n"
02432             "# $8 = probability of detection (POD) [%%]\n"
02433             "# $9 = false alarm rate (FAR) [%%]\n"
02434             "# $10 = critical success index (CSI) [%%]\n\n");
02435   }
02436
02437   /* Set time interval... */
02438   t0 = t - 0.5 * ctl->dt_mod;
02439   t1 = t + 0.5 * ctl->dt_mod;
02440
02441   /* Initialize grid cells... */
02442 #pragma omp parallel for default(shared) private(ix,iy,iz)
02443   for (ix = 0; ix < ctl->csi_nx; ix++)
02444     for (iy = 0; iy < ctl->csi_ny; iy++)
02445       for (iz = 0; iz < ctl->csi_nz; iz++)
02446         modmean[ix][iy][iz] = obsmean[ix][iy][iz] = obscount[ix][iy][iz] = 0;
02447
02448   /* Read observation data... */
02449   while (fgets(line, LEN, in)) {
02450
02451     /* Read data... */
02452     if (sscanf(line, "%lg %lg %lg %lg %lg", &rt, &rz, &rlon, &rlat, &robs) !=
02453         5)
02454       continue;
02455
02456     /* Check time... */
02457     if (rt < t0)
02458       continue;
02459     if (rt > t1)
02460       break;
02461
02462     /* Calculate indices... */
02463     ix = (int) ((rlon - ctl->csi_lon0)
02464                 / (ctl->csi_lon1 - ctl->csi_lon0) * ctl->csi_nx);
02465     iy = (int) ((rlat - ctl->csi_lat0)
02466                 / (ctl->csi_lat1 - ctl->csi_lat0) * ctl->csi_ny);
02467     iz = (int) ((rz - ctl->csi_z0)
02468                 / (ctl->csi_z1 - ctl->csi_z0) * ctl->csi_nz);
02469
02470     /* Check indices... */
02471     if (ix < 0 || ix >= ctl->csi_nx ||
02472         iy < 0 || iy >= ctl->csi_ny || iz < 0 || iz >= ctl->csi_nz)
02473       continue;
02474
02475     /* Get mean observation index... */
02476     obsmean[ix][iy][iz] += robs;
02477     obscount[ix][iy][iz]++;
02478   }
02479
02480   /* Analyze model data... */
02481 #pragma omp parallel for default(shared) private(ip,ix,iy,iz)
02482   for (ip = 0; ip < atm->np; ip++) {
02483
02484     /* Check time... */
02485     if (atm->time[ip] < t0 || atm->time[ip] > t1)
02486       continue;
02487
02488     /* Get indices... */
02489     ix = (int) ((atm->lon[ip] - ctl->csi_lon0)
02490                 / (ctl->csi_lon1 - ctl->csi_lon0) * ctl->csi_nx);
02491     iy = (int) ((atm->lat[ip] - ctl->csi_lat0)
02492                 / (ctl->csi_lat1 - ctl->csi_lat0) * ctl->csi_ny);
02493     iz = (int) ((Z(atm->p[ip]) - ctl->csi_z0)
02494                 / (ctl->csi_z1 - ctl->csi_z0) * ctl->csi_nz);
02495
02496     /* Check indices... */
02497     if (ix < 0 || ix >= ctl->csi_nx ||
02498         iy < 0 || iy >= ctl->csi_ny || iz < 0 || iz >= ctl->csi_nz)
02499       continue;
02500
02501     /* Get total mass in grid cell... */
02502     modmean[ix][iy][iz] += atm->q[ctl->qnt_m][ip];
02503   }
02504
02505   /* Analyze all grid cells... */
02506 #pragma omp parallel for default(shared) private(ix,iy,iz,dlon,dlat,lat,area)
02507   for (ix = 0; ix < ctl->csi_nx; ix++)
02508     for (iy = 0; iy < ctl->csi_ny; iy++)
02509       for (iz = 0; iz < ctl->csi_nz; iz++) {
02510
02511         /* Calculate mean observation index... */
02512         if (obscount[ix][iy][iz] > 0)
02513           obsmean[ix][iy][iz] /= obscount[ix][iy][iz];
02514
02515         /* Calculate column density... */
02516         if (modmean[ix][iy][iz] > 0) {
```

```
02517           dlon = (ctl->csi_lon1 - ctl->csi_lon0) / ctl->csi_nx;
02518           dlat = (ctl->csi_lat1 - ctl->csi_lat0) / ctl->csi_ny;
02519           lat = ctl->csi_lat0 + dlat * (iy + 0.5);
02520           area = dlat * M_PI * RE / 180. * dlon * M_PI * RE / 180.
02521             * cos(lat * M_PI / 180.);
02522           modmean[ix][iy][iz] /= (1e6 * area);
02523         }
02524
02525         /* Calculate CSI... */
02526         if (obscount[ix][iy][iz] > 0) {
02527           if (obsmean[ix][iy][iz] >= ctl->csi_obsmin &&
02528               modmean[ix][iy][iz] >= ctl->csi_modmin)
02529             cx++;
02530           else if (obsmean[ix][iy][iz] >= ctl->csi_obsmin &&
02531                    modmean[ix][iy][iz] < ctl->csi_modmin)
02532             cy++;
02533           else if (obsmean[ix][iy][iz] < ctl->csi_obsmin &&
02534                    modmean[ix][iy][iz] >= ctl->csi_modmin)
02535             cz++;
02536         }
02537       }
02538
02539   /* Write output... */
02540   if (fmod(t, ctl->csi_dt_out) == 0) {
02541
02542     /* Write... */
02543     fprintf(out, "%.2f %d %d %d %d %d %g %g %g %g\n",
02544             t, cx, cy, cz, cx + cy, cx + cz,
02545             (cx + cy > 0) ? 100. * (cx + cz) / (cx + cy) : GSL_NAN,
02546             (cx + cy > 0) ? (100. * cx) / (cx + cy) : GSL_NAN,
02547             (cx + cz > 0) ? (100. * cz) / (cx + cz) : GSL_NAN,
02548             (cx + cy + cz > 0) ? (100. * cx) / (cx + cy + cz) : GSL_NAN);
02549
02550     /* Set counters to zero... */
02551     cx = cy = cz = 0;
02552   }
02553
02554   /* Close file... */
02555   if (t == ctl->t_stop)
02556     fclose(out);
02557 }
02558
02559 /*****************************************************************************/
02560
02561 void write_ens(
02562   const char *filename,
02563   ctl_t * ctl,
02564   atm_t * atm,
02565   double t) {
02566
02567   static FILE *out;
02568
02569   static double dummy, ens, lat, lon, p[NENS], q[NQ][NENS],
02570     t0, t1, x[NENS][3], xm[3];
02571
02572   static int ip, iq;
02573
02574   static size_t i, n;
02575
02576   /* Init... */
02577   if (t == ctl->t_start) {
02578
02579     /* Check quantities... */
02580     if (ctl->qnt_ens < 0)
02581       ERRMSG("Missing ensemble IDs!");
02582
02583     /* Create new file... */
02584     printf("Write ensemble data: %s\n", filename);
02585     if (!(out = fopen(filename, "w")))
02586       ERRMSG("Cannot create file!");
02587
02588     /* Write header... */
02589     fprintf(out,
02590             "# $1 = time [s]\n"
02591             "# $2 = altitude [km]\n"
02592             "# $3 = longitude [deg]\n" "# $4 = latitude [deg]\n");
02593     for (iq = 0; iq < ctl->nq; iq++)
02594       fprintf(out, "# $%d = %s (mean) [%s]\n", 5 + iq,
02595               ctl->qnt_name[iq], ctl->qnt_unit[iq]);
02596     for (iq = 0; iq < ctl->nq; iq++)
02597       fprintf(out, "# $%d = %s (sigma) [%s]\n", 5 + ctl->nq + iq,
02598               ctl->qnt_name[iq], ctl->qnt_unit[iq]);
02599     fprintf(out, "# $%d = number of members\n\n", 5 + 2 * ctl->nq);
02600   }
02601
02602   /* Set time interval... */
02603   t0 = t - 0.5 * ctl->dt_mod;
```

```
02604   t1 = t + 0.5 * ctl->dt_mod;
02605
02606   /* Init... */
02607   ens = GSL_NAN;
02608   n = 0;
02609
02610   /* Loop over air parcels... */
02611   for (ip = 0; ip < atm->np; ip++) {
02612
02613     /* Check time... */
02614     if (atm->time[ip] < t0 || atm->time[ip] > t1)
02615       continue;
02616
02617     /* Check ensemble id... */
02618     if (atm->q[ctl->qnt_ens][ip] != ens) {
02619
02620       /* Write results... */
02621       if (n > 0) {
02622
02623         /* Get mean position... */
02624         xm[0] = xm[1] = xm[2] = 0;
02625         for (i = 0; i < n; i++) {
02626           xm[0] += x[i][0] / (double) n;
02627           xm[1] += x[i][1] / (double) n;
02628           xm[2] += x[i][2] / (double) n;
02629         }
02630         cart2geo(xm, &dummy, &lon, &lat);
02631         fprintf(out, "%.2f %g %g %g", t, Z(gsl_stats_mean(p, 1, n)), lon,
02632                 lat);
02633
02634         /* Get quantity statistics... */
02635         for (iq = 0; iq < ctl->nq; iq++) {
02636           fprintf(out, " ");
02637           fprintf(out, ctl->qnt_format[iq], gsl_stats_mean(q[iq], 1, n));
02638         }
02639         for (iq = 0; iq < ctl->nq; iq++) {
02640           fprintf(out, " ");
02641           fprintf(out, ctl->qnt_format[iq], gsl_stats_sd(q[iq], 1, n));
02642         }
02643         fprintf(out, " %lu\n", n);
02644       }
02645
02646       /* Init new ensemble... */
02647       ens = atm->q[ctl->qnt_ens][ip];
02648       n = 0;
02649     }
02650
02651     /* Save data... */
02652     p[n] = atm->p[ip];
02653     geo2cart(0, atm->lon[ip], atm->lat[ip], x[n]);
02654     for (iq = 0; iq < ctl->nq; iq++)
02655       q[iq][n] = atm->q[iq][ip];
02656     if ((++n) >= NENS)
02657       ERRMSG("Too many data points!");
02658   }
02659
02660   /* Write results... */
02661   if (n > 0) {
02662
02663     /* Get mean position... */
02664     xm[0] = xm[1] = xm[2] = 0;
02665     for (i = 0; i < n; i++) {
02666       xm[0] += x[i][0] / (double) n;
02667       xm[1] += x[i][1] / (double) n;
02668       xm[2] += x[i][2] / (double) n;
02669     }
02670     cart2geo(xm, &dummy, &lon, &lat);
02671     fprintf(out, "%.2f %g %g %g", t, Z(gsl_stats_mean(p, 1, n)), lon, lat);
02672
02673     /* Get quantity statistics... */
02674     for (iq = 0; iq < ctl->nq; iq++) {
02675       fprintf(out, " ");
02676       fprintf(out, ctl->qnt_format[iq], gsl_stats_mean(q[iq], 1, n));
02677     }
02678     for (iq = 0; iq < ctl->nq; iq++) {
02679       fprintf(out, " ");
02680       fprintf(out, ctl->qnt_format[iq], gsl_stats_sd(q[iq], 1, n));
02681     }
02682     fprintf(out, " %lu\n", n);
02683   }
02684
02685   /* Close file... */
02686   if (t == ctl->t_stop)
02687     fclose(out);
02688 }
02689
02690 /*****************************************************************************/
```

```
02691
02692 void write_grid(
02693   const char *filename,
02694   ctl_t * ctl,
02695   met_t * met0,
02696   met_t * met1,
02697   atm_t * atm,
02698   double t) {
02699
02700   FILE *in, *out;
02701
02702   char line[LEN];
02703
02704   static double mass[GX][GY][GZ], z, dz, lon, dlon, lat, dlat,
02705     area, rho_air, press, temp, cd, vmr, t0, t1, r;
02706
02707   static int ip, ix, iy, iz, year, mon, day, hour, min, sec;
02708
02709   /* Check dimensions... */
02710   if (ctl->grid_nx > GX || ctl->grid_ny > GY || ctl->grid_nz > GZ)
02711     ERRMSG("Grid dimensions too large!");
02712
02713   /* Check quantity index for mass... */
02714   if (ctl->qnt_m < 0)
02715     ERRMSG("Need quantity mass!");
02716
02717   /* Set time interval for output... */
02718   t0 = t - 0.5 * ctl->dt_mod;
02719   t1 = t + 0.5 * ctl->dt_mod;
02720
02721   /* Set grid box size... */
02722   dz = (ctl->grid_z1 - ctl->grid_z0) / ctl->grid_nz;
02723   dlon = (ctl->grid_lon1 - ctl->grid_lon0) / ctl->grid_nx;
02724   dlat = (ctl->grid_lat1 - ctl->grid_lat0) / ctl->grid_ny;
02725
02726   /* Initialize grid... */
02727 #pragma omp parallel for default(shared) private(ix,iy,iz)
02728   for (ix = 0; ix < ctl->grid_nx; ix++)
02729     for (iy = 0; iy < ctl->grid_ny; iy++)
02730       for (iz = 0; iz < ctl->grid_nz; iz++)
02731         mass[ix][iy][iz] = 0;
02732
02733   /* Average data... */
02734 #pragma omp parallel for default(shared) private(ip,ix,iy,iz)
02735   for (ip = 0; ip < atm->np; ip++)
02736     if (atm->time[ip] >= t0 && atm->time[ip] <= t1) {
02737
02738       /* Get index... */
02739       ix = (int) ((atm->lon[ip] - ctl->grid_lon0) / dlon);
02740       iy = (int) ((atm->lat[ip] - ctl->grid_lat0) / dlat);
02741       iz = (int) ((Z(atm->p[ip]) - ctl->grid_z0) / dz);
02742
02743       /* Check indices... */
02744       if (ix < 0 || ix >= ctl->grid_nx ||
02745           iy < 0 || iy >= ctl->grid_ny || iz < 0 || iz >= ctl->grid_nz)
02746         continue;
02747
02748       /* Add mass... */
02749       mass[ix][iy][iz] += atm->q[ctl->qnt_m][ip];
02750     }
02751
02752   /* Check if gnuplot output is requested... */
02753   if (ctl->grid_gpfile[0] != '-') {
02754
02755     /* Write info... */
02756     printf("Plot grid data: %s.png\n", filename);
02757
02758     /* Create gnuplot pipe... */
02759     if (!(out = popen("gnuplot", "w")))
02760       ERRMSG("Cannot create pipe to gnuplot!");
02761
02762     /* Set plot filename... */
02763     fprintf(out, "set out \"%s.png\"\n", filename);
02764
02765     /* Set time string... */
02766     jsec2time(t, &year, &mon, &day, &hour, &min, &sec, &r);
02767     fprintf(out, "timestr=\"%d-%02d-%02d, %02d:%02d UTC\"\n",
02768             year, mon, day, hour, min);
02769
02770     /* Dump gnuplot file to pipe... */
02771     if (!(in = fopen(ctl->grid_gpfile, "r")))
02772       ERRMSG("Cannot open file!");
02773     while (fgets(line, LEN, in))
02774       fprintf(out, "%s", line);
02775     fclose(in);
02776   }
02777
```

```
02778   else {
02779
02780     /* Write info... */
02781     printf("Write grid data: %s\n", filename);
02782
02783     /* Create file... */
02784     if (!(out = fopen(filename, "w")))
02785       ERRMSG("Cannot create file!");
02786   }
02787
02788   /* Write header... */
02789   fprintf(out,
02790           "# $1 = time [s]\n"
02791           "# $2 = altitude [km]\n"
02792           "# $3 = longitude [deg]\n"
02793           "# $4 = latitude [deg]\n"
02794           "# $5 = surface area [km^2]\n"
02795           "# $6 = layer width [km]\n"
02796           "# $7 = temperature [K]\n"
02797           "# $8 = column density [kg/m^2]\n"
02798           "# $9 = volume mixing ratio [1]\n\n");
02799
02800   /* Write data... */
02801   for (ix = 0; ix < ctl->grid_nx; ix++) {
02802     if (ix > 0 && ctl->grid_ny > 1 && !ctl->grid_sparse)
02803       fprintf(out, "\n");
02804     for (iy = 0; iy < ctl->grid_ny; iy++) {
02805       if (iy > 0 && ctl->grid_nz > 1 && !ctl->grid_sparse)
02806         fprintf(out, "\n");
02807       for (iz = 0; iz < ctl->grid_nz; iz++)
02808         if (!ctl->grid_sparse || mass[ix][iy][iz] > 0) {
02809
02810           /* Set coordinates... */
02811           z = ctl->grid_z0 + dz * (iz + 0.5);
02812           lon = ctl->grid_lon0 + dlon * (ix + 0.5);
02813           lat = ctl->grid_lat0 + dlat * (iy + 0.5);
02814
02815           /* Get pressure and temperature... */
02816           press = P(z);
02817           intpol_met_time(met0, met1, t, press, lon, lat, NULL, NULL,
02818                           NULL, &temp, NULL, NULL, NULL, NULL, NULL, NULL);
02819
02820           /* Calculate surface area... */
02821           area = dlat * dlon * SQR(RE * M_PI / 180.)
02822             * cos(lat * M_PI / 180.);
02823
02824           /* Calculate column density... */
02825           cd = mass[ix][iy][iz] / (1e6 * area);
02826
02827           /* Calculate volume mixing ratio... */
02828           rho_air = 100. * press / (RA * temp);
02829           vmr = MA / ctl->molmass * mass[ix][iy][iz]
02830             / (rho_air * 1e6 * area * 1e3 * dz);
02831
02832           /* Write output... */
02833           fprintf(out, "%.2f %g %g %g %g %g %g %g %g\n",
02834                   t, z, lon, lat, area, dz, temp, cd, vmr);
02835         }
02836     }
02837   }
02838
02839   /* Close file... */
02840   fclose(out);
02841 }
02842
02843 /*****************************************************************************/
02844
02845 void write_prof(
02846   const char *filename,
02847   ctl_t * ctl,
02848   met_t * met0,
02849   met_t * met1,
02850   atm_t * atm,
02851   double t) {
02852
02853   static FILE *in, *out;
02854
02855   static char line[LEN];
02856
02857   static double mass[GX][GY][GZ], obsmean[GX][GY], obsmean2[GX][GY], rt, rz,
02858     rlon, rlat, robs, t0, t1, area, dz, dlon, dlat, lon, lat, z, press, temp,
02859     rho_air, vmr, h2o, o3;
02860
02861   static int obscount[GX][GY], ip, ix, iy, iz, okay;
02862
02863   /* Init... */
02864   if (t == ctl->t_start) {
```

```
02865
02866     /* Check quantity index for mass... */
02867     if (ctl->qnt_m < 0)
02868       ERRMSG("Need quantity mass!");
02869
02870     /* Check dimensions... */
02871     if (ctl->prof_nx > GX || ctl->prof_ny > GY || ctl->prof_nz > GZ)
02872       ERRMSG("Grid dimensions too large!");
02873
02874     /* Open observation data file... */
02875     printf("Read profile observation data: %s\n", ctl->prof_obsfile);
02876     if (!(in = fopen(ctl->prof_obsfile, "r")))
02877       ERRMSG("Cannot open file!");
02878
02879     /* Create new output file... */
02880     printf("Write profile data: %s\n", filename);
02881     if (!(out = fopen(filename, "w")))
02882       ERRMSG("Cannot create file!");
02883
02884     /* Write header... */
02885     fprintf(out,
02886             "# $1 = time [s]\n"
02887             "# $2 = altitude [km]\n"
02888             "# $3 = longitude [deg]\n"
02889             "# $4 = latitude [deg]\n"
02890             "# $5 = pressure [hPa]\n"
02891             "# $6 = temperature [K]\n"
02892             "# $7 = volume mixing ratio [1]\n"
02893             "# $8 = H2O volume mixing ratio [1]\n"
02894             "# $9 = O3 volume mixing ratio [1]\n"
02895             "# $10 = observed BT index (mean) [K]\n"
02896             "# $11 = observed BT index (sigma) [K]\n");
02897
02898     /* Set grid box size... */
02899     dz = (ctl->prof_z1 - ctl->prof_z0) / ctl->prof_nz;
02900     dlon = (ctl->prof_lon1 - ctl->prof_lon0) / ctl->prof_nx;
02901     dlat = (ctl->prof_lat1 - ctl->prof_lat0) / ctl->prof_ny;
02902   }
02903
02904   /* Set time interval... */
02905   t0 = t - 0.5 * ctl->dt_mod;
02906   t1 = t + 0.5 * ctl->dt_mod;
02907
02908   /* Initialize... */
02909 #pragma omp parallel for default(shared) private(ix,iy,iz)
02910   for (ix = 0; ix < ctl->prof_nx; ix++)
02911     for (iy = 0; iy < ctl->prof_ny; iy++) {
02912       obsmean[ix][iy] = 0;
02913       obsmean2[ix][iy] = 0;
02914       obscount[ix][iy] = 0;
02915       for (iz = 0; iz < ctl->prof_nz; iz++)
02916         mass[ix][iy][iz] = 0;
02917     }
02918
02919   /* Read observation data... */
02920   while (fgets(line, LEN, in)) {
02921
02922     /* Read data... */
02923     if (sscanf(line, "%lg %lg %lg %lg %lg", &rt, &rz, &rlon, &rlat, &robs) !=
02924         5)
02925       continue;
02926
02927     /* Check time... */
02928     if (rt < t0)
02929       continue;
02930     if (rt > t1)
02931       break;
02932
02933     /* Calculate indices... */
02934     ix = (int) ((rlon - ctl->prof_lon0) / dlon);
02935     iy = (int) ((rlat - ctl->prof_lat0) / dlat);
02936
02937     /* Check indices... */
02938     if (ix < 0 || ix >= ctl->prof_nx || iy < 0 || iy >= ctl->prof_ny)
02939       continue;
02940
02941     /* Get mean observation index... */
02942     obsmean[ix][iy] += robs;
02943     obsmean2[ix][iy] += SQR(robs);
02944     obscount[ix][iy]++;
02945   }
02946
02947   /* Analyze model data... */
02948 #pragma omp parallel for default(shared) private(ip,ix,iy,iz)
02949   for (ip = 0; ip < atm->np; ip++) {
02950
02951     /* Check time... */
```

```
02952     if (atm->time[ip] < t0 || atm->time[ip] > t1)
02953       continue;
02954
02955     /* Get indices... */
02956     ix = (int) ((atm->lon[ip] - ctl->prof_lon0) / dlon);
02957     iy = (int) ((atm->lat[ip] - ctl->prof_lat0) / dlat);
02958     iz = (int) ((Z(atm->p[ip]) - ctl->prof_z0) / dz);
02959
02960     /* Check indices... */
02961     if (ix < 0 || ix >= ctl->prof_nx ||
02962         iy < 0 || iy >= ctl->prof_ny || iz < 0 || iz >= ctl->prof_nz)
02963       continue;
02964
02965     /* Get total mass in grid cell... */
02966     mass[ix][iy][iz] += atm->q[ctl->qnt_m][ip];
02967   }
02968
02969   /* Extract profiles... */
02970   for (ix = 0; ix < ctl->prof_nx; ix++)
02971     for (iy = 0; iy < ctl->prof_ny; iy++)
02972       if (obscount[ix][iy] > 0) {
02973
02974         /* Check profile... */
02975         okay = 0;
02976         for (iz = 0; iz < ctl->prof_nz; iz++)
02977           if (mass[ix][iy][iz] > 0) {
02978             okay = 1;
02979             break;
02980           }
02981         if (!okay)
02982           continue;
02983
02984         /* Write output... */
02985         fprintf(out, "\n");
02986
02987         /* Loop over altitudes... */
02988         for (iz = 0; iz < ctl->prof_nz; iz++) {
02989
02990           /* Set coordinates... */
02991           z = ctl->prof_z0 + dz * (iz + 0.5);
02992           lon = ctl->prof_lon0 + dlon * (ix + 0.5);
02993           lat = ctl->prof_lat0 + dlat * (iy + 0.5);
02994
02995           /* Get pressure and temperature... */
02996           press = P(z);
02997           intpol_met_time(met0, met1, t, press, lon, lat, NULL, NULL,
02998                           NULL, &temp, NULL, NULL, NULL, NULL, &h2o, &o3);
02999
03000           /* Calculate surface area... */
03001           area = dlat * dlon * SQR(M_PI * RE / 180.)
03002             * cos(lat * M_PI / 180.);
03003
03004           /* Calculate volume mixing ratio... */
03005           rho_air = 100. * press / (RA * temp);
03006           vmr = MA / ctl->molmass * mass[ix][iy][iz]
03007             / (rho_air * area * dz * 1e9);
03008
03009           /* Write output... */
03010           fprintf(out, "%.2f %g %g %g %g %g %g %g %g %g %g\n",
03011                   t, z, lon, lat, press, temp, vmr, h2o, o3,
03012                   obsmean[ix][iy] / obscount[ix][iy],
03013                   sqrt(obsmean2[ix][iy] / obscount[ix][iy]
03014                        - SQR(obsmean[ix][iy] / obscount[ix][iy])));
03015         }
03016       }
03017
03018   /* Close file... */
03019   if (t == ctl->t_stop)
03020     fclose(out);
03021 }
03022
03023 /*****************************************************************************/
03024
03025 void write_station(
03026   const char *filename,
03027   ctl_t * ctl,
03028   atm_t * atm,
03029   double t) {
03030
03031   static FILE *out;
03032
03033   static double rmax2, t0, t1, x0[3], x1[3];
03034
03035   static int ip, iq;
03036
03037   /* Init... */
03038   if (t == ctl->t_start) {
```

```
03039
03040     /* Write info... */
03041     printf("Write station data: %s\n", filename);
03042
03043     /* Create new file... */
03044     if (!(out = fopen(filename, "w")))
03045       ERRMSG("Cannot create file!");
03046
03047     /* Write header... */
03048     fprintf(out,
03049             "# $1 = time [s]\n"
03050             "# $2 = altitude [km]\n"
03051             "# $3 = longitude [deg]\n" "# $4 = latitude [deg]\n");
03052     for (iq = 0; iq < ctl->nq; iq++)
03053       fprintf(out, "# $%i = %s [%s]\n", (iq + 5),
03054               ctl->qnt_name[iq], ctl->qnt_unit[iq]);
03055     fprintf(out, "\n");
03056
03057     /* Set geolocation and search radius... */
03058     geo2cart(0, ctl->stat_lon, ctl->stat_lat, x0);
03059     rmax2 = SQR(ctl->stat_r);
03060   }
03061
03062   /* Set time interval for output... */
03063   t0 = t - 0.5 * ctl->dt_mod;
03064   t1 = t + 0.5 * ctl->dt_mod;
03065
03066   /* Loop over air parcels... */
03067   for (ip = 0; ip < atm->np; ip++) {
03068
03069     /* Check time... */
03070     if (atm->time[ip] < t0 || atm->time[ip] > t1)
03071       continue;
03072
03073     /* Check station flag... */
03074     if (ctl->qnt_stat >= 0)
03075       if (atm->q[ctl->qnt_stat][ip])
03076         continue;
03077
03078     /* Get Cartesian coordinates... */
03079     geo2cart(0, atm->lon[ip], atm->lat[ip], x1);
03080
03081     /* Check horizontal distance... */
03082     if (DIST2(x0, x1) > rmax2)
03083       continue;
03084
03085     /* Set station flag... */
03086     if (ctl->qnt_stat >= 0)
03087       atm->q[ctl->qnt_stat][ip] = 1;
03088
03089     /* Write data... */
03090     fprintf(out, "%.2f %g %g %g",
03091             atm->time[ip], Z(atm->p[ip]), atm->lon[ip], atm->lat[ip]);
03092     for (iq = 0; iq < ctl->nq; iq++) {
03093       fprintf(out, " ");
03094       fprintf(out, ctl->qnt_format[iq], atm->q[iq][ip]);
03095     }
03096     fprintf(out, "\n");
03097   }
03098
03099   /* Close file... */
03100   if (t == ctl->t_stop)
03101     fclose(out);
03102 }
```

5.21 libtrac.h File Reference

MPTRAC library declarations.

Data Structures

- struct ctl_t

  Control parameters.
- struct atm_t

  Atmospheric data.
- struct met_t

  Meteorological data.

Functions

- void cart2geo (double *x, double *z, double *lon, double *lat)

  Convert Cartesian coordinates to geolocation.
- double clim_hno3 (double t, double lat, double p)

  Climatology of HNO3 volume mixing ratios.
- double clim_tropo (double t, double lat)

  Climatology of tropopause pressure.
- void day2doy (int year, int mon, int day, int *doy)

  Get day of year from date.
- void doy2day (int year, int doy, int *mon, int *day)

  Get date from day of year.
- void geo2cart (double z, double lon, double lat, double *x)

  Convert geolocation to Cartesian coordinates.
- void get_met (ctl_t *ctl, char *metbase, double t, met_t **met0, met_t **met1)

  Get meteorological data for given timestep.
- void get_met_help (double t, int direct, char *metbase, double dt_met, char *filename)

  Get meteorological data for timestep.
- void intpol_met_2d (double array[EX][EY], int ix, int iy, double wx, double wy, double *var)

  Linear interpolation of 2-D meteorological data.
- void intpol_met_3d (float array[EX][EY][EP], int ip, int ix, int iy, double wp, double wx, double wy, double *var)

  Linear interpolation of 3-D meteorological data.
- void intpol_met_space (met_t *met, double p, double lon, double lat, double *ps, double *pt, double *z, double *t, double *u, double *v, double *w, double *pv, double *h2o, double *o3)

  Spatial interpolation of meteorological data.
- void intpol_met_time (met_t *met0, met_t *met1, double ts, double p, double lon, double lat, double *ps, double *pt, double *z, double *t, double *u, double *v, double *w, double *pv, double *h2o, double *o3)

  Temporal interpolation of meteorological data.
- void jsec2time (double jsec, int *year, int *mon, int *day, int *hour, int *min, int *sec, double *remain)

  Convert seconds to date.
- int locate_irr (double *xx, int n, double x)

  Find array index for irregular grid.
- int locate_reg (double *xx, int n, double x)

  Find array index for regular grid.
- void read_atm (const char *filename, ctl_t *ctl, atm_t *atm)

  Read atmospheric data.
- void read_ctl (const char *filename, int argc, char *argv[ ], ctl_t *ctl)

  Read control parameters.
- void read_met (ctl_t *ctl, char *filename, met_t *met)

  Read meteorological data file.
- void read_met_extrapolate (met_t *met)

  Extrapolate meteorological data at lower boundary.
- void read_met_geopot (ctl_t *ctl, met_t *met)

  Calculate geopotential heights.
- void read_met_help (int ncid, char *varname, char *varname2, met_t *met, float dest[EX][EY][EP], float scl)

  Read and convert variable from meteorological data file.
- void read_met_ml2pl (ctl_t *ctl, met_t *met, float var[EX][EY][EP])

  Convert meteorological data from model levels to pressure levels.
- void read_met_periodic (met_t *met)

  Create meteorological data with periodic boundary conditions.
- void read_met_pv (met_t *met)

Calculate potential vorticity.

- void read_met_sample (ctl_t *ctl, met_t *met)

  Downsampling of meteorological data.

- void read_met_tropo (ctl_t *ctl, met_t *met)

  Calculate tropopause pressure.

- double scan_ctl (const char *filename, int argc, char *argv[], const char *varname, int arridx, const char *defvalue, char *value)

  Read a control parameter from file or command line.

- void time2jsec (int year, int mon, int day, int hour, int min, int sec, double remain, double *jsec)

  Convert date to seconds.

- void timer (const char *name, int id, int mode)

  Measure wall-clock time.

- void write_atm (const char *filename, ctl_t *ctl, atm_t *atm, double t)

  Write atmospheric data.

- void write_csi (const char *filename, ctl_t *ctl, atm_t *atm, double t)

  Write CSI data.

- void write_ens (const char *filename, ctl_t *ctl, atm_t *atm, double t)

  Write ensemble data.

- void write_grid (const char *filename, ctl_t *ctl, met_t *met0, met_t *met1, atm_t *atm, double t)

  Write gridded data.

- void write_prof (const char *filename, ctl_t *ctl, met_t *met0, met_t *met1, atm_t *atm, double t)

  Write profile data.

- void write_station (const char *filename, ctl_t *ctl, atm_t *atm, double t)

  Write station data.

5.21.1 Detailed Description

MPTRAC library declarations.

Definition in file libtrac.h.

5.21.2 Function Documentation

5.21.2.1 void cart2geo (double * *x*, double * *z*, double * *lon*, double * *lat*)

Convert Cartesian coordinates to geolocation.

Definition at line 29 of file libtrac.c.

```
00033                {
00034
00035   double radius;
00036
00037   radius = NORM(x);
00038   *lat = asin(x[2] / radius) * 180 / M_PI;
00039   *lon = atan2(x[1], x[0]) * 180 / M_PI;
00040   *z = radius - RE;
00041 }
```

5.21.2.2 double clim_hno3 (double *t*, double *lat*, double *p*)

Climatology of HNO3 volume mixing ratios.

Definition at line 45 of file libtrac.c.

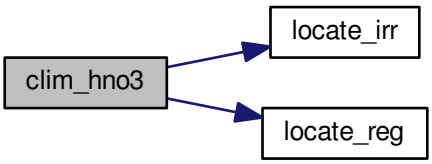
```
00048           {
00049
00050   static double secs[12] = { 1209600.00, 3888000.00, 6393600.00,
00051     9072000.00, 11664000.00, 14342400.00,
00052     16934400.00, 19612800.00, 22291200.00,
00053     24883200.00, 27561600.00, 30153600.00
00054   };
00055
00056   static double lats[18] = { -85, -75, -65, -55, -45, -35, -25, -15, -5,
00057     5, 15, 25, 35, 45, 55, 65, 75, 85
00058   };
00059
00060   static double ps[10] = { 4.64159, 6.81292, 10, 14.678, 21.5443,
00061     31.6228, 46.4159, 68.1292, 100, 146.78
00062   };
00063
00064   static double hno3[12][18][10] = {
00065     {{0.782, 1.65, 2.9, 4.59, 6.71, 8.25, 7.16, 5.75, 2.9, 1.74},
00066      {0.529, 1.64, 2.76, 4.55, 6.58, 8, 6.99, 5.55, 2.68, 1.57},
00067      {0.723, 1.55, 2.73, 4.48, 6.32, 7.58, 7.05, 5.16, 2.49, 1.54},
00068      {0.801, 1.56, 2.74, 4.52, 6.23, 7.35, 6.68, 4.4, 1.97, 1.23},
00069      {0.818, 1.62, 2.77, 4.38, 5.98, 6.84, 5.83, 3.05, 1.15, 0.709},
00070      {0.901, 1.73, 2.78, 4.21, 5.63, 6.16, 4.68, 1.87, 0.617, 0.37},
00071      {0.997, 1.8, 2.79, 4.09, 4.88, 4.96, 3.12, 1.22, 0.311, 0.244},
00072      {1, 1.71, 2.51, 3.4, 3.74, 3.39, 2.25, 0.845, 0.204, 0.222},
00073      {0.997, 1.7, 2.36, 2.88, 3.01, 2.25, 1.77, 0.608, 0.163, 0.181},
00074      {0.991, 1.79, 2.57, 3.06, 3.08, 2.15, 1.81, 0.59, 0.168, 0.104},
00075      {0.974, 1.86, 2.84, 3.8, 3.93, 3.79, 2.91, 1.02, 0.152, 0.0985},
00076      {0.85, 1.86, 3.3, 5.24, 6.55, 6.86, 5.12, 1.93, 0.378, 0.185},
00077      {0.783, 1.89, 3.85, 6.6, 8.56, 8.66, 6.95, 3.95, 1.47, 0.745},
00078      {0.883, 2.05, 4.34, 7.54, 9.68, 9.77, 8.19, 5.72, 3.15, 1.77},
00079      {1.4, 2.44, 4.72, 8.07, 10.5, 10.9, 9.28, 6.95, 4.47, 2.49},
00080      {1.7, 2.43, 4.24, 7.43, 10.4, 11.2, 9.72, 8.15, 5.7, 2.97},
00081      {2.06, 2.27, 3.68, 6.77, 10.3, 10.3, 9.05, 9.1, 6.73, 3.14},
00082      {2.33, 2.39, 3.51, 6.45, 10.3, 9.88, 8.57, 9.42, 7.22, 3.19}},
00083     {{0.947, 2.21, 3.81, 5.69, 7.55, 8.63, 7.53, 5.98, 3.03, 1.64},
00084      {0.642, 2, 3.4, 5.49, 7.5, 8.52, 7.53, 5.83, 2.74, 1.42},
00085      {0.756, 1.83, 3.18, 5.11, 7.24, 8.63, 7.66, 5.5, 2.45, 1.33},
00086      {0.837, 1.75, 3.06, 5, 6.79, 8.08, 7.05, 4.42, 1.81, 1.05},
00087      {0.86, 1.73, 2.96, 4.68, 6.38, 7.38, 6.09, 2.92, 1.06, 0.661},
00088      {0.926, 1.78, 2.89, 4.37, 5.74, 6.14, 4.59, 1.78, 0.561, 0.332},
00089      {0.988, 1.78, 2.75, 3.95, 4.64, 4.49, 2.85, 1.13, 0.271, 0.184},
00090      {0.999, 1.7, 2.44, 3.27, 3.57, 3.03, 2.06, 0.736, 0.181, 0.189},
00091      {0.971, 1.67, 2.23, 2.63, 2.83, 2.15, 1.74, 0.554, 0.157, 0.167},
00092      {0.985, 1.72, 2.34, 2.69, 2.81, 2.11, 1.78, 0.592, 0.152, 0.101},
00093      {0.95, 1.72, 2.57, 3.44, 3.84, 3.89, 2.91, 0.976, 0.135, 0.114},
00094      {0.819, 1.64, 2.93, 4.75, 6.02, 6.93, 5.2, 1.83, 0.347, 0.191},
00095      {0.731, 1.58, 3.3, 5.95, 7.81, 8.32, 6.93, 3.83, 1.47, 0.875},
00096      {0.77, 1.75, 3.74, 6.67, 8.76, 9.41, 8.19, 5.78, 3.32, 2.11},
00097      {1.08, 2.17, 4.24, 7.13, 9.2, 10.3, 9.03, 6.87, 4.65, 3.01},
00098      {1.43, 2.49, 4.31, 7, 9.14, 10.6, 9.34, 7.6, 5.86, 3.64},
00099      {1.5, 2.68, 4.32, 6.75, 8.78, 10.6, 9.05, 7.65, 6.27, 4.07},
00100      {1.73, 2.91, 4.33, 6.67, 8.73, 10.6, 8.5, 7.54, 6.63, 4.17}},
00101     {{1.43, 3.07, 5.22, 7.54, 9.78, 10.4, 10.1, 7.26, 3.61, 1.69},
00102      {0.989, 2.69, 4.76, 7.19, 9.44, 9.94, 9.5, 6.74, 3.24, 1.52},
00103      {0.908, 2.23, 4.11, 6.48, 8.74, 9.41, 8.58, 5.8, 2.66, 1.3},
00104      {0.923, 1.99, 3.61, 5.83, 7.84, 8.6, 7.55, 4.57, 1.87, 0.98},
00105      {0.933, 1.9, 3.31, 5.28, 7.1, 7.84, 6.44, 3.18, 1.1, 0.642},
00106      {0.982, 1.88, 3.1, 4.76, 6.16, 6.57, 5.16, 2.04, 0.598, 0.33},
00107      {1.02, 1.82, 2.88, 4.12, 4.71, 4.54, 3.03, 1.22, 0.268, 0.174},
00108      {0.992, 1.7, 2.51, 3.33, 3.62, 2.87, 2.05, 0.705, 0.161, 0.169},
00109      {0.969, 1.69, 2.2, 2.62, 2.84, 2.13, 1.78, 0.529, 0.146, 0.186},
00110      {0.945, 1.69, 2.27, 2.64, 2.83, 2.2, 1.83, 0.561, 0.139, 0.121},
00111      {0.922, 1.65, 2.48, 3.33, 3.83, 4.09, 2.92, 0.973, 0.117, 0.135},
00112      {0.886, 1.59, 2.66, 4.26, 5.51, 6.57, 5.09, 1.79, 0.342, 0.194},
00113      {0.786, 1.5, 2.78, 5.01, 6.8, 7.83, 6.65, 3.62, 1.45, 1},
00114      {0.745, 1.55, 3.05, 5.49, 7.44, 8.6, 7.8, 5.28, 2.95, 2.12},
00115      {0.938, 1.76, 3.4, 5.82, 7.8, 9.04, 8.43, 6.15, 3.85, 2.82},
00116      {0.999, 2, 3.66, 5.95, 7.94, 9.27, 8.8, 6.93, 4.87, 3.54},
00117      {1.13, 2.23, 3.86, 5.82, 7.65, 9, 8.82, 7.17, 5.72, 4.08},
00118      {1.23, 2.33, 3.94, 5.74, 7.48, 8.9, 8.84, 7.35, 6.3, 4.42}},
00119     {{1.55, 3.2, 6.25, 10, 12.9, 12.9, 11.9, 7.96, 3.96, 1.75},
00120      {1.32, 3.27, 6.32, 9.99, 12.7, 12.4, 11.3, 7.51, 3.66, 1.58},
00121      {1.25, 3.08, 5.77, 8.71, 11.2, 11.2, 9.84, 6.52, 3.23, 1.5},
00122      {1.18, 2.59, 4.76, 7.46, 9.61, 9.66, 8.42, 5.06, 2.25, 1.09},
00123      {1.09, 2.24, 3.99, 6.4, 8.33, 8.54, 7.08, 3.69, 1.36, 0.727},
00124      {1.06, 2.07, 3.52, 5.52, 7.06, 7.26, 5.83, 2.46, 0.732, 0.409},
```

```
00125       {1.07, 1.91, 3.09, 4.63, 5.21, 4.9, 3.68, 1.43, 0.326, 0.198},
00126       {1.03, 1.74, 2.63, 3.54, 3.78, 2.89, 2.09, 0.743, 0.175, 0.12},
00127       {0.959, 1.71, 2.32, 2.77, 2.99, 2.24, 1.76, 0.519, 0.149, 0.172},
00128       {0.931, 1.68, 2.32, 2.74, 2.99, 2.46, 1.88, 0.578, 0.156, 0.157},
00129       {0.933, 1.66, 2.49, 3.42, 3.99, 4.12, 2.93, 1.02, 0.181, 0.138},
00130       {0.952, 1.64, 2.6, 4, 5.15, 6.07, 4.84, 1.78, 0.407, 0.286},
00131       {0.84, 1.54, 2.68, 4.47, 5.97, 7.13, 6.23, 3.25, 1.38, 1.02},
00132       {0.714, 1.44, 2.73, 4.68, 6.28, 7.68, 7.21, 4.82, 2.55, 1.96},
00133       {0.838, 1.57, 2.96, 4.93, 6.55, 8.08, 7.74, 5.77, 3.32, 2.52},
00134       {0.823, 1.65, 3.11, 5.09, 6.89, 8.36, 8.31, 6.59, 4.1, 3.04},
00135       {0.886, 1.83, 3.42, 5.33, 6.92, 8.36, 8.63, 7.21, 4.82, 3.46},
00136       {1.07, 2.12, 3.74, 5.54, 6.98, 8.41, 8.75, 7.41, 5.16, 3.62}},
00137      {{1.13, 2.59, 7.49, 13.5, 15.4, 12.9, 11.3, 8.62, 4.18, 1.63},
00138       {0.973, 2.79, 7.23, 12.8, 15.2, 13.3, 11.6, 8.42, 4.06, 1.57},
00139       {1.46, 3.44, 6.78, 10.4, 12.7, 12.1, 10.5, 7.04, 3.59, 1.63},
00140       {1.52, 3.38, 6.04, 9.08, 11, 10.3, 8.9, 5.7, 2.77, 1.37},
00141       {1.32, 2.65, 4.75, 7.49, 9.32, 8.89, 7.42, 4.27, 1.7, 0.88},
00142       {1.19, 2.2, 3.88, 6.36, 8.03, 7.81, 6.19, 2.94, 0.948, 0.527},
00143       {1.14, 1.96, 3.28, 5.26, 6.12, 5.8, 4.47, 1.66, 0.388, 0.229},
00144       {1.07, 1.82, 2.82, 3.92, 4.03, 3.15, 2.31, 0.871, 0.183, 0.0972},
00145       {0.978, 1.77, 2.53, 3.04, 3.1, 2.36, 1.76, 0.575, 0.16, 0.126},
00146       {0.962, 1.72, 2.49, 3.01, 3.22, 2.72, 2, 0.716, 0.162, 0.183},
00147       {0.968, 1.7, 2.6, 3.57, 4.28, 4.35, 3.09, 1.2, 0.262, 0.18},
00148       {0.977, 1.68, 2.71, 4.03, 5.17, 6.01, 4.81, 1.81, 0.473, 0.343},
00149       {0.819, 1.58, 2.75, 4.37, 5.8, 6.9, 5.96, 2.95, 1.19, 0.964},
00150       {0.672, 1.44, 2.69, 4.42, 5.92, 7.26, 6.79, 4.32, 2.22, 1.83},
00151       {0.783, 1.42, 2.65, 4.45, 6.04, 7.57, 7.39, 5.4, 2.94, 2.25},
00152       {0.757, 1.43, 2.7, 4.54, 6.14, 7.65, 7.51, 5.95, 3.42, 2.39},
00153       {0.758, 1.57, 3.04, 4.88, 6.24, 7.85, 7.58, 6.35, 3.81, 2.52},
00154       {0.835, 1.72, 3.35, 5.24, 6.5, 8.1, 7.67, 6.51, 4, 2.6}},
00155      {{1.5, 2.12, 7.64, 10.5, 5.59, 2.14, 2.2, 3.5, 4.71, 3.26},
00156       {1.32, 2.14, 7.23, 12, 9.3, 5.3, 5.11, 5.37, 5.12, 3.05},
00157       {1.53, 2.92, 6.9, 11.9, 13.5, 11.3, 9.91, 7.18, 4.75, 2.65},
00158       {1.66, 3.48, 6.25, 9.53, 11.3, 10.3, 9.01, 5.76, 2.99, 1.67},
00159       {1.54, 3.03, 5.21, 8.03, 9.66, 8.98, 7.5, 4.64, 2.11, 1.13},
00160       {1.32, 2.39, 4.03, 6.74, 8.52, 8.05, 6.4, 3.48, 1.2, 0.639},
00161       {1.17, 2.08, 3.35, 5.52, 6.86, 6.54, 5.08, 1.97, 0.462, 0.217},
00162       {1.07, 1.92, 3.01, 4.24, 4.47, 3.77, 2.77, 1.07, 0.213, 0.0694},
00163       {0.992, 1.88, 2.76, 3.39, 3.32, 2.52, 1.8, 0.713, 0.192, 0.136},
00164       {0.992, 1.8, 2.63, 3.34, 3.46, 2.95, 2.09, 0.9, 0.242, 0.194},
00165       {0.987, 1.77, 2.67, 3.64, 4.37, 4.36, 3, 1.27, 0.354, 0.229},
00166       {0.979, 1.74, 2.77, 3.99, 5.12, 5.75, 4.53, 1.75, 0.555, 0.302},
00167       {0.832, 1.6, 2.78, 4.32, 5.53, 6.67, 5.69, 2.59, 0.982, 0.66},
00168       {0.696, 1.41, 2.64, 4.31, 5.65, 7.14, 6.56, 3.8, 1.75, 1.41},
00169       {0.788, 1.36, 2.59, 4.3, 5.73, 7.35, 7.04, 4.82, 2.41, 1.8},
00170       {0.761, 1.43, 2.61, 4.28, 5.64, 7.37, 7.11, 5.37, 2.68, 1.9},
00171       {0.701, 1.44, 2.82, 4.64, 5.76, 7.63, 7.07, 5.74, 2.98, 1.88},
00172       {0.763, 1.5, 2.95, 4.97, 6.08, 7.88, 7.12, 5.98, 3.21, 1.91}},
00173      {{3.58, 2.59, 6.49, 5.84, 1.63, 0.282, 0.647, 0.371, 1.36, 2.33},
00174       {3.09, 2.38, 6.37, 7.66, 4.06, 1.23, 1.8, 1.65, 2.32, 2.78},
00175       {2.31, 2.84, 5.58, 9.63, 11, 9.02, 8.2, 6.23, 4.17, 3.08},
00176       {1.61, 3.16, 5.72, 9.13, 11.4, 10.4, 9.15, 6.18, 3.52, 2.3},
00177       {1.32, 2.8, 4.79, 7.44, 9.43, 8.83, 7.41, 4.9, 2.38, 1.38},
00178       {1.14, 2.36, 3.94, 6.41, 8.38, 8.17, 6.53, 3.76, 1.31, 0.656},
00179       {1.05, 2.1, 3.36, 5.45, 7.07, 6.98, 5.44, 2.22, 0.52, 0.176},
00180       {1.02, 2, 3.05, 4.33, 4.74, 4.21, 3.2, 1.26, 0.277, 0.0705},
00181       {1.01, 1.96, 2.9, 3.53, 3.46, 2.69, 1.89, 0.859, 0.254, 0.12},
00182       {1.01, 1.86, 2.7, 3.46, 3.59, 3.03, 2.14, 1, 0.34, 0.199},
00183       {1.02, 1.81, 2.67, 3.68, 4.39, 4.3, 2.93, 1.35, 0.477, 0.25},
00184       {0.991, 1.79, 2.82, 4.05, 5.08, 5.5, 4.21, 1.74, 0.605, 0.259},
00185       {0.844, 1.73, 2.87, 4.38, 5.49, 6.47, 5.5, 2.44, 0.85, 0.422},
00186       {0.729, 1.57, 2.76, 4.43, 5.73, 7.13, 6.43, 3.52, 1.38, 0.913},
00187       {0.819, 1.46, 2.69, 4.45, 5.92, 7.47, 7.05, 4.52, 2, 1.4},
00188       {0.783, 1.47, 2.71, 4.48, 5.92, 7.46, 7.16, 5.08, 2.35, 1.56},
00189       {0.735, 1.51, 2.96, 4.84, 5.92, 7.77, 7.2, 5.54, 2.56, 1.61},
00190       {0.8, 1.61, 3.14, 5.2, 6.26, 8.08, 7.27, 5.72, 2.75, 1.62}},
00191      {{5, 4.43, 5.53, 5.35, 2.33, 0.384, 0.663, 0.164, 0.692, 1.4},
00192       {3.62, 3.79, 4.77, 5.94, 4.12, 1.36, 1.3, 0.973, 1.37, 1.73},
00193       {2.11, 2.7, 4.12, 7.14, 9.03, 7.74, 7.12, 5.44, 3.73, 2.6},
00194       {1.13, 2.32, 4.12, 6.97, 9.86, 9.69, 8.85, 6.22, 3.59, 2.14},
00195       {0.957, 2.28, 4.11, 6.47, 8.66, 8.78, 7.33, 4.94, 2.44, 1.38},
00196       {0.881, 2.1, 3.65, 5.94, 7.98, 8.29, 6.69, 3.95, 1.36, 0.672},
00197       {0.867, 1.96, 3.26, 5.23, 6.94, 7.2, 5.63, 2.41, 0.578, 0.19},
00198       {0.953, 1.94, 2.98, 4.23, 4.83, 4.52, 3.38, 1.34, 0.293, 0.181},
00199       {1.01, 1.91, 2.77, 3.35, 3.3, 2.62, 1.99, 0.905, 0.245, 0.107},
00200       {1.03, 1.81, 2.57, 3.29, 3.43, 2.87, 2.13, 0.988, 0.306, 0.185},
00201       {1.02, 1.78, 2.58, 3.59, 4.19, 4, 2.72, 1.29, 0.389, 0.224},
00202       {1.01, 1.84, 2.84, 4.06, 4.9, 5.08, 3.71, 1.64, 0.529, 0.232},
00203       {0.902, 1.84, 2.98, 4.43, 5.5, 6.28, 5.18, 2.35, 0.734, 0.341},
00204       {0.785, 1.68, 2.93, 4.67, 5.95, 7.3, 6.52, 3.48, 1.24, 0.754},
00205       {0.847, 1.62, 2.94, 4.86, 6.38, 7.99, 7.5, 4.64, 1.93, 1.23},
00206       {0.8, 1.6, 2.94, 4.95, 6.62, 8.16, 7.91, 5.43, 2.43, 1.45},
00207       {0.82, 1.76, 3.37, 5.47, 6.82, 8.24, 7.73, 5.79, 2.69, 1.5},
00208       {0.988, 2.05, 3.87, 6.01, 7.18, 8.41, 7.7, 5.93, 2.89, 1.55}},
00209      {{1.52, 2.7, 3.79, 4.95, 3.8, 1.51, 1.11, 0.784, 1.1, 1.56},
00210       {1.19, 2.16, 3.34, 4.76, 4.61, 2.93, 2.07, 1.65, 1.63, 1.74},
00211       {0.804, 1.65, 2.79, 4.63, 6.64, 6.95, 6.68, 5.11, 3.3, 2.09},
```

```
00212     {0.86, 1.8, 3.25, 5.3, 7.91, 8.76, 8.28, 6.01, 3.39, 1.83},
00213     {0.859, 1.95, 3.54, 5.64, 7.88, 8.55, 7.3, 4.88, 2.3, 1.22},
00214     {0.809, 1.88, 3.38, 5.45, 7.47, 8.02, 6.69, 3.98, 1.35, 0.646},
00215     {0.822, 1.81, 3.11, 4.9, 6.62, 6.96, 5.63, 2.47, 0.614, 0.169},
00216     {0.92, 1.83, 2.8, 3.93, 4.56, 4.4, 3.25, 1.31, 0.295, 0.0587},
00217     {0.986, 1.83, 2.6, 3.13, 3.08, 2.53, 1.94, 0.886, 0.244, 0.0815},
00218     {0.997, 1.74, 2.5, 3.16, 3.24, 2.67, 2.05, 0.939, 0.281, 0.147},
00219     {1.01, 1.75, 2.57, 3.55, 4.1, 3.81, 2.53, 1.21, 0.354, 0.197},
00220     {1.04, 1.88, 2.9, 4.16, 4.95, 4.96, 3.48, 1.63, 0.502, 0.163},
00221     {0.967, 1.95, 3.17, 4.72, 5.85, 6.5, 5.34, 2.53, 0.748, 0.303},
00222     {0.846, 1.83, 3.23, 5.15, 6.62, 7.82, 6.85, 3.79, 1.36, 0.714},
00223     {0.91, 1.81, 3.35, 5.55, 7.32, 8.55, 7.88, 5.03, 2.13, 1.1},
00224     {0.87, 1.94, 3.6, 5.97, 7.98, 9.14, 8.71, 6.04, 2.73, 1.41},
00225     {1.04, 2.36, 4.22, 6.57, 8.5, 9.53, 9.22, 6.71, 3.2, 1.56},
00226     {1.36, 2.84, 4.72, 6.94, 8.81, 9.87, 9.59, 7.1, 3.43, 1.65}},
00227    {{0.704, 1.4, 2.03, 3.08, 4.64, 4.24, 2.55, 1.57, 1.99, 1.91},
00228     {0.484, 1.38, 2.08, 3.54, 5.11, 4.98, 3.73, 2.57, 2.29, 1.84},
00229     {0.749, 1.57, 2.63, 4.17, 6.15, 6.97, 6.64, 5.11, 3.35, 1.97},
00230     {0.864, 1.69, 3.16, 4.87, 7.13, 8.33, 7.87, 5.9, 3.17, 1.56},
00231     {0.861, 1.79, 3.28, 5.2, 7.29, 8.32, 7.38, 4.9, 2.23, 1.11},
00232     {0.835, 1.79, 3.19, 4.99, 6.72, 7.58, 6.45, 3.68, 1.25, 0.616},
00233     {0.847, 1.8, 3.07, 4.66, 6.12, 6.6, 5.21, 2.18, 0.554, 0.21},
00234     {0.941, 1.78, 2.68, 3.68, 4.28, 4.18, 2.97, 1.15, 0.238, 0.0968},
00235     {0.98, 1.78, 2.48, 2.99, 2.96, 2.35, 1.88, 0.747, 0.207, 0.105},
00236     {0.978, 1.74, 2.51, 3.07, 3.12, 2.36, 1.95, 0.777, 0.216, 0.146},
00237     {1.01, 1.79, 2.63, 3.53, 3.95, 3.47, 2.38, 1.08, 0.265, 0.178},
00238     {1.06, 1.94, 3.02, 4.43, 5.19, 5.01, 3.68, 1.71, 0.429, 0.14},
00239     {0.99, 2.02, 3.38, 5.22, 6.56, 6.91, 5.56, 2.75, 0.816, 0.353},
00240     {0.923, 2.05, 3.66, 5.98, 7.78, 8.5, 7.23, 4.26, 1.67, 0.802},
00241     {1.08, 2.27, 4.17, 6.8, 8.89, 9.55, 8.59, 5.64, 2.58, 1.2},
00242     {1.12, 2.5, 4.52, 7.22, 9.76, 10.3, 9.72, 6.79, 3.32, 1.52},
00243     {1.2, 2.64, 4.81, 7.64, 10.5, 11.4, 10.6, 7.65, 3.87, 1.73},
00244     {1.4, 2.91, 5.01, 7.75, 10.7, 11.6, 11.1, 8.02, 4.04, 1.8}},
00245    {{0.75, 1.49, 2.39, 3.39, 4.93, 5.94, 5.03, 2.75, 2.27, 1.78},
00246     {0.508, 1.52, 2.38, 3.82, 5.34, 6.13, 5.6, 3.31, 2.42, 1.73},
00247     {0.715, 1.56, 2.7, 4.39, 6.18, 6.96, 7.1, 5.04, 3.01, 1.75},
00248     {0.813, 1.62, 2.94, 4.65, 6.53, 7.65, 7.52, 5.49, 2.75, 1.41},
00249     {0.802, 1.68, 2.97, 4.64, 6.37, 7.53, 7.01, 4.56, 1.9, 0.955},
00250     {0.816, 1.75, 3.01, 4.59, 6.15, 7.06, 6.15, 3.38, 1.11, 0.61},
00251     {0.867, 1.78, 2.92, 4.35, 5.69, 6.05, 4.73, 1.91, 0.519, 0.269},
00252     {0.932, 1.7, 2.55, 3.44, 4.03, 3.98, 2.74, 1.08, 0.247, 0.132},
00253     {0.937, 1.74, 2.51, 3.09, 3.11, 2.34, 1.84, 0.67, 0.189, 0.121},
00254     {0.942, 1.75, 2.63, 3.3, 3.27, 2.21, 1.87, 0.663, 0.171, 0.147},
00255     {0.959, 1.8, 2.82, 3.78, 4.03, 3.37, 2.53, 1.04, 0.199, 0.146},
00256     {1.01, 1.9, 3.13, 4.76, 5.63, 5.6, 4.31, 1.83, 0.367, 0.172},
00257     {0.989, 2.04, 3.64, 6, 7.62, 7.6, 6, 3.35, 1.05, 0.448},
00258     {1.02, 2.28, 4.32, 7.19, 9.21, 9.16, 7.64, 4.97, 2.2, 0.948},
00259     {1.26, 2.77, 5.2, 8.31, 10.5, 10.4, 9.01, 6.37, 3.46, 1.56},
00260     {1.31, 2.76, 5.23, 8.49, 11.2, 11.3, 10.1, 7.27, 3.98, 1.76},
00261     {1.26, 2.5, 5.14, 8.85, 12.3, 12.3, 11.2, 8.13, 4.45, 1.97},
00262     {1.35, 2.49, 5.26, 9.16, 13, 12.8, 11.8, 8.57, 4.72, 2.05}},
00263    {{0.759, 1.54, 2.54, 4.22, 6.26, 7.44, 7.14, 4.99, 2.84, 1.89},
00264     {0.508, 1.55, 2.5, 4.29, 6.29, 7.29, 7.07, 5.03, 2.77, 1.74},
00265     {0.699, 1.56, 2.62, 4.17, 6.08, 7.38, 7.04, 5.17, 2.81, 1.65},
00266     {0.778, 1.5, 2.65, 4.35, 6.07, 7.28, 6.84, 4.8, 2.28, 1.28},
00267     {0.772, 1.55, 2.71, 4.3, 5.76, 6.91, 6.2, 3.69, 1.45, 0.837},
00268     {0.836, 1.67, 2.78, 4.21, 5.56, 6.41, 5.33, 2.47, 0.807, 0.488},
00269     {0.937, 1.79, 2.78, 4.12, 5.17, 5.38, 3.89, 1.47, 0.392, 0.256},
00270     {0.97, 1.75, 2.52, 3.39, 3.83, 3.63, 2.48, 0.968, 0.212, 0.198},
00271     {0.968, 1.74, 2.5, 3.11, 3.2, 2.34, 1.79, 0.629, 0.169, 0.173},
00272     {0.98, 1.8, 2.69, 3.42, 3.4, 2.18, 1.81, 0.606, 0.164, 0.138},
00273     {0.975, 1.84, 2.96, 4.08, 4.12, 3.5, 2.79, 1.02, 0.145, 0.133},
00274     {0.96, 1.94, 3.27, 5.17, 6.26, 6.35, 4.88, 1.91, 0.329, 0.189},
00275     {0.954, 2.06, 3.8, 6.53, 8.46, 8.32, 6.53, 3.83, 1.32, 0.6},
00276     {1, 2.34, 4.58, 7.71, 9.68, 9.75, 7.96, 5.45, 2.84, 1.39},
00277     {1.24, 2.65, 5.14, 8.51, 10.7, 10.6, 8.96, 6.51, 3.83, 1.85},
00278     {1.34, 2.44, 4.99, 8.63, 11.6, 11.4, 10.1, 7.84, 4.77, 2.24},
00279     {1.33, 2.1, 4.76, 8.78, 12.2, 11.7, 10.8, 8.68, 5.15, 2.35},
00280     {1.42, 2.04, 4.68, 8.92, 12.7, 12, 11.2, 8.99, 5.32, 2.33}}
00281   };
00282
00283   double aux00, aux01, aux10, aux11, sec;
00284
00285   int ilat, ip, isec;
00286
00287   /* Get seconds since begin of year... */
00288   sec = fmod(t, 365.25 * 86400.);
00289
00290   /* Get indices... */
00291   isec = locate_irr(secs, 12, sec);
00292   ilat = locate_reg(lats, 18, lat);
00293   ip = locate_irr(ps, 10, p);
00294
00295   /* Interpolate... */
00296   aux00 = LIN(ps[ip], hno3[isec][ilat][ip],
00297               ps[ip + 1], hno3[isec][ilat][ip + 1], p);
00298   aux01 = LIN(ps[ip], hno3[isec][ilat + 1][ip],
```

```
00299                ps[ip + 1], hno3[isec][ilat + 1][ip + 1], p);
00300    aux10 = LIN(ps[ip], hno3[isec + 1][ilat][ip],
00301                ps[ip + 1], hno3[isec + 1][ilat][ip + 1], p);
00302    aux11 = LIN(ps[ip], hno3[isec + 1][ilat + 1][ip],
00303                ps[ip + 1], hno3[isec + 1][ilat + 1][ip + 1], p);
00304    aux00 = LIN(lats[ilat], aux00, lats[ilat + 1], aux01, lat);
00305    aux11 = LIN(lats[ilat], aux10, lats[ilat + 1], aux11, lat);
00306    return LIN(secs[isec], aux00, secs[isec + 1], aux11, sec);
00307  }
```

Here is the call graph for this function:



5.21.2.3 double clim_tropo (double *t*, double *lat*)

Climatology of tropopause pressure.

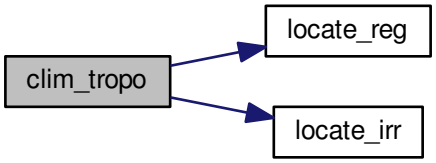
Definition at line 311 of file libtrac.c.

```
00313                {
00314
00315    static double doys[12]
00316    = { 1, 32, 60, 91, 121, 152, 182, 213, 244, 274, 305, 335 };
00317
00318    static double lats[73]
00319      = { -90, -87.5, -85, -82.5, -80, -77.5, -75, -72.5, -70, -67.5,
00320      -65, -62.5, -60, -57.5, -55, -52.5, -50, -47.5, -45, -42.5,
00321      -40, -37.5, -35, -32.5, -30, -27.5, -25, -22.5, -20, -17.5,
00322      -15, -12.5, -10, -7.5, -5, -2.5, 0, 2.5, 5, 7.5, 10, 12.5,
00323      15, 17.5, 20, 22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5,
00324      45, 47.5, 50, 52.5, 55, 57.5, 60, 62.5, 65, 67.5, 70, 72.5,
00325      75, 77.5, 80, 82.5, 85, 87.5, 90
00326    };
00327
00328    static double tps[12][73]
00329      = { {324.1, 325.6, 325, 324.3, 322.5, 319.7, 314, 307.2, 301.8, 299.6,
00330           297.1, 292.2, 285.6, 276.1, 264, 248.9, 231.9, 213.5, 194.4,
00331           175.3, 157, 140.4, 126.7, 116.3, 109.5, 105.4, 103, 101.4, 100.4,
00332           99.69, 99.19, 98.84, 98.56, 98.39, 98.39, 98.42, 98.44, 98.54,
00333           98.68, 98.81, 98.89, 98.96, 99.12, 99.65, 101.4, 105.4, 113.5, 128,
00334           152.1, 184.7, 214, 234.1, 247.3, 255.8, 262.6, 267.7, 271.7, 275,
00335           277.2, 279, 280.1, 280.4, 280.6, 280.1, 279.3, 278.3, 276.8, 275.8,
00336           275.3, 275.6, 275.4, 274.1, 273.5},
00337    {337.3, 338.7, 337.8, 336.4, 333, 328.8, 321.1, 312.6, 306.6, 303.7,
00338     300.2, 293.8, 285.4, 273.8, 259.6, 242.7, 224.4, 205.2, 186, 167.5,
00339     150.3, 135, 122.8, 113.9, 108.2, 104.7, 102.5, 101.1, 100.2, 99.42,
00340     98.88, 98.52, 98.25, 98.09, 98.07, 98.1, 98.12, 98.2, 98.25, 98.27,
00341     98.26, 98.27, 98.36, 98.79, 100.2, 104.2, 113.7, 131.2, 159.5, 193,
00342     220.4, 238.1, 250.2, 258.1, 264.7, 269.7, 273.7, 277.3, 280.2, 282.8,
00343     284.9, 286.5, 288.1, 288.8, 289, 288.5, 287.2, 286.3, 286.1, 287.2,
00344     287.5, 286.2, 285.8},
00345    {335, 336, 335.7, 335.1, 332.3, 328.1, 320.6, 311.8, 305.1, 301.9,
00346     297.6, 290, 280.4, 268.3, 254.6, 239.6, 223.9, 207.9, 192.2, 176.9,
00347     161.7, 146.4, 132.2, 120.6, 112.3, 107.2, 104.3, 102.4, 101.3,
00348     100.4, 99.86, 99.47, 99.16, 98.97, 98.94, 98.97, 99, 99.09, 99.2,
00349     99.31, 99.35, 99.41, 99.51, 99.86, 101.1, 104.9, 114.3, 131, 156.8,
00350     186.3, 209.3, 224.6, 236.8, 246.3, 254.9, 262.3, 268.8, 274.8,
00351     279.9, 284.6, 288.6, 291.6, 294.9, 297.5, 299.8, 301.8, 303.1,
00352     304.3, 304.9, 306, 306.6, 306.2, 306},
```

```
00353   {306.2, 306.7, 305.7, 307.1, 307.3, 306.4, 301.8, 296.2, 292.4,
00354    290.3, 287.1, 280.9, 273.4, 264.3, 254.1, 242.8, 231, 219, 207.2,
00355    195.5, 183.3, 169.7, 154.7, 138.7, 124.1, 113.6, 107.8, 104.7,
00356    102.8, 101.7, 100.9, 100.4, 100, 99.79, 99.7, 99.66, 99.68, 99.79,
00357    99.94, 100.2, 100.5, 100.9, 101.4, 102.1, 103.4, 107, 115.2, 129.1,
00358    148.7, 171, 190.8, 205.6, 218.4, 229.4, 239.6, 248.6, 256.5,
00359    263.7, 270.3, 276.6, 282.6, 288.1, 294.5, 300.4, 306.3, 311.4,
00360    315.1, 318.3, 320.3, 322.2, 322.8, 321.5, 321.1},
00361   {266.5, 264.9, 260.8, 261, 262, 263, 261.3, 259.7, 259.2, 259.8,
00362    260.1, 258.6, 256.7, 253.6, 249.5, 243.9, 237.4, 230, 222.1, 213.9,
00363    205, 194.4, 180.4, 161.8, 140.7, 122.9, 112.1, 106.7, 104.1, 102.7,
00364    101.8, 101.4, 101.1, 101, 101, 101, 101.1, 101.2, 101.5, 101.9,
00365    102.4, 103, 103.8, 104.9, 106.8, 110.1, 115.6, 124, 135.2, 148.9,
00366    165.2, 181.3, 198, 211.8, 223.5, 233.8, 242.9, 251.5, 259, 266.2,
00367    273.1, 279.2, 286.2, 292.8, 299.6, 306, 311.1, 315.5, 318.8, 322.6,
00368    325.3, 325.8, 325.8},
00369   {220.1, 218.1, 210.8, 207.2, 207.6, 210.5, 211.4, 213.5, 217.3,
00370    222.4, 227.9, 232.8, 237.4, 240.8, 242.8, 243, 241.5, 238.6, 234.2,
00371    228.5, 221, 210.7, 195.1, 172.9, 147.8, 127.6, 115.6, 109.9, 107.1,
00372    105.7, 105, 104.8, 104.8, 104.9, 105, 105.1, 105.3, 105.5, 105.8,
00373    106.4, 107, 107.6, 108.1, 108.8, 110, 111.8, 114.2, 117.4, 121.6,
00374    127.9, 137.3, 151.2, 169.5, 189, 205.8, 218.9, 229.1, 237.8, 245,
00375    251.5, 257.1, 262.3, 268.2, 274, 280.4, 286.7, 292.4, 297.9, 302.9,
00376    308.5, 312.2, 313.1, 313.3},
00377   {187.4, 184.5, 173.3, 166.1, 165.4, 167.8, 169.6, 173.6, 179.6,
00378    187.9, 198.9, 210, 220.5, 229.2, 235.7, 239.9, 241.8, 241.6, 239.6,
00379    235.8, 229.4, 218.6, 200.9, 175.9, 149.4, 129.4, 118.3, 113.1,
00380    110.8, 109.7, 109.3, 109.4, 109.7, 110, 110.2, 110.4, 110.5, 110.7,
00381    111, 111.4, 111.8, 112.1, 112.3, 112.7, 113.2, 113.9, 115, 116.4,
00382    117.9, 120.4, 124.1, 130.9, 142.2, 159.6, 179.6, 198.5, 212.9,
00383    224.2, 232.7, 239.1, 243.8, 247.7, 252.4, 257.3, 263.2, 269.5,
00384    275.4, 281.1, 286.3, 292, 296.3, 298.2, 298.8},
00385   {166, 166.4, 155.7, 148.3, 147.1, 149, 152.1, 157, 163.6, 172.4,
00386    185.3, 199.2, 212.6, 224, 233.2, 239.6, 243.3, 244.6, 243.6, 240.3,
00387    233.9, 222.6, 203.7, 177, 149.5, 129.7, 119, 114, 111.7, 110.7,
00388    110.3, 110.3, 110.6, 110.9, 111.1, 111.3, 111.5, 111.6, 111.9,
00389    112.2, 112.5, 112.6, 112.8, 113, 113.4, 114, 115.1, 116.5, 118.3,
00390    120.9, 124.4, 130.2, 139.4, 154.6, 173.8, 193.1, 208.1, 220.4,
00391    230.1, 238.2, 244.7, 249.5, 254.5, 259.3, 264.5, 269.4, 273.7,
00392    278.2, 282.6, 287.4, 290.9, 292.5, 293},
00393   {171.9, 172.8, 166.2, 162.3, 161.4, 162.5, 165.2, 169.6, 175.3,
00394    183.1, 193.8, 205.9, 218.3, 229.6, 238.5, 244.3, 246.9, 246.7,
00395    243.8, 238.4, 230.2, 217.9, 199.6, 174.9, 148.9, 129.8, 119.5,
00396    114.8, 112.3, 110.9, 110.3, 110.1, 110.2, 110.3, 110.4, 110.5,
00397    110.6, 110.8, 111, 111.4, 111.8, 112, 112.2, 112.4, 112.9, 113.6,
00398    114.7, 116.3, 118.4, 121.9, 127.1, 136.1, 149.8, 168.4, 186.9,
00399    203.3, 217, 229.1, 238.7, 247, 254, 259.3, 264.3, 268.3, 272.5,
00400    276.6, 280.4, 284.4, 288.4, 293.3, 297.2, 298.7, 299.1},
00401   {191.6, 192.2, 189, 188.1, 190.2, 193.7, 197.8, 202.9, 208.5,
00402    215.6, 224.2, 233.1, 241.2, 247.3, 250.8, 251.3, 248.9, 244.2,
00403    237.3, 228.4, 217.2, 202.9, 184.5, 162.5, 140.7, 124.8, 116.2,
00404    111.8, 109.4, 107.9, 107, 106.7, 106.6, 106.6, 106.7, 106.7,
00405    106.8, 107, 107.4, 108, 108.7, 109.3, 109.8, 110.4, 111.2,
00406    112.4, 114.2, 116.9, 121.1, 127.9, 139.3, 155.2, 173.6, 190.7,
00407    206.1, 220.1, 232.3, 243, 251.8, 259.2, 265.7, 270.6, 275.3,
00408    279.3, 283.3, 286.9, 289.7, 292.8, 296.1, 300.5, 303.9, 304.8,
00409    305.1},
00410   {241.5, 239.6, 236.8, 237.4, 239.4, 242.3, 244.2, 246.4, 249.2,
00411    253.6, 258.6, 262.7, 264.8, 264.2, 260.6, 254.1, 245.5, 235.3,
00412    223.9, 211.7, 198.3, 183.1, 165.6, 147.1, 130.5, 118.7, 111.9,
00413    108.1, 105.8, 104.3, 103.4, 102.8, 102.5, 102.4, 102.5, 102.5,
00414    102.5, 102.7, 103.1, 103.8, 104.6, 105.4, 106.1, 107, 108.2,
00415    109.9, 112.8, 117.5, 126, 140.4, 161, 181.9, 201.2, 216.8, 230.4,
00416    241.8, 251.4, 259.9, 266.9, 272.8, 277.4, 280.4, 282.9, 284.6,
00417    286.1, 287.4, 288.3, 289.5, 290.9, 294.2, 296.9, 297.5, 297.6},
00418   {301.2, 300.3, 296.6, 295.4, 295, 294.3, 291.2, 287.4, 284.9, 284.7,
00419    284.1, 281.5, 277.1, 270.4, 261.7, 250.6, 237.6, 223.1, 207.9, 192,
00420    175.8, 158.8, 142.1, 127.6, 116.8, 109.9, 106, 103.6, 102.1, 101.1,
00421    100.4, 99.96, 99.6, 99.37, 99.32, 99.32, 99.31, 99.46, 99.77, 100.2,
00422    100.7, 101.3, 101.8, 102.7, 104.1, 106.8, 111.9, 121, 136.7, 160,
00423    186.9, 209.9, 228.1, 241.2, 251.5, 259.5, 265.7, 270.9, 274.8, 278,
00424    280.3, 281.8, 283, 283.3, 283.7, 283.8, 283, 282.2, 281.2, 281.4,
00425    281.7, 281.1, 281.2}
00426   };
00427
00428   double doy, p0, p1;
00429
00430   int imon, ilat;
00431
00432   /* Get day of year... */
00433   doy = fmod(t / 86400., 365.25);
00434   while (doy < 0)
00435     doy += 365.25;
00436
00437   /* Get indices... */
00438   ilat = locate_reg(lats, 73, lat);
00439   imon = locate_irr(doys, 12, doy);
```

```
00440
00441   /* Interpolate... */
00442   p0 = LIN(lats[ilat], tps[imon][ilat],
00443            lats[ilat + 1], tps[imon][ilat + 1], lat);
00444   p1 = LIN(lats[ilat], tps[imon + 1][ilat],
00445            lats[ilat + 1], tps[imon + 1][ilat + 1], lat);
00446   return LIN(doys[imon], p0, doys[imon + 1], p1, doy);
00447 }
```

Here is the call graph for this function:



5.21.2.4 void day2doy (int *year*, int *mon*, int *day*, int * *doy*)

Get day of year from date.

Definition at line 451 of file libtrac.c.

```
00455             {
00456
00457   int d0[12] = { 1, 32, 60, 91, 121, 152, 182, 213, 244, 274, 305, 335 };
00458   int d01[12] = { 1, 32, 61, 92, 122, 153, 183, 214, 245, 275, 306, 336 };
00459
00460   /* Get day of year... */
00461   if (year % 400 == 0 || (year % 100 != 0 && year % 4 == 0))
00462     *doy = d01[mon - 1] + day - 1;
00463   else
00464     *doy = d0[mon - 1] + day - 1;
00465 }
```

5.21.2.5 void doy2day (int *year*, int *doy*, int * *mon*, int * *day*)

Get date from day of year.

Definition at line 469 of file libtrac.c.

```
00473             {
00474
00475   int d0[12] = { 1, 32, 60, 91, 121, 152, 182, 213, 244, 274, 305, 335 };
00476   int d01[12] = { 1, 32, 61, 92, 122, 153, 183, 214, 245, 275, 306, 336 };
00477   int i;
00478
00479   /* Get month and day... */
00480   if (year % 400 == 0 || (year % 100 != 0 && year % 4 == 0)) {
00481     for (i = 11; i >= 0; i--)
00482       if (d01[i] <= doy)
00483         break;
00484     *mon = i + 1;
00485     *day = doy - d01[i] + 1;
00486   } else {
00487     for (i = 11; i >= 0; i--)
00488       if (d0[i] <= doy)
00489         break;
00490     *mon = i + 1;
00491     *day = doy - d0[i] + 1;
00492   }
00493 }
```

5.21.2.6 void geo2cart (double *z*, double *lon*, double *lat*, double * *x*)

Convert geolocation to Cartesian coordinates.

Definition at line 497 of file libtrac.c.

```
00501             {
00502
00503   double radius;
00504
00505   radius = z + RE;
00506   x[0] = radius * cos(lat / 180 * M_PI) * cos(lon / 180 * M_PI);
00507   x[1] = radius * cos(lat / 180 * M_PI) * sin(lon / 180 * M_PI);
00508   x[2] = radius * sin(lat / 180 * M_PI);
00509 }
```

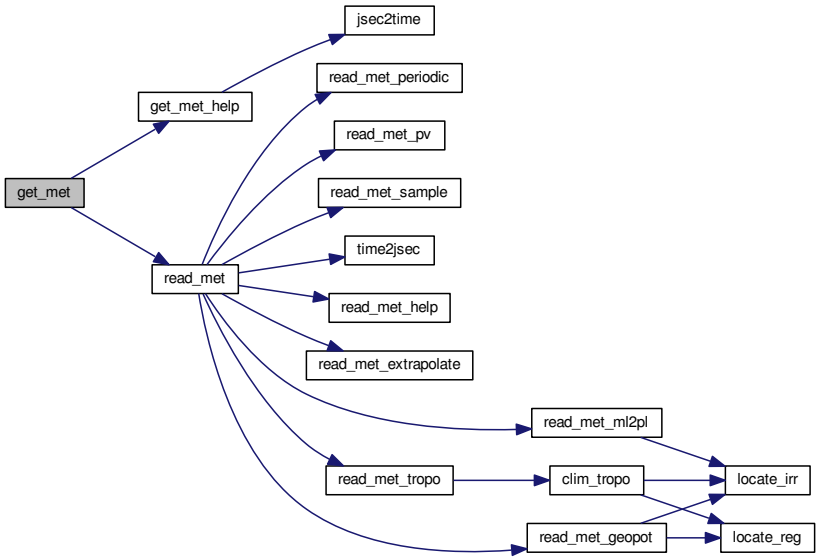
5.21.2.7 void get_met (ctl_t * *ctl*, char * *metbase*, double *t*, met_t ** *met0*, met_t ** *met1*)

Get meteorological data for given timestep.

Definition at line 513 of file libtrac.c.

```
00518                 {
00519
00520   static int init, ip, ix, iy;
00521
00522   met_t *mets;
00523
00524   char filename[LEN];
00525
00526   /* Init... */
00527   if (t == ctl->t_start || !init) {
00528     init = 1;
00529
00530     get_met_help(t, -1, metbase, ctl->dt_met, filename);
00531     read_met(ctl, filename, *met0);
00532
00533     get_met_help(t + 1.0 * ctl->direction, 1, metbase, ctl->
      dt_met, filename);
00534     read_met(ctl, filename, *met1);
00535   }
00536
00537   /* Read new data for forward trajectories... */
00538   if (t > (*met1)->time && ctl->direction == 1) {
00539     mets = *met1;
00540     *met1 = *met0;
00541     *met0 = mets;
00542     get_met_help(t, 1, metbase, ctl->dt_met, filename);
00543     read_met(ctl, filename, *met1);
00544   }
00545
00546   /* Read new data for backward trajectories... */
00547   if (t < (*met0)->time && ctl->direction == -1) {
00548     mets = *met1;
00549     *met1 = *met0;
00550     *met0 = mets;
00551     get_met_help(t, -1, metbase, ctl->dt_met, filename);
00552     read_met(ctl, filename, *met0);
00553   }
00554
00555   /* Check that grids are consistent... */
00556   if ((*met0)->nx != (*met1)->nx
00557       || (*met0)->ny != (*met1)->ny || (*met0)->np != (*met1)->np)
00558     ERRMSG("Meteo grid dimensions do not match!");
00559   for (ix = 0; ix < (*met0)->nx; ix++)
00560     if ((*met0)->lon[ix] != (*met1)->lon[ix])
00561       ERRMSG("Meteo grid longitudes do not match!");
00562   for (iy = 0; iy < (*met0)->ny; iy++)
00563     if ((*met0)->lat[iy] != (*met1)->lat[iy])
00564       ERRMSG("Meteo grid latitudes do not match!");
00565   for (ip = 0; ip < (*met0)->np; ip++)
00566     if ((*met0)->p[ip] != (*met1)->p[ip])
00567       ERRMSG("Meteo grid pressure levels do not match!");
00568 }
```

Here is the call graph for this function:



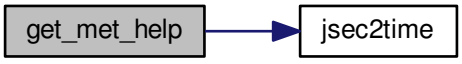
5.21.2.8 void get_met_help (double *t*, int *direct*, char * *metbase*, double *dt_met*, char * *filename*)

Get meteorological data for timestep.

Definition at line 572 of file libtrac.c.

```
00577                   {
00578
00579   double t6, r;
00580
00581   int year, mon, day, hour, min, sec;
00582
00583   /* Round time to fixed intervals... */
00584   if (direct == -1)
00585     t6 = floor(t / dt_met) * dt_met;
00586   else
00587     t6 = ceil(t / dt_met) * dt_met;
00588
00589   /* Decode time... */
00590   jsec2time(t6, &year, &mon, &day, &hour, &min, &sec, &r);
00591
00592   /* Set filename... */
00593   sprintf(filename, "%s_%d_%02d_%02d_%02d.nc", metbase, year, mon, day, hour);
00594 }
```

Here is the call graph for this function:



5.21.2.9 void intpol_met_2d (double *array[EX][EY]*, int *ix*, int *iy*, double *wx*, double *wy*, double * *var*)

Linear interpolation of 2-D meteorological data.

Definition at line 598 of file libtrac.c.

```
00604                {
00605
00606   double aux00, aux01, aux10, aux11;
00607
00608   /* Set variables... */
00609   aux00 = array[ix][iy];
00610   aux01 = array[ix][iy + 1];
00611   aux10 = array[ix + 1][iy];
00612   aux11 = array[ix + 1][iy + 1];
00613
00614   /* Interpolate horizontally... */
00615   aux00 = wy * (aux00 - aux01) + aux01;
00616   aux11 = wy * (aux10 - aux11) + aux11;
00617   *var = wx * (aux00 - aux11) + aux11;
00618 }
```

5.21.2.10 void intpol_met_3d (float *array[EX][EY][EP]*, int *ip*, int *ix*, int *iy*, double *wp*, double *wx*, double *wy*, double * *var*)

Linear interpolation of 3-D meteorological data.

Definition at line 622 of file libtrac.c.

```
00630                {
00631
00632   double aux00, aux01, aux10, aux11;
00633
00634   /* Interpolate vertically... */
00635   aux00 = wp * (array[ix][iy][ip] - array[ix][iy][ip + 1])
00636     + array[ix][iy][ip + 1];
00637   aux01 = wp * (array[ix][iy + 1][ip] - array[ix][iy + 1][ip + 1])
00638     + array[ix][iy + 1][ip + 1];
00639   aux10 = wp * (array[ix + 1][iy][ip] - array[ix + 1][iy][ip + 1])
00640     + array[ix + 1][iy][ip + 1];
00641   aux11 = wp * (array[ix + 1][iy + 1][ip] - array[ix + 1][iy + 1][ip + 1])
00642     + array[ix + 1][iy + 1][ip + 1];
00643
00644   /* Interpolate horizontally... */
00645   aux00 = wy * (aux00 - aux01) + aux01;
00646   aux11 = wy * (aux10 - aux11) + aux11;
00647   *var = wx * (aux00 - aux11) + aux11;
00648 }
```

5.21.2.11 void intpol_met_space (met_t * *met*, double *p*, double *lon*, double *lat*, double * *ps*, double * *pt*, double * *z*, double * *t*, double * *u*, double * *v*, double * *w*, double * *pv*, double * *h2o*, double * *o3*)

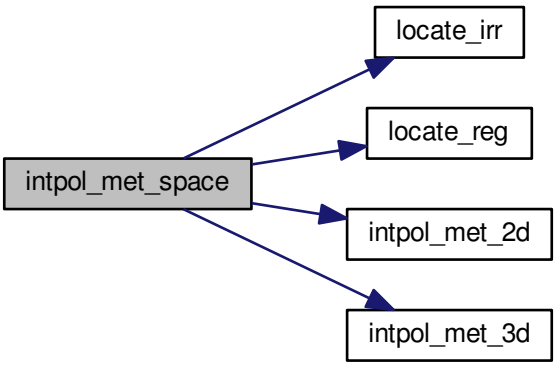
Spatial interpolation of meteorological data.

Definition at line 652 of file libtrac.c.

```
00666                {
00667
00668   double wp, wx, wy;
00669
00670   int ip, ix, iy;
00671
00672   /* Check longitude... */
00673   if (met->lon[met->nx - 1] > 180 && lon < 0)
00674     lon += 360;
00675
00676   /* Get indices... */
00677   ip = locate_irr(met->p, met->np, p);
00678   ix = locate_reg(met->lon, met->nx, lon);
00679   iy = locate_reg(met->lat, met->ny, lat);
```

```
00680
00681   /* Get weights... */
00682   wp = (met->p[ip + 1] - p) / (met->p[ip + 1] - met->p[ip]);
00683   wx = (met->lon[ix + 1] - lon) / (met->lon[ix + 1] - met->lon[ix]);
00684   wy = (met->lat[iy + 1] - lat) / (met->lat[iy + 1] - met->lat[iy]);
00685
00686   /* Interpolate... */
00687   if (ps != NULL)
00688     intpol_met_2d(met->ps, ix, iy, wx, wy, ps);
00689   if (pt != NULL)
00690     intpol_met_2d(met->pt, ix, iy, wx, wy, pt);
00691   if (z != NULL)
00692     intpol_met_3d(met->z, ip, ix, iy, wp, wx, wy, z);
00693   if (t != NULL)
00694     intpol_met_3d(met->t, ip, ix, iy, wp, wx, wy, t);
00695   if (u != NULL)
00696     intpol_met_3d(met->u, ip, ix, iy, wp, wx, wy, u);
00697   if (v != NULL)
00698     intpol_met_3d(met->v, ip, ix, iy, wp, wx, wy, v);
00699   if (w != NULL)
00700     intpol_met_3d(met->w, ip, ix, iy, wp, wx, wy, w);
00701   if (pv != NULL)
00702     intpol_met_3d(met->pv, ip, ix, iy, wp, wx, wy, pv);
00703   if (h2o != NULL)
00704     intpol_met_3d(met->h2o, ip, ix, iy, wp, wx, wy, h2o);
00705   if (o3 != NULL)
00706     intpol_met_3d(met->o3, ip, ix, iy, wp, wx, wy, o3);
00707 }
```

Here is the call graph for this function:



5.21.2.12 void intpol_met_time (met_t * *met0*, met_t * *met1*, double *ts*, double *p*, double *lon*, double *lat*, double * *ps*, double * *pt*, double * *z*, double * *t*, double * *u*, double * *v*, double * *w*, double * *pv*, double * *h2o*, double * *o3*)

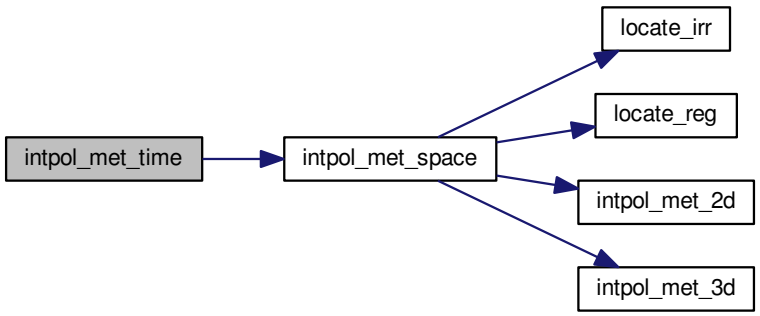
Temporal interpolation of meteorological data.

Definition at line 711 of file libtrac.c.

```
00727               {
00728
00729   double h2o0, h2o1, o30, o31, ps0, ps1, pt0, pt1, pv0, pv1, t0, t1, u0, u1,
00730     v0, v1, w0, w1, wt, z0, z1;
00731
00732   /* Spatial interpolation... */
00733   intpol_met_space(met0, p, lon, lat,
00734                    ps == NULL ? NULL : &ps0,
00735                    pt == NULL ? NULL : &pt0,
00736                    z == NULL ? NULL : &z0,
```

```
00737                   t == NULL ? NULL : &t0,
00738                   u == NULL ? NULL : &u0,
00739                   v == NULL ? NULL : &v0,
00740                   w == NULL ? NULL : &w0,
00741                   pv == NULL ? NULL : &pv0,
00742                   h2o == NULL ? NULL : &h2o0, o3 == NULL ? NULL : &o30);
00743   intpol_met_space(met1, p, lon, lat,
00744                   ps == NULL ? NULL : &ps1,
00745                   pt == NULL ? NULL : &pt1,
00746                   z == NULL ? NULL : &z1,
00747                   t == NULL ? NULL : &t1,
00748                   u == NULL ? NULL : &u1,
00749                   v == NULL ? NULL : &v1,
00750                   w == NULL ? NULL : &w1,
00751                   pv == NULL ? NULL : &pv1,
00752                   h2o == NULL ? NULL : &h2o1, o3 == NULL ? NULL : &o31);
00753
00754   /* Get weighting factor... */
00755   wt = (met1->time - ts) / (met1->time - met0->time);
00756
00757   /* Interpolate... */
00758   if (ps != NULL)
00759     *ps = wt * (ps0 - ps1) + ps1;
00760   if (pt != NULL)
00761     *pt = wt * (pt0 - pt1) + pt1;
00762   if (z != NULL)
00763     *z = wt * (z0 - z1) + z1;
00764   if (t != NULL)
00765     *t = wt * (t0 - t1) + t1;
00766   if (u != NULL)
00767     *u = wt * (u0 - u1) + u1;
00768   if (v != NULL)
00769     *v = wt * (v0 - v1) + v1;
00770   if (w != NULL)
00771     *w = wt * (w0 - w1) + w1;
00772   if (pv != NULL)
00773     *pv = wt * (pv0 - pv1) + pv1;
00774   if (h2o != NULL)
00775     *h2o = wt * (h2o0 - h2o1) + h2o1;
00776   if (o3 != NULL)
00777     *o3 = wt * (o30 - o31) + o31;
00778 }
```

Here is the call graph for this function:



5.21.2.13 void jsec2time (double *jsec*, int * *year*, int * *mon*, int * *day*, int * *hour*, int * *min*, int * *sec*, double * *remain*)

Convert seconds to date.

Definition at line 782 of file libtrac.c.

```
00790                   {
00791
00792   struct tm t0, *t1;
00793
00794   time_t jsec0;
00795
00796   t0.tm_year = 100;
00797   t0.tm_mon = 0;
00798   t0.tm_mday = 1;
00799   t0.tm_hour = 0;
00800   t0.tm_min = 0;
00801   t0.tm_sec = 0;
00802
00803   jsec0 = (time_t) jsec + timegm(&t0);
00804   t1 = gmtime(&jsec0);
00805
00806   *year = t1->tm_year + 1900;
00807   *mon = t1->tm_mon + 1;
00808   *day = t1->tm_mday;
00809   *hour = t1->tm_hour;
00810   *min = t1->tm_min;
00811   *sec = t1->tm_sec;
00812   *remain = jsec - floor(jsec);
00813 }
```

5.21.2.14 int locate_irr (double * *xx*, int *n*, double *x*)

Find array index for irregular grid.

Definition at line 817 of file libtrac.c.

```
00820             {
00821
00822   int i, ilo, ihi;
00823
00824   ilo = 0;
00825   ihi = n - 1;
00826   i = (ihi + ilo) >> 1;
00827
00828   if (xx[i] < xx[i + 1])
00829     while (ihi > ilo + 1) {
00830       i = (ihi + ilo) >> 1;
00831       if (xx[i] > x)
00832         ihi = i;
00833       else
00834         ilo = i;
00835   } else
00836     while (ihi > ilo + 1) {
00837       i = (ihi + ilo) >> 1;
00838       if (xx[i] <= x)
00839         ihi = i;
00840       else
00841         ilo = i;
00842     }
00843
00844   return ilo;
00845 }
```

5.21.2.15 int locate_reg (double * *xx*, int *n*, double *x*)

Find array index for regular grid.

Definition at line 849 of file libtrac.c.

```
00852             {
00853
00854   int i;
00855
00856   /* Calculate index... */
00857   i = (int) ((x - xx[0]) / (xx[1] - xx[0]));
00858
00859   /* Check range... */
00860   if (i < 0)
00861     i = 0;
00862   else if (i >= n - 2)
00863     i = n - 2;
00864
00865   return i;
00866 }
```

5.21.2.16 void read_atm (const char * *filename*, ctl_t * *ctl*, atm_t * *atm*)

Read atmospheric data.

Definition at line 870 of file libtrac.c.

```
00873                {
00874
00875   FILE *in;
00876
00877   char line[LEN], *tok;
00878
00879   double t0;
00880
00881   int dimid, ip, iq, ncid, varid;
00882
00883   size_t nparts;
00884
00885   /* Init... */
00886   atm->np = 0;
00887
00888   /* Write info... */
00889   printf("Read atmospheric data: %s\n", filename);
00890
00891   /* Read ASCII data... */
00892   if (ctl->atm_type == 0) {
00893
00894     /* Open file... */
00895     if (!(in = fopen(filename, "r")))
00896       ERRMSG("Cannot open file!");
00897
00898     /* Read line... */
00899     while (fgets(line, LEN, in)) {
00900
00901       /* Read data... */
00902       TOK(line, tok, "%lg", atm->time[atm->np]);
00903       TOK(NULL, tok, "%lg", atm->p[atm->np]);
00904       TOK(NULL, tok, "%lg", atm->lon[atm->np]);
00905       TOK(NULL, tok, "%lg", atm->lat[atm->np]);
00906       for (iq = 0; iq < ctl->nq; iq++)
00907         TOK(NULL, tok, "%lg", atm->q[iq][atm->np]);
00908
00909       /* Convert altitude to pressure... */
00910       atm->p[atm->np] = P(atm->p[atm->np]);
00911
00912       /* Increment data point counter... */
00913       if ((++atm->np) > NP)
00914         ERRMSG("Too many data points!");
00915     }
00916
00917     /* Close file... */
00918     fclose(in);
00919   }
00920
00921   /* Read binary data... */
00922   else if (ctl->atm_type == 1) {
00923
00924     /* Open file... */
00925     if (!(in = fopen(filename, "r")))
00926       ERRMSG("Cannot open file!");
00927
00928     /* Read data... */
00929     FREAD(&atm->np, int,
00930           1,
00931           in);
00932     FREAD(atm->time, double,
00933             (size_t) atm->np,
00934           in);
00935     FREAD(atm->p, double,
00936             (size_t) atm->np,
00937           in);
00938     FREAD(atm->lon, double,
00939             (size_t) atm->np,
00940           in);
00941     FREAD(atm->lat, double,
00942             (size_t) atm->np,
00943           in);
00944     for (iq = 0; iq < ctl->nq; iq++)
00945       FREAD(atm->q[iq], double,
00946               (size_t) atm->np,
00947             in);
00948
00949     /* Close file... */
```

```
00950     fclose(in);
00951   }
00952
00953   /* Read netCDF data... */
00954   else if (ctl->atm_type == 2) {
00955
00956     /* Open file... */
00957     NC(nc_open(filename, NC_NOWRITE, &ncid));
00958
00959     /* Get dimensions... */
00960     NC(nc_inq_dimid(ncid, "NPARTS", &dimid));
00961     NC(nc_inq_dimlen(ncid, dimid, &nparts));
00962     atm->np = (int) nparts;
00963     if (atm->np > NP)
00964       ERRMSG("Too many particles!");
00965
00966     /* Get time... */
00967     NC(nc_inq_varid(ncid, "time", &varid));
00968     NC(nc_get_var_double(ncid, varid, &t0));
00969     for (ip = 0; ip < atm->np; ip++)
00970       atm->time[ip] = t0;
00971
00972     /* Read geolocations... */
00973     NC(nc_inq_varid(ncid, "PRESS", &varid));
00974     NC(nc_get_var_double(ncid, varid, atm->p));
00975     NC(nc_inq_varid(ncid, "LON", &varid));
00976     NC(nc_get_var_double(ncid, varid, atm->lon));
00977     NC(nc_inq_varid(ncid, "LAT", &varid));
00978     NC(nc_get_var_double(ncid, varid, atm->lat));
00979
00980     /* Read variables... */
00981     if (ctl->qnt_p >= 0)
00982       if (nc_inq_varid(ncid, "PRESS", &varid) == NC_NOERR)
00983         NC(nc_get_var_double(ncid, varid, atm->q[ctl->qnt_p]));
00984     if (ctl->qnt_t >= 0)
00985       if (nc_inq_varid(ncid, "TEMP", &varid) == NC_NOERR)
00986         NC(nc_get_var_double(ncid, varid, atm->q[ctl->qnt_t]));
00987     if (ctl->qnt_u >= 0)
00988       if (nc_inq_varid(ncid, "U", &varid) == NC_NOERR)
00989         NC(nc_get_var_double(ncid, varid, atm->q[ctl->qnt_u]));
00990     if (ctl->qnt_v >= 0)
00991       if (nc_inq_varid(ncid, "V", &varid) == NC_NOERR)
00992         NC(nc_get_var_double(ncid, varid, atm->q[ctl->qnt_v]));
00993     if (ctl->qnt_w >= 0)
00994       if (nc_inq_varid(ncid, "W", &varid) == NC_NOERR)
00995         NC(nc_get_var_double(ncid, varid, atm->q[ctl->qnt_w]));
00996     if (ctl->qnt_h2o >= 0)
00997       if (nc_inq_varid(ncid, "SH", &varid) == NC_NOERR)
00998         NC(nc_get_var_double(ncid, varid, atm->q[ctl->qnt_h2o]));
00999     if (ctl->qnt_o3 >= 0)
01000       if (nc_inq_varid(ncid, "O3", &varid) == NC_NOERR)
01001         NC(nc_get_var_double(ncid, varid, atm->q[ctl->qnt_o3]));
01002     if (ctl->qnt_theta >= 0)
01003       if (nc_inq_varid(ncid, "THETA", &varid) == NC_NOERR)
01004         NC(nc_get_var_double(ncid, varid, atm->q[ctl->qnt_theta]));
01005     if (ctl->qnt_pv >= 0)
01006       if (nc_inq_varid(ncid, "PV", &varid) == NC_NOERR)
01007         NC(nc_get_var_double(ncid, varid, atm->q[ctl->qnt_pv]));
01008
01009     /* Check data... */
01010     for (ip = 0; ip < atm->np; ip++)
01011       if (fabs(atm->lon[ip]) > 360 || fabs(atm->lat[ip]) > 90
01012           || (ctl->qnt_t >= 0 && fabs(atm->q[ctl->qnt_t][ip]) > 350)
01013           || (ctl->qnt_h2o >= 0 && fabs(atm->q[ctl->qnt_h2o][ip]) > 1)
01014           || (ctl->qnt_theta >= 0 && fabs(atm->q[ctl->qnt_theta][ip]) > 1e10)
01015           || (ctl->qnt_pv >= 0 && fabs(atm->q[ctl->qnt_pv][ip]) > 1e10)) {
01016         atm->time[ip] = GSL_NAN;
01017         atm->p[ip] = GSL_NAN;
01018         atm->lon[ip] = GSL_NAN;
01019         atm->lat[ip] = GSL_NAN;
01020         for (iq = 0; iq < ctl->nq; iq++)
01021           atm->q[iq][ip] = GSL_NAN;
01022       } else {
01023         if (ctl->qnt_h2o >= 0)
01024           atm->q[ctl->qnt_h2o][ip] *= 1.608;
01025         if (ctl->qnt_pv >= 0)
01026           atm->q[ctl->qnt_pv][ip] *= 1e6;
01027         if (atm->lon[ip] > 180)
01028           atm->lon[ip] -= 360;
01029       }
01030
01031     /* Close file... */
01032     NC(nc_close(ncid));
01033   }
01034
01035   /* Error... */
01036   else
```

```
01037     ERRMSG("Atmospheric data type not supported!");
01038
01039   /* Check number of points... */
01040   if (atm->np < 1)
01041     ERRMSG("Can not read any data!");
01042 }
```

5.21.2.17 void read_ctl (const char * *filename*, int *argc*, char * *argv[]*, ctl_t * *ctl*)

Read control parameters.

Definition at line 1046 of file libtrac.c.

```
01050               {
01051
01052   int ip, iq;
01053
01054   /* Write info... */
01055   printf("\nMassive-Parallel Trajectory Calculations (MPTRAC)\n"
01056          "(executable: %s | compiled: %s, %s)\n\n",
01057          argv[0], __DATE__, __TIME__);
01058
01059   /* Initialize quantity indices... */
01060   ctl->qnt_ens = -1;
01061   ctl->qnt_m = -1;
01062   ctl->qnt_r = -1;
01063   ctl->qnt_rho = -1;
01064   ctl->qnt_ps = -1;
01065   ctl->qnt_pt = -1;
01066   ctl->qnt_z = -1;
01067   ctl->qnt_p = -1;
01068   ctl->qnt_t = -1;
01069   ctl->qnt_u = -1;
01070   ctl->qnt_v = -1;
01071   ctl->qnt_w = -1;
01072   ctl->qnt_h2o = -1;
01073   ctl->qnt_o3 = -1;
01074   ctl->qnt_theta = -1;
01075   ctl->qnt_vh = -1;
01076   ctl->qnt_vz = -1;
01077   ctl->qnt_pv = -1;
01078   ctl->qnt_tice = -1;
01079   ctl->qnt_tsts = -1;
01080   ctl->qnt_tnat = -1;
01081   ctl->qnt_stat = -1;
01082
01083   /* Read quantities... */
01084   ctl->nq = (int) scan_ctl(filename, argc, argv, "NQ", -1, "0", NULL);
01085   if (ctl->nq > NQ)
01086     ERRMSG("Too many quantities!");
01087   for (iq = 0; iq < ctl->nq; iq++) {
01088
01089     /* Read quantity name and format... */
01090     scan_ctl(filename, argc, argv, "QNT_NAME", iq, "", ctl->qnt_name[iq]);
01091     scan_ctl(filename, argc, argv, "QNT_FORMAT", iq, "%g",
01092              ctl->qnt_format[iq]);
01093
01094     /* Try to identify quantity... */
01095     if (strcmp(ctl->qnt_name[iq], "ens") == 0) {
01096       ctl->qnt_ens = iq;
01097       sprintf(ctl->qnt_unit[iq], "-");
01098     } else if (strcmp(ctl->qnt_name[iq], "m") == 0) {
01099       ctl->qnt_m = iq;
01100       sprintf(ctl->qnt_unit[iq], "kg");
01101     } else if (strcmp(ctl->qnt_name[iq], "r") == 0) {
01102       ctl->qnt_r = iq;
01103       sprintf(ctl->qnt_unit[iq], "m");
01104     } else if (strcmp(ctl->qnt_name[iq], "rho") == 0) {
01105       ctl->qnt_rho = iq;
01106       sprintf(ctl->qnt_unit[iq], "kg/m^3");
01107     } else if (strcmp(ctl->qnt_name[iq], "ps") == 0) {
01108       ctl->qnt_ps = iq;
01109       sprintf(ctl->qnt_unit[iq], "hPa");
01110     } else if (strcmp(ctl->qnt_name[iq], "pt") == 0) {
01111       ctl->qnt_pt = iq;
01112       sprintf(ctl->qnt_unit[iq], "hPa");
01113     } else if (strcmp(ctl->qnt_name[iq], "z") == 0) {
01114       ctl->qnt_z = iq;
01115       sprintf(ctl->qnt_unit[iq], "km");
01116     } else if (strcmp(ctl->qnt_name[iq], "p") == 0) {
```

```
01117       ctl->qnt_p = iq;
01118       sprintf(ctl->qnt_unit[iq], "hPa");
01119     } else if (strcmp(ctl->qnt_name[iq], "t") == 0) {
01120       ctl->qnt_t = iq;
01121       sprintf(ctl->qnt_unit[iq], "K");
01122     } else if (strcmp(ctl->qnt_name[iq], "u") == 0) {
01123       ctl->qnt_u = iq;
01124       sprintf(ctl->qnt_unit[iq], "m/s");
01125     } else if (strcmp(ctl->qnt_name[iq], "v") == 0) {
01126       ctl->qnt_v = iq;
01127       sprintf(ctl->qnt_unit[iq], "m/s");
01128     } else if (strcmp(ctl->qnt_name[iq], "w") == 0) {
01129       ctl->qnt_w = iq;
01130       sprintf(ctl->qnt_unit[iq], "hPa/s");
01131     } else if (strcmp(ctl->qnt_name[iq], "h2o") == 0) {
01132       ctl->qnt_h2o = iq;
01133       sprintf(ctl->qnt_unit[iq], "1");
01134     } else if (strcmp(ctl->qnt_name[iq], "o3") == 0) {
01135       ctl->qnt_o3 = iq;
01136       sprintf(ctl->qnt_unit[iq], "1");
01137     } else if (strcmp(ctl->qnt_name[iq], "theta") == 0) {
01138       ctl->qnt_theta = iq;
01139       sprintf(ctl->qnt_unit[iq], "K");
01140     } else if (strcmp(ctl->qnt_name[iq], "vh") == 0) {
01141       ctl->qnt_vh = iq;
01142       sprintf(ctl->qnt_unit[iq], "m/s");
01143     } else if (strcmp(ctl->qnt_name[iq], "vz") == 0) {
01144       ctl->qnt_vz = iq;
01145       sprintf(ctl->qnt_unit[iq], "m/s");
01146     } else if (strcmp(ctl->qnt_name[iq], "pv") == 0) {
01147       ctl->qnt_pv = iq;
01148       sprintf(ctl->qnt_unit[iq], "PVU");
01149     } else if (strcmp(ctl->qnt_name[iq], "tice") == 0) {
01150       ctl->qnt_tice = iq;
01151       sprintf(ctl->qnt_unit[iq], "K");
01152     } else if (strcmp(ctl->qnt_name[iq], "tsts") == 0) {
01153       ctl->qnt_tsts = iq;
01154       sprintf(ctl->qnt_unit[iq], "K");
01155     } else if (strcmp(ctl->qnt_name[iq], "tnat") == 0) {
01156       ctl->qnt_tnat = iq;
01157       sprintf(ctl->qnt_unit[iq], "K");
01158     } else if (strcmp(ctl->qnt_name[iq], "stat") == 0) {
01159       ctl->qnt_stat = iq;
01160       sprintf(ctl->qnt_unit[iq], "-");
01161     } else
01162       scan_ctl(filename, argc, argv, "QNT_UNIT", iq, "", ctl->qnt_unit[iq]);
01163   }
01164
01165   /* Time steps of simulation... */
01166   ctl->direction =
01167     (int) scan_ctl(filename, argc, argv, "DIRECTION", -1, "1", NULL);
01168   if (ctl->direction != -1 && ctl->direction != 1)
01169     ERRMSG("Set DIRECTION to -1 or 1!");
01170   ctl->t_stop = scan_ctl(filename, argc, argv, "T_STOP", -1, "1e100", NULL);
01171   ctl->dt_mod = scan_ctl(filename, argc, argv, "DT_MOD", -1, "600", NULL);
01172
01173   /* Meteorological data... */
01174   ctl->dt_met = scan_ctl(filename, argc, argv, "DT_MET", -1, "21600", NULL);
01175   ctl->met_dx = (int) scan_ctl(filename, argc, argv, "MET_DX", -1, "1", NULL);
01176   ctl->met_dy = (int) scan_ctl(filename, argc, argv, "MET_DY", -1, "1", NULL);
01177   ctl->met_dp = (int) scan_ctl(filename, argc, argv, "MET_DP", -1, "1", NULL);
01178   ctl->met_sx = (int) scan_ctl(filename, argc, argv, "MET_SX", -1, "1", NULL);
01179   ctl->met_sy = (int) scan_ctl(filename, argc, argv, "MET_SY", -1, "1", NULL);
01180   ctl->met_sp = (int) scan_ctl(filename, argc, argv, "MET_SP", -1, "1", NULL);
01181   ctl->met_np = (int) scan_ctl(filename, argc, argv, "MET_NP", -1, "0", NULL);
01182   if (ctl->met_np > EP)
01183     ERRMSG("Too many levels!");
01184   for (ip = 0; ip < ctl->met_np; ip++)
01185     ctl->met_p[ip] = scan_ctl(filename, argc, argv, "MET_P", ip, "", NULL);
01186   ctl->met_tropo
01187     = (int) scan_ctl(filename, argc, argv, "MET_TROPO", -1, "0", NULL);
01188   scan_ctl(filename, argc, argv, "MET_GEOPOT", -1, "-", ctl->met_geopot);
01189   scan_ctl(filename, argc, argv, "MET_STAGE", -1, "-", ctl->met_stage);
01190   ctl->met_dt_out =
01191     scan_ctl(filename, argc, argv, "MET_DT_OUT", -1, "0.1", NULL);
01192
01193   /* Isosurface parameters... */
01194   ctl->isosurf
01195     = (int) scan_ctl(filename, argc, argv, "ISOSURF", -1, "0", NULL);
01196   scan_ctl(filename, argc, argv, "BALLOON", -1, "-", ctl->balloon);
01197
01198   /* Diffusion parameters... */
01199   ctl->turb_dx_trop
01200     = scan_ctl(filename, argc, argv, "TURB_DX_TROP", -1, "50", NULL);
01201   ctl->turb_dx_strat
01202     = scan_ctl(filename, argc, argv, "TURB_DX_STRAT", -1, "0", NULL);
01203   ctl->turb_dz_trop
```

```
01204     = scan_ctl(filename, argc, argv, "TURB_DZ_TROP", -1, "0", NULL);
01205   ctl->turb_dz_strat
01206     = scan_ctl(filename, argc, argv, "TURB_DZ_STRAT", -1, "0.1", NULL);
01207   ctl->turb_mesox =
01208     scan_ctl(filename, argc, argv, "TURB_MESOX", -1, "0.16", NULL);
01209   ctl->turb_mesoz =
01210     scan_ctl(filename, argc, argv, "TURB_MESOZ", -1, "0.16", NULL);
01211
01212   /* Mass and life time... */
01213   ctl->molmass = scan_ctl(filename, argc, argv, "MOLMASS", -1, "1", NULL);
01214   ctl->tdec_trop = scan_ctl(filename, argc, argv, "TDEC_TROP", -1, "0", NULL);
01215   ctl->tdec_strat =
01216     scan_ctl(filename, argc, argv, "TDEC_STRAT", -1, "0", NULL);
01217
01218   /* PSC analysis... */
01219   ctl->psc_h2o = scan_ctl(filename, argc, argv, "PSC_H2O", -1, "4e-6", NULL);
01220   ctl->psc_hno3 =
01221     scan_ctl(filename, argc, argv, "PSC_HNO3", -1, "9e-9", NULL);
01222
01223   /* Output of atmospheric data... */
01224   scan_ctl(filename, argc, argv, "ATM_BASENAME", -1, "-", ctl->
      atm_basename);
01225   scan_ctl(filename, argc, argv, "ATM_GPFILE", -1, "-", ctl->atm_gpfile);
01226   ctl->atm_dt_out =
01227     scan_ctl(filename, argc, argv, "ATM_DT_OUT", -1, "86400", NULL);
01228   ctl->atm_filter =
01229     (int) scan_ctl(filename, argc, argv, "ATM_FILTER", -1, "0", NULL);
01230   ctl->atm_type =
01231     (int) scan_ctl(filename, argc, argv, "ATM_TYPE", -1, "0", NULL);
01232
01233   /* Output of CSI data... */
01234   scan_ctl(filename, argc, argv, "CSI_BASENAME", -1, "-", ctl->
      csi_basename);
01235   ctl->csi_dt_out =
01236     scan_ctl(filename, argc, argv, "CSI_DT_OUT", -1, "86400", NULL);
01237   scan_ctl(filename, argc, argv, "CSI_OBSFILE", -1, "-", ctl->
      csi_obsfile);
01238   ctl->csi_obsmin =
01239     scan_ctl(filename, argc, argv, "CSI_OBSMIN", -1, "0", NULL);
01240   ctl->csi_modmin =
01241     scan_ctl(filename, argc, argv, "CSI_MODMIN", -1, "0", NULL);
01242   ctl->csi_z0 = scan_ctl(filename, argc, argv, "CSI_Z0", -1, "0", NULL);
01243   ctl->csi_z1 = scan_ctl(filename, argc, argv, "CSI_Z1", -1, "100", NULL);
01244   ctl->csi_nz = (int) scan_ctl(filename, argc, argv, "CSI_NZ", -1, "1", NULL);
01245   ctl->csi_lon0 =
01246     scan_ctl(filename, argc, argv, "CSI_LON0", -1, "-180", NULL);
01247   ctl->csi_lon1 = scan_ctl(filename, argc, argv, "CSI_LON1", -1, "180", NULL);
01248   ctl->csi_nx =
01249     (int) scan_ctl(filename, argc, argv, "CSI_NX", -1, "360", NULL);
01250   ctl->csi_lat0 = scan_ctl(filename, argc, argv, "CSI_LAT0", -1, "-90", NULL);
01251   ctl->csi_lat1 = scan_ctl(filename, argc, argv, "CSI_LAT1", -1, "90", NULL);
01252   ctl->csi_ny =
01253     (int) scan_ctl(filename, argc, argv, "CSI_NY", -1, "180", NULL);
01254
01255   /* Output of ensemble data... */
01256   scan_ctl(filename, argc, argv, "ENS_BASENAME", -1, "-", ctl->
      ens_basename);
01257
01258   /* Output of grid data... */
01259   scan_ctl(filename, argc, argv, "GRID_BASENAME", -1, "-",
01260            ctl->grid_basename);
01261   scan_ctl(filename, argc, argv, "GRID_GPFILE", -1, "-", ctl->
      grid_gpfile);
01262   ctl->grid_dt_out =
01263     scan_ctl(filename, argc, argv, "GRID_DT_OUT", -1, "86400", NULL);
01264   ctl->grid_sparse =
01265     (int) scan_ctl(filename, argc, argv, "GRID_SPARSE", -1, "0", NULL);
01266   ctl->grid_z0 = scan_ctl(filename, argc, argv, "GRID_Z0", -1, "0", NULL);
01267   ctl->grid_z1 = scan_ctl(filename, argc, argv, "GRID_Z1", -1, "100", NULL);
01268   ctl->grid_nz =
01269     (int) scan_ctl(filename, argc, argv, "GRID_NZ", -1, "1", NULL);
01270   ctl->grid_lon0 =
01271     scan_ctl(filename, argc, argv, "GRID_LON0", -1, "-180", NULL);
01272   ctl->grid_lon1 =
01273     scan_ctl(filename, argc, argv, "GRID_LON1", -1, "180", NULL);
01274   ctl->grid_nx =
01275     (int) scan_ctl(filename, argc, argv, "GRID_NX", -1, "360", NULL);
01276   ctl->grid_lat0 =
01277     scan_ctl(filename, argc, argv, "GRID_LAT0", -1, "-90", NULL);
01278   ctl->grid_lat1 =
01279     scan_ctl(filename, argc, argv, "GRID_LAT1", -1, "90", NULL);
01280   ctl->grid_ny =
01281     (int) scan_ctl(filename, argc, argv, "GRID_NY", -1, "180", NULL);
01282
01283   /* Output of profile data... */
01284   scan_ctl(filename, argc, argv, "PROF_BASENAME", -1, "-",
01285            ctl->prof_basename);
```

```
01286   scan_ctl(filename, argc, argv, "PROF_OBSFILE", -1, "-", ctl->
      prof_obsfile);
01287   ctl->prof_z0 = scan_ctl(filename, argc, argv, "PROF_Z0", -1, "0", NULL);
01288   ctl->prof_z1 = scan_ctl(filename, argc, argv, "PROF_Z1", -1, "60", NULL);
01289   ctl->prof_nz =
01290     (int) scan_ctl(filename, argc, argv, "PROF_NZ", -1, "60", NULL);
01291   ctl->prof_lon0 =
01292     scan_ctl(filename, argc, argv, "PROF_LON0", -1, "-180", NULL);
01293   ctl->prof_lon1 =
01294     scan_ctl(filename, argc, argv, "PROF_LON1", -1, "180", NULL);
01295   ctl->prof_nx =
01296     (int) scan_ctl(filename, argc, argv, "PROF_NX", -1, "360", NULL);
01297   ctl->prof_lat0 =
01298     scan_ctl(filename, argc, argv, "PROF_LAT0", -1, "-90", NULL);
01299   ctl->prof_lat1 =
01300     scan_ctl(filename, argc, argv, "PROF_LAT1", -1, "90", NULL);
01301   ctl->prof_ny =
01302     (int) scan_ctl(filename, argc, argv, "PROF_NY", -1, "180", NULL);
01303
01304   /* Output of station data... */
01305   scan_ctl(filename, argc, argv, "STAT_BASENAME", -1, "-",
01306            ctl->stat_basename);
01307   ctl->stat_lon = scan_ctl(filename, argc, argv, "STAT_LON", -1, "0", NULL);
01308   ctl->stat_lat = scan_ctl(filename, argc, argv, "STAT_LAT", -1, "0", NULL);
01309   ctl->stat_r = scan_ctl(filename, argc, argv, "STAT_R", -1, "50", NULL);
01310 }
```

Here is the call graph for this function:

5.21.2.18 void read_met (ctl_t * *ctl*, char * *filename*, met_t * *met*)

Read meteorological data file.

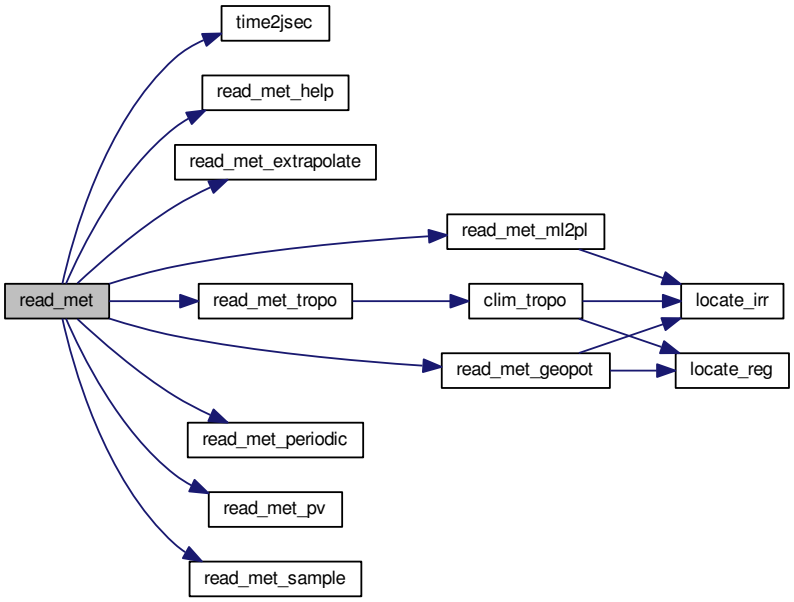
Definition at line 1314 of file libtrac.c.

```
01317               {
01318
01319   char cmd[2 * LEN], levname[LEN], tstr[10];
01320
01321   static float help[EX * EY];
01322
01323   int ix, iy, ip, dimid, ncid, varid, year, mon, day, hour;
01324
01325   size_t np, nx, ny;
01326
01327   /* Write info... */
01328   printf("Read meteorological data: %s\n", filename);
01329
01330   /* Get time from filename... */
01331   sprintf(tstr, "%.4s", &filename[strlen(filename) - 16]);
01332   year = atoi(tstr);
01333   sprintf(tstr, "%.2s", &filename[strlen(filename) - 11]);
01334   mon = atoi(tstr);
01335   sprintf(tstr, "%.2s", &filename[strlen(filename) - 8]);
01336   day = atoi(tstr);
01337   sprintf(tstr, "%.2s", &filename[strlen(filename) - 5]);
01338   hour = atoi(tstr);
01339   time2jsec(year, mon, day, hour, 0, 0, 0, &met->time);
01340
01341   /* Open netCDF file... */
01342   if (nc_open(filename, NC_NOWRITE, &ncid) != NC_NOERR) {
01343
```

```
01344     /* Try to stage meteo file... */
01345     if (ctl->met_stage[0] != '-') {
01346       sprintf(cmd, "%s %d %02d %02d %02d %s", ctl->met_stage,
01347               year, mon, day, hour, filename);
01348       if (system(cmd) != 0)
01349         ERRMSG("Error while staging meteo data!");
01350     }
01351
01352     /* Try to open again... */
01353     NC(nc_open(filename, NC_NOWRITE, &ncid));
01354   }
01355
01356   /* Get dimensions... */
01357   NC(nc_inq_dimid(ncid, "lon", &dimid));
01358   NC(nc_inq_dimlen(ncid, dimid, &nx));
01359   if (nx < 2 || nx > EX)
01360     ERRMSG("Number of longitudes out of range!");
01361
01362   NC(nc_inq_dimid(ncid, "lat", &dimid));
01363   NC(nc_inq_dimlen(ncid, dimid, &ny));
01364   if (ny < 2 || ny > EY)
01365     ERRMSG("Number of latitudes out of range!");
01366
01367   sprintf(levname, "lev");
01368   NC(nc_inq_dimid(ncid, levname, &dimid));
01369   NC(nc_inq_dimlen(ncid, dimid, &np));
01370   if (np == 1) {
01371     sprintf(levname, "lev_2");
01372     NC(nc_inq_dimid(ncid, levname, &dimid));
01373     NC(nc_inq_dimlen(ncid, dimid, &np));
01374   }
01375   if (np < 2 || np > EP)
01376     ERRMSG("Number of levels out of range!");
01377
01378   /* Store dimensions... */
01379   met->np = (int) np;
01380   met->nx = (int) nx;
01381   met->ny = (int) ny;
01382
01383   /* Get horizontal grid... */
01384   NC(nc_inq_varid(ncid, "lon", &varid));
01385   NC(nc_get_var_double(ncid, varid, met->lon));
01386   NC(nc_inq_varid(ncid, "lat", &varid));
01387   NC(nc_get_var_double(ncid, varid, met->lat));
01388
01389   /* Read meteorological data... */
01390   read_met_help(ncid, "t", "T", met, met->t, 1.0);
01391   read_met_help(ncid, "u", "U", met, met->u, 1.0);
01392   read_met_help(ncid, "v", "V", met, met->v, 1.0);
01393   read_met_help(ncid, "w", "W", met, met->w, 0.01f);
01394   read_met_help(ncid, "q", "Q", met, met->h2o, (float) (MA / 18.01528));
01395   read_met_help(ncid, "o3", "O3", met, met->o3, (float) (MA / 48.00));
01396
01397   /* Meteo data on pressure levels... */
01398   if (ctl->met_np <= 0) {
01399
01400     /* Read pressure levels from file... */
01401     NC(nc_inq_varid(ncid, levname, &varid));
01402     NC(nc_get_var_double(ncid, varid, met->p));
01403     for (ip = 0; ip < met->np; ip++)
01404       met->p[ip] /= 100.;
01405
01406     /* Extrapolate data for lower boundary... */
01407     read_met_extrapolate(met);
01408   }
01409
01410   /* Meteo data on model levels... */
01411   else {
01412
01413     /* Read pressure data from file... */
01414     read_met_help(ncid, "pl", "PL", met, met->pl, 0.01f);
01415
01416     /* Interpolate from model levels to pressure levels... */
01417     read_met_ml2pl(ctl, met, met->t);
01418     read_met_ml2pl(ctl, met, met->u);
01419     read_met_ml2pl(ctl, met, met->v);
01420     read_met_ml2pl(ctl, met, met->w);
01421     read_met_ml2pl(ctl, met, met->h2o);
01422     read_met_ml2pl(ctl, met, met->o3);
01423
01424     /* Set pressure levels... */
01425     met->np = ctl->met_np;
01426     for (ip = 0; ip < met->np; ip++)
01427       met->p[ip] = ctl->met_p[ip];
01428   }
01429
01430   /* Check ordering of pressure levels... */
```

```
01431   for (ip = 1; ip < met->np; ip++)
01432     if (met->p[ip - 1] < met->p[ip])
01433       ERRMSG("Pressure levels must be descending!");
01434
01435   /* Read surface pressure... */
01436   if (nc_inq_varid(ncid, "ps", &varid) == NC_NOERR
01437       || nc_inq_varid(ncid, "PS", &varid) == NC_NOERR) {
01438     NC(nc_get_var_float(ncid, varid, help));
01439     for (iy = 0; iy < met->ny; iy++)
01440       for (ix = 0; ix < met->nx; ix++)
01441         met->ps[ix][iy] = help[iy * met->nx + ix] / 100.;
01442   } else if (nc_inq_varid(ncid, "lnsp", &varid) == NC_NOERR
01443              || nc_inq_varid(ncid, "LNSP", &varid) == NC_NOERR) {
01444     NC(nc_get_var_float(ncid, varid, help));
01445     for (iy = 0; iy < met->ny; iy++)
01446       for (ix = 0; ix < met->nx; ix++)
01447         met->ps[ix][iy] = exp(help[iy * met->nx + ix]) / 100.;
01448   } else
01449     for (ix = 0; ix < met->nx; ix++)
01450       for (iy = 0; iy < met->ny; iy++)
01451         met->ps[ix][iy] = met->p[0];
01452
01453   /* Create periodic boundary conditions... */
01454   read_met_periodic(met);
01455
01456   /* Calculate geopotential heights... */
01457   read_met_geopot(ctl, met);
01458
01459   /* Calculate potential vorticity... */
01460   read_met_pv(met);
01461
01462   /* Calculate tropopause pressure... */
01463   read_met_tropo(ctl, met);
01464
01465   /* Downsampling... */
01466   read_met_sample(ctl, met);
01467
01468   /* Close file... */
01469   NC(nc_close(ncid));
01470 }
```

Here is the call graph for this function:



5.21.2.19 void read_met_extrapolate (met_t * *met*)

Extrapolate meteorological data at lower boundary.

Definition at line 1474 of file libtrac.c.

```
01475               {
01476
01477   int ip, ip0, ix, iy;
01478
01479   /* Loop over columns... */
01480 #pragma omp parallel for default(shared) private(ix,iy,ip0,ip)
01481   for (ix = 0; ix < met->nx; ix++)
01482     for (iy = 0; iy < met->ny; iy++) {
01483
01484       /* Find lowest valid data point... */
01485       for (ip0 = met->np - 1; ip0 >= 0; ip0--)
01486         if (!gsl_finite(met->t[ix][iy][ip0])
01487             || !gsl_finite(met->u[ix][iy][ip0])
01488             || !gsl_finite(met->v[ix][iy][ip0])
01489             || !gsl_finite(met->w[ix][iy][ip0]))
01490           break;
01491
01492       /* Extrapolate... */
01493       for (ip = ip0; ip >= 0; ip--) {
01494         met->t[ix][iy][ip] = met->t[ix][iy][ip + 1];
01495         met->u[ix][iy][ip] = met->u[ix][iy][ip + 1];
01496         met->v[ix][iy][ip] = met->v[ix][iy][ip + 1];
01497         met->w[ix][iy][ip] = met->w[ix][iy][ip + 1];
01498         met->h2o[ix][iy][ip] = met->h2o[ix][iy][ip + 1];
01499         met->o3[ix][iy][ip] = met->o3[ix][iy][ip + 1];
01500       }
01501     }
01502 }
```

5.21.2.20 void read_met_geopot (ctl_t * *ctl*, met_t * *met*)

Calculate geopotential heights.

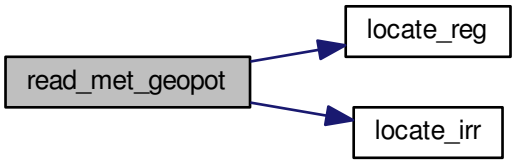
Definition at line 1506 of file libtrac.c.

```
01508               {
01509
01510   static double topo_lat[EY], topo_lon[EX], topo_z[EX][EY];
01511
01512   static int init, topo_nx = -1, topo_ny;
01513
01514   FILE *in;
01515
01516   char line[LEN];
01517
01518   double data[30], lat, lon, rlat, rlon, rlon_old = -999, rz, ts, z0, z1;
01519
01520   float help[EX][EY];
01521
01522   int ip, ip0, ix, ix2, ix3, iy, iy2, n, tx, ty;
01523
01524   /* Initialize geopotential heights... */
01525 #pragma omp parallel for default(shared) private(ix,iy,ip)
01526   for (ix = 0; ix < met->nx; ix++)
01527     for (iy = 0; iy < met->ny; iy++)
01528       for (ip = 0; ip < met->np; ip++)
01529         met->z[ix][iy][ip] = GSL_NAN;
01530
01531   /* Check filename... */
01532   if (ctl->met_geopot[0] == '-')
01533     return;
01534
01535   /* Read surface geopotential... */
01536   if (!init) {
01537     init = 1;
01538
01539     /* Write info... */
01540     printf("Read surface geopotential: %s\n", ctl->met_geopot);
01541
01542     /* Open file... */
01543     if (!(in = fopen(ctl->met_geopot, "r")))
01544       ERRMSG("Cannot open file!");
01545
01546     /* Read data... */
01547     while (fgets(line, LEN, in))
01548       if (sscanf(line, "%lg %lg %lg", &rlon, &rlat, &rz) == 3) {
01549         if (rlon != rlon_old) {
```

```
01550           if ((++topo_nx) >= EX)
01551             ERRMSG("Too many longitudes!");
01552           topo_ny = 0;
01553         }
01554         rlon_old = rlon;
01555         topo_lon[topo_nx] = rlon;
01556         topo_lat[topo_ny] = rlat;
01557         topo_z[topo_nx][topo_ny] = rz;
01558         if ((++topo_ny) >= EY)
01559           ERRMSG("Too many latitudes!");
01560       }
01561     if ((++topo_nx) >= EX)
01562       ERRMSG("Too many longitudes!");
01563
01564     /* Close file... */
01565     fclose(in);
01566
01567     /* Check grid spacing... */
01568     if (fabs(met->lon[0] - met->lon[1]) != fabs(topo_lon[0] - topo_lon[1])
01569         || fabs(met->lat[0] - met->lat[1]) != fabs(topo_lat[0] - topo_lat[1]))
01570       printf("Warning: Grid spacing does not match!\n");
01571   }
01572
01573   /* Apply hydrostatic equation to calculate geopotential heights... */
01574 #pragma omp parallel for default(shared) private(ix,iy,lon,lat,tx,ty,z0,z1,ip0,ts,ip)
01575   for (ix = 0; ix < met->nx; ix++)
01576     for (iy = 0; iy < met->ny; iy++) {
01577
01578       /* Get surface height... */
01579       lon = met->lon[ix];
01580       if (lon < topo_lon[0])
01581         lon += 360;
01582       else if (lon > topo_lon[topo_nx - 1])
01583         lon -= 360;
01584       lat = met->lat[iy];
01585       tx = locate_reg(topo_lon, topo_nx, lon);
01586       ty = locate_reg(topo_lat, topo_ny, lat);
01587       z0 = LIN(topo_lon[tx], topo_z[tx][ty],
01588                topo_lon[tx + 1], topo_z[tx + 1][ty], lon);
01589       z1 = LIN(topo_lon[tx], topo_z[tx][ty + 1],
01590                topo_lon[tx + 1], topo_z[tx + 1][ty + 1], lon);
01591       z0 = LIN(topo_lat[ty], z0, topo_lat[ty + 1], z1, lat);
01592
01593       /* Find surface pressure level... */
01594       ip0 = locate_irr(met->p, met->np, met->ps[ix][iy]);
01595
01596       /* Get surface temperature... */
01597       ts = LIN(met->p[ip0], met->t[ix][iy][ip0],
01598                met->p[ip0 + 1], met->t[ix][iy][ip0 + 1], met->ps[ix][iy]);
01599
01600       /* Upper part of profile... */
01601       met->z[ix][iy][ip0 + 1]
01602         = (float) (z0 + RI / MA / G0 * 0.5 * (ts + met->t[ix][iy][ip0 + 1])
01603                    * log(met->ps[ix][iy] / met->p[ip0 + 1]));
01604       for (ip = ip0 + 2; ip < met->np; ip++)
01605         met->z[ix][iy][ip]
01606           = (float) (met->z[ix][iy][ip - 1] + RI / MA / G0
01607                      * 0.5 * (met->t[ix][iy][ip - 1] + met->t[ix][iy][ip])
01608                      * log(met->p[ip - 1] / met->p[ip]));
01609     }
01610
01611   /* Smooth fields... */
01612 #pragma omp parallel for default(shared) private(ip,ix,iy,n,ix2,ix3,iy2,data)
01613   for (ip = 0; ip < met->np; ip++) {
01614
01615     /* Median filter... */
01616     for (ix = 0; ix < met->nx; ix++)
01617       for (iy = 0; iy < met->ny; iy++) {
01618         n = 0;
01619         for (ix2 = ix - 2; ix2 <= ix + 2; ix2++) {
01620           ix3 = ix2;
01621           if (ix3 < 0)
01622             ix3 += met->nx;
01623           if (ix3 >= met->nx)
01624             ix3 -= met->nx;
01625           for (iy2 = GSL_MAX(iy - 2, 0); iy2 <= GSL_MIN(iy + 2, met->ny - 1);
01626                iy2++)
01627             if (gsl_finite(met->z[ix3][iy2][ip])) {
01628               data[n] = met->z[ix3][iy2][ip];
01629               n++;
01630             }
01631         }
01632         if (n > 0) {
01633           gsl_sort(data, 1, (size_t) n);
01634           help[ix][iy] = (float)
01635             gsl_stats_median_from_sorted_data(data, 1, (size_t) n);
01636         } else
```

```
01637           help[ix][iy] = GSL_NAN;
01638       }
01639
01640     /* Copy data... */
01641     for (ix = 0; ix < met->nx; ix++)
01642       for (iy = 0; iy < met->nx; iy++)
01643         met->z[ix][iy][ip] = help[ix][iy];
01644   }
01645 }
```

Here is the call graph for this function:



5.21.2.21 void read_met_help (int *ncid*, char * *varname*, char * *varname2*, met_t * *met*, float *dest[EX][EY][EP]*, float *scl*)

Read and convert variable from meteorological data file.

Definition at line 1649 of file libtrac.c.

```
01655             {
01656
01657   static float help[EX * EY * EP];
01658
01659   int ip, ix, iy, varid;
01660
01661   /* Check if variable exists... */
01662   if (nc_inq_varid(ncid, varname, &varid) != NC_NOERR)
01663     if (nc_inq_varid(ncid, varname2, &varid) != NC_NOERR)
01664       return;
01665
01666   /* Read data... */
01667   NC(nc_get_var_float(ncid, varid, help));
01668
01669   /* Copy and check data... */
01670 #pragma omp parallel for default(shared) private(ix,iy,ip)
01671   for (ix = 0; ix < met->nx; ix++)
01672     for (iy = 0; iy < met->ny; iy++)
01673       for (ip = 0; ip < met->np; ip++) {
01674         dest[ix][iy][ip] = help[(ip * met->ny + iy) * met->nx + ix];
01675         if (fabsf(dest[ix][iy][ip]) < 1e14f)
01676           dest[ix][iy][ip] *= scl;
01677         else
01678           dest[ix][iy][ip] = GSL_NAN;
01679       }
01680 }
```

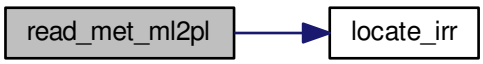
5.21.2.22 void read_met_ml2pl (ctl_t * *ctl*, met_t * *met*, float *var[EX][EY][EP]*)

Convert meteorological data from model levels to pressure levels.

Definition at line 1684 of file libtrac.c.

```
01687                           {
01688
01689   double aux[EP], p[EP], pt;
01690
01691   int ip, ip2, ix, iy;
01692
01693   /* Loop over columns... */
01694 #pragma omp parallel for default(shared) private(ix,iy,ip,p,pt,ip2,aux)
01695   for (ix = 0; ix < met->nx; ix++)
01696     for (iy = 0; iy < met->ny; iy++) {
01697
01698       /* Copy pressure profile... */
01699       for (ip = 0; ip < met->np; ip++)
01700         p[ip] = met->pl[ix][iy][ip];
01701
01702       /* Interpolate... */
01703       for (ip = 0; ip < ctl->met_np; ip++) {
01704         pt = ctl->met_p[ip];
01705         if ((pt > p[0] && p[0] > p[1]) || (pt < p[0] && p[0] < p[1]))
01706           pt = p[0];
01707         else if ((pt > p[met->np - 1] && p[1] > p[0])
01708                  || (pt < p[met->np - 1] && p[1] < p[0]))
01709           pt = p[met->np - 1];
01710         ip2 = locate_irr(p, met->np, pt);
01711         aux[ip] = LIN(p[ip2], var[ix][iy][ip2],
01712                       p[ip2 + 1], var[ix][iy][ip2 + 1], pt);
01713       }
01714
01715       /* Copy data... */
01716       for (ip = 0; ip < ctl->met_np; ip++)
01717         var[ix][iy][ip] = (float) aux[ip];
01718     }
01719 }
```

Here is the call graph for this function:



5.21.2.23 void read_met_periodic (met_t * *met*)

Create meteorological data with periodic boundary conditions.

Definition at line 1723 of file libtrac.c.

```
01724                {
01725
01726   int ip, iy;
01727
01728   /* Check longitudes... */
01729   if (!(fabs(met->lon[met->nx - 1] - met->lon[0]
01730              + met->lon[1] - met->lon[0] - 360) < 0.01))
01731     return;
01732
01733   /* Increase longitude counter... */
01734   if ((++met->nx) > EX)
01735     ERRMSG("Cannot create periodic boundary conditions!");
01736
01737   /* Set longitude... */
01738   met->lon[met->nx - 1] = met->lon[met->nx - 2] + met->lon[1] - met->
      lon[0];
01739
01740   /* Loop over latitudes and pressure levels... */
01741 #pragma omp parallel for default(shared) private(iy,ip)
01742   for (iy = 0; iy < met->ny; iy++) {
```

```
01743     met->ps[met->nx - 1][iy] = met->ps[0][iy];
01744     met->pt[met->nx - 1][iy] = met->pt[0][iy];
01745     for (ip = 0; ip < met->np; ip++) {
01746       met->z[met->nx - 1][iy][ip] = met->z[0][iy][ip];
01747       met->t[met->nx - 1][iy][ip] = met->t[0][iy][ip];
01748       met->u[met->nx - 1][iy][ip] = met->u[0][iy][ip];
01749       met->v[met->nx - 1][iy][ip] = met->v[0][iy][ip];
01750       met->w[met->nx - 1][iy][ip] = met->w[0][iy][ip];
01751       met->pv[met->nx - 1][iy][ip] = met->pv[0][iy][ip];
01752       met->h2o[met->nx - 1][iy][ip] = met->h2o[0][iy][ip];
01753       met->o3[met->nx - 1][iy][ip] = met->o3[0][iy][ip];
01754     }
01755   }
01756 }
```

5.21.2.24 void read_met_pv (met_t * *met*)

Calculate potential vorticity.

Definition at line 1760 of file libtrac.c.

```
01761               {
01762
01763   double c0, c1, cr, dx, dy, dp0, dp1, denom, dtdx, dvdx, dtdy, dudy,
01764     dtdp, dudp, dvdp, latr, vort, pows[EP];
01765
01766   int ip, ip0, ip1, ix, ix0, ix1, iy, iy0, iy1;
01767
01768   /* Set powers... */
01769   for (ip = 0; ip < met->np; ip++)
01770     pows[ip] = pow(1000. / met->p[ip], 0.286);
01771
01772   /* Loop over grid points... */
01773 #pragma omp parallel for default(shared)
      private(ix,ix0,ix1,iy,iy0,iy1,latr,dx,dy,c0,c1,cr,vort,ip,ip0,ip1,dp0,dp1,denom,dtdx,dvdx,dtdy,dudy,dtdp,dudp,dvdp)
01774   for (ix = 0; ix < met->nx; ix++) {
01775
01776     /* Set indices... */
01777     ix0 = GSL_MAX(ix - 1, 0);
01778     ix1 = GSL_MIN(ix + 1, met->nx - 1);
01779
01780     /* Loop over grid points... */
01781     for (iy = 0; iy < met->ny; iy++) {
01782
01783       /* Set indices... */
01784       iy0 = GSL_MAX(iy - 1, 0);
01785       iy1 = GSL_MIN(iy + 1, met->ny - 1);
01786
01787       /* Set auxiliary variables... */
01788       latr = GSL_MIN(GSL_MAX(met->lat[iy], -89.), 89.);
01789       dx = 1000. * DEG2DX(met->lon[ix1] - met->lon[ix0], latr);
01790       dy = 1000. * DEG2DY(met->lat[iy1] - met->lat[iy0]);
01791       c0 = cos(met->lat[iy0] / 180. * M_PI);
01792       c1 = cos(met->lat[iy1] / 180. * M_PI);
01793       cr = cos(latr / 180. * M_PI);
01794       vort = 2 * 7.2921e-5 * sin(latr * M_PI / 180.);
01795
01796       /* Loop over grid points... */
01797       for (ip = 0; ip < met->np; ip++) {
01798
01799         /* Get gradients in longitude... */
01800         dtdx = (met->t[ix1][iy][ip] - met->t[ix0][iy][ip]) * pows[ip] / dx;
01801         dvdx = (met->v[ix1][iy][ip] - met->v[ix0][iy][ip]) / dx;
01802
01803         /* Get gradients in latitude... */
01804         dtdy = (met->t[ix][iy1][ip] - met->t[ix][iy0][ip]) * pows[ip] / dy;
01805         dudy = (met->u[ix][iy1][ip] * c1 - met->u[ix][iy0][ip] * c0) / dy;
01806
01807         /* Set indices... */
01808         ip0 = GSL_MAX(ip - 1, 0);
01809         ip1 = GSL_MIN(ip + 1, met->np - 1);
01810
01811         /* Get gradients in pressure... */
01812         dp0 = 100. * (met->p[ip] - met->p[ip0]);
01813         dp1 = 100. * (met->p[ip1] - met->p[ip]);
01814         if (ip != ip0 && ip != ip1) {
01815           denom = dp0 * dp1 * (dp0 + dp1);
01816           dtdp = (dp0 * dp0 * met->t[ix][iy][ip1] * pows[ip1]
01817                   - dp1 * dp1 * met->t[ix][iy][ip0] * pows[ip0]
01818                   + (dp1 * dp1 - dp0 * dp0) * met->t[ix][iy][ip] * pows[ip])
```

```
01819             / denom;
01820           dudp = (dp0 * dp0 * met->u[ix][iy][ip1]
01821                   - dp1 * dp1 * met->u[ix][iy][ip0]
01822                   + (dp1 * dp1 - dp0 * dp0) * met->u[ix][iy][ip])
01823             / denom;
01824           dvdp = (dp0 * dp0 * met->v[ix][iy][ip1]
01825                   - dp1 * dp1 * met->v[ix][iy][ip0]
01826                   + (dp1 * dp1 - dp0 * dp0) * met->v[ix][iy][ip])
01827             / denom;
01828         } else {
01829           denom = dp0 + dp1;
01830           dtdp =
01831             (met->t[ix][iy][ip1] * pows[ip1] -
01832              met->t[ix][iy][ip0] * pows[ip0]) / denom;
01833           dudp = (met->u[ix][iy][ip1] - met->u[ix][iy][ip0]) / denom;
01834           dvdp = (met->v[ix][iy][ip1] - met->v[ix][iy][ip0]) / denom;
01835         }
01836
01837         /* Calculate PV... */
01838         met->pv[ix][iy][ip] = (float)
01839           (1e6 * G0 *
01840            (-dtdp * (dvdx - dudy / cr + vort) + dvdp * dtdx - dudp * dtdy));
01841       }
01842     }
01843   }
01844 }
```

5.21.2.25 void read_met_sample (ctl_t * *ctl*, met_t * *met*)

Downsampling of meteorological data.

Definition at line 1848 of file libtrac.c.

```
01850               {
01851
01852   met_t *help;
01853
01854   float w, wsum;
01855
01856   int ip, ip2, ix, ix2, ix3, iy, iy2;
01857
01858   /* Check parameters... */
01859   if (ctl->met_dp <= 1 && ctl->met_dx <= 1 && ctl->met_dy <= 1
01860       && ctl->met_sp <= 1 && ctl->met_sx <= 1 && ctl->met_sy <= 1)
01861     return;
01862
01863   /* Allocate... */
01864   ALLOC(help, met_t, 1);
01865
01866   /* Copy data... */
01867   help->nx = met->nx;
01868   help->ny = met->ny;
01869   help->np = met->np;
01870   memcpy(help->lon, met->lon, sizeof(met->lon));
01871   memcpy(help->lat, met->lat, sizeof(met->lat));
01872   memcpy(help->p, met->p, sizeof(met->p));
01873
01874   /* Smoothing... */
01875   for (ix = 0; ix < met->nx; ix += ctl->met_dx) {
01876     for (iy = 0; iy < met->ny; iy += ctl->met_dy) {
01877       for (ip = 0; ip < met->np; ip += ctl->met_dp) {
01878         help->ps[ix][iy] = 0;
01879         help->pt[ix][iy] = 0;
01880         help->z[ix][iy][ip] = 0;
01881         help->t[ix][iy][ip] = 0;
01882         help->u[ix][iy][ip] = 0;
01883         help->v[ix][iy][ip] = 0;
01884         help->w[ix][iy][ip] = 0;
01885         help->pv[ix][iy][ip] = 0;
01886         help->h2o[ix][iy][ip] = 0;
01887         help->o3[ix][iy][ip] = 0;
01888         wsum = 0;
01889         for (ix2 = ix - ctl->met_sx + 1; ix2 <= ix + ctl->met_sx - 1; ix2++) {
01890           ix3 = ix2;
01891           if (ix3 < 0)
01892             ix3 += met->nx;
01893           else if (ix3 >= met->nx)
01894             ix3 -= met->nx;
01895
01896           for (iy2 = GSL_MAX(iy - ctl->met_sy + 1, 0);
```

```
01897                iy2 <= GSL_MIN(iy + ctl->met_sy - 1, met->ny - 1); iy2++)
01898             for (ip2 = GSL_MAX(ip - ctl->met_sp + 1, 0);
01899                  ip2 <= GSL_MIN(ip + ctl->met_sp - 1, met->np - 1); ip2++) {
01900               w = (float) (1.0 - fabs(ix - ix2) / ctl->met_sx)
01901                 * (float) (1.0 - fabs(iy - iy2) / ctl->met_sy)
01902                 * (float) (1.0 - fabs(ip - ip2) / ctl->met_sp);
01903               help->ps[ix][iy] += w * met->ps[ix3][iy2];
01904               help->pt[ix][iy] += w * met->pt[ix3][iy2];
01905               help->z[ix][iy][ip] += w * met->z[ix3][iy2][ip2];
01906               help->t[ix][iy][ip] += w * met->t[ix3][iy2][ip2];
01907               help->u[ix][iy][ip] += w * met->u[ix3][iy2][ip2];
01908               help->v[ix][iy][ip] += w * met->v[ix3][iy2][ip2];
01909               help->w[ix][iy][ip] += w * met->w[ix3][iy2][ip2];
01910               help->pv[ix][iy][ip] += w * met->pv[ix3][iy2][ip2];
01911               help->h2o[ix][iy][ip] += w * met->h2o[ix3][iy2][ip2];
01912               help->o3[ix][iy][ip] += w * met->o3[ix3][iy2][ip2];
01913               wsum += w;
01914             }
01915         }
01916         help->ps[ix][iy] /= wsum;
01917         help->pt[ix][iy] /= wsum;
01918         help->t[ix][iy][ip] /= wsum;
01919         help->z[ix][iy][ip] /= wsum;
01920         help->u[ix][iy][ip] /= wsum;
01921         help->v[ix][iy][ip] /= wsum;
01922         help->w[ix][iy][ip] /= wsum;
01923         help->pv[ix][iy][ip] /= wsum;
01924         help->h2o[ix][iy][ip] /= wsum;
01925         help->o3[ix][iy][ip] /= wsum;
01926       }
01927     }
01928   }
01929
01930   /* Downsampling... */
01931   met->nx = 0;
01932   for (ix = 0; ix < help->nx; ix += ctl->met_dx) {
01933     met->lon[met->nx] = help->lon[ix];
01934     met->ny = 0;
01935     for (iy = 0; iy < help->ny; iy += ctl->met_dy) {
01936       met->lat[met->ny] = help->lat[iy];
01937       met->ps[met->nx][met->ny] = help->ps[ix][iy];
01938       met->pt[met->nx][met->ny] = help->pt[ix][iy];
01939       met->np = 0;
01940       for (ip = 0; ip < help->np; ip += ctl->met_dp) {
01941         met->p[met->np] = help->p[ip];
01942         met->z[met->nx][met->ny][met->np] = help->z[ix][iy][ip];
01943         met->t[met->nx][met->ny][met->np] = help->t[ix][iy][ip];
01944         met->u[met->nx][met->ny][met->np] = help->u[ix][iy][ip];
01945         met->v[met->nx][met->ny][met->np] = help->v[ix][iy][ip];
01946         met->w[met->nx][met->ny][met->np] = help->w[ix][iy][ip];
01947         met->pv[met->nx][met->ny][met->np] = help->pv[ix][iy][ip];
01948         met->h2o[met->nx][met->ny][met->np] = help->h2o[ix][iy][ip];
01949         met->o3[met->nx][met->ny][met->np] = help->o3[ix][iy][ip];
01950         met->np++;
01951       }
01952       met->ny++;
01953     }
01954     met->nx++;
01955   }
01956
01957   /* Free... */
01958   free(help);
01959 }
```

5.21.2.26 void read_met_tropo (ctl_t * *ctl*, met_t * *met*)

Calculate tropopause pressure.

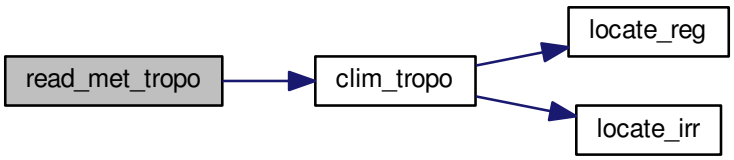
Definition at line 1963 of file libtrac.c.

```
01965               {
01966
01967   gsl_interp_accel *acc;
01968
01969   gsl_spline *spline;
01970
01971   double p2[400], pv[400], pv2[400], t[400], t2[400], th[400], th2[400],
01972     z[400], z2[400];
01973
01974   int found, ix, iy, iz, iz2;
```

```
01975
01976   /* Allocate... */
01977   acc = gsl_interp_accel_alloc();
01978   spline = gsl_spline_alloc(gsl_interp_cspline, (size_t) met->np);
01979
01980   /* Get altitude and pressure profiles... */
01981   for (iz = 0; iz < met->np; iz++)
01982     z[iz] = Z(met->p[iz]);
01983   for (iz = 0; iz <= 170; iz++) {
01984     z2[iz] = 4.5 + 0.1 * iz;
01985     p2[iz] = P(z2[iz]);
01986   }
01987
01988   /* Do not calculate tropopause... */
01989   if (ctl->met_tropo == 0)
01990     for (ix = 0; ix < met->nx; ix++)
01991       for (iy = 0; iy < met->ny; iy++)
01992         met->pt[ix][iy] = GSL_NAN;
01993
01994   /* Use tropopause climatology... */
01995   else if (ctl->met_tropo == 1)
01996     for (ix = 0; ix < met->nx; ix++)
01997       for (iy = 0; iy < met->ny; iy++)
01998         met->pt[ix][iy] = clim_tropo(met->time, met->lat[iy]);
01999
02000   /* Use cold point... */
02001   else if (ctl->met_tropo == 2) {
02002
02003     /* Loop over grid points... */
02004     for (ix = 0; ix < met->nx; ix++)
02005       for (iy = 0; iy < met->ny; iy++) {
02006
02007         /* Interpolate temperature profile... */
02008         for (iz = 0; iz < met->np; iz++)
02009           t[iz] = met->t[ix][iy][iz];
02010         gsl_spline_init(spline, z, t, (size_t) met->np);
02011         for (iz = 0; iz <= 170; iz++)
02012           t2[iz] = gsl_spline_eval(spline, z2[iz], acc);
02013
02014         /* Find minimum... */
02015         iz = (int) gsl_stats_min_index(t2, 1, 171);
02016         if (iz <= 0 || iz >= 170)
02017           met->pt[ix][iy] = GSL_NAN;
02018         else
02019           met->pt[ix][iy] = p2[iz];
02020       }
02021   }
02022
02023   /* Use WMO definition... */
02024   else if (ctl->met_tropo == 3 || ctl->met_tropo == 4) {
02025
02026     /* Loop over grid points... */
02027     for (ix = 0; ix < met->nx; ix++)
02028       for (iy = 0; iy < met->ny; iy++) {
02029
02030         /* Interpolate temperature profile... */
02031         for (iz = 0; iz < met->np; iz++)
02032           t[iz] = met->t[ix][iy][iz];
02033         gsl_spline_init(spline, z, t, (size_t) met->np);
02034         for (iz = 0; iz <= 160; iz++)
02035           t2[iz] = gsl_spline_eval(spline, z2[iz], acc);
02036
02037         /* Find 1st tropopause... */
02038         met->pt[ix][iy] = GSL_NAN;
02039         for (iz = 0; iz <= 140; iz++) {
02040           found = 1;
02041           for (iz2 = iz + 1; iz2 <= iz + 20; iz2++)
02042             if (1000. * G0 / RA * log(t2[iz2] / t2[iz])
02043                 / log(p2[iz2] / p2[iz]) > 2.0) {
02044               found = 0;
02045               break;
02046             }
02047           if (found) {
02048             if (iz > 0 && iz < 140)
02049               met->pt[ix][iy] = p2[iz];
02050             break;
02051           }
02052         }
02053
02054         /* Find 2nd tropopause... */
02055         if (ctl->met_tropo == 4) {
02056           met->pt[ix][iy] = GSL_NAN;
02057           for (; iz <= 140; iz++) {
02058             found = 1;
02059             for (iz2 = iz + 1; iz2 <= iz + 10; iz2++)
02060               if (1000. * G0 / RA * log(t2[iz2] / t2[iz])
02061                   / log(p2[iz2] / p2[iz]) < 3.0) {
```

```
02062                 found = 0;
02063                 break;
02064               }
02065             if (found)
02066               break;
02067           }
02068           for (; iz <= 140; iz++) {
02069             found = 1;
02070             for (iz2 = iz + 1; iz2 <= iz + 20; iz2++)
02071               if (1000. * G0 / RA * log(t2[iz2] / t2[iz])
02072                   / log(p2[iz2] / p2[iz]) > 2.0) {
02073                 found = 0;
02074                 break;
02075               }
02076             if (found) {
02077               if (iz > 0 && iz < 140)
02078                 met->pt[ix][iy] = p2[iz];
02079               break;
02080             }
02081           }
02082         }
02083       }
02084   }
02085
02086   /* Use dynamical tropopause... */
02087   else if (ctl->met_tropo == 5) {
02088
02089     /* Loop over grid points... */
02090     for (ix = 0; ix < met->nx; ix++)
02091       for (iy = 0; iy < met->ny; iy++) {
02092
02093         /* Interpolate potential vorticity profile... */
02094         for (iz = 0; iz < met->np; iz++)
02095           pv[iz] = met->pv[ix][iy][iz];
02096         gsl_spline_init(spline, z, pv, (size_t) met->np);
02097         for (iz = 0; iz <= 160; iz++)
02098           pv2[iz] = gsl_spline_eval(spline, z2[iz], acc);
02099
02100         /* Interpolate potential temperature profile... */
02101         for (iz = 0; iz < met->np; iz++)
02102           th[iz] = THETA(met->p[iz], met->t[ix][iy][iz]);
02103         gsl_spline_init(spline, z, th, (size_t) met->np);
02104         for (iz = 0; iz <= 160; iz++)
02105           th2[iz] = gsl_spline_eval(spline, z2[iz], acc);
02106
02107         /* Find dynamical tropopause 3.5 PVU + 380 K */
02108         met->pt[ix][iy] = GSL_NAN;
02109         for (iz = 0; iz <= 160; iz++)
02110           if (fabs(pv2[iz]) >= 3.5 || th2[iz] >= 380.) {
02111             if (iz > 0 && iz < 160)
02112               met->pt[ix][iy] = p2[iz];
02113             break;
02114           }
02115       }
02116   }
02117
02118   else
02119     ERRMSG("Cannot calculate tropopause!");
02120
02121   /* Free... */
02122   gsl_spline_free(spline);
02123   gsl_interp_accel_free(acc);
02124 }
```

Here is the call graph for this function:



5.21.2.27 double scan_ctl (const char * *filename*, int *argc*, char * *argv[]*, const char * *varname*, int *arridx*, const char * *defvalue*, char * *value*)

Read a control parameter from file or command line.

Definition at line 2128 of file libtrac.c.

```
02135               {
02136
02137   FILE *in = NULL;
02138
02139   char dummy[LEN], fullname1[LEN], fullname2[LEN], line[LEN],
02140     msg[2 * LEN], rvarname[LEN], rval[LEN];
02141
02142   int contain = 0, i;
02143
02144   /* Open file... */
02145   if (filename[strlen(filename) - 1] != '-')
02146     if (!(in = fopen(filename, "r")))
02147       ERRMSG("Cannot open file!");
02148
02149   /* Set full variable name... */
02150   if (arridx >= 0) {
02151     sprintf(fullname1, "%s[%d]", varname, arridx);
02152     sprintf(fullname2, "%s[*]", varname);
02153   } else {
02154     sprintf(fullname1, "%s", varname);
02155     sprintf(fullname2, "%s", varname);
02156   }
02157
02158   /* Read data... */
02159   if (in != NULL)
02160     while (fgets(line, LEN, in))
02161       if (sscanf(line, "%s %s %s", rvarname, dummy, rval) == 3)
02162         if (strcasecmp(rvarname, fullname1) == 0 ||
02163             strcasecmp(rvarname, fullname2) == 0) {
02164           contain = 1;
02165           break;
02166         }
02167   for (i = 1; i < argc - 1; i++)
02168     if (strcasecmp(argv[i], fullname1) == 0 ||
02169         strcasecmp(argv[i], fullname2) == 0) {
02170       sprintf(rval, "%s", argv[i + 1]);
02171       contain = 1;
02172       break;
02173     }
02174
02175   /* Close file... */
02176   if (in != NULL)
02177     fclose(in);
02178
02179   /* Check for missing variables... */
02180   if (!contain) {
02181     if (strlen(defvalue) > 0)
02182       sprintf(rval, "%s", defvalue);
02183     else {
02184       sprintf(msg, "Missing variable %s!\n", fullname1);
02185       ERRMSG(msg);
02186     }
02187   }
02188
02189   /* Write info... */
02190   printf("%s = %s\n", fullname1, rval);
02191
02192   /* Return values... */
02193   if (value != NULL)
02194     sprintf(value, "%s", rval);
02195   return atof(rval);
02196 }
```

5.21.2.28 void time2jsec (int *year*, int *mon*, int *day*, int *hour*, int *min*, int *sec*, double *remain*, double * *jsec*)

Convert date to seconds.

Definition at line 2200 of file libtrac.c.

```
02208                {
02209
02210   struct tm t0, t1;
02211
02212   t0.tm_year = 100;
02213   t0.tm_mon = 0;
02214   t0.tm_mday = 1;
02215   t0.tm_hour = 0;
02216   t0.tm_min = 0;
02217   t0.tm_sec = 0;
02218
02219   t1.tm_year = year - 1900;
02220   t1.tm_mon = mon - 1;
02221   t1.tm_mday = day;
02222   t1.tm_hour = hour;
02223   t1.tm_min = min;
02224   t1.tm_sec = sec;
02225
02226   *jsec = (double) timegm(&t1) - (double) timegm(&t0) + remain;
02227 }
```

5.21.2.29 void timer (const char * *name*, int *id*, int *mode*)

Measure wall-clock time.

Definition at line 2231 of file libtrac.c.

```
02234            {
02235
02236   static double starttime[NTIMER], runtime[NTIMER];
02237
02238   /* Check id... */
02239   if (id < 0 || id >= NTIMER)
02240     ERRMSG("Too many timers!");
02241
02242   /* Start timer... */
02243   if (mode == 1) {
02244     if (starttime[id] <= 0)
02245       starttime[id] = omp_get_wtime();
02246     else
02247       ERRMSG("Timer already started!");
02248   }
02249
02250   /* Stop timer... */
02251   else if (mode == 2) {
02252     if (starttime[id] > 0) {
02253       runtime[id] = runtime[id] + omp_get_wtime() - starttime[id];
02254       starttime[id] = -1;
02255     }
02256   }
02257
02258   /* Print timer... */
02259   else if (mode == 3) {
02260     printf("%s = %.3f s\n", name, runtime[id]);
02261     runtime[id] = 0;
02262   }
02263 }
```

5.21.2.30 void write_atm (const char * *filename*, ctl_t * *ctl*, atm_t * *atm*, double *t*)

Write atmospheric data.

Definition at line 2267 of file libtrac.c.

```
02271            {
02272
02273   FILE *in, *out;
02274
02275   char line[LEN];
02276
02277   double r, t0, t1;
02278
02279   int ip, iq, year, mon, day, hour, min, sec;
02280
```

```
02281   /* Set time interval for output... */
02282   t0 = t - 0.5 * ctl->dt_mod;
02283   t1 = t + 0.5 * ctl->dt_mod;
02284
02285   /* Write info... */
02286   printf("Write atmospheric data: %s\n", filename);
02287
02288   /* Write ASCII data... */
02289   if (ctl->atm_type == 0) {
02290
02291     /* Check if gnuplot output is requested... */
02292     if (ctl->atm_gpfile[0] != '-') {
02293
02294       /* Create gnuplot pipe... */
02295       if (!(out = popen("gnuplot", "w")))
02296         ERRMSG("Cannot create pipe to gnuplot!");
02297
02298       /* Set plot filename... */
02299       fprintf(out, "set out \"%s.png\"\n", filename);
02300
02301       /* Set time string... */
02302       jsec2time(t, &year, &mon, &day, &hour, &min, &sec, &r);
02303       fprintf(out, "timestr=\"%d-%02d-%02d, %02d:%02d UTC\"\n",
02304               year, mon, day, hour, min);
02305
02306       /* Dump gnuplot file to pipe... */
02307       if (!(in = fopen(ctl->atm_gpfile, "r")))
02308         ERRMSG("Cannot open file!");
02309       while (fgets(line, LEN, in))
02310         fprintf(out, "%s", line);
02311       fclose(in);
02312     }
02313
02314     else {
02315
02316       /* Create file... */
02317       if (!(out = fopen(filename, "w")))
02318         ERRMSG("Cannot create file!");
02319     }
02320
02321     /* Write header... */
02322     fprintf(out,
02323             "# $1 = time [s]\n"
02324             "# $2 = altitude [km]\n"
02325             "# $3 = longitude [deg]\n" "# $4 = latitude [deg]\n");
02326     for (iq = 0; iq < ctl->nq; iq++)
02327       fprintf(out, "# $%i = %s [%s]\n", iq + 5, ctl->qnt_name[iq],
02328               ctl->qnt_unit[iq]);
02329     fprintf(out, "\n");
02330
02331     /* Write data... */
02332     for (ip = 0; ip < atm->np; ip++) {
02333
02334       /* Check time... */
02335       if (ctl->atm_filter && (atm->time[ip] < t0 || atm->time[ip] > t1))
02336         continue;
02337
02338       /* Write output... */
02339       fprintf(out, "%.2f %g %g %g", atm->time[ip], Z(atm->p[ip]),
02340               atm->lon[ip], atm->lat[ip]);
02341       for (iq = 0; iq < ctl->nq; iq++) {
02342         fprintf(out, " ");
02343         fprintf(out, ctl->qnt_format[iq], atm->q[iq][ip]);
02344       }
02345       fprintf(out, "\n");
02346     }
02347
02348     /* Close file... */
02349     fclose(out);
02350   }
02351
02352   /* Write binary data... */
02353   else if (ctl->atm_type == 1) {
02354
02355     /* Create file... */
02356     if (!(out = fopen(filename, "w")))
02357       ERRMSG("Cannot create file!");
02358
02359     /* Write data... */
02360     FWRITE(&atm->np, int,
02361            1,
02362            out);
02363     FWRITE(atm->time, double,
02364              (size_t) atm->np,
02365            out);
02366     FWRITE(atm->p, double,
02367              (size_t) atm->np,
```

```
02368             out);
02369     FWRITE(atm->lon, double,
02370              (size_t) atm->np,
02371             out);
02372     FWRITE(atm->lat, double,
02373              (size_t) atm->np,
02374             out);
02375     for (iq = 0; iq < ctl->nq; iq++)
02376       FWRITE(atm->q[iq], double,
02377                (size_t) atm->np,
02378              out);
02379
02380     /* Close file... */
02381     fclose(out);
02382   }
02383
02384   /* Error... */
02385   else
02386     ERRMSG("Atmospheric data type not supported!");
02387 }
```

Here is the call graph for this function:

5.21.2.31 void write_csi (const char * *filename*, ctl_t * *ctl*, atm_t * *atm*, double *t*)

Write CSI data.

Definition at line 2391 of file libtrac.c.

```
02395             {
02396
02397   static FILE *in, *out;
02398
02399   static char line[LEN];
02400
02401   static double modmean[GX][GY][GZ], obsmean[GX][GY][GZ],
02402     rt, rz, rlon, rlat, robs, t0, t1, area, dlon, dlat, lat;
02403
02404   static int obscount[GX][GY][GZ], cx, cy, cz, ip, ix, iy, iz;
02405
02406   /* Init... */
02407   if (t == ctl->t_start) {
02408
02409     /* Check quantity index for mass... */
02410     if (ctl->qnt_m < 0)
02411       ERRMSG("Need quantity mass!");
02412
02413     /* Open observation data file... */
02414     printf("Read CSI observation data: %s\n", ctl->csi_obsfile);
02415     if (!(in = fopen(ctl->csi_obsfile, "r")))
02416       ERRMSG("Cannot open file!");
02417
02418     /* Create new file... */
02419     printf("Write CSI data: %s\n", filename);
02420     if (!(out = fopen(filename, "w")))
02421       ERRMSG("Cannot create file!");
02422
02423     /* Write header... */
02424     fprintf(out,
02425             "# $1 = time [s]\n"
02426             "# $2 = number of hits (cx)\n"
02427             "# $3 = number of misses (cy)\n"
```

```
02428             "# $4 = number of false alarms (cz)\n"
02429             "# $5 = number of observations (cx + cy)\n"
02430             "# $6 = number of forecasts (cx + cz)\n"
02431             "# $7 = bias (forecasts/observations) [%%]\n"
02432             "# $8 = probability of detection (POD) [%%]\n"
02433             "# $9 = false alarm rate (FAR) [%%]\n"
02434             "# $10 = critical success index (CSI) [%%]\n\n");
02435   }
02436
02437   /* Set time interval... */
02438   t0 = t - 0.5 * ctl->dt_mod;
02439   t1 = t + 0.5 * ctl->dt_mod;
02440
02441   /* Initialize grid cells... */
02442 #pragma omp parallel for default(shared) private(ix,iy,iz)
02443   for (ix = 0; ix < ctl->csi_nx; ix++)
02444     for (iy = 0; iy < ctl->csi_ny; iy++)
02445       for (iz = 0; iz < ctl->csi_nz; iz++)
02446         modmean[ix][iy][iz] = obsmean[ix][iy][iz] = obscount[ix][iy][iz] = 0;
02447
02448   /* Read observation data... */
02449   while (fgets(line, LEN, in)) {
02450
02451     /* Read data... */
02452     if (sscanf(line, "%lg %lg %lg %lg %lg", &rt, &rz, &rlon, &rlat, &robs) !=
02453         5)
02454       continue;
02455
02456     /* Check time... */
02457     if (rt < t0)
02458       continue;
02459     if (rt > t1)
02460       break;
02461
02462     /* Calculate indices... */
02463     ix = (int) ((rlon - ctl->csi_lon0)
02464                 / (ctl->csi_lon1 - ctl->csi_lon0) * ctl->csi_nx);
02465     iy = (int) ((rlat - ctl->csi_lat0)
02466                 / (ctl->csi_lat1 - ctl->csi_lat0) * ctl->csi_ny);
02467     iz = (int) ((rz - ctl->csi_z0)
02468                 / (ctl->csi_z1 - ctl->csi_z0) * ctl->csi_nz);
02469
02470     /* Check indices... */
02471     if (ix < 0 || ix >= ctl->csi_nx ||
02472         iy < 0 || iy >= ctl->csi_ny || iz < 0 || iz >= ctl->csi_nz)
02473       continue;
02474
02475     /* Get mean observation index... */
02476     obsmean[ix][iy][iz] += robs;
02477     obscount[ix][iy][iz]++;
02478   }
02479
02480   /* Analyze model data... */
02481 #pragma omp parallel for default(shared) private(ip,ix,iy,iz)
02482   for (ip = 0; ip < atm->np; ip++) {
02483
02484     /* Check time... */
02485     if (atm->time[ip] < t0 || atm->time[ip] > t1)
02486       continue;
02487
02488     /* Get indices... */
02489     ix = (int) ((atm->lon[ip] - ctl->csi_lon0)
02490                 / (ctl->csi_lon1 - ctl->csi_lon0) * ctl->csi_nx);
02491     iy = (int) ((atm->lat[ip] - ctl->csi_lat0)
02492                 / (ctl->csi_lat1 - ctl->csi_lat0) * ctl->csi_ny);
02493     iz = (int) ((Z(atm->p[ip]) - ctl->csi_z0)
02494                 / (ctl->csi_z1 - ctl->csi_z0) * ctl->csi_nz);
02495
02496     /* Check indices... */
02497     if (ix < 0 || ix >= ctl->csi_nx ||
02498         iy < 0 || iy >= ctl->csi_ny || iz < 0 || iz >= ctl->csi_nz)
02499       continue;
02500
02501     /* Get total mass in grid cell... */
02502     modmean[ix][iy][iz] += atm->q[ctl->qnt_m][ip];
02503   }
02504
02505   /* Analyze all grid cells... */
02506 #pragma omp parallel for default(shared) private(ix,iy,iz,dlon,dlat,lat,area)
02507   for (ix = 0; ix < ctl->csi_nx; ix++)
02508     for (iy = 0; iy < ctl->csi_ny; iy++)
02509       for (iz = 0; iz < ctl->csi_nz; iz++) {
02510
02511         /* Calculate mean observation index... */
02512         if (obscount[ix][iy][iz] > 0)
02513           obsmean[ix][iy][iz] /= obscount[ix][iy][iz];
02514
```

```
02515         /* Calculate column density... */
02516         if (modmean[ix][iy][iz] > 0) {
02517           dlon = (ctl->csi_lon1 - ctl->csi_lon0) / ctl->csi_nx;
02518           dlat = (ctl->csi_lat1 - ctl->csi_lat0) / ctl->csi_ny;
02519           lat = ctl->csi_lat0 + dlat * (iy + 0.5);
02520           area = dlat * M_PI * RE / 180. * dlon * M_PI * RE / 180.
02521             * cos(lat * M_PI / 180.);
02522           modmean[ix][iy][iz] /= (1e6 * area);
02523         }
02524
02525         /* Calculate CSI... */
02526         if (obscount[ix][iy][iz] > 0) {
02527           if (obsmean[ix][iy][iz] >= ctl->csi_obsmin &&
02528               modmean[ix][iy][iz] >= ctl->csi_modmin)
02529             cx++;
02530           else if (obsmean[ix][iy][iz] >= ctl->csi_obsmin &&
02531                    modmean[ix][iy][iz] < ctl->csi_modmin)
02532             cy++;
02533           else if (obsmean[ix][iy][iz] < ctl->csi_obsmin &&
02534                    modmean[ix][iy][iz] >= ctl->csi_modmin)
02535             cz++;
02536         }
02537       }
02538
02539   /* Write output... */
02540   if (fmod(t, ctl->csi_dt_out) == 0) {
02541
02542     /* Write... */
02543     fprintf(out, "%.2f %d %d %d %d %d %g %g %g %g\n",
02544             t, cx, cy, cz, cx + cy, cx + cz,
02545             (cx + cy > 0) ? 100. * (cx + cz) / (cx + cy) : GSL_NAN,
02546             (cx + cy > 0) ? (100. * cx) / (cx + cy) : GSL_NAN,
02547             (cx + cz > 0) ? (100. * cz) / (cx + cz) : GSL_NAN,
02548             (cx + cy + cz > 0) ? (100. * cx) / (cx + cy + cz) : GSL_NAN);
02549
02550     /* Set counters to zero... */
02551     cx = cy = cz = 0;
02552   }
02553
02554   /* Close file... */
02555   if (t == ctl->t_stop)
02556     fclose(out);
02557 }
```

5.21.2.32 void write_ens (const char * *filename*, ctl_t * *ctl*, atm_t * *atm*, double *t*)

Write ensemble data.

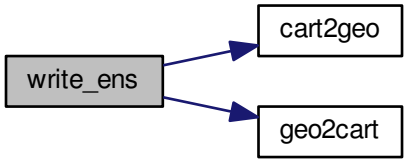
Definition at line 2561 of file libtrac.c.

```
02565             {
02566
02567   static FILE *out;
02568
02569   static double dummy, ens, lat, lon, p[NENS], q[NQ][NENS],
02570     t0, t1, x[NENS][3], xm[3];
02571
02572   static int ip, iq;
02573
02574   static size_t i, n;
02575
02576   /* Init... */
02577   if (t == ctl->t_start) {
02578
02579     /* Check quantities... */
02580     if (ctl->qnt_ens < 0)
02581       ERRMSG("Missing ensemble IDs!");
02582
02583     /* Create new file... */
02584     printf("Write ensemble data: %s\n", filename);
02585     if (!(out = fopen(filename, "w")))
02586       ERRMSG("Cannot create file!");
02587
02588     /* Write header... */
02589     fprintf(out,
02590             "# $1 = time [s]\n"
02591             "# $2 = altitude [km]\n"
02592             "# $3 = longitude [deg]\n" "# $4 = latitude [deg]\n");
02593     for (iq = 0; iq < ctl->nq; iq++)
02594       fprintf(out, "# $%d = %s (mean) [%s]\n", 5 + iq,
```

```
02595               ctl->qnt_name[iq], ctl->qnt_unit[iq]);
02596     for (iq = 0; iq < ctl->nq; iq++)
02597       fprintf(out, "# $%d = %s (sigma) [%s]\n", 5 + ctl->nq + iq,
02598               ctl->qnt_name[iq], ctl->qnt_unit[iq]);
02599     fprintf(out, "# $%d = number of members\n\n", 5 + 2 * ctl->nq);
02600   }
02601
02602   /* Set time interval... */
02603   t0 = t - 0.5 * ctl->dt_mod;
02604   t1 = t + 0.5 * ctl->dt_mod;
02605
02606   /* Init... */
02607   ens = GSL_NAN;
02608   n = 0;
02609
02610   /* Loop over air parcels... */
02611   for (ip = 0; ip < atm->np; ip++) {
02612
02613     /* Check time... */
02614     if (atm->time[ip] < t0 || atm->time[ip] > t1)
02615       continue;
02616
02617     /* Check ensemble id... */
02618     if (atm->q[ctl->qnt_ens][ip] != ens) {
02619
02620       /* Write results... */
02621       if (n > 0) {
02622
02623         /* Get mean position... */
02624         xm[0] = xm[1] = xm[2] = 0;
02625         for (i = 0; i < n; i++) {
02626           xm[0] += x[i][0] / (double) n;
02627           xm[1] += x[i][1] / (double) n;
02628           xm[2] += x[i][2] / (double) n;
02629         }
02630         cart2geo(xm, &dummy, &lon, &lat);
02631         fprintf(out, "%.2f %g %g %g", t, Z(gsl_stats_mean(p, 1, n)), lon,
02632                 lat);
02633
02634         /* Get quantity statistics... */
02635         for (iq = 0; iq < ctl->nq; iq++) {
02636           fprintf(out, " ");
02637           fprintf(out, ctl->qnt_format[iq], gsl_stats_mean(q[iq], 1, n));
02638         }
02639         for (iq = 0; iq < ctl->nq; iq++) {
02640           fprintf(out, " ");
02641           fprintf(out, ctl->qnt_format[iq], gsl_stats_sd(q[iq], 1, n));
02642         }
02643         fprintf(out, " %lu\n", n);
02644       }
02645
02646       /* Init new ensemble... */
02647       ens = atm->q[ctl->qnt_ens][ip];
02648       n = 0;
02649     }
02650
02651     /* Save data... */
02652     p[n] = atm->p[ip];
02653     geo2cart(0, atm->lon[ip], atm->lat[ip], x[n]);
02654     for (iq = 0; iq < ctl->nq; iq++)
02655       q[iq][n] = atm->q[iq][ip];
02656     if ((++n) >= NENS)
02657       ERRMSG("Too many data points!");
02658   }
02659
02660   /* Write results... */
02661   if (n > 0) {
02662
02663     /* Get mean position... */
02664     xm[0] = xm[1] = xm[2] = 0;
02665     for (i = 0; i < n; i++) {
02666       xm[0] += x[i][0] / (double) n;
02667       xm[1] += x[i][1] / (double) n;
02668       xm[2] += x[i][2] / (double) n;
02669     }
02670     cart2geo(xm, &dummy, &lon, &lat);
02671     fprintf(out, "%.2f %g %g %g", t, Z(gsl_stats_mean(p, 1, n)), lon, lat);
02672
02673     /* Get quantity statistics... */
02674     for (iq = 0; iq < ctl->nq; iq++) {
02675       fprintf(out, " ");
02676       fprintf(out, ctl->qnt_format[iq], gsl_stats_mean(q[iq], 1, n));
02677     }
02678     for (iq = 0; iq < ctl->nq; iq++) {
02679       fprintf(out, " ");
02680       fprintf(out, ctl->qnt_format[iq], gsl_stats_sd(q[iq], 1, n));
02681     }
```

```
02682     fprintf(out, " %lu\n", n);
02683   }
02684
02685   /* Close file... */
02686   if (t == ctl->t_stop)
02687     fclose(out);
02688 }
```

Here is the call graph for this function:



5.21.2.33 void write_grid (const char * *filename*, ctl_t * *ctl*, met_t * *met0*, met_t * *met1*, atm_t * *atm*, double *t*)

Write gridded data.

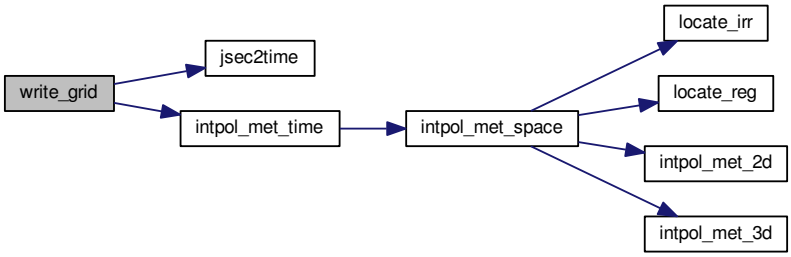
Definition at line 2692 of file libtrac.c.

```
02698             {
02699
02700   FILE *in, *out;
02701
02702   char line[LEN];
02703
02704   static double mass[GX][GY][GZ], z, dz, lon, dlon, lat, dlat,
02705     area, rho_air, press, temp, cd, vmr, t0, t1, r;
02706
02707   static int ip, ix, iy, iz, year, mon, day, hour, min, sec;
02708
02709   /* Check dimensions... */
02710   if (ctl->grid_nx > GX || ctl->grid_ny > GY || ctl->grid_nz > GZ)
02711     ERRMSG("Grid dimensions too large!");
02712
02713   /* Check quantity index for mass... */
02714   if (ctl->qnt_m < 0)
02715     ERRMSG("Need quantity mass!");
02716
02717   /* Set time interval for output... */
02718   t0 = t - 0.5 * ctl->dt_mod;
02719   t1 = t + 0.5 * ctl->dt_mod;
02720
02721   /* Set grid box size... */
02722   dz = (ctl->grid_z1 - ctl->grid_z0) / ctl->grid_nz;
02723   dlon = (ctl->grid_lon1 - ctl->grid_lon0) / ctl->grid_nx;
02724   dlat = (ctl->grid_lat1 - ctl->grid_lat0) / ctl->grid_ny;
02725
02726   /* Initialize grid... */
02727 #pragma omp parallel for default(shared) private(ix,iy,iz)
02728   for (ix = 0; ix < ctl->grid_nx; ix++)
02729     for (iy = 0; iy < ctl->grid_ny; iy++)
02730       for (iz = 0; iz < ctl->grid_nz; iz++)
02731         mass[ix][iy][iz] = 0;
02732
02733   /* Average data... */
02734 #pragma omp parallel for default(shared) private(ip,ix,iy,iz)
02735   for (ip = 0; ip < atm->np; ip++)
02736     if (atm->time[ip] >= t0 && atm->time[ip] <= t1) {
02737
02738       /* Get index... */
02739       ix = (int) ((atm->lon[ip] - ctl->grid_lon0) / dlon);
```

```
02740       iy = (int) ((atm->lat[ip] - ctl->grid_lat0) / dlat);
02741       iz = (int) ((Z(atm->p[ip]) - ctl->grid_z0) / dz);
02742
02743       /* Check indices... */
02744       if (ix < 0 || ix >= ctl->grid_nx ||
02745           iy < 0 || iy >= ctl->grid_ny || iz < 0 || iz >= ctl->grid_nz)
02746         continue;
02747
02748       /* Add mass... */
02749       mass[ix][iy][iz] += atm->q[ctl->qnt_m][ip];
02750     }
02751
02752   /* Check if gnuplot output is requested... */
02753   if (ctl->grid_gpfile[0] != '-') {
02754
02755     /* Write info... */
02756     printf("Plot grid data: %s.png\n", filename);
02757
02758     /* Create gnuplot pipe... */
02759     if (!(out = popen("gnuplot", "w")))
02760       ERRMSG("Cannot create pipe to gnuplot!");
02761
02762     /* Set plot filename... */
02763     fprintf(out, "set out \"%s.png\"\n", filename);
02764
02765     /* Set time string... */
02766     jsec2time(t, &year, &mon, &day, &hour, &min, &sec, &r);
02767     fprintf(out, "timestr=\"%d-%02d-%02d, %02d:%02d UTC\"\n",
02768             year, mon, day, hour, min);
02769
02770     /* Dump gnuplot file to pipe... */
02771     if (!(in = fopen(ctl->grid_gpfile, "r")))
02772       ERRMSG("Cannot open file!");
02773     while (fgets(line, LEN, in))
02774       fprintf(out, "%s", line);
02775     fclose(in);
02776   }
02777
02778   else {
02779
02780     /* Write info... */
02781     printf("Write grid data: %s\n", filename);
02782
02783     /* Create file... */
02784     if (!(out = fopen(filename, "w")))
02785       ERRMSG("Cannot create file!");
02786   }
02787
02788   /* Write header... */
02789   fprintf(out,
02790           "# $1 = time [s]\n"
02791           "# $2 = altitude [km]\n"
02792           "# $3 = longitude [deg]\n"
02793           "# $4 = latitude [deg]\n"
02794           "# $5 = surface area [km^2]\n"
02795           "# $6 = layer width [km]\n"
02796           "# $7 = temperature [K]\n"
02797           "# $8 = column density [kg/m^2]\n"
02798           "# $9 = volume mixing ratio [1]\n\n");
02799
02800   /* Write data... */
02801   for (ix = 0; ix < ctl->grid_nx; ix++) {
02802     if (ix > 0 && ctl->grid_ny > 1 && !ctl->grid_sparse)
02803       fprintf(out, "\n");
02804     for (iy = 0; iy < ctl->grid_ny; iy++) {
02805       if (iy > 0 && ctl->grid_nz > 1 && !ctl->grid_sparse)
02806         fprintf(out, "\n");
02807       for (iz = 0; iz < ctl->grid_nz; iz++)
02808         if (!ctl->grid_sparse || mass[ix][iy][iz] > 0) {
02809
02810           /* Set coordinates... */
02811           z = ctl->grid_z0 + dz * (iz + 0.5);
02812           lon = ctl->grid_lon0 + dlon * (ix + 0.5);
02813           lat = ctl->grid_lat0 + dlat * (iy + 0.5);
02814
02815           /* Get pressure and temperature... */
02816           press = P(z);
02817           intpol_met_time(met0, met1, t, press, lon, lat, NULL, NULL,
02818                           NULL, &temp, NULL, NULL, NULL, NULL, NULL, NULL);
02819
02820           /* Calculate surface area... */
02821           area = dlat * dlon * SQR(RE * M_PI / 180.)
02822             * cos(lat * M_PI / 180.);
02823
02824           /* Calculate column density... */
02825           cd = mass[ix][iy][iz] / (1e6 * area);
02826
```

```
02827           /* Calculate volume mixing ratio... */
02828           rho_air = 100. * press / (RA * temp);
02829           vmr = MA / ctl->molmass * mass[ix][iy][iz]
02830             / (rho_air * 1e6 * area * 1e3 * dz);
02831
02832           /* Write output... */
02833           fprintf(out, "%.2f %g %g %g %g %g %g %g %g\n",
02834                   t, z, lon, lat, area, dz, temp, cd, vmr);
02835         }
02836     }
02837   }
02838
02839   /* Close file... */
02840   fclose(out);
02841 }
```

Here is the call graph for this function:



5.21.2.34 void write_prof (const char * *filename*, ctl_t * *ctl*, met_t * *met0*, met_t * *met1*, atm_t * *atm*, double *t*)

Write profile data.

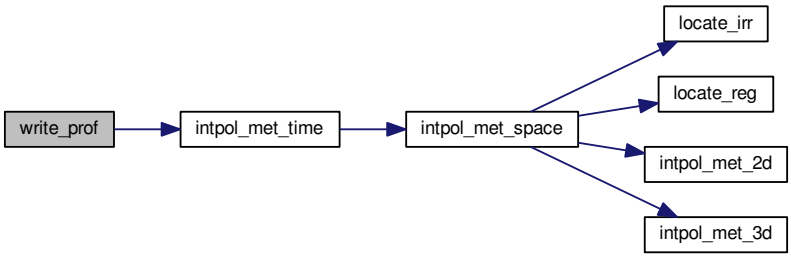
Definition at line 2845 of file libtrac.c.

```
02851             {
02852
02853   static FILE *in, *out;
02854
02855   static char line[LEN];
02856
02857   static double mass[GX][GY][GZ], obsmean[GX][GY], obsmean2[GX][GY], rt, rz,
02858     rlon, rlat, robs, t0, t1, area, dz, dlon, dlat, lon, lat, z, press, temp,
02859     rho_air, vmr, h2o, o3;
02860
02861   static int obscount[GX][GY], ip, ix, iy, iz, okay;
02862
02863   /* Init... */
02864   if (t == ctl->t_start) {
02865
02866     /* Check quantity index for mass... */
02867     if (ctl->qnt_m < 0)
02868       ERRMSG("Need quantity mass!");
02869
02870     /* Check dimensions... */
02871     if (ctl->prof_nx > GX || ctl->prof_ny > GY || ctl->prof_nz > GZ)
02872       ERRMSG("Grid dimensions too large!");
02873
02874     /* Open observation data file... */
02875     printf("Read profile observation data: %s\n", ctl->prof_obsfile);
02876     if (!(in = fopen(ctl->prof_obsfile, "r")))
02877       ERRMSG("Cannot open file!");
02878
02879     /* Create new output file... */
02880     printf("Write profile data: %s\n", filename);
02881     if (!(out = fopen(filename, "w")))
02882       ERRMSG("Cannot create file!");
```

```
02883
02884     /* Write header... */
02885     fprintf(out,
02886             "# $1 = time [s]\n"
02887             "# $2 = altitude [km]\n"
02888             "# $3 = longitude [deg]\n"
02889             "# $4 = latitude [deg]\n"
02890             "# $5 = pressure [hPa]\n"
02891             "# $6 = temperature [K]\n"
02892             "# $7 = volume mixing ratio [1]\n"
02893             "# $8 = H2O volume mixing ratio [1]\n"
02894             "# $9 = O3 volume mixing ratio [1]\n"
02895             "# $10 = observed BT index (mean) [K]\n"
02896             "# $11 = observed BT index (sigma) [K]\n");
02897
02898     /* Set grid box size... */
02899     dz = (ctl->prof_z1 - ctl->prof_z0) / ctl->prof_nz;
02900     dlon = (ctl->prof_lon1 - ctl->prof_lon0) / ctl->prof_nx;
02901     dlat = (ctl->prof_lat1 - ctl->prof_lat0) / ctl->prof_ny;
02902   }
02903
02904   /* Set time interval... */
02905   t0 = t - 0.5 * ctl->dt_mod;
02906   t1 = t + 0.5 * ctl->dt_mod;
02907
02908   /* Initialize... */
02909 #pragma omp parallel for default(shared) private(ix,iy,iz)
02910   for (ix = 0; ix < ctl->prof_nx; ix++)
02911     for (iy = 0; iy < ctl->prof_ny; iy++) {
02912       obsmean[ix][iy] = 0;
02913       obsmean2[ix][iy] = 0;
02914       obscount[ix][iy] = 0;
02915       for (iz = 0; iz < ctl->prof_nz; iz++)
02916         mass[ix][iy][iz] = 0;
02917     }
02918
02919   /* Read observation data... */
02920   while (fgets(line, LEN, in)) {
02921
02922     /* Read data... */
02923     if (sscanf(line, "%lg %lg %lg %lg %lg", &rt, &rz, &rlon, &rlat, &robs) !=
02924         5)
02925       continue;
02926
02927     /* Check time... */
02928     if (rt < t0)
02929       continue;
02930     if (rt > t1)
02931       break;
02932
02933     /* Calculate indices... */
02934     ix = (int) ((rlon - ctl->prof_lon0) / dlon);
02935     iy = (int) ((rlat - ctl->prof_lat0) / dlat);
02936
02937     /* Check indices... */
02938     if (ix < 0 || ix >= ctl->prof_nx || iy < 0 || iy >= ctl->prof_ny)
02939       continue;
02940
02941     /* Get mean observation index... */
02942     obsmean[ix][iy] += robs;
02943     obsmean2[ix][iy] += SQR(robs);
02944     obscount[ix][iy]++;
02945   }
02946
02947   /* Analyze model data... */
02948 #pragma omp parallel for default(shared) private(ip,ix,iy,iz)
02949   for (ip = 0; ip < atm->np; ip++) {
02950
02951     /* Check time... */
02952     if (atm->time[ip] < t0 || atm->time[ip] > t1)
02953       continue;
02954
02955     /* Get indices... */
02956     ix = (int) ((atm->lon[ip] - ctl->prof_lon0) / dlon);
02957     iy = (int) ((atm->lat[ip] - ctl->prof_lat0) / dlat);
02958     iz = (int) ((Z(atm->p[ip]) - ctl->prof_z0) / dz);
02959
02960     /* Check indices... */
02961     if (ix < 0 || ix >= ctl->prof_nx ||
02962         iy < 0 || iy >= ctl->prof_ny || iz < 0 || iz >= ctl->prof_nz)
02963       continue;
02964
02965     /* Get total mass in grid cell... */
02966     mass[ix][iy][iz] += atm->q[ctl->qnt_m][ip];
02967   }
02968
02969   /* Extract profiles... */
```

```
02970   for (ix = 0; ix < ctl->prof_nx; ix++)
02971     for (iy = 0; iy < ctl->prof_ny; iy++)
02972       if (obscount[ix][iy] > 0) {
02973
02974         /* Check profile... */
02975         okay = 0;
02976         for (iz = 0; iz < ctl->prof_nz; iz++)
02977           if (mass[ix][iy][iz] > 0) {
02978             okay = 1;
02979             break;
02980           }
02981         if (!okay)
02982           continue;
02983
02984         /* Write output... */
02985         fprintf(out, "\n");
02986
02987         /* Loop over altitudes... */
02988         for (iz = 0; iz < ctl->prof_nz; iz++) {
02989
02990           /* Set coordinates... */
02991           z = ctl->prof_z0 + dz * (iz + 0.5);
02992           lon = ctl->prof_lon0 + dlon * (ix + 0.5);
02993           lat = ctl->prof_lat0 + dlat * (iy + 0.5);
02994
02995           /* Get pressure and temperature... */
02996           press = P(z);
02997           intpol_met_time(met0, met1, t, press, lon, lat, NULL, NULL,
02998                           NULL, &temp, NULL, NULL, NULL, NULL, &h2o, &o3);
02999
03000           /* Calculate surface area... */
03001           area = dlat * dlon * SQR(M_PI * RE / 180.)
03002             * cos(lat * M_PI / 180.);
03003
03004           /* Calculate volume mixing ratio... */
03005           rho_air = 100. * press / (RA * temp);
03006           vmr = MA / ctl->molmass * mass[ix][iy][iz]
03007             / (rho_air * area * dz * 1e9);
03008
03009           /* Write output... */
03010           fprintf(out, "%.2f %g %g %g %g %g %g %g %g %g %g\n",
03011                   t, z, lon, lat, press, temp, vmr, h2o, o3,
03012                   obsmean[ix][iy] / obscount[ix][iy],
03013                   sqrt(obsmean2[ix][iy] / obscount[ix][iy]
03014                        - SQR(obsmean[ix][iy] / obscount[ix][iy])));
03015         }
03016       }
03017
03018   /* Close file... */
03019   if (t == ctl->t_stop)
03020     fclose(out);
03021 }
```

Here is the call graph for this function:



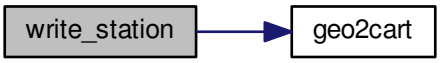
5.21.2.35 void write_station (const char * *filename*, ctl_t * *ctl*, atm_t * *atm*, double *t*)

Write station data.

Definition at line 3025 of file libtrac.c.

```
03029            {
03030
03031   static FILE *out;
03032
03033   static double rmax2, t0, t1, x0[3], x1[3];
03034
03035   static int ip, iq;
03036
03037   /* Init... */
03038   if (t == ctl->t_start) {
03039
03040     /* Write info... */
03041     printf("Write station data: %s\n", filename);
03042
03043     /* Create new file... */
03044     if (!(out = fopen(filename, "w")))
03045       ERRMSG("Cannot create file!");
03046
03047     /* Write header... */
03048     fprintf(out,
03049             "# $1 = time [s]\n"
03050             "# $2 = altitude [km]\n"
03051             "# $3 = longitude [deg]\n" "# $4 = latitude [deg]\n");
03052     for (iq = 0; iq < ctl->nq; iq++)
03053       fprintf(out, "# $%i = %s [%s]\n", (iq + 5),
03054               ctl->qnt_name[iq], ctl->qnt_unit[iq]);
03055     fprintf(out, "\n");
03056
03057     /* Set geolocation and search radius... */
03058     geo2cart(0, ctl->stat_lon, ctl->stat_lat, x0);
03059     rmax2 = SQR(ctl->stat_r);
03060   }
03061
03062   /* Set time interval for output... */
03063   t0 = t - 0.5 * ctl->dt_mod;
03064   t1 = t + 0.5 * ctl->dt_mod;
03065
03066   /* Loop over air parcels... */
03067   for (ip = 0; ip < atm->np; ip++) {
03068
03069     /* Check time... */
03070     if (atm->time[ip] < t0 || atm->time[ip] > t1)
03071       continue;
03072
03073     /* Check station flag... */
03074     if (ctl->qnt_stat >= 0)
03075       if (atm->q[ctl->qnt_stat][ip])
03076         continue;
03077
03078     /* Get Cartesian coordinates... */
03079     geo2cart(0, atm->lon[ip], atm->lat[ip], x1);
03080
03081     /* Check horizontal distance... */
03082     if (DIST2(x0, x1) > rmax2)
03083       continue;
03084
03085     /* Set station flag... */
03086     if (ctl->qnt_stat >= 0)
03087       atm->q[ctl->qnt_stat][ip] = 1;
03088
03089     /* Write data... */
03090     fprintf(out, "%.2f %g %g %g",
03091             atm->time[ip], Z(atm->p[ip]), atm->lon[ip], atm->lat[ip]);
03092     for (iq = 0; iq < ctl->nq; iq++) {
03093       fprintf(out, " ");
03094       fprintf(out, ctl->qnt_format[iq], atm->q[iq][ip]);
03095     }
03096     fprintf(out, "\n");
03097   }
03098
03099   /* Close file... */
03100   if (t == ctl->t_stop)
03101     fclose(out);
03102 }
```

Here is the call graph for this function:



5.22 libtrac.h

```
00001 /*
00002   This file is part of MPTRAC.
00003
00004   MPTRAC is free software: you can redistribute it and/or modify
00005   it under the terms of the GNU General Public License as published by
00006   the Free Software Foundation, either version 3 of the License, or
00007   (at your option) any later version.
00008
00009   MPTRAC is distributed in the hope that it will be useful,
00010   but WITHOUT ANY WARRANTY; without even the implied warranty of
00011   MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
00012   GNU General Public License for more details.
00013
00014   You should have received a copy of the GNU General Public License
00015   along with MPTRAC. If not, see <http://www.gnu.org/licenses/>.
00016
00017   Copyright (C) 2013-2019 Forschungszentrum Juelich GmbH
00018 */
00019
00035 #include <ctype.h>
00036 #include <gsl/gsl_math.h>
00037 #include <gsl/gsl_randist.h>
00038 #include <gsl/gsl_rng.h>
00039 #include <gsl/gsl_sort.h>
00040 #include <gsl/gsl_spline.h>
00041 #include <gsl/gsl_statistics.h>
00042 #include <math.h>
00043 #include <netcdf.h>
00044 #include <omp.h>
00045 #include <stdio.h>
00046 #include <stdlib.h>
00047 #include <string.h>
00048 #include <time.h>
00049 #include <sys/time.h>
00050
00051 /* ------------------------------------------------------------
00052    Constants...
00053    ------------------------------------------------------------ */
00054
00056 #define G0 9.80665
00057
00059 #define H0 7.0
00060
00062 #define KB 1.3806504e-23
00063
00065 #define MA 28.9644
00066
00068 #define P0 1013.25
00069
00071 #define RA 287.058
00072
00074 #define RI 8.3144598
00075
00077 #define RE 6367.421
00078
00079 /* ------------------------------------------------------------
00080    Dimensions...
00081    ------------------------------------------------------------ */
00082
00084 #define LEN 5000
00085
00087 #define NP 10000000
00088
```

```
00090 #define NQ 12
00091
00093 #define EP 112
00094
00096 #define EX 1201
00097
00099 #define EY 601
00100
00102 #define GX 720
00103
00105 #define GY 360
00106
00108 #define GZ 100
00109
00111 #define NENS 2000
00112
00114 #define NTHREADS 512
00115
00116 /* ------------------------------------------------------------
00117    Macros...
00118    ------------------------------------------------------------ */
00119
00121 #define ALLOC(ptr, type, n)                                  \
00122   if((ptr=calloc((size_t)(n), sizeof(type)))==NULL)          \
00123     ERRMSG("Out of memory!");
00124
00126 #define DEG2DX(dlon, lat)                                    \
00127   ((dlon) * M_PI * RE / 180. * cos((lat) / 180. * M_PI))
00128
00130 #define DEG2DY(dlat)                                 \
00131   ((dlat) * M_PI * RE / 180.)
00132
00134 #define DP2DZ(dp, p)                                 \
00135   (- (dp) * H0 / (p))
00136
00138 #define DX2DEG(dx, lat)                                      \
00139   (((lat) < -89.999 || (lat) > 89.999) ? 0                   \
00140    : (dx) * 180. / (M_PI * RE * cos((lat) / 180. * M_PI)))
00141
00143 #define DY2DEG(dy)                                   \
00144   ((dy) * 180. / (M_PI * RE))
00145
00147 #define DZ2DP(dz, p)                                 \
00148   (-(dz) * (p) / H0)
00149
00151 #define DIST(a, b) sqrt(DIST2(a, b))
00152
00154 #define DIST2(a, b)                                                  \
00155   ((a[0]-b[0])*(a[0]-b[0])+(a[1]-b[1])*(a[1]-b[1])+(a[2]-b[2])*(a[2]-b[2]))
00156
00158 #define DOTP(a, b) (a[0]*b[0]+a[1]*b[1]+a[2]*b[2])
00159
00161 #define ERRMSG(msg) {                                                \
00162     printf("\nError (%s, %s, l%d): %s\n\n",                          \
00163            __FILE__, __func__, __LINE__, msg);                       \
00164     exit(EXIT_FAILURE);                                              \
00165   }
00166
00168 #define FREAD(ptr, type, size, out) {                                \
00169     if(fread(ptr, sizeof(type), size, out)!=size)                    \
00170       ERRMSG("Error while reading!");                                \
00171   }
00172
00174 #define FWRITE(ptr, type, size, out) {                               \
00175     if(fwrite(ptr, sizeof(type), size, out)!=size)                   \
00176       ERRMSG("Error while writing!");                                \
00177   }
00178
00180 #define LIN(x0, y0, x1, y1, x)                       \
00181   ((y0)+((y1)-(y0))/((x1)-(x0))*((x)-(x0)))
00182
00184 #define NC(cmd) {                                        \
00185     if((cmd)!=NC_NOERR)                                  \
00186       ERRMSG(nc_strerror(cmd));                          \
00187   }
00188
00190 #define NORM(a) sqrt(DOTP(a, a))
00191
00193 #define PRINT(format, var)                                           \
00194   printf("Print (%s, %s, l%d): %s= "format"\n",                      \
00195          __FILE__, __func__, __LINE__, #var, var);
00196
00198 #define P(z) (P0*exp(-(z)/H0))
00199
00201 #define SQR(x) ((x)*(x))
00202
00204 #define THETA(p, t) ((t)*pow(1000./(p), 0.286))
```

```
00205
00207 #define TOK(line, tok, format, var) {                                   \
00208     if(((tok)=strtok((line), " \t"))) {                                   \
00209       if(sscanf(tok, format, &(var))!=1) continue;                        \
00210     } else ERRMSG("Error while reading!");                                \
00211   }
00212
00214 #define Z(p) (H0*log(P0/(p)))
00215
00216 /* ------------------------------------------------------------
00217    Timers...
00218    ------------------------------------------------------------ */
00219
00221 #define START_TIMER(id) timer(#id, id, 1)
00222
00224 #define STOP_TIMER(id) timer(#id, id, 2)
00225
00227 #define PRINT_TIMER(id) timer(#id, id, 3)
00228
00230 #define NTIMER 12
00231
00233 #define TIMER_TOTAL 0
00234
00236 #define TIMER_INIT 1
00237
00239 #define TIMER_INPUT 2
00240
00242 #define TIMER_OUTPUT 3
00243
00245 #define TIMER_ADVECT 4
00246
00248 #define TIMER_DECAY 5
00249
00251 #define TIMER_DIFFMESO 6
00252
00254 #define TIMER_DIFFTURB 7
00255
00257 #define TIMER_ISOSURF 8
00258
00260 #define TIMER_METEO 9
00261
00263 #define TIMER_POSITION 10
00264
00266 #define TIMER_SEDI 11
00267
00268 /* ------------------------------------------------------------
00269    Structs...
00270    ------------------------------------------------------------ */
00271
00273 typedef struct {
00274
00276   int nq;
00277
00279   char qnt_name[NQ][LEN];
00280
00282   char qnt_unit[NQ][LEN];
00283
00285   char qnt_format[NQ][LEN];
00286
00288   int qnt_ens;
00289
00291   int qnt_m;
00292
00294   int qnt_rho;
00295
00297   int qnt_r;
00298
00300   int qnt_ps;
00301
00303   int qnt_pt;
00304
00306   int qnt_z;
00307
00309   int qnt_p;
00310
00312   int qnt_t;
00313
00315   int qnt_u;
00316
00318   int qnt_v;
00319
00321   int qnt_w;
00322
00324   int qnt_h2o;
00325
00327   int qnt_o3;
00328
```

```
00330   int qnt_theta;
00331
00333   int qnt_vh;
00334
00336   int qnt_vz;
00337
00339   int qnt_pv;
00340
00342   int qnt_tice;
00343
00345   int qnt_tsts;
00346
00348   int qnt_tnat;
00349
00351   int qnt_stat;
00352
00354   int direction;
00355
00357   double t_start;
00358
00360   double t_stop;
00361
00363   double dt_mod;
00364
00366   double dt_met;
00367
00369   int met_dx;
00370
00372   int met_dy;
00373
00375   int met_dp;
00376
00378   int met_sx;
00379
00381   int met_sy;
00382
00384   int met_sp;
00385
00387   int met_np;
00388
00390   double met_p[EP];
00391
00394   int met_tropo;
00395
00397   char met_geopot[LEN];
00398
00400   double met_dt_out;
00401
00403   char met_stage[LEN];
00404
00407   int isosurf;
00408
00410   char balloon[LEN];
00411
00413   double turb_dx_trop;
00414
00416   double turb_dx_strat;
00417
00419   double turb_dz_trop;
00420
00422   double turb_dz_strat;
00423
00425   double turb_mesox;
00426
00428   double turb_mesoz;
00429
00431   double molmass;
00432
00434   double tdec_trop;
00435
00437   double tdec_strat;
00438
00440   double psc_h2o;
00441
00443   double psc_hno3;
00444
00446   char atm_basename[LEN];
00447
00449   char atm_gpfile[LEN];
00450
00452   double atm_dt_out;
00453
00455   int atm_filter;
00456
00458   int atm_type;
00459
00461   char csi_basename[LEN];
```

```
00462
00464   double csi_dt_out;
00465
00467   char csi_obsfile[LEN];
00468
00470   double csi_obsmin;
00471
00473   double csi_modmin;
00474
00476   int csi_nz;
00477
00479   double csi_z0;
00480
00482   double csi_z1;
00483
00485   int csi_nx;
00486
00488   double csi_lon0;
00489
00491   double csi_lon1;
00492
00494   int csi_ny;
00495
00497   double csi_lat0;
00498
00500   double csi_lat1;
00501
00503   char grid_basename[LEN];
00504
00506   char grid_gpfile[LEN];
00507
00509   double grid_dt_out;
00510
00512   int grid_sparse;
00513
00515   int grid_nz;
00516
00518   double grid_z0;
00519
00521   double grid_z1;
00522
00524   int grid_nx;
00525
00527   double grid_lon0;
00528
00530   double grid_lon1;
00531
00533   int grid_ny;
00534
00536   double grid_lat0;
00537
00539   double grid_lat1;
00540
00542   char prof_basename[LEN];
00543
00545   char prof_obsfile[LEN];
00546
00548   int prof_nz;
00549
00551   double prof_z0;
00552
00554   double prof_z1;
00555
00557   int prof_nx;
00558
00560   double prof_lon0;
00561
00563   double prof_lon1;
00564
00566   int prof_ny;
00567
00569   double prof_lat0;
00570
00572   double prof_lat1;
00573
00575   char ens_basename[LEN];
00576
00578   char stat_basename[LEN];
00579
00581   double stat_lon;
00582
00584   double stat_lat;
00585
00587   double stat_r;
00588
00589 } ctl_t;
00590
```

```
00592 typedef struct {
00593
00595   int np;
00596
00598   double time[NP];
00599
00601   double p[NP];
00602
00604   double lon[NP];
00605
00607   double lat[NP];
00608
00610   double q[NQ][NP];
00611
00613   float up[NP];
00614
00616   float vp[NP];
00617
00619   float wp[NP];
00620
00622   double cache_time[EX][EY][EP];
00623
00625   float cache_usig[EX][EY][EP];
00626
00628   float cache_vsig[EX][EY][EP];
00629
00631   float cache_wsig[EX][EY][EP];
00632
00633 } atm_t;
00634
00636 typedef struct {
00637
00639   double time;
00640
00642   int nx;
00643
00645   int ny;
00646
00648   int np;
00649
00651   double lon[EX];
00652
00654   double lat[EY];
00655
00657   double p[EP];
00658
00660   double ps[EX][EY];
00661
00663   double pt[EX][EY];
00664
00666   float z[EX][EY][EP];
00667
00669   float t[EX][EY][EP];
00670
00672   float u[EX][EY][EP];
00673
00675   float v[EX][EY][EP];
00676
00678   float w[EX][EY][EP];
00679
00681   float pv[EX][EY][EP];
00682
00684   float h2o[EX][EY][EP];
00685
00687   float o3[EX][EY][EP];
00688
00690   float pl[EX][EY][EP];
00691
00692 } met_t;
00693
00694 /* ------------------------------------------------------------
00695    Functions...
00696    ------------------------------------------------------------ */
00697
00699 void cart2geo(
00700   double *x,
00701   double *z,
00702   double *lon,
00703   double *lat);
00704
00706 double clim_hno3(
00707   double t,
00708   double lat,
00709   double p);
00710
00712 double clim_tropo(
00713   double t,
```

```
00714   double lat);
00715
00717 void day2doy(
00718   int year,
00719   int mon,
00720   int day,
00721   int *doy);
00722
00724 void doy2day(
00725   int year,
00726   int doy,
00727   int *mon,
00728   int *day);
00729
00731 void geo2cart(
00732   double z,
00733   double lon,
00734   double lat,
00735   double *x);
00736
00738 void get_met(
00739   ctl_t * ctl,
00740   char *metbase,
00741   double t,
00742   met_t ** met0,
00743   met_t ** met1);
00744
00746 void get_met_help(
00747   double t,
00748   int direct,
00749   char *metbase,
00750   double dt_met,
00751   char *filename);
00752
00754 void intpol_met_2d(
00755   double array[EX][EY],
00756   int ix,
00757   int iy,
00758   double wx,
00759   double wy,
00760   double *var);
00761
00763 void intpol_met_3d(
00764   float array[EX][EY][EP],
00765   int ip,
00766   int ix,
00767   int iy,
00768   double wp,
00769   double wx,
00770   double wy,
00771   double *var);
00772
00774 void intpol_met_space(
00775   met_t * met,
00776   double p,
00777   double lon,
00778   double lat,
00779   double *ps,
00780   double *pt,
00781   double *z,
00782   double *t,
00783   double *u,
00784   double *v,
00785   double *w,
00786   double *pv,
00787   double *h2o,
00788   double *o3);
00789
00791 void intpol_met_time(
00792   met_t * met0,
00793   met_t * met1,
00794   double ts,
00795   double p,
00796   double lon,
00797   double lat,
00798   double *ps,
00799   double *pt,
00800   double *z,
00801   double *t,
00802   double *u,
00803   double *v,
00804   double *w,
00805   double *pv,
00806   double *h2o,
00807   double *o3);
00808
00810 void jsec2time(
```

```
00811   double jsec,
00812   int *year,
00813   int *mon,
00814   int *day,
00815   int *hour,
00816   int *min,
00817   int *sec,
00818   double *remain);
00819
00821 int locate_irr(
00822   double *xx,
00823   int n,
00824   double x);
00825
00827 int locate_reg(
00828   double *xx,
00829   int n,
00830   double x);
00831
00833 void read_atm(
00834   const char *filename,
00835   ctl_t * ctl,
00836   atm_t * atm);
00837
00839 void read_ctl(
00840   const char *filename,
00841   int argc,
00842   char *argv[],
00843   ctl_t * ctl);
00844
00846 void read_met(
00847   ctl_t * ctl,
00848   char *filename,
00849   met_t * met);
00850
00852 void read_met_extrapolate(
00853   met_t * met);
00854
00856 void read_met_geopot(
00857   ctl_t * ctl,
00858   met_t * met);
00859
00861 void read_met_help(
00862   int ncid,
00863   char *varname,
00864   char *varname2,
00865   met_t * met,
00866   float dest[EX][EY][EP],
00867   float scl);
00868
00870 void read_met_ml2pl(
00871   ctl_t * ctl,
00872   met_t * met,
00873   float var[EX][EY][EP]);
00874
00876 void read_met_periodic(
00877   met_t * met);
00878
00880 void read_met_pv(
00881   met_t * met);
00882
00884 void read_met_sample(
00885   ctl_t * ctl,
00886   met_t * met);
00887
00889 void read_met_tropo(
00890   ctl_t * ctl,
00891   met_t * met);
00892
00894 double scan_ctl(
00895   const char *filename,
00896   int argc,
00897   char *argv[],
00898   const char *varname,
00899   int arridx,
00900   const char *defvalue,
00901   char *value);
00902
00904 void time2jsec(
00905   int year,
00906   int mon,
00907   int day,
00908   int hour,
00909   int min,
00910   int sec,
00911   double remain,
00912   double *jsec);
```

```
00913
00915 void timer(
00916   const char *name,
00917   int id,
00918   int mode);
00919
00921 void write_atm(
00922   const char *filename,
00923   ctl_t * ctl,
00924   atm_t * atm,
00925   double t);
00926
00928 void write_csi(
00929   const char *filename,
00930   ctl_t * ctl,
00931   atm_t * atm,
00932   double t);
00933
00935 void write_ens(
00936   const char *filename,
00937   ctl_t * ctl,
00938   atm_t * atm,
00939   double t);
00940
00942 void write_grid(
00943   const char *filename,
00944   ctl_t * ctl,
00945   met_t * met0,
00946   met_t * met1,
00947   atm_t * atm,
00948   double t);
00949
00951 void write_prof(
00952   const char *filename,
00953   ctl_t * ctl,
00954   met_t * met0,
00955   met_t * met1,
00956   atm_t * atm,
00957   double t);
00958
00960 void write_station(
00961   const char *filename,
00962   ctl_t * ctl,
00963   atm_t * atm,
00964   double t);
```

5.23 met_map.c File Reference

Extract global map from meteorological data.

Functions

- int main (int argc, char ∗argv[ ])

5.23.1 Detailed Description

Extract global map from meteorological data.

Definition in file met_map.c.

5.23.2 Function Documentation

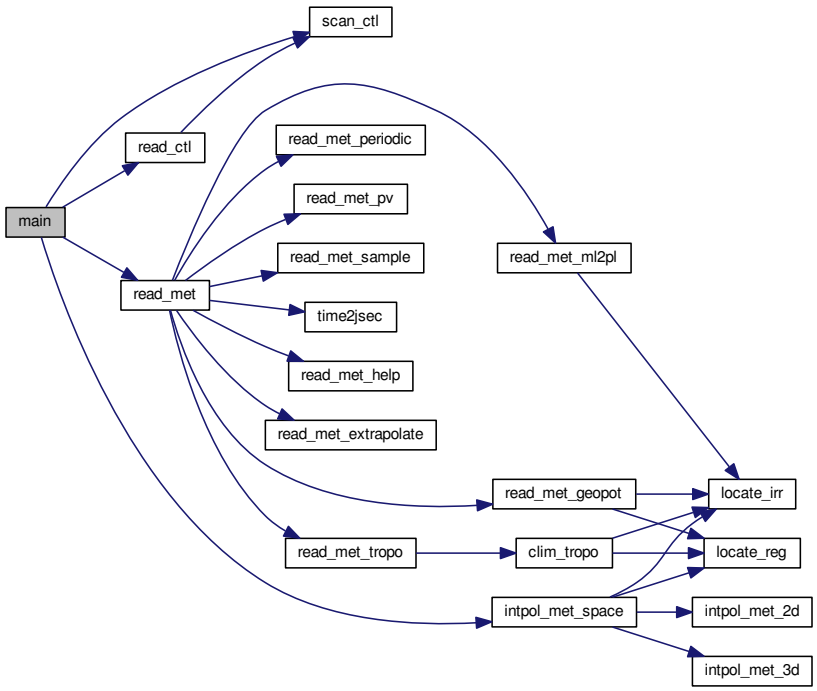
5.23.2.1 int main (int *argc*, char ∗ *argv[ ]*)

Definition at line 27 of file met_map.c.

```
00029                {
00030
00031   ctl_t ctl;
00032
00033   met_t *met;
00034
00035   FILE *out;
00036
00037   static double dz, dzmin = 1e10, z, timem[EX][EY], psm[EX][EY], ptm[EX][EY],
00038     tm[EX][EY], um[EX][EY], vm[EX][EY], wm[EX][EY], h2om[EX][EY], o3m[EX][EY],
00039     zm[EX][EY], pvm[EX][EY], zt, ztm[EX][EY], tt, ttm[EX][EY];
00040
00041   static int i, ip, ip2, ix, iy, np[EX][EY];
00042
00043   /* Allocate... */
00044   ALLOC(met, met_t, 1);
00045
00046   /* Check arguments... */
00047   if (argc < 4)
00048     ERRMSG("Give parameters: <ctl> <map.tab> <met0> [ <met1> ... ]");
00049
00050   /* Read control parameters... */
00051   read_ctl(argv[1], argc, argv, &ctl);
00052   z = scan_ctl(argv[1], argc, argv, "Z", -1, "", NULL);
00053
00054   /* Loop over files... */
00055   for (i = 3; i < argc; i++) {
00056
00057     /* Read meteorological data... */
00058     read_met(&ctl, argv[i], met);
00059
00060     /* Find nearest pressure level... */
00061     for (ip2 = 0; ip2 < met->np; ip2++) {
00062       dz = fabs(Z(met->p[ip2]) - z);
00063       if (dz < dzmin) {
00064         dzmin = dz;
00065         ip = ip2;
00066       }
00067     }
00068
00069     /* Average data... */
00070     for (ix = 0; ix < met->nx; ix++)
00071       for (iy = 0; iy < met->ny; iy++) {
00072         intpol_met_space(met, met->pt[ix][iy], met->lon[ix], met->
      lat[iy],
00073                          NULL, NULL, &zt, &tt, NULL, NULL, NULL, NULL, NULL,
00074                          NULL);
00075         timem[ix][iy] += met->time;
00076         zm[ix][iy] += met->z[ix][iy][ip];
00077         tm[ix][iy] += met->t[ix][iy][ip];
00078         um[ix][iy] += met->u[ix][iy][ip];
00079         vm[ix][iy] += met->v[ix][iy][ip];
00080         wm[ix][iy] += met->w[ix][iy][ip];
00081         pvm[ix][iy] += met->pv[ix][iy][ip];
00082         h2om[ix][iy] += met->h2o[ix][iy][ip];
00083         o3m[ix][iy] += met->o3[ix][iy][ip];
00084         psm[ix][iy] += met->ps[ix][iy];
00085         ptm[ix][iy] += met->pt[ix][iy];
00086         ztm[ix][iy] += zt;
00087         ttm[ix][iy] += tt;
00088         np[ix][iy]++;
00089       }
00090   }
00091
00092   /* Create output file... */
00093   printf("Write meteorological data file: %s\n", argv[2]);
00094   if (!(out = fopen(argv[2], "w")))
00095     ERRMSG("Cannot create file!");
00096
00097   /* Write header... */
00098   fprintf(out,
00099           "# $1  = time [s]\n"
00100           "# $2  = altitude [km]\n"
00101           "# $3  = longitude [deg]\n"
00102           "# $4  = latitude [deg]\n"
00103           "# $5  = pressure [hPa]\n"
00104           "# $6  = temperature [K]\n"
00105           "# $7  = zonal wind [m/s]\n"
00106           "# $8  = meridional wind [m/s]\n"
00107           "# $9  = vertical wind [hPa/s]\n"
00108           "# $10 = H2O volume mixing ratio [1]\n");
00109   fprintf(out,
00110           "# $11 = O3 volume mixing ratio [1]\n"
00111           "# $12 = geopotential height [km]\n"
00112           "# $13 = potential vorticity [PVU]\n"
00113           "# $14 = surface pressure [hPa]\n"
00114           "# $15 = tropopause pressure [hPa]\n"
```

```
00115           "# $16 = tropopause geopotential height [km]\n"
00116           "# $17 = tropopause temperature [K]\n");
00117
00118   /* Write data... */
00119   for (iy = 0; iy < met->ny; iy++) {
00120     fprintf(out, "\n");
00121     for (ix = 0; ix < met->nx; ix++)
00122       if (met->lon[ix] >= 180)
00123         fprintf(out, "%.2f %g %g %g %g %g %g %g %g %g %g %g %g %g %g %g %g\n",
00124                 timem[ix][iy] / np[ix][iy], Z(met->p[ip]),
00125                 met->lon[ix] - 360.0, met->lat[iy], met->p[ip],
00126                 tm[ix][iy] / np[ix][iy], um[ix][iy] / np[ix][iy],
00127                 vm[ix][iy] / np[ix][iy], wm[ix][iy] / np[ix][iy],
00128                 h2om[ix][iy] / np[ix][iy], o3m[ix][iy] / np[ix][iy],
00129                 zm[ix][iy] / np[ix][iy], pvm[ix][iy] / np[ix][iy],
00130                 psm[ix][iy] / np[ix][iy], ptm[ix][iy] / np[ix][iy],
00131                 ztm[ix][iy] / np[ix][iy], ttm[ix][iy] / np[ix][iy]);
00132     for (ix = 0; ix < met->nx; ix++)
00133       if (met->lon[ix] <= 180)
00134         fprintf(out, "%.2f %g %g %g %g %g %g %g %g %g %g %g %g %g %g %g %g\n",
00135                 timem[ix][iy] / np[ix][iy], Z(met->p[ip]),
00136                 met->lon[ix], met->lat[iy], met->p[ip],
00137                 tm[ix][iy] / np[ix][iy], um[ix][iy] / np[ix][iy],
00138                 vm[ix][iy] / np[ix][iy], wm[ix][iy] / np[ix][iy],
00139                 h2om[ix][iy] / np[ix][iy], o3m[ix][iy] / np[ix][iy],
00140                 zm[ix][iy] / np[ix][iy], pvm[ix][iy] / np[ix][iy],
00141                 psm[ix][iy] / np[ix][iy], ptm[ix][iy] / np[ix][iy],
00142                 ztm[ix][iy] / np[ix][iy], ttm[ix][iy] / np[ix][iy]);
00143   }
00144
00145   /* Close file... */
00146   fclose(out);
00147
00148   /* Free... */
00149   free(met);
00150
00151   return EXIT_SUCCESS;
00152 }
```

Here is the call graph for this function:



5.24 met_map.c

```
00001 /*
00002   This file is part of MPTRAC.
00003
00004   MPTRAC is free software: you can redistribute it and/or modify
00005   it under the terms of the GNU General Public License as published by
00006   the Free Software Foundation, either version 3 of the License, or
00007   (at your option) any later version.
00008
00009   MPTRAC is distributed in the hope that it will be useful,
00010   but WITHOUT ANY WARRANTY; without even the implied warranty of
00011   MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
00012   GNU General Public License for more details.
00013
00014   You should have received a copy of the GNU General Public License
00015   along with MPTRAC. If not, see <http://www.gnu.org/licenses/>.
00016
00017   Copyright (C) 2013-2019 Forschungszentrum Juelich GmbH
00018 */
00019
00025 #include "libtrac.h"
00026
00027 int main(
00028   int argc,
00029   char *argv[]) {
00030
00031   ctl_t ctl;
00032
00033   met_t *met;
00034
00035   FILE *out;
00036
00037   static double dz, dzmin = 1e10, z, timem[EX][EY], psm[EX][EY], ptm[EX][EY],
00038     tm[EX][EY], um[EX][EY], vm[EX][EY], wm[EX][EY], h2om[EX][EY], o3m[EX][EY],
00039     zm[EX][EY], pvm[EX][EY], zt, ztm[EX][EY], tt, ttm[EX][EY];
00040
00041   static int i, ip, ip2, ix, iy, np[EX][EY];
00042
00043   /* Allocate... */
00044   ALLOC(met, met_t, 1);
00045
00046   /* Check arguments... */
00047   if (argc < 4)
00048     ERRMSG("Give parameters: <ctl> <map.tab> <met0> [ <met1> ... ]");
00049
00050   /* Read control parameters... */
00051   read_ctl(argv[1], argc, argv, &ctl);
00052   z = scan_ctl(argv[1], argc, argv, "Z", -1, "", NULL);
00053
00054   /* Loop over files... */
00055   for (i = 3; i < argc; i++) {
00056
00057     /* Read meteorological data... */
00058     read_met(&ctl, argv[i], met);
00059
00060     /* Find nearest pressure level... */
00061     for (ip2 = 0; ip2 < met->np; ip2++) {
00062       dz = fabs(Z(met->p[ip2]) - z);
00063       if (dz < dzmin) {
00064         dzmin = dz;
00065         ip = ip2;
00066       }
00067     }
00068
00069     /* Average data... */
00070     for (ix = 0; ix < met->nx; ix++)
00071       for (iy = 0; iy < met->ny; iy++) {
00072         intpol_met_space(met, met->pt[ix][iy], met->lon[ix], met->
      lat[iy],
00073                          NULL, NULL, &zt, &tt, NULL, NULL, NULL, NULL, NULL,
00074                          NULL);
00075         timem[ix][iy] += met->time;
00076         zm[ix][iy] += met->z[ix][iy][ip];
00077         tm[ix][iy] += met->t[ix][iy][ip];
00078         um[ix][iy] += met->u[ix][iy][ip];
00079         vm[ix][iy] += met->v[ix][iy][ip];
00080         wm[ix][iy] += met->w[ix][iy][ip];
00081         pvm[ix][iy] += met->pv[ix][iy][ip];
00082         h2om[ix][iy] += met->h2o[ix][iy][ip];
00083         o3m[ix][iy] += met->o3[ix][iy][ip];
00084         psm[ix][iy] += met->ps[ix][iy];
00085         ptm[ix][iy] += met->pt[ix][iy];
00086         ztm[ix][iy] += zt;
00087         ttm[ix][iy] += tt;
00088         np[ix][iy]++;
```

```
00089       }
00090   }
00091
00092   /* Create output file... */
00093   printf("Write meteorological data file: %s\n", argv[2]);
00094   if (!(out = fopen(argv[2], "w")))
00095     ERRMSG("Cannot create file!");
00096
00097   /* Write header... */
00098   fprintf(out,
00099           "# $1  = time [s]\n"
00100           "# $2  = altitude [km]\n"
00101           "# $3  = longitude [deg]\n"
00102           "# $4  = latitude [deg]\n"
00103           "# $5  = pressure [hPa]\n"
00104           "# $6  = temperature [K]\n"
00105           "# $7  = zonal wind [m/s]\n"
00106           "# $8  = meridional wind [m/s]\n"
00107           "# $9  = vertical wind [hPa/s]\n"
00108           "# $10 = H2O volume mixing ratio [1]\n");
00109   fprintf(out,
00110           "# $11 = O3 volume mixing ratio [1]\n"
00111           "# $12 = geopotential height [km]\n"
00112           "# $13 = potential vorticity [PVU]\n"
00113           "# $14 = surface pressure [hPa]\n"
00114           "# $15 = tropopause pressure [hPa]\n"
00115           "# $16 = tropopause geopotential height [km]\n"
00116           "# $17 = tropopause temperature [K]\n");
00117
00118   /* Write data... */
00119   for (iy = 0; iy < met->ny; iy++) {
00120     fprintf(out, "\n");
00121     for (ix = 0; ix < met->nx; ix++)
00122       if (met->lon[ix] >= 180)
00123         fprintf(out, "%.2f %g %g %g %g %g %g %g %g %g %g %g %g %g %g %g %g\n",
00124                 timem[ix][iy] / np[ix][iy], Z(met->p[ip]),
00125                 met->lon[ix] - 360.0, met->lat[iy], met->p[ip],
00126                 tm[ix][iy] / np[ix][iy], um[ix][iy] / np[ix][iy],
00127                 vm[ix][iy] / np[ix][iy], wm[ix][iy] / np[ix][iy],
00128                 h2om[ix][iy] / np[ix][iy], o3m[ix][iy] / np[ix][iy],
00129                 zm[ix][iy] / np[ix][iy], pvm[ix][iy] / np[ix][iy],
00130                 psm[ix][iy] / np[ix][iy], ptm[ix][iy] / np[ix][iy],
00131                 ztm[ix][iy] / np[ix][iy], ttm[ix][iy] / np[ix][iy]);
00132     for (ix = 0; ix < met->nx; ix++)
00133       if (met->lon[ix] <= 180)
00134         fprintf(out, "%.2f %g %g %g %g %g %g %g %g %g %g %g %g %g %g %g %g\n",
00135                 timem[ix][iy] / np[ix][iy], Z(met->p[ip]),
00136                 met->lon[ix], met->lat[iy], met->p[ip],
00137                 tm[ix][iy] / np[ix][iy], um[ix][iy] / np[ix][iy],
00138                 vm[ix][iy] / np[ix][iy], wm[ix][iy] / np[ix][iy],
00139                 h2om[ix][iy] / np[ix][iy], o3m[ix][iy] / np[ix][iy],
00140                 zm[ix][iy] / np[ix][iy], pvm[ix][iy] / np[ix][iy],
00141                 psm[ix][iy] / np[ix][iy], ptm[ix][iy] / np[ix][iy],
00142                 ztm[ix][iy] / np[ix][iy], ttm[ix][iy] / np[ix][iy]);
00143   }
00144
00145   /* Close file... */
00146   fclose(out);
00147
00148   /* Free... */
00149   free(met);
00150
00151   return EXIT_SUCCESS;
00152 }
```

5.25 met_prof.c File Reference

Extract vertical profile from meteorological data.

Functions

- int main (int argc, char *argv[])

5.25.1 Detailed Description

Extract vertical profile from meteorological data.

Definition in file met_prof.c.

5.25.2 Function Documentation

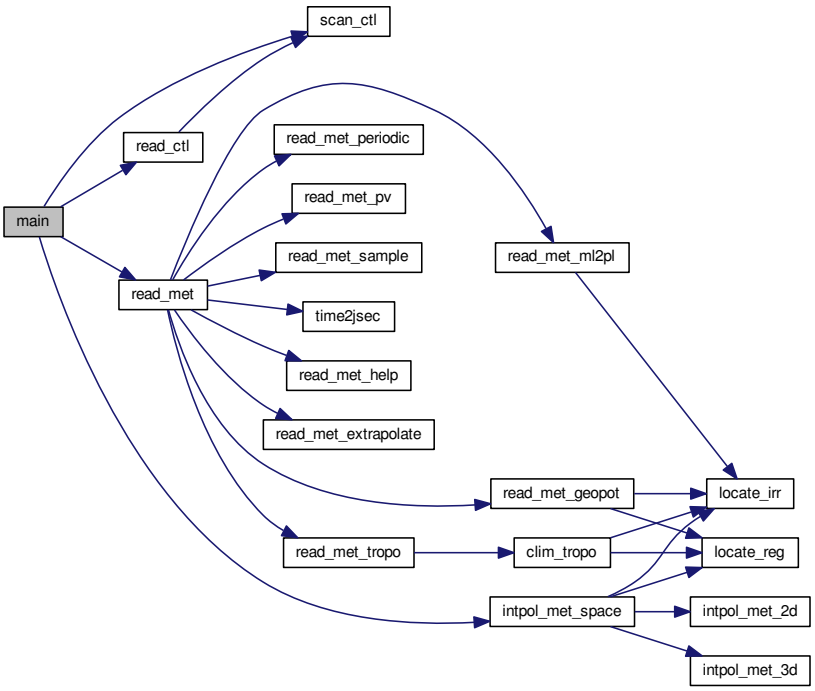
5.25.2.1 int main (int *argc*, char * *argv[]*)

Definition at line 38 of file met_prof.c.

```
00040                {
00041
00042   ctl_t ctl;
00043
00044   met_t *met;
00045
00046   FILE *out;
00047
00048   static double timem[NZ], z, z0, z1, dz, lon, lon0, lon1, dlon, lonm[NZ],
00049     lat, lat0, lat1, dlat, latm[NZ], t, tm[NZ], u, um[NZ], v, vm[NZ], w,
00050     wm[NZ], h2o, h2om[NZ], o3, o3m[NZ], ps, psm[NZ], pt, ptm[NZ], tt, ttm[NZ],
00051     zg, zgm[NZ], zt, ztm[NZ], pv, pvm[NZ];
00052
00053   static int i, iz, np[NZ];
00054
00055   /* Allocate... */
00056   ALLOC(met, met_t, 1);
00057
00058   /* Check arguments... */
00059   if (argc < 4)
00060     ERRMSG("Give parameters: <ctl> <prof.tab> <met0> [ <met1> ... ]");
00061
00062   /* Read control parameters... */
00063   read_ctl(argv[1], argc, argv, &ctl);
00064   z0 = scan_ctl(argv[1], argc, argv, "Z0", -1, "0", NULL);
00065   z1 = scan_ctl(argv[1], argc, argv, "Z1", -1, "60", NULL);
00066   dz = scan_ctl(argv[1], argc, argv, "DZ", -1, "1", NULL);
00067   lon0 = scan_ctl(argv[1], argc, argv, "LON0", -1, "0", NULL);
00068   lon1 = scan_ctl(argv[1], argc, argv, "LON1", -1, "0", NULL);
00069   dlon = scan_ctl(argv[1], argc, argv, "DLON", -1, "1", NULL);
00070   lat0 = scan_ctl(argv[1], argc, argv, "LAT0", -1, "0", NULL);
00071   lat1 = scan_ctl(argv[1], argc, argv, "LAT1", -1, "0", NULL);
00072   dlat = scan_ctl(argv[1], argc, argv, "DLAT", -1, "1", NULL);
00073
00074   /* Loop over input files... */
00075   for (i = 3; i < argc; i++) {
00076
00077     /* Read meteorological data... */
00078     read_met(&ctl, argv[i], met);
00079
00080     /* Average... */
00081     for (z = z0; z <= z1; z += dz) {
00082       iz = (int) ((z - z0) / dz);
00083       if (iz < 0 || iz > NZ)
00084         ERRMSG("Too many altitudes!");
00085       for (lon = lon0; lon <= lon1; lon += dlon)
00086         for (lat = lat0; lat <= lat1; lat += dlat) {
00087           intpol_met_space(met, P(z), lon, lat, &ps, &pt, &zg,
00088                            &t, &u, &v, &w, &pv, &h2o, &o3);
00089           intpol_met_space(met, pt, lon, lat, NULL, NULL, &zt,
00090                            &tt, NULL, NULL, NULL, NULL, NULL);
00091           if (gsl_finite(t) && gsl_finite(u)
00092               && gsl_finite(v) && gsl_finite(w)) {
00093             timem[iz] += met->time;
00094             lonm[iz] += lon;
00095             latm[iz] += lat;
00096             zgm[iz] += zg;
00097             tm[iz] += t;
00098             um[iz] += u;
00099             vm[iz] += v;
00100            wm[iz] += w;
00101            pvm[iz] += pv;
00102            h2om[iz] += h2o;
00103            o3m[iz] += o3;
00104            psm[iz] += ps;
00105            ptm[iz] += pt;
00106            ztm[iz] += zt;
00107            ttm[iz] += tt;
00108            np[iz]++;
00109          }
00110       }
00111   }
00112 }
00113
00114 /* Create output file... */
00115 printf("Write meteorological data file: %s\n", argv[2]);
```

```
00116   if (!(out = fopen(argv[2], "w")))
00117     ERRMSG("Cannot create file!");
00118
00119   /* Write header... */
00120   fprintf(out,
00121           "# $1  = time [s]\n"
00122           "# $2  = altitude [km]\n"
00123           "# $3  = longitude [deg]\n"
00124           "# $4  = latitude [deg]\n"
00125           "# $5  = pressure [hPa]\n"
00126           "# $6  = temperature [K]\n"
00127           "# $7  = zonal wind [m/s]\n"
00128           "# $8  = meridional wind [m/s]\n"
00129           "# $9  = vertical wind [hPa/s]\n");
00130   fprintf(out,
00131           "# $10 = H2O volume mixing ratio [1]\n"
00132           "# $11 = O3 volume mixing ratio [1]\n"
00133           "# $12 = geopotential height [km]\n"
00134           "# $13 = potential vorticity [PVU]\n"
00135           "# $14 = surface pressure [hPa]\n"
00136           "# $15 = tropopause pressure [hPa]\n"
00137           "# $16 = tropopause geopotential height [km]\n"
00138           "# $17 = tropopause temperature [K]\n\n");
00139
00140   /* Write data... */
00141   for (z = z0; z <= z1; z += dz) {
00142     iz = (int) ((z - z0) / dz);
00143     fprintf(out, "%.2f %g %g %g %g %g %g %g %g %g %g %g %g %g %g %g %g %g\n",
00144             timem[iz] / np[iz], z, lonm[iz] / np[iz], latm[iz] / np[iz], P(z),
00145             tm[iz] / np[iz], um[iz] / np[iz], vm[iz] / np[iz],
00146             wm[iz] / np[iz], h2om[iz] / np[iz], o3m[iz] / np[iz],
00147             zgm[iz] / np[iz], pvm[iz] / np[iz], psm[iz] / np[iz],
00148             ptm[iz] / np[iz], ztm[iz] / np[iz], ttm[iz] / np[iz]);
00149   }
00150
00151   /* Close file... */
00152   fclose(out);
00153
00154   /* Free... */
00155   free(met);
00156
00157   return EXIT_SUCCESS;
00158 }
```

Here is the call graph for this function:



5.26 met_prof.c

```
00001 /*
00002   This file is part of MPTRAC.
00003
00004   MPTRAC is free software: you can redistribute it and/or modify
00005   it under the terms of the GNU General Public License as published by
00006   the Free Software Foundation, either version 3 of the License, or
00007   (at your option) any later version.
00008
00009   MPTRAC is distributed in the hope that it will be useful,
00010   but WITHOUT ANY WARRANTY; without even the implied warranty of
00011   MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
00012   GNU General Public License for more details.
00013
00014   You should have received a copy of the GNU General Public License
00015   along with MPTRAC. If not, see <http://www.gnu.org/licenses/>.
00016
00017   Copyright (C) 2013-2019 Forschungszentrum Juelich GmbH
00018 */
00019
00025 #include "libtrac.h"
00026
00027 /* ------------------------------------------------------------
00028    Dimensions...
00029    ------------------------------------------------------------ */
00030
00031 /* Maximum number of altitudes. */
00032 #define NZ 1000
00033
00034 /* ------------------------------------------------------------
00035    Main...
00036    ------------------------------------------------------------ */
00037
00038 int main(
00039   int argc,
00040   char *argv[]) {
00041
00042   ctl_t ctl;
00043
00044   met_t *met;
00045
00046   FILE *out;
00047
00048   static double timem[NZ], z, z0, z1, dz, lon, lon0, lon1, dlon, lonm[NZ],
00049     lat, lat0, lat1, dlat, latm[NZ], t, tm[NZ], u, um[NZ], v, vm[NZ], w,
00050     wm[NZ], h2o, h2om[NZ], o3, o3m[NZ], ps, psm[NZ], pt, ptm[NZ], tt, ttm[NZ],
00051     zg, zgm[NZ], zt, ztm[NZ], pv, pvm[NZ];
00052
00053   static int i, iz, np[NZ];
00054
00055   /* Allocate... */
00056   ALLOC(met, met_t, 1);
00057
00058   /* Check arguments... */
00059   if (argc < 4)
00060     ERRMSG("Give parameters: <ctl> <prof.tab> <met0> [ <met1> ... ]");
00061
00062   /* Read control parameters... */
00063   read_ctl(argv[1], argc, argv, &ctl);
00064   z0 = scan_ctl(argv[1], argc, argv, "Z0", -1, "0", NULL);
00065   z1 = scan_ctl(argv[1], argc, argv, "Z1", -1, "60", NULL);
00066   dz = scan_ctl(argv[1], argc, argv, "DZ", -1, "1", NULL);
00067   lon0 = scan_ctl(argv[1], argc, argv, "LON0", -1, "0", NULL);
00068   lon1 = scan_ctl(argv[1], argc, argv, "LON1", -1, "0", NULL);
00069   dlon = scan_ctl(argv[1], argc, argv, "DLON", -1, "1", NULL);
00070   lat0 = scan_ctl(argv[1], argc, argv, "LAT0", -1, "0", NULL);
00071   lat1 = scan_ctl(argv[1], argc, argv, "LAT1", -1, "0", NULL);
00072   dlat = scan_ctl(argv[1], argc, argv, "DLAT", -1, "1", NULL);
00073
00074   /* Loop over input files... */
00075   for (i = 3; i < argc; i++) {
00076
00077     /* Read meteorological data... */
00078     read_met(&ctl, argv[i], met);
00079
00080     /* Average... */
00081     for (z = z0; z <= z1; z += dz) {
00082       iz = (int) ((z - z0) / dz);
00083       if (iz < 0 || iz > NZ)
00084         ERRMSG("Too many altitudes!");
00085       for (lon = lon0; lon <= lon1; lon += dlon)
00086         for (lat = lat0; lat <= lat1; lat += dlat) {
00087           intpol_met_space(met, P(z), lon, lat, &ps, &pt, &zg,
00088                            &t, &u, &v, &w, &pv, &h2o, &o3);
00089           intpol_met_space(met, pt, lon, lat, NULL, NULL, &zt,
```

```
00090                           &tt, NULL, NULL, NULL, NULL, NULL, NULL);
00091           if (gsl_finite(t) && gsl_finite(u)
00092               && gsl_finite(v) && gsl_finite(w)) {
00093             timem[iz] += met->time;
00094             lonm[iz] += lon;
00095             latm[iz] += lat;
00096             zgm[iz] += zg;
00097             tm[iz] += t;
00098             um[iz] += u;
00099             vm[iz] += v;
00100            wm[iz] += w;
00101            pvm[iz] += pv;
00102            h2om[iz] += h2o;
00103            o3m[iz] += o3;
00104            psm[iz] += ps;
00105            ptm[iz] += pt;
00106            ztm[iz] += zt;
00107            ttm[iz] += tt;
00108            np[iz]++;
00109          }
00110        }
00111    }
00112  }
00113
00114  /* Create output file... */
00115  printf("Write meteorological data file: %s\n", argv[2]);
00116  if (!(out = fopen(argv[2], "w")))
00117    ERRMSG("Cannot create file!");
00118
00119  /* Write header... */
00120  fprintf(out,
00121          "# $1  = time [s]\n"
00122          "# $2  = altitude [km]\n"
00123          "# $3  = longitude [deg]\n"
00124          "# $4  = latitude [deg]\n"
00125          "# $5  = pressure [hPa]\n"
00126          "# $6  = temperature [K]\n"
00127          "# $7  = zonal wind [m/s]\n"
00128          "# $8  = meridional wind [m/s]\n"
00129          "# $9  = vertical wind [hPa/s]\n");
00130  fprintf(out,
00131          "# $10 = H2O volume mixing ratio [1]\n"
00132          "# $11 = O3 volume mixing ratio [1]\n"
00133          "# $12 = geopotential height [km]\n"
00134          "# $13 = potential vorticity [PVU]\n"
00135          "# $14 = surface pressure [hPa]\n"
00136          "# $15 = tropopause pressure [hPa]\n"
00137          "# $16 = tropopause geopotential height [km]\n"
00138          "# $17 = tropopause temperature [K]\n\n");
00139
00140  /* Write data... */
00141  for (z = z0; z <= z1; z += dz) {
00142    iz = (int) ((z - z0) / dz);
00143    fprintf(out, "%.2f %g %g %g %g %g %g %g %g %g %g %g %g %g %g %g %g %g\n",
00144            timem[iz] / np[iz], z, lonm[iz] / np[iz], latm[iz] / np[iz], P(z),
00145            tm[iz] / np[iz], um[iz] / np[iz], vm[iz] / np[iz],
00146            wm[iz] / np[iz], h2om[iz] / np[iz], o3m[iz] / np[iz],
00147            zgm[iz] / np[iz], pvm[iz] / np[iz], psm[iz] / np[iz],
00148            ptm[iz] / np[iz], ztm[iz] / np[iz], ttm[iz] / np[iz]);
00149  }
00150
00151  /* Close file... */
00152  fclose(out);
00153
00154  /* Free... */
00155  free(met);
00156
00157  return EXIT_SUCCESS;
00158 }
```

5.27 met_sample.c File Reference

Sample meteorological data at given geolocations.

Functions

- int main (int argc, char *argv[])

5.27.1 Detailed Description

Sample meteorological data at given geolocations.

Definition in file met_sample.c.

5.27.2 Function Documentation

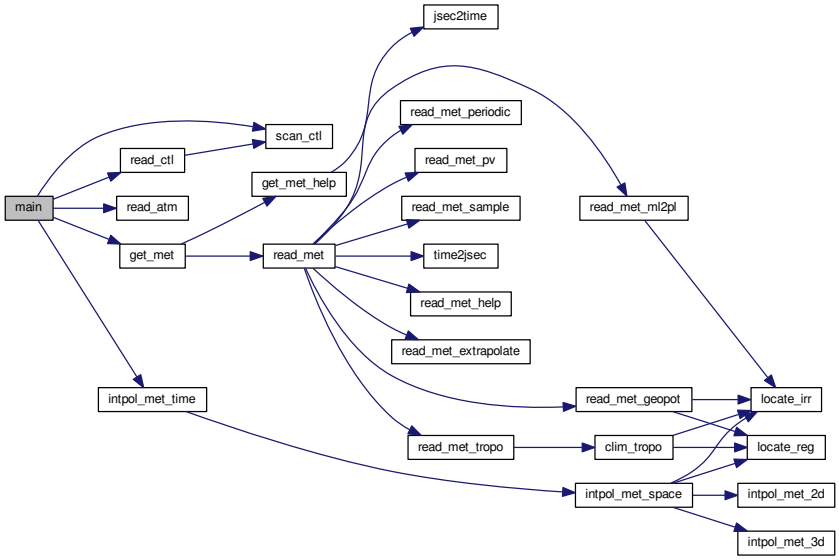
5.27.2.1 int main (int *argc*, char * *argv[]*)

Definition at line 31 of file met_sample.c.

```
00033                {
00034
00035   ctl_t ctl;
00036
00037   atm_t *atm;
00038
00039   met_t *met0, *met1;
00040
00041   FILE *out;
00042
00043   double h2o, o3, p0, p1, pref, ps, pt, pv, t, tt, u, v, w, z, zm, zref, zt;
00044
00045   int geopot, ip, it;
00046
00047   /* Check arguments... */
00048   if (argc < 4)
00049     ERRMSG("Give parameters: <ctl> <metbase> <atm_in> <sample.tab>");
00050
00051   /* Allocate... */
00052   ALLOC(atm, atm_t, 1);
00053   ALLOC(met0, met_t, 1);
00054   ALLOC(met1, met_t, 1);
00055
00056   /* Read control parameters... */
00057   read_ctl(argv[1], argc, argv, &ctl);
00058   geopot =
00059     (int) scan_ctl(argv[1], argc, argv, "MET_SAMPLE_GEOPOT", -1, "0", NULL);
00060
00061   /* Read atmospheric data... */
00062   read_atm(argv[3], &ctl, atm);
00063
00064   /* Create output file... */
00065   printf("Write meteorological data file: %s\n", argv[4]);
00066   if (!(out = fopen(argv[4], "w")))
00067     ERRMSG("Cannot create file!");
00068
00069   /* Write header... */
00070   fprintf(out,
00071           "# $1  = time [s]\n"
00072           "# $2  = altitude [km]\n"
00073           "# $3  = longitude [deg]\n"
00074           "# $4  = latitude [deg]\n"
00075           "# $5  = pressure [hPa]\n"
00076           "# $6  = temperature [K]\n"
00077           "# $7  = zonal wind [m/s]\n"
00078           "# $8  = meridional wind [m/s]\n"
00079           "# $9  = vertical wind [hPa/s]\n");
00080   fprintf(out,
00081           "# $10 = H2O volume mixing ratio [1]\n"
00082           "# $11 = O3 volume mixing ratio [1]\n"
00083           "# $12 = geopotential height [km]\n"
00084           "# $13 = potential vorticity [PVU]\n"
00085           "# $14 = surface pressure [hPa]\n"
00086           "# $15 = tropopause pressure [hPa]\n"
00087           "# $16 = tropopause geopotential height [km]\n"
00088           "# $17 = tropopause temperature [K]\n\n");
00089
00090   /* Loop over air parcels... */
00091   for (ip = 0; ip < atm->np; ip++) {
00092
00093     /* Get meteorological data... */
00094     get_met(&ctl, argv[2], atm->time[ip], &met0, &met1);
00095
00096     /* Set reference pressure for interpolation... */
00097     pref = atm->p[ip];
```

```
00098     if (geopot) {
00099       zref = Z(pref);
00100       p0 = met0->p[0];
00101       p1 = met0->p[met0->np - 1];
00102       for (it = 0; it < 24; it++) {
00103         pref = 0.5 * (p0 + p1);
00104         intpol_met_time(met0, met1, atm->time[ip], pref, atm->
      lon[ip],
00105                         atm->lat[ip], NULL, NULL, &zm, NULL, NULL, NULL, NULL,
00106                         NULL, NULL, NULL);
00107         if (zref > zm || !gsl_finite(zm))
00108           p0 = pref;
00109         else
00110           p1 = pref;
00111       }
00112       pref = 0.5 * (p0 + p1);
00113     }
00114
00115     /* Interpolate meteorological data... */
00116     intpol_met_time(met0, met1, atm->time[ip], pref, atm->lon[ip],
00117                     atm->lat[ip], &ps, &pt, &z, &t, &u, &v, &w, &pv, &h2o,
00118                     &o3);
00119     intpol_met_time(met0, met1, atm->time[ip], pt, atm->lon[ip], atm->
      lat[ip],
00120                     NULL, NULL, &zt, &tt, NULL, NULL, NULL, NULL, NULL, NULL);
00121
00122     /* Write data... */
00123     fprintf(out, "%.2f %g %g %g %g %g %g %g %g %g %g %g %g %g %g %g %g\n",
00124             atm->time[ip], Z(atm->p[ip]), atm->lon[ip], atm->lat[ip],
00125             atm->p[ip], t, u, v, w, h2o, o3, z, pv, ps, pt, zt, tt);
00126   }
00127
00128   /* Close file... */
00129   fclose(out);
00130
00131   /* Free... */
00132   free(atm);
00133   free(met0);
00134   free(met1);
00135
00136   return EXIT_SUCCESS;
00137 }
```

Here is the call graph for this function:



5.28 met_sample.c

```
00001 /*
```

```
00002   This file is part of MPTRAC.
00003
00004   MPTRAC is free software: you can redistribute it and/or modify
00005   it under the terms of the GNU General Public License as published by
00006   the Free Software Foundation, either version 3 of the License, or
00007   (at your option) any later version.
00008
00009   MPTRAC is distributed in the hope that it will be useful,
00010   but WITHOUT ANY WARRANTY; without even the implied warranty of
00011   MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
00012   GNU General Public License for more details.
00013
00014   You should have received a copy of the GNU General Public License
00015   along with MPTRAC. If not, see <http://www.gnu.org/licenses/>.
00016
00017   Copyright (C) 2013-2019 Forschungszentrum Juelich GmbH
00018 */
00019
00025 #include "libtrac.h"
00026
00027 /* ------------------------------------------------------------
00028    Main...
00029    ------------------------------------------------------------ */
00030
00031 int main(
00032   int argc,
00033   char *argv[]) {
00034
00035   ctl_t ctl;
00036
00037   atm_t *atm;
00038
00039   met_t *met0, *met1;
00040
00041   FILE *out;
00042
00043   double h2o, o3, p0, p1, pref, ps, pt, pv, t, tt, u, v, w, z, zm, zref, zt;
00044
00045   int geopot, ip, it;
00046
00047   /* Check arguments... */
00048   if (argc < 4)
00049     ERRMSG("Give parameters: <ctl> <metbase> <atm_in> <sample.tab>");
00050
00051   /* Allocate... */
00052   ALLOC(atm, atm_t, 1);
00053   ALLOC(met0, met_t, 1);
00054   ALLOC(met1, met_t, 1);
00055
00056   /* Read control parameters... */
00057   read_ctl(argv[1], argc, argv, &ctl);
00058   geopot =
00059     (int) scan_ctl(argv[1], argc, argv, "MET_SAMPLE_GEOPOT", -1, "0", NULL);
00060
00061   /* Read atmospheric data... */
00062   read_atm(argv[3], &ctl, atm);
00063
00064   /* Create output file... */
00065   printf("Write meteorological data file: %s\n", argv[4]);
00066   if (!(out = fopen(argv[4], "w")))
00067     ERRMSG("Cannot create file!");
00068
00069   /* Write header... */
00070   fprintf(out,
00071           "# $1  = time [s]\n"
00072           "# $2  = altitude [km]\n"
00073           "# $3  = longitude [deg]\n"
00074           "# $4  = latitude [deg]\n"
00075           "# $5  = pressure [hPa]\n"
00076           "# $6  = temperature [K]\n"
00077           "# $7  = zonal wind [m/s]\n"
00078           "# $8  = meridional wind [m/s]\n"
00079           "# $9  = vertical wind [hPa/s]\n");
00080   fprintf(out,
00081           "# $10 = H2O volume mixing ratio [1]\n"
00082           "# $11 = O3 volume mixing ratio [1]\n"
00083           "# $12 = geopotential height [km]\n"
00084           "# $13 = potential vorticity [PVU]\n"
00085           "# $14 = surface pressure [hPa]\n"
00086           "# $15 = tropopause pressure [hPa]\n"
00087           "# $16 = tropopause geopotential height [km]\n"
00088           "# $17 = tropopause temperature [K]\n\n");
00089
00090   /* Loop over air parcels... */
00091   for (ip = 0; ip < atm->np; ip++) {
00092
00093     /* Get meteorological data... */
```

```
00094     get_met(&ctl, argv[2], atm->time[ip], &met0, &met1);
00095
00096     /* Set reference pressure for interpolation... */
00097     pref = atm->p[ip];
00098     if (geopot) {
00099       zref = Z(pref);
00100       p0 = met0->p[0];
00101       p1 = met0->p[met0->np - 1];
00102       for (it = 0; it < 24; it++) {
00103         pref = 0.5 * (p0 + p1);
00104         intpol_met_time(met0, met1, atm->time[ip], pref, atm->
      lon[ip],
00105                         atm->lat[ip], NULL, NULL, &zm, NULL, NULL, NULL, NULL,
00106                         NULL, NULL, NULL);
00107         if (zref > zm || !gsl_finite(zm))
00108           p0 = pref;
00109         else
00110           p1 = pref;
00111       }
00112       pref = 0.5 * (p0 + p1);
00113     }
00114
00115     /* Interpolate meteorological data... */
00116     intpol_met_time(met0, met1, atm->time[ip], pref, atm->lon[ip],
00117                     atm->lat[ip], &ps, &pt, &z, &t, &u, &v, &w, &pv, &h2o,
00118                     &o3);
00119     intpol_met_time(met0, met1, atm->time[ip], pt, atm->lon[ip], atm->
      lat[ip],
00120                     NULL, NULL, &zt, &tt, NULL, NULL, NULL, NULL, NULL, NULL);
00121
00122     /* Write data... */
00123     fprintf(out, "%.2f %g %g %g %g %g %g %g %g %g %g %g %g %g %g %g %g\n",
00124             atm->time[ip], Z(atm->p[ip]), atm->lon[ip], atm->lat[ip],
00125             atm->p[ip], t, u, v, w, h2o, o3, z, pv, ps, pt, zt, tt);
00126   }
00127
00128   /* Close file... */
00129   fclose(out);
00130
00131   /* Free... */
00132   free(atm);
00133   free(met0);
00134   free(met1);
00135
00136   return EXIT_SUCCESS;
00137 }
```

5.29 met_zm.c File Reference

Extract zonal mean from meteorological data.

Functions

- int main (int argc, char *argv[])

5.29.1 Detailed Description

Extract zonal mean from meteorological data.

Definition in file met_zm.c.

5.29.2 Function Documentation

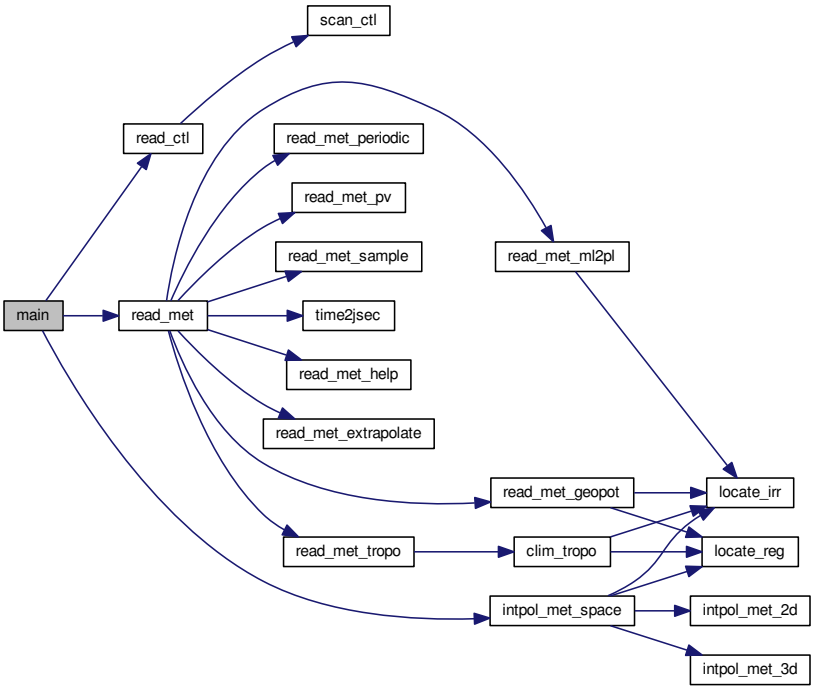
5.29.2.1 int main (int *argc*, char * *argv[]*)

Definition at line 27 of file met_zm.c.

```
00029                {
00030
00031   ctl_t ctl;
00032
00033   met_t *met;
00034
00035   FILE *out;
00036
00037   static double timem[EP][EY], psm[EP][EY], ptm[EP][EY], ttm[EP][EY],
00038     ztm[EP][EY], tm[EP][EY], um[EP][EY], vm[EP][EY], wm[EP][EY], h2om[EP][EY],
00039     pvm[EP][EY], o3m[EP][EY], zm[EP][EY], zt, tt;
00040
00041   static int i, ip, ix, iy, np[EP][EY], npt[EP][EY];
00042
00043   /* Allocate... */
00044   ALLOC(met, met_t, 1);
00045
00046   /* Check arguments... */
00047   if (argc < 4)
00048     ERRMSG("Give parameters: <ctl> <zm.tab> <met0> [ <met1> ... ]");
00049
00050   /* Read control parameters... */
00051   read_ctl(argv[1], argc, argv, &ctl);
00052
00053   /* Loop over files... */
00054   for (i = 3; i < argc; i++) {
00055
00056     /* Read meteorological data... */
00057     read_met(&ctl, argv[i], met);
00058
00059     /* Average data... */
00060     for (ix = 0; ix < met->nx; ix++)
00061       for (iy = 0; iy < met->ny; iy++)
00062         for (ip = 0; ip < met->np; ip++) {
00063           intpol_met_space(met, met->pt[ix][iy], met->lon[ix], met->
      lat[iy],
00064                            NULL, NULL, &zt, &tt, NULL, NULL, NULL, NULL, NULL,
00065                            NULL);
00066           timem[ip][iy] += met->time;
00067           zm[ip][iy] += met->z[ix][iy][ip];
00068           tm[ip][iy] += met->t[ix][iy][ip];
00069           um[ip][iy] += met->u[ix][iy][ip];
00070           vm[ip][iy] += met->v[ix][iy][ip];
00071           wm[ip][iy] += met->w[ix][iy][ip];
00072           pvm[ip][iy] += met->pv[ix][iy][ip];
00073           h2om[ip][iy] += met->h2o[ix][iy][ip];
00074           o3m[ip][iy] += met->o3[ix][iy][ip];
00075           psm[ip][iy] += met->ps[ix][iy];
00076           if (gsl_finite(met->pt[ix][iy])) {
00077             ptm[ip][iy] += met->pt[ix][iy];
00078             ztm[ip][iy] += zt;
00079             ttm[ip][iy] += tt;
00080             npt[ip][iy]++;
00081           }
00082           np[ip][iy]++;
00083         }
00084   }
00085
00086   /* Create output file... */
00087   printf("Write meteorological data file: %s\n", argv[2]);
00088   if (!(out = fopen(argv[2], "w")))
00089     ERRMSG("Cannot create file!");
00090
00091   /* Write header... */
00092   fprintf(out,
00093           "# $1  = time [s]\n"
00094           "# $2  = altitude [km]\n"
00095           "# $3  = longitude [deg]\n"
00096           "# $4  = latitude [deg]\n"
00097           "# $5  = pressure [hPa]\n"
00098           "# $6  = temperature [K]\n"
00099           "# $7  = zonal wind [m/s]\n"
00100           "# $8  = meridional wind [m/s]\n"
00101           "# $9  = vertical wind [hPa/s]\n"
00102           "# $10 = H2O volume mixing ratio [1]\n");
00103   fprintf(out,
```

```
00104           "# $11 = O3 volume mixing ratio [1]\n"
00105           "# $12 = geopotential height [km]\n"
00106           "# $13 = potential vorticity [PVU]\n"
00107           "# $14 = surface pressure [hPa]\n"
00108           "# $15 = tropopause pressure [hPa]\n"
00109           "# $16 = tropopause geopotential height [km]\n"
00110           "# $17 = tropopause temperature [K]\n");
00111
00112   /* Write data... */
00113   for (ip = 0; ip < met->np; ip++) {
00114     fprintf(out, "\n");
00115     for (iy = 0; iy < met->ny; iy++)
00116       fprintf(out, "%.2f %g %g %g %g %g %g %g %g %g %g %g %g %g %g %g %g\n",
00117               timem[ip][iy] / np[ip][iy], Z(met->p[ip]), 0.0, met->lat[iy],
00118               met->p[ip], tm[ip][iy] / np[ip][iy], um[ip][iy] / np[ip][iy],
00119               vm[ip][iy] / np[ip][iy], wm[ip][iy] / np[ip][iy],
00120               h2om[ip][iy] / np[ip][iy], o3m[ip][iy] / np[ip][iy],
00121               zm[ip][iy] / np[ip][iy], pvm[ip][iy] / np[ip][iy],
00122               psm[ip][iy] / np[ip][iy], ptm[ip][iy] / npt[ip][iy],
00123               ztm[ip][iy] / npt[ip][iy], ttm[ip][iy] / npt[ip][iy]);
00124   }
00125
00126   /* Close file... */
00127   fclose(out);
00128
00129   /* Free... */
00130   free(met);
00131
00132   return EXIT_SUCCESS;
00133 }
```

Here is the call graph for this function:



5.30 met_zm.c

```
00001 /*
00002   This file is part of MPTRAC.
00003
00004   MPTRAC is free software: you can redistribute it and/or modify
00005   it under the terms of the GNU General Public License as published by
```

```
00006   the Free Software Foundation, either version 3 of the License, or
00007   (at your option) any later version.
00008
00009   MPTRAC is distributed in the hope that it will be useful,
00010   but WITHOUT ANY WARRANTY; without even the implied warranty of
00011   MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
00012   GNU General Public License for more details.
00013
00014   You should have received a copy of the GNU General Public License
00015   along with MPTRAC. If not, see <http://www.gnu.org/licenses/>.
00016
00017   Copyright (C) 2013-2019 Forschungszentrum Juelich GmbH
00018 */
00019
00025 #include "libtrac.h"
00026
00027 int main(
00028   int argc,
00029   char *argv[]) {
00030
00031   ctl_t ctl;
00032
00033   met_t *met;
00034
00035   FILE *out;
00036
00037   static double timem[EP][EY], psm[EP][EY], ptm[EP][EY], ttm[EP][EY],
00038     ztm[EP][EY], tm[EP][EY], um[EP][EY], vm[EP][EY], wm[EP][EY], h2om[EP][EY],
00039     pvm[EP][EY], o3m[EP][EY], zm[EP][EY], zt, tt;
00040
00041   static int i, ip, ix, iy, np[EP][EY], npt[EP][EY];
00042
00043   /* Allocate... */
00044   ALLOC(met, met_t, 1);
00045
00046   /* Check arguments... */
00047   if (argc < 4)
00048     ERRMSG("Give parameters: <ctl> <zm.tab> <met0> [ <met1> ... ]");
00049
00050   /* Read control parameters... */
00051   read_ctl(argv[1], argc, argv, &ctl);
00052
00053   /* Loop over files... */
00054   for (i = 3; i < argc; i++) {
00055
00056     /* Read meteorological data... */
00057     read_met(&ctl, argv[i], met);
00058
00059     /* Average data... */
00060     for (ix = 0; ix < met->nx; ix++)
00061       for (iy = 0; iy < met->ny; iy++)
00062         for (ip = 0; ip < met->np; ip++) {
00063           intpol_met_space(met, met->pt[ix][iy], met->lon[ix], met->
      lat[iy],
00064                            NULL, NULL, &zt, &tt, NULL, NULL, NULL, NULL, NULL,
00065                            NULL);
00066           timem[ip][iy] += met->time;
00067           zm[ip][iy] += met->z[ix][iy][ip];
00068           tm[ip][iy] += met->t[ix][iy][ip];
00069           um[ip][iy] += met->u[ix][iy][ip];
00070           vm[ip][iy] += met->v[ix][iy][ip];
00071           wm[ip][iy] += met->w[ix][iy][ip];
00072           pvm[ip][iy] += met->pv[ix][iy][ip];
00073           h2om[ip][iy] += met->h2o[ix][iy][ip];
00074           o3m[ip][iy] += met->o3[ix][iy][ip];
00075           psm[ip][iy] += met->ps[ix][iy];
00076           if (gsl_finite(met->pt[ix][iy])) {
00077             ptm[ip][iy] += met->pt[ix][iy];
00078             ztm[ip][iy] += zt;
00079             ttm[ip][iy] += tt;
00080             npt[ip][iy]++;
00081           }
00082           np[ip][iy]++;
00083         }
00084   }
00085
00086   /* Create output file... */
00087   printf("Write meteorological data file: %s\n", argv[2]);
00088   if (!(out = fopen(argv[2], "w")))
00089     ERRMSG("Cannot create file!");
00090
00091   /* Write header... */
00092   fprintf(out,
00093           "# $1  = time [s]\n"
00094           "# $2  = altitude [km]\n"
00095           "# $3  = longitude [deg]\n"
00096           "# $4  = latitude [deg]\n"
```

```
00097           "# $5  = pressure [hPa]\n"
00098           "# $6  = temperature [K]\n"
00099           "# $7  = zonal wind [m/s]\n"
00100           "# $8  = meridional wind [m/s]\n"
00101           "# $9  = vertical wind [hPa/s]\n"
00102           "# $10 = H2O volume mixing ratio [1]\n");
00103   fprintf(out,
00104           "# $11 = O3 volume mixing ratio [1]\n"
00105           "# $12 = geopotential height [km]\n"
00106           "# $13 = potential vorticity [PVU]\n"
00107           "# $14 = surface pressure [hPa]\n"
00108           "# $15 = tropopause pressure [hPa]\n"
00109           "# $16 = tropopause geopotential height [km]\n"
00110           "# $17 = tropopause temperature [K]\n");
00111
00112   /* Write data... */
00113   for (ip = 0; ip < met->np; ip++) {
00114     fprintf(out, "\n");
00115     for (iy = 0; iy < met->ny; iy++)
00116       fprintf(out, "%.2f %g %g %g %g %g %g %g %g %g %g %g %g %g %g %g %g\n",
00117               timem[ip][iy] / np[ip][iy], Z(met->p[ip]), 0.0, met->lat[iy],
00118               met->p[ip], tm[ip][iy] / np[ip][iy], um[ip][iy] / np[ip][iy],
00119               vm[ip][iy] / np[ip][iy], wm[ip][iy] / np[ip][iy],
00120               h2om[ip][iy] / np[ip][iy], o3m[ip][iy] / np[ip][iy],
00121               zm[ip][iy] / np[ip][iy], pvm[ip][iy] / np[ip][iy],
00122               psm[ip][iy] / np[ip][iy], ptm[ip][iy] / npt[ip][iy],
00123               ztm[ip][iy] / npt[ip][iy], ttm[ip][iy] / npt[ip][iy]);
00124   }
00125
00126   /* Close file... */
00127   fclose(out);
00128
00129   /* Free... */
00130   free(met);
00131
00132   return EXIT_SUCCESS;
00133 }
```

5.31 smago.c File Reference

Estimate horizontal diffusivity based on Smagorinsky theory.

Functions

- int main (int argc, char ∗argv[ ])

5.31.1 Detailed Description

Estimate horizontal diffusivity based on Smagorinsky theory.

Definition in file smago.c.

5.31.2 Function Documentation

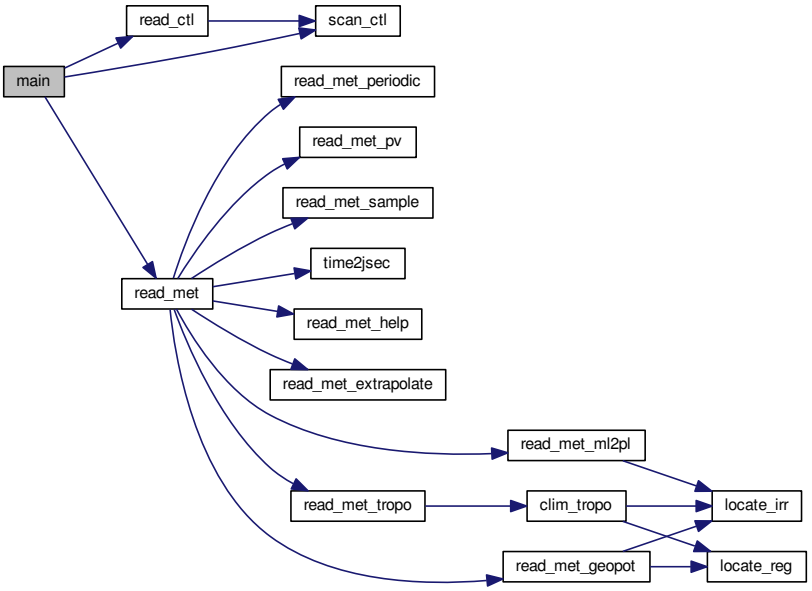
5.31.2.1 int main (int *argc*, char ∗ *argv[ ]*)

Definition at line 27 of file smago.c.

```
00029                {
00030
00031   ctl_t ctl;
00032
00033   met_t *met;
00034
00035   FILE *out;
00036
00037   static double dz, dzmin = 1e10, z, t, s, ls2, k[EX][EY], c = 0.15;
00038
00039   static int ip, ip2, ix, iy;
00040
00041   /* Allocate... */
00042   ALLOC(met, met_t, 1);
00043
00044   /* Check arguments... */
00045   if (argc < 4)
00046     ERRMSG("Give parameters: <ctl> <map.tab> <met>");
00047
00048   /* Read control parameters... */
00049   read_ctl(argv[1], argc, argv, &ctl);
00050   z = scan_ctl(argv[1], argc, argv, "Z", -1, "", NULL);
00051
00052   /* Read meteorological data... */
00053   read_met(&ctl, argv[3], met);
00054
00055   /* Find nearest pressure level... */
00056   for (ip2 = 0; ip2 < met->np; ip2++) {
00057     dz = fabs(Z(met->p[ip2]) - z);
00058     if (dz < dzmin) {
00059       dzmin = dz;
00060       ip = ip2;
00061     }
00062   }
00063
00064   /* Write info... */
00065   printf("Analyze %g hPa...\n", met->p[ip]);
00066
00067   /* Calculate horizontal diffusion coefficients... */
00068   for (ix = 1; ix < met->nx - 1; ix++)
00069     for (iy = 1; iy < met->ny - 1; iy++) {
00070       t = 0.5 * ((met->u[ix + 1][iy][ip] - met->u[ix - 1][iy][ip])
00071                  / (1000. *
00072                     DEG2DX(met->lon[ix + 1] - met->lon[ix - 1], met->lat[iy]))
00073                  - (met->v[ix][iy + 1][ip] - met->v[ix][iy - 1][ip])
00074                  / (1000. * DEG2DY(met->lat[iy + 1] - met->lat[iy - 1])));
00075       s = 0.5 * ((met->u[ix][iy + 1][ip] - met->u[ix][iy - 1][ip])
00076                  / (1000. * DEG2DY(met->lat[iy + 1] - met->lat[iy - 1]))
00077                  + (met->v[ix + 1][iy][ip] - met->v[ix - 1][iy][ip])
00078                  / (1000. *
00079                     DEG2DX(met->lon[ix + 1] - met->lon[ix - 1],
00080                            met->lat[iy])));
00081       ls2 = SQR(c * 500. * DEG2DY(met->lat[iy + 1] - met->lat[iy - 1]));
00082       if (fabs(met->lat[iy]) > 80)
00083         ls2 *= (90. - fabs(met->lat[iy])) / 10.;
00084       k[ix][iy] = ls2 * sqrt(2.0 * (SQR(t) + SQR(s)));
00085     }
00086
00087   /* Create output file... */
00088   printf("Write data file: %s\n", argv[2]);
00089   if (!(out = fopen(argv[2], "w")))
00090     ERRMSG("Cannot create file!");
00091
00092   /* Write header... */
00093   fprintf(out,
00094           "# $1 = longitude [deg]\n"
00095           "# $2 = latitude [deg]\n"
00096           "# $3 = zonal wind [m/s]\n"
00097           "# $4 = meridional wind [m/s]\n"
00098           "# $5 = horizontal diffusivity [m^2/s]\n");
00099
00100   /* Write data... */
00101   for (iy = 0; iy < met->ny; iy++) {
00102     fprintf(out, "\n");
00103     for (ix = 0; ix < met->nx; ix++)
00104       if (met->lon[ix] >= 180)
00105         fprintf(out, "%g %g %g %g %g\n",
00106                 met->lon[ix] - 360.0, met->lat[iy],
00107                 met->u[ix][iy][ip], met->v[ix][iy][ip], k[ix][iy]);
00108     for (ix = 0; ix < met->nx; ix++)
00109       if (met->lon[ix] <= 180)
00110         fprintf(out, "%g %g %g %g %g\n",
00111                 met->lon[ix], met->lat[iy],
00112                 met->u[ix][iy][ip], met->v[ix][iy][ip], k[ix][iy]);
00113   }
00114
00115   /* Close file... */
```

```
00116   fclose(out);
00117
00118   /* Free... */
00119   free(met);
00120
00121   return EXIT_SUCCESS;
00122 }
```

Here is the call graph for this function:



5.32 smago.c

```
00001 /*
00002   This file is part of MPTRAC.
00003
00004   MPTRAC is free software: you can redistribute it and/or modify
00005   it under the terms of the GNU General Public License as published by
00006   the Free Software Foundation, either version 3 of the License, or
00007   (at your option) any later version.
00008
00009   MPTRAC is distributed in the hope that it will be useful,
00010   but WITHOUT ANY WARRANTY; without even the implied warranty of
00011   MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
00012   GNU General Public License for more details.
00013
00014   You should have received a copy of the GNU General Public License
00015   along with MPTRAC. If not, see <http://www.gnu.org/licenses/>.
00016
00017   Copyright (C) 2013-2019 Forschungszentrum Juelich GmbH
00018 */
00019
00025 #include "libtrac.h"
00026
00027 int main(
00028   int argc,
00029   char *argv[]) {
00030
00031   ctl_t ctl;
00032
00033   met_t *met;
00034
00035   FILE *out;
00036
00037   static double dz, dzmin = 1e10, z, t, s, ls2, k[EX][EY], c = 0.15;
```

```
00038
00039   static int ip, ip2, ix, iy;
00040
00041   /* Allocate... */
00042   ALLOC(met, met_t, 1);
00043
00044   /* Check arguments... */
00045   if (argc < 4)
00046     ERRMSG("Give parameters: <ctl> <map.tab> <met>");
00047
00048   /* Read control parameters... */
00049   read_ctl(argv[1], argc, argv, &ctl);
00050   z = scan_ctl(argv[1], argc, argv, "Z", -1, "", NULL);
00051
00052   /* Read meteorological data... */
00053   read_met(&ctl, argv[3], met);
00054
00055   /* Find nearest pressure level... */
00056   for (ip2 = 0; ip2 < met->np; ip2++) {
00057     dz = fabs(Z(met->p[ip2]) - z);
00058     if (dz < dzmin) {
00059       dzmin = dz;
00060       ip = ip2;
00061     }
00062   }
00063
00064   /* Write info... */
00065   printf("Analyze %g hPa...\n", met->p[ip]);
00066
00067   /* Calculate horizontal diffusion coefficients... */
00068   for (ix = 1; ix < met->nx - 1; ix++)
00069     for (iy = 1; iy < met->ny - 1; iy++) {
00070       t = 0.5 * ((met->u[ix + 1][iy][ip] - met->u[ix - 1][iy][ip])
00071                  / (1000. *
00072                     DEG2DX(met->lon[ix + 1] - met->lon[ix - 1], met->lat[iy]))
00073                  - (met->v[ix][iy + 1][ip] - met->v[ix][iy - 1][ip])
00074                  / (1000. * DEG2DY(met->lat[iy + 1] - met->lat[iy - 1])));
00075       s = 0.5 * ((met->u[ix][iy + 1][ip] - met->u[ix][iy - 1][ip])
00076                  / (1000. * DEG2DY(met->lat[iy + 1] - met->lat[iy - 1]))
00077                  + (met->v[ix + 1][iy][ip] - met->v[ix - 1][iy][ip])
00078                  / (1000. *
00079                     DEG2DX(met->lon[ix + 1] - met->lon[ix - 1],
00080                            met->lat[iy])));
00081       ls2 = SQR(c * 500. * DEG2DY(met->lat[iy + 1] - met->lat[iy - 1]));
00082       if (fabs(met->lat[iy]) > 80)
00083         ls2 *= (90. - fabs(met->lat[iy])) / 10.;
00084       k[ix][iy] = ls2 * sqrt(2.0 * (SQR(t) + SQR(s)));
00085     }
00086
00087   /* Create output file... */
00088   printf("Write data file: %s\n", argv[2]);
00089   if (!(out = fopen(argv[2], "w")))
00090     ERRMSG("Cannot create file!");
00091
00092   /* Write header... */
00093   fprintf(out,
00094           "# $1 = longitude [deg]\n"
00095           "# $2 = latitude [deg]\n"
00096           "# $3 = zonal wind [m/s]\n"
00097           "# $4 = meridional wind [m/s]\n"
00098           "# $5 = horizontal diffusivity [m^2/s]\n");
00099
00100   /* Write data... */
00101   for (iy = 0; iy < met->ny; iy++) {
00102     fprintf(out, "\n");
00103     for (ix = 0; ix < met->nx; ix++)
00104       if (met->lon[ix] >= 180)
00105         fprintf(out, "%g %g %g %g %g\n",
00106                 met->lon[ix] - 360.0, met->lat[iy],
00107                 met->u[ix][iy][ip], met->v[ix][iy][ip], k[ix][iy]);
00108     for (ix = 0; ix < met->nx; ix++)
00109       if (met->lon[ix] <= 180)
00110         fprintf(out, "%g %g %g %g %g\n",
00111                 met->lon[ix], met->lat[iy],
00112                 met->u[ix][iy][ip], met->v[ix][iy][ip], k[ix][iy]);
00113   }
00114
00115   /* Close file... */
00116   fclose(out);
00117
00118   /* Free... */
00119   free(met);
00120
00121   return EXIT_SUCCESS;
00122 }
```

5.33 time2jsec.c File Reference

Convert date to Julian seconds.

Functions

- int main (int argc, char ∗argv[ ])

5.33.1 Detailed Description

Convert date to Julian seconds.

Definition in file time2jsec.c.

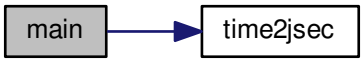
5.33.2 Function Documentation

5.33.2.1 int main (int *argc*, char ∗ *argv[ ]*)

Definition at line 27 of file time2jsec.c.

```
00029                {
00030
00031   double jsec, remain;
00032
00033   int day, hour, min, mon, sec, year;
00034
00035   /* Check arguments... */
00036   if (argc < 8)
00037     ERRMSG("Give parameters: <year> <mon> <day> <hour> <min> <sec> <remain>");
00038
00039   /* Read arguments... */
00040   year = atoi(argv[1]);
00041   mon = atoi(argv[2]);
00042   day = atoi(argv[3]);
00043   hour = atoi(argv[4]);
00044   min = atoi(argv[5]);
00045   sec = atoi(argv[6]);
00046   remain = atof(argv[7]);
00047
00048   /* Convert... */
00049   time2jsec(year, mon, day, hour, min, sec, remain, &jsec);
00050   printf("%.2f\n", jsec);
00051
00052   return EXIT_SUCCESS;
00053 }
```

Here is the call graph for this function:



5.34 time2jsec.c

```
00001 /*
00002   This file is part of MPTRAC.
00003
00004   MPTRAC is free software: you can redistribute it and/or modify
00005   it under the terms of the GNU General Public License as published by
00006   the Free Software Foundation, either version 3 of the License, or
00007   (at your option) any later version.
00008
00009   MPTRAC is distributed in the hope that it will be useful,
00010   but WITHOUT ANY WARRANTY; without even the implied warranty of
00011   MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
00012   GNU General Public License for more details.
00013
00014   You should have received a copy of the GNU General Public License
00015   along with MPTRAC. If not, see <http://www.gnu.org/licenses/>.
00016
00017   Copyright (C) 2013-2019 Forschungszentrum Juelich GmbH
00018 */
00019
00025 #include "libtrac.h"
00026
00027 int main(
00028   int argc,
00029   char *argv[]) {
00030
00031   double jsec, remain;
00032
00033   int day, hour, min, mon, sec, year;
00034
00035   /* Check arguments... */
00036   if (argc < 8)
00037     ERRMSG("Give parameters: <year> <mon> <day> <hour> <min> <sec> <remain>");
00038
00039   /* Read arguments... */
00040   year = atoi(argv[1]);
00041   mon = atoi(argv[2]);
00042   day = atoi(argv[3]);
00043   hour = atoi(argv[4]);
00044   min = atoi(argv[5]);
00045   sec = atoi(argv[6]);
00046   remain = atof(argv[7]);
00047
00048   /* Convert... */
00049   time2jsec(year, mon, day, hour, min, sec, remain, &jsec);
00050   printf("%.2f\n", jsec);
00051
00052   return EXIT_SUCCESS;
00053 }
```

5.35 trac.c File Reference

Lagrangian particle dispersion model.

Functions

- void module_advection (met_t *met0, met_t *met1, atm_t *atm, int ip, double dt)

  Calculate advection of air parcels.
- void module_decay (ctl_t *ctl, met_t *met0, met_t *met1, atm_t *atm, int ip, double dt)

  Calculate exponential decay of particle mass.
- void module_diffusion_meso (ctl_t *ctl, met_t *met0, met_t *met1, atm_t *atm, int ip, double dt, gsl_rng *rng)

  Calculate mesoscale diffusion.
- void module_diffusion_turb (ctl_t *ctl, atm_t *atm, int ip, double dt, gsl_rng *rng)

  Calculate turbulent diffusion.
- void module_isosurf (ctl_t *ctl, met_t *met0, met_t *met1, atm_t *atm, int ip)

  Force air parcels to stay on isosurface.
- void module_meteo (ctl_t *ctl, met_t *met0, met_t *met1, atm_t *atm, int ip)

  Interpolate meteorological data for air parcel positions.

- void module_position (met_t *met0, met_t *met1, atm_t *atm, int ip)
  Check position of air parcels.
- void module_sedi (ctl_t *ctl, met_t *met0, met_t *met1, atm_t *atm, int ip, double dt)
  Calculate sedimentation of air parcels.
- void write_output (const char *dirname, ctl_t *ctl, met_t *met0, met_t *met1, atm_t *atm, double t)
  Write simulation output.
- int main (int argc, char *argv[])

5.35.1 Detailed Description

Lagrangian particle dispersion model.

Definition in file trac.c.

5.35.2 Function Documentation

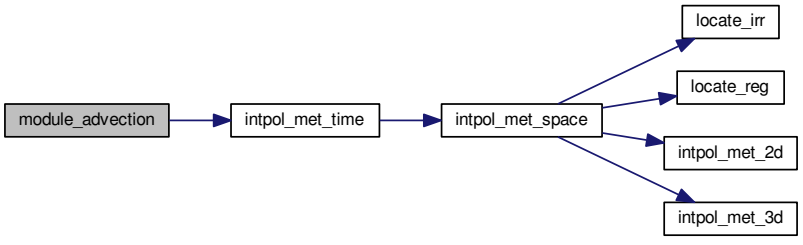
5.35.2.1 void module_advection (met_t * *met0*, met_t * *met1*, atm_t * *atm*, int *ip*, double *dt*)

Calculate advection of air parcels.

Definition at line 386 of file trac.c.

```
00391             {
00392
00393   double v[3], xm[3];
00394
00395   /* Interpolate meteorological data... */
00396   intpol_met_time(met0, met1, atm->time[ip], atm->p[ip],
00397                   atm->lon[ip], atm->lat[ip], NULL, NULL, NULL, NULL,
00398                   &v[0], &v[1], &v[2], NULL, NULL, NULL);
00399
00400   /* Get position of the mid point... */
00401   xm[0] = atm->lon[ip] + DX2DEG(0.5 * dt * v[0] / 1000., atm->lat[ip]);
00402   xm[1] = atm->lat[ip] + DY2DEG(0.5 * dt * v[1] / 1000.);
00403   xm[2] = atm->p[ip] + 0.5 * dt * v[2];
00404
00405   /* Interpolate meteorological data for mid point... */
00406   intpol_met_time(met0, met1, atm->time[ip] + 0.5 * dt,
00407                   xm[2], xm[0], xm[1], NULL, NULL, NULL, NULL,
00408                   &v[0], &v[1], &v[2], NULL, NULL, NULL);
00409
00410   /* Save new position... */
00411   atm->time[ip] += dt;
00412   atm->lon[ip] += DX2DEG(dt * v[0] / 1000., xm[1]);
00413   atm->lat[ip] += DY2DEG(dt * v[1] / 1000.);
00414   atm->p[ip] += dt * v[2];
00415 }
```

Here is the call graph for this function:



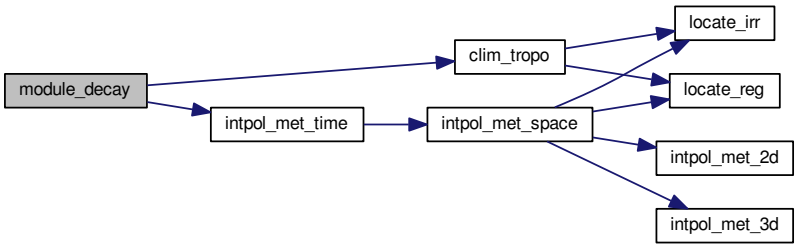
5.35.2.2 void module_decay (ctl_t * *ctl*, met_t * *met0*, met_t * *met1*, atm_t * *atm*, int *ip*, double *dt*)

Calculate exponential decay of particle mass.

Definition at line 419 of file trac.c.

```
00425             {
00426
00427   double ps, pt, tdec;
00428
00429   /* Set constant lifetime... */
00430   if (ctl->tdec_trop == ctl->tdec_strat)
00431     tdec = ctl->tdec_trop;
00432
00433   /* Set altitude-dependent lifetime... */
00434   else {
00435
00436     /* Get surface pressure... */
00437     intpol_met_time(met0, met1, atm->time[ip], atm->p[ip],
00438                     atm->lon[ip], atm->lat[ip], &ps, NULL, NULL, NULL,
00439                     NULL, NULL, NULL, NULL, NULL, NULL);
00440
00441     /* Get tropopause pressure... */
00442     pt = clim_tropo(atm->time[ip], atm->lat[ip]);
00443
00444     /* Set lifetime... */
00445     if (atm->p[ip] <= pt)
00446       tdec = ctl->tdec_strat;
00447     else
00448       tdec = LIN(ps, ctl->tdec_trop, pt, ctl->tdec_strat, atm->
      p[ip]);
00449   }
00450
00451   /* Calculate exponential decay... */
00452   atm->q[ctl->qnt_m][ip] *= exp(-dt / tdec);
00453 }
```

Here is the call graph for this function:



5.35.2.3 void module_diffusion_meso (ctl_t * *ctl*, met_t * *met0*, met_t * *met1*, atm_t * *atm*, int *ip*, double *dt*, gsl_rng * *rng*)

Calculate mesoscale diffusion.

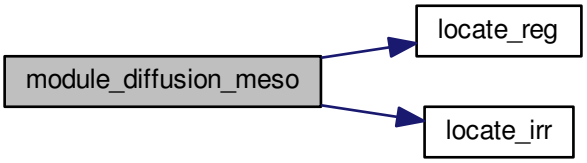
Definition at line 457 of file trac.c.

```
00464                 {
00465
00466   double r, rs, u[16], v[16], w[16];
00467
00468   int ix, iy, iz;
00469
00470   /* Get indices... */
```

```
00471   ix = locate_reg(met0->lon, met0->nx, atm->lon[ip]);
00472   iy = locate_reg(met0->lat, met0->ny, atm->lat[ip]);
00473   iz = locate_irr(met0->p, met0->np, atm->p[ip]);
00474
00475   /* Caching of wind standard deviations... */
00476   if (atm->cache_time[ix][iy][iz] != met0->time) {
00477
00478     /* Collect local wind data... */
00479     u[0] = met0->u[ix][iy][iz];
00480     u[1] = met0->u[ix + 1][iy][iz];
00481     u[2] = met0->u[ix][iy + 1][iz];
00482     u[3] = met0->u[ix + 1][iy + 1][iz];
00483     u[4] = met0->u[ix][iy][iz + 1];
00484     u[5] = met0->u[ix + 1][iy][iz + 1];
00485     u[6] = met0->u[ix][iy + 1][iz + 1];
00486     u[7] = met0->u[ix + 1][iy + 1][iz + 1];
00487
00488     v[0] = met0->v[ix][iy][iz];
00489     v[1] = met0->v[ix + 1][iy][iz];
00490     v[2] = met0->v[ix][iy + 1][iz];
00491     v[3] = met0->v[ix + 1][iy + 1][iz];
00492     v[4] = met0->v[ix][iy][iz + 1];
00493     v[5] = met0->v[ix + 1][iy][iz + 1];
00494     v[6] = met0->v[ix][iy + 1][iz + 1];
00495     v[7] = met0->v[ix + 1][iy + 1][iz + 1];
00496
00497     w[0] = met0->w[ix][iy][iz];
00498     w[1] = met0->w[ix + 1][iy][iz];
00499     w[2] = met0->w[ix][iy + 1][iz];
00500     w[3] = met0->w[ix + 1][iy + 1][iz];
00501     w[4] = met0->w[ix][iy][iz + 1];
00502     w[5] = met0->w[ix + 1][iy][iz + 1];
00503     w[6] = met0->w[ix][iy + 1][iz + 1];
00504     w[7] = met0->w[ix + 1][iy + 1][iz + 1];
00505
00506     /* Collect local wind data... */
00507     u[8] = met1->u[ix][iy][iz];
00508     u[9] = met1->u[ix + 1][iy][iz];
00509     u[10] = met1->u[ix][iy + 1][iz];
00510     u[11] = met1->u[ix + 1][iy + 1][iz];
00511     u[12] = met1->u[ix][iy][iz + 1];
00512     u[13] = met1->u[ix + 1][iy][iz + 1];
00513     u[14] = met1->u[ix][iy + 1][iz + 1];
00514     u[15] = met1->u[ix + 1][iy + 1][iz + 1];
00515
00516     v[8] = met1->v[ix][iy][iz];
00517     v[9] = met1->v[ix + 1][iy][iz];
00518     v[10] = met1->v[ix][iy + 1][iz];
00519     v[11] = met1->v[ix + 1][iy + 1][iz];
00520     v[12] = met1->v[ix][iy][iz + 1];
00521     v[13] = met1->v[ix + 1][iy][iz + 1];
00522     v[14] = met1->v[ix][iy + 1][iz + 1];
00523     v[15] = met1->v[ix + 1][iy + 1][iz + 1];
00524
00525     w[8] = met1->w[ix][iy][iz];
00526     w[9] = met1->w[ix + 1][iy][iz];
00527     w[10] = met1->w[ix][iy + 1][iz];
00528     w[11] = met1->w[ix + 1][iy + 1][iz];
00529     w[12] = met1->w[ix][iy][iz + 1];
00530     w[13] = met1->w[ix + 1][iy][iz + 1];
00531     w[14] = met1->w[ix][iy + 1][iz + 1];
00532     w[15] = met1->w[ix + 1][iy + 1][iz + 1];
00533
00534     /* Get standard deviations of local wind data... */
00535     atm->cache_usig[ix][iy][iz] = (float) gsl_stats_sd(u, 1, 16);
00536     atm->cache_vsig[ix][iy][iz] = (float) gsl_stats_sd(v, 1, 16);
00537     atm->cache_wsig[ix][iy][iz] = (float) gsl_stats_sd(w, 1, 16);
00538     atm->cache_time[ix][iy][iz] = met0->time;
00539   }
00540
00541   /* Set temporal correlations for mesoscale fluctuations... */
00542   r = 1 - 2 * fabs(dt) / ctl->dt_met;
00543   rs = sqrt(1 - r * r);
00544
00545   /* Calculate horizontal mesoscale wind fluctuations... */
00546   if (ctl->turb_mesox > 0) {
00547     atm->up[ip] = (float)
00548       (r * atm->up[ip]
00549        + rs * gsl_ran_gaussian_ziggurat(rng,
00550                                         ctl->turb_mesox *
00551                                         atm->cache_usig[ix][iy][iz]));
00552     atm->lon[ip] += DX2DEG(atm->up[ip] * dt / 1000., atm->lat[ip]);
00553
00554     atm->vp[ip] = (float)
00555       (r * atm->vp[ip]
00556        + rs * gsl_ran_gaussian_ziggurat(rng,
00557                                         ctl->turb_mesox *
```

```
00558                                       atm->cache_vsig[ix][iy][iz]));
00559     atm->lat[ip] += DY2DEG(atm->vp[ip] * dt / 1000.);
00560   }
00561
00562   /* Calculate vertical mesoscale wind fluctuations... */
00563   if (ctl->turb_mesoz > 0) {
00564     atm->wp[ip] = (float)
00565       (r * atm->wp[ip]
00566        + rs * gsl_ran_gaussian_ziggurat(rng,
00567                                         ctl->turb_mesoz *
00568                                         atm->cache_wsig[ix][iy][iz]));
00569     atm->p[ip] += atm->wp[ip] * dt;
00570   }
00571 }
```

Here is the call graph for this function:



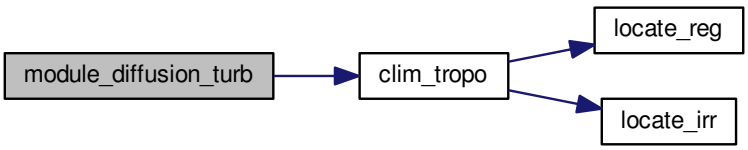
5.35.2.4 void module_diffusion_turb (ctl_t * *ctl*, atm_t * *atm*, int *ip*, double *dt*, gsl_rng * *rng*)

Calculate turbulent diffusion.

Definition at line 575 of file trac.c.

```
00580                 {
00581
00582   double dx, dz, pt, p0, p1, w;
00583
00584   /* Get tropopause pressure... */
00585   pt = clim_tropo(atm->time[ip], atm->lat[ip]);
00586
00587   /* Get weighting factor... */
00588   p1 = pt * 0.866877899;
00589   p0 = pt / 0.866877899;
00590   if (atm->p[ip] > p0)
00591     w = 1;
00592   else if (atm->p[ip] < p1)
00593     w = 0;
00594   else
00595     w = LIN(p0, 1.0, p1, 0.0, atm->p[ip]);
00596
00597   /* Set diffusivity... */
00598   dx = w * ctl->turb_dx_trop + (1 - w) * ctl->turb_dx_strat;
00599   dz = w * ctl->turb_dz_trop + (1 - w) * ctl->turb_dz_strat;
00600
00601   /* Horizontal turbulent diffusion... */
00602   if (dx > 0) {
00603     atm->lon[ip]
00604       += DX2DEG(gsl_ran_gaussian_ziggurat(rng, sqrt(2.0 * dx * fabs(dt)))
00605                 / 1000., atm->lat[ip]);
00606     atm->lat[ip]
00607       += DY2DEG(gsl_ran_gaussian_ziggurat(rng, sqrt(2.0 * dx * fabs(dt)))
00608                 / 1000.);
00609   }
00610
00611   /* Vertical turbulent diffusion... */
00612   if (dz > 0)
00613     atm->p[ip]
00614       += DZ2DP(gsl_ran_gaussian_ziggurat(rng, sqrt(2.0 * dz * fabs(dt)))
00615                / 1000., atm->p[ip]);
00616 }
```

Here is the call graph for this function:



5.35.2.5 void module_isosurf (ctl_t * *ctl*, met_t * *met0*, met_t * *met1*, atm_t * *atm*, int *ip*)

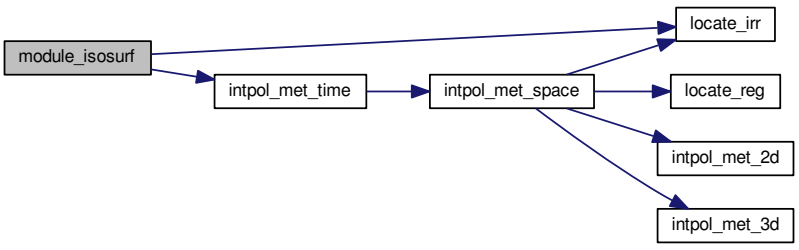
Force air parcels to stay on isosurface.

Definition at line 620 of file trac.c.

```
00625           {
00626
00627     static double *iso, *ps, t, *ts;
00628
00629     static int idx, ip2, n;
00630
00631     FILE *in;
00632
00633     char line[LEN];
00634
00635     /* Initialize... */
00636     if (ip < 0) {
00637
00638       /* Allocate... */
00639       ALLOC(iso, double,
00640             NP);
00641       ALLOC(ps, double,
00642             NP);
00643       ALLOC(ts, double,
00644             NP);
00645
00646       /* Save pressure... */
00647       if (ctl->isosurf == 1)
00648         for (ip2 = 0; ip2 < atm->np; ip2++)
00649           iso[ip2] = atm->p[ip2];
00650
00651       /* Save density... */
00652       else if (ctl->isosurf == 2)
00653         for (ip2 = 0; ip2 < atm->np; ip2++) {
00654           intpol_met_time(met0, met1, atm->time[ip2], atm->p[ip2],
00655                           atm->lon[ip2], atm->lat[ip2], NULL, NULL, NULL,
00656                           &t, NULL, NULL, NULL, NULL, NULL, NULL);
00657           iso[ip2] = atm->p[ip2] / t;
00658         }
00659
00660       /* Save potential temperature... */
00661       else if (ctl->isosurf == 3)
00662         for (ip2 = 0; ip2 < atm->np; ip2++) {
00663           intpol_met_time(met0, met1, atm->time[ip2], atm->p[ip2],
00664                           atm->lon[ip2], atm->lat[ip2], NULL, NULL, NULL,
00665                           &t, NULL, NULL, NULL, NULL, NULL, NULL);
00666           iso[ip2] = THETA(atm->p[ip2], t);
00667         }
00668
00669       /* Read balloon pressure data... */
00670       else if (ctl->isosurf == 4) {
00671
00672         /* Write info... */
00673         printf("Read balloon pressure data: %s\n", ctl->balloon);
00674
00675         /* Open file... */
00676         if (!(in = fopen(ctl->balloon, "r")))
00677           ERRMSG("Cannot open file!");
```

```
00678
00679       /* Read pressure time series... */
00680       while (fgets(line, LEN, in))
00681         if (sscanf(line, "%lg %lg", &ts[n], &ps[n]) == 2)
00682           if ((++n) > NP)
00683             ERRMSG("Too many data points!");
00684
00685       /* Check number of points... */
00686       if (n < 1)
00687         ERRMSG("Could not read any data!");
00688
00689       /* Close file... */
00690       fclose(in);
00691     }
00692
00693     /* Leave initialization... */
00694     return;
00695   }
00696
00697   /* Restore pressure... */
00698   if (ctl->isosurf == 1)
00699     atm->p[ip] = iso[ip];
00700
00701   /* Restore density... */
00702   else if (ctl->isosurf == 2) {
00703     intpol_met_time(met0, met1, atm->time[ip], atm->p[ip], atm->
      lon[ip],
00704                     atm->lat[ip], NULL, NULL, NULL, &t,
00705                     NULL, NULL, NULL, NULL, NULL, NULL);
00706     atm->p[ip] = iso[ip] * t;
00707   }
00708
00709   /* Restore potential temperature... */
00710   else if (ctl->isosurf == 3) {
00711     intpol_met_time(met0, met1, atm->time[ip], atm->p[ip], atm->
      lon[ip],
00712                     atm->lat[ip], NULL, NULL, NULL, &t,
00713                     NULL, NULL, NULL, NULL, NULL, NULL);
00714     atm->p[ip] = 1000. * pow(iso[ip] / t, -1. / 0.286);
00715   }
00716
00717   /* Interpolate pressure... */
00718   else if (ctl->isosurf == 4) {
00719     if (atm->time[ip] <= ts[0])
00720       atm->p[ip] = ps[0];
00721     else if (atm->time[ip] >= ts[n - 1])
00722       atm->p[ip] = ps[n - 1];
00723     else {
00724       idx = locate_irr(ts, n, atm->time[ip]);
00725       atm->p[ip] = LIN(ts[idx], ps[idx],
00726                        ts[idx + 1], ps[idx + 1], atm->time[ip]);
00727     }
00728   }
00729 }
```

Here is the call graph for this function:



5.35.2.6 void module_meteo (ctl_t * *ctl*, met_t * *met0*, met_t * *met1*, atm_t * *atm*, int *ip*)

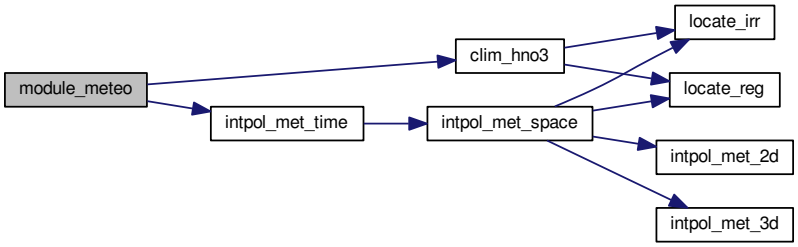
Interpolate meteorological data for air parcel positions.

Definition at line 733 of file trac.c.

```
00738           {
00739
00740   double a, b, c, ps, pt, pv, p_hno3, p_h2o, t, u, v, w, x1, x2, h2o, o3, z;
00741
00742   /* Interpolate meteorological data... */
00743   intpol_met_time(met0, met1, atm->time[ip], atm->p[ip], atm->
    lon[ip],
00744                   atm->lat[ip], &ps, &pt, &z, &t, &u, &v, &w, &pv, &h2o, &o3);
00745
00746   /* Set surface pressure... */
00747   if (ctl->qnt_ps >= 0)
00748     atm->q[ctl->qnt_ps][ip] = ps;
00749
00750   /* Set tropopause pressure... */
00751   if (ctl->qnt_pt >= 0)
00752     atm->q[ctl->qnt_pt][ip] = pt;
00753
00754   /* Set pressure... */
00755   if (ctl->qnt_p >= 0)
00756     atm->q[ctl->qnt_p][ip] = atm->p[ip];
00757
00758   /* Set geopotential height... */
00759   if (ctl->qnt_z >= 0)
00760     atm->q[ctl->qnt_z][ip] = z;
00761
00762   /* Set temperature... */
00763   if (ctl->qnt_t >= 0)
00764     atm->q[ctl->qnt_t][ip] = t;
00765
00766   /* Set zonal wind... */
00767   if (ctl->qnt_u >= 0)
00768     atm->q[ctl->qnt_u][ip] = u;
00769
00770   /* Set meridional wind... */
00771   if (ctl->qnt_v >= 0)
00772     atm->q[ctl->qnt_v][ip] = v;
00773
00774   /* Set vertical velocity... */
00775   if (ctl->qnt_w >= 0)
00776     atm->q[ctl->qnt_w][ip] = w;
00777
00778   /* Set water vapor vmr... */
00779   if (ctl->qnt_h2o >= 0)
00780     atm->q[ctl->qnt_h2o][ip] = h2o;
00781
00782   /* Set ozone vmr... */
00783   if (ctl->qnt_o3 >= 0)
00784     atm->q[ctl->qnt_o3][ip] = o3;
00785
00786   /* Calculate horizontal wind... */
00787   if (ctl->qnt_vh >= 0)
00788     atm->q[ctl->qnt_vh][ip] = sqrt(u * u + v * v);
00789
00790   /* Calculate vertical velocity... */
00791   if (ctl->qnt_vz >= 0)
00792     atm->q[ctl->qnt_vz][ip] = -1e3 * H0 / atm->p[ip] * w;
00793
00794   /* Calculate potential temperature... */
00795   if (ctl->qnt_theta >= 0)
00796     atm->q[ctl->qnt_theta][ip] = THETA(atm->p[ip], t);
00797
00798   /* Set potential vorticity... */
00799   if (ctl->qnt_pv >= 0)
00800     atm->q[ctl->qnt_pv][ip] = pv;
00801
00802   /* Calculate T_ice (Marti and Mauersberger, 1993)... */
00803   if (ctl->qnt_tice >= 0)
00804     atm->q[ctl->qnt_tice][ip] =
00805       -2663.5 /
00806       (log10((ctl->psc_h2o > 0 ? ctl->psc_h2o : h2o) * atm->p[ip] * 100.) -
00807        12.537);
00808
00809   /* Calculate T_NAT (Hanson and Mauersberger, 1988)... */
00810   if (ctl->qnt_tnat >= 0) {
00811     if (ctl->psc_hno3 > 0)
00812       p_hno3 = ctl->psc_hno3 * atm->p[ip] / 1.333224;
00813     else
00814       p_hno3 = clim_hno3(atm->time[ip], atm->lat[ip], atm->p[ip])
00815         * 1e-9 * atm->p[ip] / 1.333224;
00816     p_h2o = (ctl->psc_h2o > 0 ? ctl->psc_h2o : h2o) * atm->p[ip] / 1.333224;
00817     a = 0.009179 - 0.00088 * log10(p_h2o);
00818     b = (38.9855 - log10(p_hno3) - 2.7836 * log10(p_h2o)) / a;
00819     c = -11397.0 / a;
00820     x1 = (-b + sqrt(b * b - 4. * c)) / 2.;
00821     x2 = (-b - sqrt(b * b - 4. * c)) / 2.;
00822     if (x1 > 0)
00823       atm->q[ctl->qnt_tnat][ip] = x1;
```

```
00824     if (x2 > 0)
00825       atm->q[ctl->qnt_tnat][ip] = x2;
00826   }
00827
00828   /* Calculate T_STS (mean of T_ice and T_NAT)... */
00829   if (ctl->qnt_tsts >= 0) {
00830     if (ctl->qnt_tice < 0 || ctl->qnt_tnat < 0)
00831       ERRMSG("Need T_ice and T_NAT to calculate T_STS!");
00832     atm->q[ctl->qnt_tsts][ip] = 0.5 * (atm->q[ctl->qnt_tice][ip]
00833                                        + atm->q[ctl->qnt_tnat][ip]);
00834   }
00835 }
```

Here is the call graph for this function:



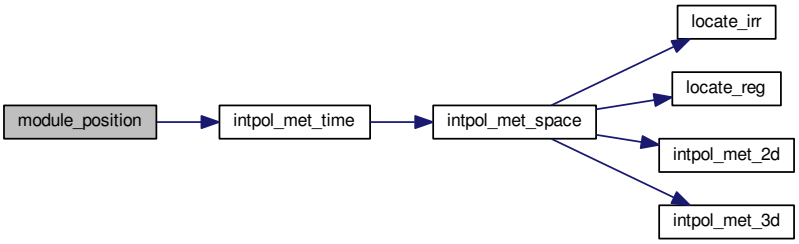
5.35.2.7 void module_position (met_t * *met0*, met_t * *met1*, atm_t * *atm*, int *ip*)

Check position of air parcels.

Definition at line 839 of file trac.c.

```
00843           {
00844
00845   double ps;
00846
00847   /* Calculate modulo... */
00848   atm->lon[ip] = fmod(atm->lon[ip], 360);
00849   atm->lat[ip] = fmod(atm->lat[ip], 360);
00850
00851   /* Check latitude... */
00852   while (atm->lat[ip] < -90 || atm->lat[ip] > 90) {
00853     if (atm->lat[ip] > 90) {
00854       atm->lat[ip] = 180 - atm->lat[ip];
00855       atm->lon[ip] += 180;
00856     }
00857     if (atm->lat[ip] < -90) {
00858       atm->lat[ip] = -180 - atm->lat[ip];
00859       atm->lon[ip] += 180;
00860     }
00861   }
00862
00863   /* Check longitude... */
00864   while (atm->lon[ip] < -180)
00865     atm->lon[ip] += 360;
00866   while (atm->lon[ip] >= 180)
00867     atm->lon[ip] -= 360;
00868
00869   /* Get surface pressure... */
00870   intpol_met_time(met0, met1, atm->time[ip], atm->p[ip],
00871                   atm->lon[ip], atm->lat[ip], &ps, NULL, NULL, NULL,
00872                   NULL, NULL, NULL, NULL, NULL, NULL);
00873
00874   /* Check pressure... */
00875   if (atm->p[ip] > ps)
00876     atm->p[ip] = ps;
00877   else if (atm->p[ip] < met0->p[met0->np - 1])
00878     atm->p[ip] = met0->p[met0->np - 1];
00879 }
```

Here is the call graph for this function:



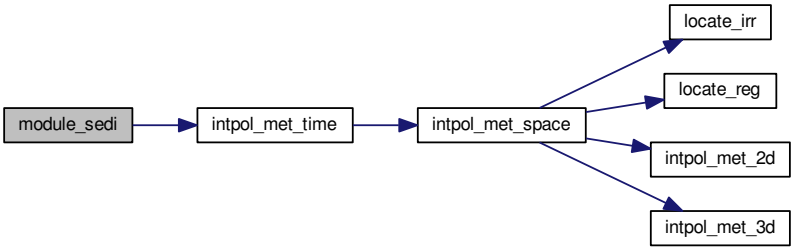
5.35.2.8 void module_sedi (ctl_t * *ctl*, met_t * *met0*, met_t * *met1*, atm_t * *atm*, int *ip*, double *dt*)

Calculate sedimentation of air parcels.

Definition at line 883 of file trac.c.

```
00889             {
00890
00891   /* Coefficients for Cunningham slip-flow correction (Kasten, 1968): */
00892   const double A = 1.249, B = 0.42, C = 0.87;
00893
00894   /* Average mass of an air molecule [kg/molec]: */
00895   const double m = 4.8096e-26;
00896
00897   double G, K, eta, lambda, p, r_p, rho, rho_p, T, v, v_p;
00898
00899   /* Convert units... */
00900   p = 100 * atm->p[ip];
00901   r_p = 1e-6 * atm->q[ctl->qnt_r][ip];
00902   rho_p = atm->q[ctl->qnt_rho][ip];
00903
00904   /* Get temperature... */
00905   intpol_met_time(met0, met1, atm->time[ip], atm->p[ip], atm->
      lon[ip],
00906                   atm->lat[ip], NULL, NULL, NULL, &T,
00907                   NULL, NULL, NULL, NULL, NULL, NULL);
00908
00909   /* Density of dry air... */
00910   rho = p / (RA * T);
00911
00912   /* Dynamic viscosity of air... */
00913   eta = 1.8325e-5 * (416.16 / (T + 120.)) * pow(T / 296.16, 1.5);
00914
00915   /* Thermal velocity of an air molecule... */
00916   v = sqrt(8 * KB * T / (M_PI * m));
00917
00918   /* Mean free path of an air molecule... */
00919   lambda = 2 * eta / (rho * v);
00920
00921   /* Knudsen number for air... */
00922   K = lambda / r_p;
00923
00924   /* Cunningham slip-flow correction... */
00925   G = 1 + K * (A + B * exp(-C / K));
00926
00927   /* Sedimentation (fall) velocity... */
00928   v_p = 2. * SQR(r_p) * (rho_p - rho) * G0 / (9. * eta) * G;
00929
00930   /* Calculate pressure change... */
00931   atm->p[ip] += DZ2DP(v_p * dt / 1000., atm->p[ip]);
00932 }
```

Here is the call graph for this function:



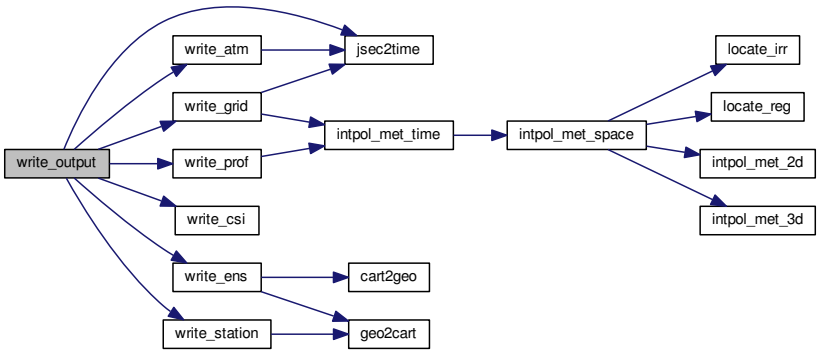
5.35.2.9 void write_output (const char * *dirname*, ctl_t * *ctl*, met_t * *met0*, met_t * *met1*, atm_t * *atm*, double *t*)

Write simulation output.

Definition at line 936 of file trac.c.

```
00942            {
00943
00944   char filename[2 * LEN];
00945
00946   double r;
00947
00948   int year, mon, day, hour, min, sec;
00949
00950   /* Get time... */
00951   jsec2time(t, &year, &mon, &day, &hour, &min, &sec, &r);
00952
00953   /* Write atmospheric data... */
00954   if (ctl->atm_basename[0] != '-' && fmod(t, ctl->atm_dt_out) == 0) {
00955     sprintf(filename, "%s/%s_%04d_%02d_%02d_%02d_%02d.tab",
00956             dirname, ctl->atm_basename, year, mon, day, hour, min);
00957     write_atm(filename, ctl, atm, t);
00958   }
00959
00960   /* Write CSI data... */
00961   if (ctl->csi_basename[0] != '-') {
00962     sprintf(filename, "%s/%s.tab", dirname, ctl->csi_basename);
00963     write_csi(filename, ctl, atm, t);
00964   }
00965
00966   /* Write ensemble data... */
00967   if (ctl->ens_basename[0] != '-') {
00968     sprintf(filename, "%s/%s.tab", dirname, ctl->ens_basename);
00969     write_ens(filename, ctl, atm, t);
00970   }
00971
00972   /* Write gridded data... */
00973   if (ctl->grid_basename[0] != '-' && fmod(t, ctl->grid_dt_out) == 0) {
00974     sprintf(filename, "%s/%s_%04d_%02d_%02d_%02d_%02d.tab",
00975             dirname, ctl->grid_basename, year, mon, day, hour, min);
00976     write_grid(filename, ctl, met0, met1, atm, t);
00977   }
00978
00979   /* Write profile data... */
00980   if (ctl->prof_basename[0] != '-') {
00981     sprintf(filename, "%s/%s.tab", dirname, ctl->prof_basename);
00982     write_prof(filename, ctl, met0, met1, atm, t);
00983   }
00984
00985   /* Write station data... */
00986   if (ctl->stat_basename[0] != '-') {
00987     sprintf(filename, "%s/%s.tab", dirname, ctl->stat_basename);
00988     write_station(filename, ctl, atm, t);
00989   }
00990 }
```

Here is the call graph for this function:



5.35.2.10 int main (int *argc*, char * *argv[ ]*)

Definition at line 115 of file trac.c.

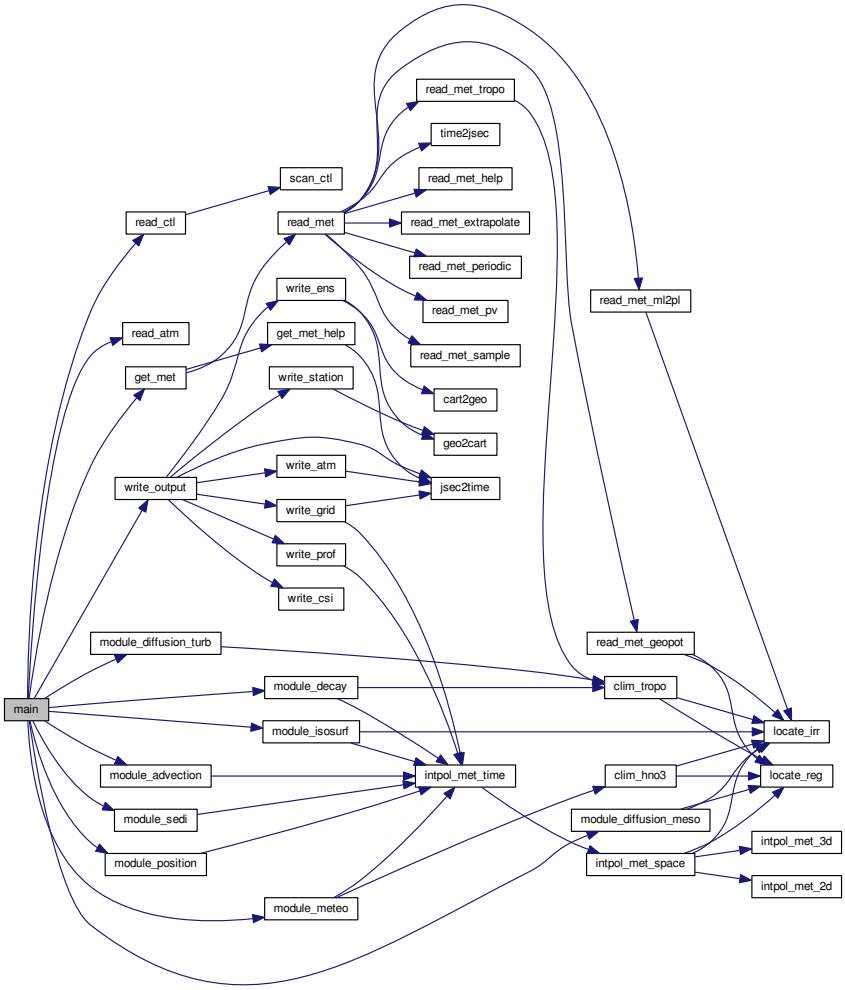
```
00117                {
00118
00119   ctl_t ctl;
00120
00121   atm_t *atm;
00122
00123   met_t *met0, *met1;
00124
00125   gsl_rng *rng[NTHREADS];
00126
00127   FILE *dirlist;
00128
00129   char dirname[LEN], filename[2 * LEN];
00130
00131   double *dt, t;
00132
00133   int i, ip, ntask = -1, rank = 0, size = 1;
00134
00135 #ifdef MPI
00136   /* Initialize MPI... */
00137   MPI_Init(&argc, &argv);
00138   MPI_Comm_rank(MPI_COMM_WORLD, &rank);
00139   MPI_Comm_size(MPI_COMM_WORLD, &size);
00140 #endif
00141
00142   /* Check arguments... */
00143   if (argc < 5)
00144     ERRMSG("Give parameters: <dirlist> <ctl> <atm_in> <metbase>");
00145
00146   /* Open directory list... */
00147   if (!(dirlist = fopen(argv[1], "r")))
00148     ERRMSG("Cannot open directory list!");
00149
00150   /* Loop over directories... */
00151   while (fscanf(dirlist, "%s", dirname) != EOF) {
00152
00153     /* MPI parallelization... */
00154     if ((++ntask) % size != rank)
00155       continue;
00156
00157     /* ------------------------------------------------------------
00158        Initialize model run...
00159        ------------------------------------------------------------ */
00160
00161     /* Set timers... */
00162     START_TIMER(TIMER_TOTAL);
00163     START_TIMER(TIMER_INIT);
00164
00165     /* Allocate... */
00166     ALLOC(atm, atm_t, 1);
```

```
00167     ALLOC(met0, met_t, 1);
00168     ALLOC(met1, met_t, 1);
00169     ALLOC(dt, double,
00170           NP);
00171
00172     /* Initialize random number generators... */
00173     gsl_rng_env_setup();
00174     if (omp_get_max_threads() > NTHREADS)
00175       ERRMSG("Too many threads!");
00176     for (i = 0; i < NTHREADS; i++) {
00177       rng[i] = gsl_rng_alloc(gsl_rng_default);
00178       gsl_rng_set(rng[i], gsl_rng_default_seed + (long unsigned) i);
00179     }
00180
00181     /* Read control parameters... */
00182     sprintf(filename, "%s/%s", dirname, argv[2]);
00183     read_ctl(filename, argc, argv, &ctl);
00184
00185     /* Read atmospheric data... */
00186     sprintf(filename, "%s/%s", dirname, argv[3]);
00187     read_atm(filename, &ctl, atm);
00188
00189     /* Set start time... */
00190     if (ctl.direction == 1) {
00191       ctl.t_start = gsl_stats_min(atm->time, 1, (size_t) atm->np);
00192       if (ctl.t_stop > 1e99)
00193         ctl.t_stop = gsl_stats_max(atm->time, 1, (size_t) atm->np);
00194     } else {
00195       ctl.t_start = gsl_stats_max(atm->time, 1, (size_t) atm->np);
00196       if (ctl.t_stop > 1e99)
00197         ctl.t_stop = gsl_stats_min(atm->time, 1, (size_t) atm->np);
00198     }
00199
00200     /* Check time interval... */
00201     if (ctl.direction * (ctl.t_stop - ctl.t_start) <= 0)
00202       ERRMSG("Nothing to do!");
00203
00204     /* Round start time... */
00205     if (ctl.direction == 1)
00206       ctl.t_start = floor(ctl.t_start / ctl.dt_mod) * ctl.
      dt_mod;
00207     else
00208       ctl.t_start = ceil(ctl.t_start / ctl.dt_mod) * ctl.
      dt_mod;
00209
00210     /* Set timers... */
00211     STOP_TIMER(TIMER_INIT);
00212
00213     /* ------------------------------------------------------------
00214        Loop over timesteps...
00215        ------------------------------------------------------------ */
00216
00217     /* Loop over timesteps... */
00218     for (t = ctl.t_start; ctl.direction * (t - ctl.t_stop) < ctl.
      dt_mod;
00219          t += ctl.direction * ctl.dt_mod) {
00220
00221       /* Adjust length of final time step... */
00222       if (ctl.direction * (t - ctl.t_stop) > 0)
00223         t = ctl.t_stop;
00224
00225       /* Set time steps for air parcels... */
00226       for (ip = 0; ip < atm->np; ip++)
00227         if ((ctl.direction * (atm->time[ip] - ctl.t_start) >= 0
00228              && ctl.direction * (atm->time[ip] - ctl.t_stop) <= 0
00229              && ctl.direction * (atm->time[ip] - t) < 0))
00230           dt[ip] = t - atm->time[ip];
00231         else
00232           dt[ip] = GSL_NAN;
00233
00234       /* Get meteorological data... */
00235       START_TIMER(TIMER_INPUT);
00236       get_met(&ctl, argv[4], t, &met0, &met1);
00237       if (ctl.dt_mod > fabs(met0->lon[1] - met0->lon[0]) * 111132. / 150.)
00238         printf("Warning: Violation of CFL criterion! Set DT_MOD <= %g s!\n",
00239                fabs(met0->lon[1] - met0->lon[0]) * 111132. / 150.);
00240       STOP_TIMER(TIMER_INPUT);
00241
00242       /* Initialize isosurface... */
00243       START_TIMER(TIMER_ISOSURF);
00244       if (ctl.isosurf >= 1 && ctl.isosurf <= 4 && t == ctl.t_start)
00245         module_isosurf(&ctl, met0, met1, atm, -1);
00246       STOP_TIMER(TIMER_ISOSURF);
00247
00248       /* Advection... */
00249       START_TIMER(TIMER_ADVECT);
00250 #pragma omp parallel for default(shared) private(ip)
```

```
00251       for (ip = 0; ip < atm->np; ip++)
00252         if (gsl_finite(dt[ip]))
00253           module_advection(met0, met1, atm, ip, dt[ip]);
00254       STOP_TIMER(TIMER_ADVECT);
00255
00256       /* Turbulent diffusion... */
00257       START_TIMER(TIMER_DIFFTURB);
00258       if (ctl.turb_dx_trop > 0 || ctl.turb_dz_trop > 0
00259           || ctl.turb_dx_strat > 0 || ctl.turb_dz_strat > 0) {
00260 #pragma omp parallel for default(shared) private(ip)
00261         for (ip = 0; ip < atm->np; ip++)
00262           if (gsl_finite(dt[ip]))
00263             module_diffusion_turb(&ctl, atm, ip, dt[ip],
00264                                   rng[omp_get_thread_num()]);
00265       }
00266       STOP_TIMER(TIMER_DIFFTURB);
00267
00268       /* Mesoscale diffusion... */
00269       START_TIMER(TIMER_DIFFMESO);
00270       if (ctl.turb_mesox > 0 || ctl.turb_mesoz > 0) {
00271 #pragma omp parallel for default(shared) private(ip)
00272         for (ip = 0; ip < atm->np; ip++)
00273           if (gsl_finite(dt[ip]))
00274             module_diffusion_meso(&ctl, met0, met1, atm, ip, dt[ip],
00275                                   rng[omp_get_thread_num()]);
00276       }
00277       STOP_TIMER(TIMER_DIFFMESO);
00278
00279       /* Sedimentation... */
00280       START_TIMER(TIMER_SEDI);
00281       if (ctl.qnt_r >= 0 && ctl.qnt_rho >= 0) {
00282 #pragma omp parallel for default(shared) private(ip)
00283         for (ip = 0; ip < atm->np; ip++)
00284           if (gsl_finite(dt[ip]))
00285             module_sedi(&ctl, met0, met1, atm, ip, dt[ip]);
00286       }
00287       STOP_TIMER(TIMER_SEDI);
00288
00289       /* Isosurface... */
00290       START_TIMER(TIMER_ISOSURF);
00291       if (ctl.isosurf >= 1 && ctl.isosurf <= 4) {
00292 #pragma omp parallel for default(shared) private(ip)
00293         for (ip = 0; ip < atm->np; ip++)
00294           module_isosurf(&ctl, met0, met1, atm, ip);
00295       }
00296       STOP_TIMER(TIMER_ISOSURF);
00297
00298       /* Position... */
00299       START_TIMER(TIMER_POSITION);
00300 #pragma omp parallel for default(shared) private(ip)
00301       for (ip = 0; ip < atm->np; ip++)
00302         module_position(met0, met1, atm, ip);
00303       STOP_TIMER(TIMER_POSITION);
00304
00305       /* Meteorological data... */
00306       START_TIMER(TIMER_METEO);
00307       if (ctl.met_dt_out > 0
00308           && (ctl.met_dt_out < ctl.dt_mod || fmod(t, ctl.
      met_dt_out) == 0)) {
00309 #pragma omp parallel for default(shared) private(ip)
00310         for (ip = 0; ip < atm->np; ip++)
00311           module_meteo(&ctl, met0, met1, atm, ip);
00312       }
00313       STOP_TIMER(TIMER_METEO);
00314
00315       /* Decay... */
00316       START_TIMER(TIMER_DECAY);
00317       if ((ctl.tdec_trop > 0 || ctl.tdec_strat > 0) && ctl.
      qnt_m >= 0) {
00318 #pragma omp parallel for default(shared) private(ip)
00319         for (ip = 0; ip < atm->np; ip++)
00320           if (gsl_finite(dt[ip]))
00321             module_decay(&ctl, met0, met1, atm, ip, dt[ip]);
00322       }
00323       STOP_TIMER(TIMER_DECAY);
00324
00325       /* Write output... */
00326       START_TIMER(TIMER_OUTPUT);
00327       write_output(dirname, &ctl, met0, met1, atm, t);
00328       STOP_TIMER(TIMER_OUTPUT);
00329     }
00330
00331     /* ------------------------------------------------------------
00332        Finalize model run...
00333        ------------------------------------------------------------ */
00334
00335     /* Report memory usage... */
```

```
00336     printf("MEMORY_ATM = %g MByte\n", sizeof(atm_t) / 1024. / 1024.);
00337     printf("MEMORY_METEO = %g MByte\n", 2. * sizeof(met_t) / 1024. / 1024.);
00338     printf("MEMORY_DYNAMIC = %g MByte\n",
00339            4 * NP * sizeof(double) / 1024. / 1024.);
00340     printf("MEMORY_STATIC = %g MByte\n",
00341            ((3 * GX * GY + 4 * GX * GY * GZ) * sizeof(double)
00342             + (EX * EY + EX * EY * EP) * sizeof(float)
00343             + (GX * GY + GX * GY * GZ) * sizeof(int)) / 1024. / 1024.);
00344
00345     /* Report problem size... */
00346     printf("SIZE_NP = %d\n", atm->np);
00347     printf("SIZE_TASKS = %d\n", size);
00348     printf("SIZE_THREADS = %d\n", omp_get_max_threads());
00349
00350     /* Report timers... */
00351     STOP_TIMER(TIMER_TOTAL);
00352     PRINT_TIMER(TIMER_TOTAL);
00353     PRINT_TIMER(TIMER_INIT);
00354     PRINT_TIMER(TIMER_INPUT);
00355     PRINT_TIMER(TIMER_OUTPUT);
00356     PRINT_TIMER(TIMER_ADVECT);
00357     PRINT_TIMER(TIMER_DECAY);
00358     PRINT_TIMER(TIMER_DIFFMESO);
00359     PRINT_TIMER(TIMER_DIFFTURB);
00360     PRINT_TIMER(TIMER_ISOSURF);
00361     PRINT_TIMER(TIMER_METEO);
00362     PRINT_TIMER(TIMER_POSITION);
00363     PRINT_TIMER(TIMER_SEDI);
00364
00365     /* Free random number generators... */
00366     for (i = 0; i < NTHREADS; i++)
00367       gsl_rng_free(rng[i]);
00368
00369     /* Free... */
00370     free(atm);
00371     free(met0);
00372     free(met1);
00373     free(dt);
00374   }
00375
00376 #ifdef MPI
00377   /* Finalize MPI... */
00378   MPI_Finalize();
00379 #endif
00380
00381   return EXIT_SUCCESS;
00382 }
```

Here is the call graph for this function:



5.36 trac.c

```
00001 /*
00002   This file is part of MPTRAC.
00003
00004   MPTRAC is free software: you can redistribute it and/or modify
00005   it under the terms of the GNU General Public License as published by
00006   the Free Software Foundation, either version 3 of the License, or
00007   (at your option) any later version.
00008
00009   MPTRAC is distributed in the hope that it will be useful,
00010   but WITHOUT ANY WARRANTY; without even the implied warranty of
00011   MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
00012   GNU General Public License for more details.
00013
00014   You should have received a copy of the GNU General Public License
00015   along with MPTRAC. If not, see <http://www.gnu.org/licenses/>.
00016
00017   Copyright (C) 2013-2019 Forschungszentrum Juelich GmbH
00018 */
00019
00025 #include "libtrac.h"
00026
00027 #ifdef MPI
00028 #include "mpi.h"
00029 #endif
00030
```

```
00031 /* ------------------------------------------------------------
00032    Functions...
00033    ------------------------------------------------------------ */
00034
00036 void module_advection(
00037   met_t * met0,
00038   met_t * met1,
00039   atm_t * atm,
00040   int ip,
00041   double dt);
00042
00044 void module_decay(
00045   ctl_t * ctl,
00046   met_t * met0,
00047   met_t * met1,
00048   atm_t * atm,
00049   int ip,
00050   double dt);
00051
00053 void module_diffusion_meso(
00054   ctl_t * ctl,
00055   met_t * met0,
00056   met_t * met1,
00057   atm_t * atm,
00058   int ip,
00059   double dt,
00060   gsl_rng * rng);
00061
00063 void module_diffusion_turb(
00064   ctl_t * ctl,
00065   atm_t * atm,
00066   int ip,
00067   double dt,
00068   gsl_rng * rng);
00069
00071 void module_isosurf(
00072   ctl_t * ctl,
00073   met_t * met0,
00074   met_t * met1,
00075   atm_t * atm,
00076   int ip);
00077
00079 void module_meteo(
00080   ctl_t * ctl,
00081   met_t * met0,
00082   met_t * met1,
00083   atm_t * atm,
00084   int ip);
00085
00087 void module_position(
00088   met_t * met0,
00089   met_t * met1,
00090   atm_t * atm,
00091   int ip);
00092
00094 void module_sedi(
00095   ctl_t * ctl,
00096   met_t * met0,
00097   met_t * met1,
00098   atm_t * atm,
00099   int ip,
00100   double dt);
00101
00103 void write_output(
00104   const char *dirname,
00105   ctl_t * ctl,
00106   met_t * met0,
00107   met_t * met1,
00108   atm_t * atm,
00109   double t);
00110
00111 /* ------------------------------------------------------------
00112    Main...
00113    ------------------------------------------------------------ */
00114
00115 int main(
00116   int argc,
00117   char *argv[]) {
00118
00119   ctl_t ctl;
00120
00121   atm_t *atm;
00122
00123   met_t *met0, *met1;
00124
00125   gsl_rng *rng[NTHREADS];
00126
```

```
00127   FILE *dirlist;
00128
00129   char dirname[LEN], filename[2 * LEN];
00130
00131   double *dt, t;
00132
00133   int i, ip, ntask = -1, rank = 0, size = 1;
00134
00135 #ifdef MPI
00136   /* Initialize MPI... */
00137   MPI_Init(&argc, &argv);
00138   MPI_Comm_rank(MPI_COMM_WORLD, &rank);
00139   MPI_Comm_size(MPI_COMM_WORLD, &size);
00140 #endif
00141
00142   /* Check arguments... */
00143   if (argc < 5)
00144     ERRMSG("Give parameters: <dirlist> <ctl> <atm_in> <metbase>");
00145
00146   /* Open directory list... */
00147   if (!(dirlist = fopen(argv[1], "r")))
00148     ERRMSG("Cannot open directory list!");
00149
00150   /* Loop over directories... */
00151   while (fscanf(dirlist, "%s", dirname) != EOF) {
00152
00153     /* MPI parallelization... */
00154     if ((++ntask) % size != rank)
00155       continue;
00156
00157     /* ------------------------------------------------------------
00158        Initialize model run...
00159        ------------------------------------------------------------ */
00160
00161     /* Set timers... */
00162     START_TIMER(TIMER_TOTAL);
00163     START_TIMER(TIMER_INIT);
00164
00165     /* Allocate... */
00166     ALLOC(atm, atm_t, 1);
00167     ALLOC(met0, met_t, 1);
00168     ALLOC(met1, met_t, 1);
00169     ALLOC(dt, double,
00170           NP);
00171
00172     /* Initialize random number generators... */
00173     gsl_rng_env_setup();
00174     if (omp_get_max_threads() > NTHREADS)
00175       ERRMSG("Too many threads!");
00176     for (i = 0; i < NTHREADS; i++) {
00177       rng[i] = gsl_rng_alloc(gsl_rng_default);
00178       gsl_rng_set(rng[i], gsl_rng_default_seed + (long unsigned) i);
00179     }
00180
00181     /* Read control parameters... */
00182     sprintf(filename, "%s/%s", dirname, argv[2]);
00183     read_ctl(filename, argc, argv, &ctl);
00184
00185     /* Read atmospheric data... */
00186     sprintf(filename, "%s/%s", dirname, argv[3]);
00187     read_atm(filename, &ctl, atm);
00188
00189     /* Set start time... */
00190     if (ctl.direction == 1) {
00191       ctl.t_start = gsl_stats_min(atm->time, 1, (size_t) atm->np);
00192       if (ctl.t_stop > 1e99)
00193         ctl.t_stop = gsl_stats_max(atm->time, 1, (size_t) atm->np);
00194     } else {
00195       ctl.t_start = gsl_stats_max(atm->time, 1, (size_t) atm->np);
00196       if (ctl.t_stop > 1e99)
00197         ctl.t_stop = gsl_stats_min(atm->time, 1, (size_t) atm->np);
00198     }
00199
00200     /* Check time interval... */
00201     if (ctl.direction * (ctl.t_stop - ctl.t_start) <= 0)
00202       ERRMSG("Nothing to do!");
00203
00204     /* Round start time... */
00205     if (ctl.direction == 1)
00206       ctl.t_start = floor(ctl.t_start / ctl.dt_mod) * ctl.
      dt_mod;
00207     else
00208       ctl.t_start = ceil(ctl.t_start / ctl.dt_mod) * ctl.
      dt_mod;
00209
00210     /* Set timers... */
00211     STOP_TIMER(TIMER_INIT);
```

```
00212
00213     /* ------------------------------------------------------------
00214        Loop over timesteps...
00215        ------------------------------------------------------------ */
00216
00217     /* Loop over timesteps... */
00218     for (t = ctl.t_start; ctl.direction * (t - ctl.t_stop) < ctl.
      dt_mod;
00219          t += ctl.direction * ctl.dt_mod) {
00220
00221       /* Adjust length of final time step... */
00222       if (ctl.direction * (t - ctl.t_stop) > 0)
00223         t = ctl.t_stop;
00224
00225       /* Set time steps for air parcels... */
00226       for (ip = 0; ip < atm->np; ip++)
00227         if ((ctl.direction * (atm->time[ip] - ctl.t_start) >= 0
00228              && ctl.direction * (atm->time[ip] - ctl.t_stop) <= 0
00229              && ctl.direction * (atm->time[ip] - t) < 0))
00230           dt[ip] = t - atm->time[ip];
00231         else
00232           dt[ip] = GSL_NAN;
00233
00234       /* Get meteorological data... */
00235       START_TIMER(TIMER_INPUT);
00236       get_met(&ctl, argv[4], t, &met0, &met1);
00237       if (ctl.dt_mod > fabs(met0->lon[1] - met0->lon[0]) * 111132. / 150.)
00238         printf("Warning: Violation of CFL criterion! Set DT_MOD <= %g s!\n",
00239                fabs(met0->lon[1] - met0->lon[0]) * 111132. / 150.);
00240       STOP_TIMER(TIMER_INPUT);
00241
00242       /* Initialize isosurface... */
00243       START_TIMER(TIMER_ISOSURF);
00244       if (ctl.isosurf >= 1 && ctl.isosurf <= 4 && t == ctl.t_start)
00245         module_isosurf(&ctl, met0, met1, atm, -1);
00246       STOP_TIMER(TIMER_ISOSURF);
00247
00248       /* Advection... */
00249       START_TIMER(TIMER_ADVECT);
00250 #pragma omp parallel for default(shared) private(ip)
00251       for (ip = 0; ip < atm->np; ip++)
00252         if (gsl_finite(dt[ip]))
00253           module_advection(met0, met1, atm, ip, dt[ip]);
00254       STOP_TIMER(TIMER_ADVECT);
00255
00256       /* Turbulent diffusion... */
00257       START_TIMER(TIMER_DIFFTURB);
00258       if (ctl.turb_dx_trop > 0 || ctl.turb_dz_trop > 0
00259           || ctl.turb_dx_strat > 0 || ctl.turb_dz_strat > 0) {
00260 #pragma omp parallel for default(shared) private(ip)
00261         for (ip = 0; ip < atm->np; ip++)
00262           if (gsl_finite(dt[ip]))
00263             module_diffusion_turb(&ctl, atm, ip, dt[ip],
00264                                   rng[omp_get_thread_num()]);
00265       }
00266       STOP_TIMER(TIMER_DIFFTURB);
00267
00268       /* Mesoscale diffusion... */
00269       START_TIMER(TIMER_DIFFMESO);
00270       if (ctl.turb_mesox > 0 || ctl.turb_mesoz > 0) {
00271 #pragma omp parallel for default(shared) private(ip)
00272         for (ip = 0; ip < atm->np; ip++)
00273           if (gsl_finite(dt[ip]))
00274             module_diffusion_meso(&ctl, met0, met1, atm, ip, dt[ip],
00275                                   rng[omp_get_thread_num()]);
00276       }
00277       STOP_TIMER(TIMER_DIFFMESO);
00278
00279       /* Sedimentation... */
00280       START_TIMER(TIMER_SEDI);
00281       if (ctl.qnt_r >= 0 && ctl.qnt_rho >= 0) {
00282 #pragma omp parallel for default(shared) private(ip)
00283         for (ip = 0; ip < atm->np; ip++)
00284           if (gsl_finite(dt[ip]))
00285             module_sedi(&ctl, met0, met1, atm, ip, dt[ip]);
00286       }
00287       STOP_TIMER(TIMER_SEDI);
00288
00289       /* Isosurface... */
00290       START_TIMER(TIMER_ISOSURF);
00291       if (ctl.isosurf >= 1 && ctl.isosurf <= 4) {
00292 #pragma omp parallel for default(shared) private(ip)
00293         for (ip = 0; ip < atm->np; ip++)
00294           module_isosurf(&ctl, met0, met1, atm, ip);
00295       }
00296       STOP_TIMER(TIMER_ISOSURF);
00297
```

```
00298       /* Position... */
00299       START_TIMER(TIMER_POSITION);
00300 #pragma omp parallel for default(shared) private(ip)
00301       for (ip = 0; ip < atm->np; ip++)
00302         module_position(met0, met1, atm, ip);
00303       STOP_TIMER(TIMER_POSITION);
00304
00305       /* Meteorological data... */
00306       START_TIMER(TIMER_METEO);
00307       if (ctl.met_dt_out > 0
00308           && (ctl.met_dt_out < ctl.dt_mod || fmod(t, ctl.
      met_dt_out) == 0)) {
00309 #pragma omp parallel for default(shared) private(ip)
00310         for (ip = 0; ip < atm->np; ip++)
00311           module_meteo(&ctl, met0, met1, atm, ip);
00312       }
00313       STOP_TIMER(TIMER_METEO);
00314
00315       /* Decay... */
00316       START_TIMER(TIMER_DECAY);
00317       if ((ctl.tdec_trop > 0 || ctl.tdec_strat > 0) && ctl.
      qnt_m >= 0) {
00318 #pragma omp parallel for default(shared) private(ip)
00319         for (ip = 0; ip < atm->np; ip++)
00320           if (gsl_finite(dt[ip]))
00321             module_decay(&ctl, met0, met1, atm, ip, dt[ip]);
00322       }
00323       STOP_TIMER(TIMER_DECAY);
00324
00325       /* Write output... */
00326       START_TIMER(TIMER_OUTPUT);
00327       write_output(dirname, &ctl, met0, met1, atm, t);
00328       STOP_TIMER(TIMER_OUTPUT);
00329     }
00330
00331     /* ------------------------------------------------------------
00332        Finalize model run...
00333        ------------------------------------------------------------ */
00334
00335     /* Report memory usage... */
00336     printf("MEMORY_ATM = %g MByte\n", sizeof(atm_t) / 1024. / 1024.);
00337     printf("MEMORY_METEO = %g MByte\n", 2. * sizeof(met_t) / 1024. / 1024.);
00338     printf("MEMORY_DYNAMIC = %g MByte\n",
00339            4 * NP * sizeof(double) / 1024. / 1024.);
00340     printf("MEMORY_STATIC = %g MByte\n",
00341            ((3 * GX * GY + 4 * GX * GY * GZ) * sizeof(double)
00342             + (EX * EY + EX * EY * EP) * sizeof(float)
00343             + (GX * GY + GX * GY * GZ) * sizeof(int)) / 1024. / 1024.);
00344
00345     /* Report problem size... */
00346     printf("SIZE_NP = %d\n", atm->np);
00347     printf("SIZE_TASKS = %d\n", size);
00348     printf("SIZE_THREADS = %d\n", omp_get_max_threads());
00349
00350     /* Report timers... */
00351     STOP_TIMER(TIMER_TOTAL);
00352     PRINT_TIMER(TIMER_TOTAL);
00353     PRINT_TIMER(TIMER_INIT);
00354     PRINT_TIMER(TIMER_INPUT);
00355     PRINT_TIMER(TIMER_OUTPUT);
00356     PRINT_TIMER(TIMER_ADVECT);
00357     PRINT_TIMER(TIMER_DECAY);
00358     PRINT_TIMER(TIMER_DIFFMESO);
00359     PRINT_TIMER(TIMER_DIFFTURB);
00360     PRINT_TIMER(TIMER_ISOSURF);
00361     PRINT_TIMER(TIMER_METEO);
00362     PRINT_TIMER(TIMER_POSITION);
00363     PRINT_TIMER(TIMER_SEDI);
00364
00365     /* Free random number generators... */
00366     for (i = 0; i < NTHREADS; i++)
00367       gsl_rng_free(rng[i]);
00368
00369     /* Free... */
00370     free(atm);
00371     free(met0);
00372     free(met1);
00373     free(dt);
00374   }
00375
00376 #ifdef MPI
00377   /* Finalize MPI... */
00378   MPI_Finalize();
00379 #endif
00380
00381   return EXIT_SUCCESS;
00382 }
```

```
00383
00384 /*****************************************************************************/
00385
00386 void module_advection(
00387   met_t * met0,
00388   met_t * met1,
00389   atm_t * atm,
00390   int ip,
00391   double dt) {
00392
00393   double v[3], xm[3];
00394
00395   /* Interpolate meteorological data... */
00396   intpol_met_time(met0, met1, atm->time[ip], atm->p[ip],
00397                   atm->lon[ip], atm->lat[ip], NULL, NULL, NULL, NULL,
00398                   &v[0], &v[1], &v[2], NULL, NULL, NULL);
00399
00400   /* Get position of the mid point... */
00401   xm[0] = atm->lon[ip] + DX2DEG(0.5 * dt * v[0] / 1000., atm->lat[ip]);
00402   xm[1] = atm->lat[ip] + DY2DEG(0.5 * dt * v[1] / 1000.);
00403   xm[2] = atm->p[ip] + 0.5 * dt * v[2];
00404
00405   /* Interpolate meteorological data for mid point... */
00406   intpol_met_time(met0, met1, atm->time[ip] + 0.5 * dt,
00407                   xm[2], xm[0], xm[1], NULL, NULL, NULL, NULL,
00408                   &v[0], &v[1], &v[2], NULL, NULL, NULL);
00409
00410   /* Save new position... */
00411   atm->time[ip] += dt;
00412   atm->lon[ip] += DX2DEG(dt * v[0] / 1000., xm[1]);
00413   atm->lat[ip] += DY2DEG(dt * v[1] / 1000.);
00414   atm->p[ip] += dt * v[2];
00415 }
00416
00417 /*****************************************************************************/
00418
00419 void module_decay(
00420   ctl_t * ctl,
00421   met_t * met0,
00422   met_t * met1,
00423   atm_t * atm,
00424   int ip,
00425   double dt) {
00426
00427   double ps, pt, tdec;
00428
00429   /* Set constant lifetime... */
00430   if (ctl->tdec_trop == ctl->tdec_strat)
00431     tdec = ctl->tdec_trop;
00432
00433   /* Set altitude-dependent lifetime... */
00434   else {
00435
00436     /* Get surface pressure... */
00437     intpol_met_time(met0, met1, atm->time[ip], atm->p[ip],
00438                     atm->lon[ip], atm->lat[ip], &ps, NULL, NULL, NULL,
00439                     NULL, NULL, NULL, NULL, NULL, NULL);
00440
00441     /* Get tropopause pressure... */
00442     pt = clim_tropo(atm->time[ip], atm->lat[ip]);
00443
00444     /* Set lifetime... */
00445     if (atm->p[ip] <= pt)
00446       tdec = ctl->tdec_strat;
00447     else
00448       tdec = LIN(ps, ctl->tdec_trop, pt, ctl->tdec_strat, atm->
      p[ip]);
00449   }
00450
00451   /* Calculate exponential decay... */
00452   atm->q[ctl->qnt_m][ip] *= exp(-dt / tdec);
00453 }
00454
00455 /*****************************************************************************/
00456
00457 void module_diffusion_meso(
00458   ctl_t * ctl,
00459   met_t * met0,
00460   met_t * met1,
00461   atm_t * atm,
00462   int ip,
00463   double dt,
00464   gsl_rng * rng) {
00465
00466   double r, rs, u[16], v[16], w[16];
00467
00468   int ix, iy, iz;
```

```
00469
00470   /* Get indices... */
00471   ix = locate_reg(met0->lon, met0->nx, atm->lon[ip]);
00472   iy = locate_reg(met0->lat, met0->ny, atm->lat[ip]);
00473   iz = locate_irr(met0->p, met0->np, atm->p[ip]);
00474
00475   /* Caching of wind standard deviations... */
00476   if (atm->cache_time[ix][iy][iz] != met0->time) {
00477
00478     /* Collect local wind data... */
00479     u[0] = met0->u[ix][iy][iz];
00480     u[1] = met0->u[ix + 1][iy][iz];
00481     u[2] = met0->u[ix][iy + 1][iz];
00482     u[3] = met0->u[ix + 1][iy + 1][iz];
00483     u[4] = met0->u[ix][iy][iz + 1];
00484     u[5] = met0->u[ix + 1][iy][iz + 1];
00485     u[6] = met0->u[ix][iy + 1][iz + 1];
00486     u[7] = met0->u[ix + 1][iy + 1][iz + 1];
00487
00488     v[0] = met0->v[ix][iy][iz];
00489     v[1] = met0->v[ix + 1][iy][iz];
00490     v[2] = met0->v[ix][iy + 1][iz];
00491     v[3] = met0->v[ix + 1][iy + 1][iz];
00492     v[4] = met0->v[ix][iy][iz + 1];
00493     v[5] = met0->v[ix + 1][iy][iz + 1];
00494     v[6] = met0->v[ix][iy + 1][iz + 1];
00495     v[7] = met0->v[ix + 1][iy + 1][iz + 1];
00496
00497     w[0] = met0->w[ix][iy][iz];
00498     w[1] = met0->w[ix + 1][iy][iz];
00499     w[2] = met0->w[ix][iy + 1][iz];
00500     w[3] = met0->w[ix + 1][iy + 1][iz];
00501     w[4] = met0->w[ix][iy][iz + 1];
00502     w[5] = met0->w[ix + 1][iy][iz + 1];
00503     w[6] = met0->w[ix][iy + 1][iz + 1];
00504     w[7] = met0->w[ix + 1][iy + 1][iz + 1];
00505
00506     /* Collect local wind data... */
00507     u[8] = met1->u[ix][iy][iz];
00508     u[9] = met1->u[ix + 1][iy][iz];
00509     u[10] = met1->u[ix][iy + 1][iz];
00510     u[11] = met1->u[ix + 1][iy + 1][iz];
00511     u[12] = met1->u[ix][iy][iz + 1];
00512     u[13] = met1->u[ix + 1][iy][iz + 1];
00513     u[14] = met1->u[ix][iy + 1][iz + 1];
00514     u[15] = met1->u[ix + 1][iy + 1][iz + 1];
00515
00516     v[8] = met1->v[ix][iy][iz];
00517     v[9] = met1->v[ix + 1][iy][iz];
00518     v[10] = met1->v[ix][iy + 1][iz];
00519     v[11] = met1->v[ix + 1][iy + 1][iz];
00520     v[12] = met1->v[ix][iy][iz + 1];
00521     v[13] = met1->v[ix + 1][iy][iz + 1];
00522     v[14] = met1->v[ix][iy + 1][iz + 1];
00523     v[15] = met1->v[ix + 1][iy + 1][iz + 1];
00524
00525     w[8] = met1->w[ix][iy][iz];
00526     w[9] = met1->w[ix + 1][iy][iz];
00527     w[10] = met1->w[ix][iy + 1][iz];
00528     w[11] = met1->w[ix + 1][iy + 1][iz];
00529     w[12] = met1->w[ix][iy][iz + 1];
00530     w[13] = met1->w[ix + 1][iy][iz + 1];
00531     w[14] = met1->w[ix][iy + 1][iz + 1];
00532     w[15] = met1->w[ix + 1][iy + 1][iz + 1];
00533
00534     /* Get standard deviations of local wind data... */
00535     atm->cache_usig[ix][iy][iz] = (float) gsl_stats_sd(u, 1, 16);
00536     atm->cache_vsig[ix][iy][iz] = (float) gsl_stats_sd(v, 1, 16);
00537     atm->cache_wsig[ix][iy][iz] = (float) gsl_stats_sd(w, 1, 16);
00538     atm->cache_time[ix][iy][iz] = met0->time;
00539   }
00540
00541   /* Set temporal correlations for mesoscale fluctuations... */
00542   r = 1 - 2 * fabs(dt) / ctl->dt_met;
00543   rs = sqrt(1 - r * r);
00544
00545   /* Calculate horizontal mesoscale wind fluctuations... */
00546   if (ctl->turb_mesox > 0) {
00547     atm->up[ip] = (float)
00548       (r * atm->up[ip]
00549        + rs * gsl_ran_gaussian_ziggurat(rng,
00550                                         ctl->turb_mesox *
00551                                         atm->cache_usig[ix][iy][iz]));
00552     atm->lon[ip] += DX2DEG(atm->up[ip] * dt / 1000., atm->lat[ip]);
00553
00554     atm->vp[ip] = (float)
00555       (r * atm->vp[ip]
```

```
00556         + rs * gsl_ran_gaussian_ziggurat(rng,
00557                                          ctl->turb_mesox *
00558                                          atm->cache_vsig[ix][iy][iz]));
00559       atm->lat[ip] += DY2DEG(atm->vp[ip] * dt / 1000.);
00560     }
00561
00562     /* Calculate vertical mesoscale wind fluctuations... */
00563     if (ctl->turb_mesoz > 0) {
00564       atm->wp[ip] = (float)
00565         (r * atm->wp[ip]
00566          + rs * gsl_ran_gaussian_ziggurat(rng,
00567                                           ctl->turb_mesoz *
00568                                           atm->cache_wsig[ix][iy][iz]));
00569       atm->p[ip] += atm->wp[ip] * dt;
00570     }
00571 }
00572
00573 /*****************************************************************************/
00574
00575 void module_diffusion_turb(
00576   ctl_t * ctl,
00577   atm_t * atm,
00578   int ip,
00579   double dt,
00580   gsl_rng * rng) {
00581
00582   double dx, dz, pt, p0, p1, w;
00583
00584   /* Get tropopause pressure... */
00585   pt = clim_tropo(atm->time[ip], atm->lat[ip]);
00586
00587   /* Get weighting factor... */
00588   p1 = pt * 0.866877899;
00589   p0 = pt / 0.866877899;
00590   if (atm->p[ip] > p0)
00591     w = 1;
00592   else if (atm->p[ip] < p1)
00593     w = 0;
00594   else
00595     w = LIN(p0, 1.0, p1, 0.0, atm->p[ip]);
00596
00597   /* Set diffusivity... */
00598   dx = w * ctl->turb_dx_trop + (1 - w) * ctl->turb_dx_strat;
00599   dz = w * ctl->turb_dz_trop + (1 - w) * ctl->turb_dz_strat;
00600
00601   /* Horizontal turbulent diffusion... */
00602   if (dx > 0) {
00603     atm->lon[ip]
00604       += DX2DEG(gsl_ran_gaussian_ziggurat(rng, sqrt(2.0 * dx * fabs(dt)))
00605                 / 1000., atm->lat[ip]);
00606     atm->lat[ip]
00607       += DY2DEG(gsl_ran_gaussian_ziggurat(rng, sqrt(2.0 * dx * fabs(dt)))
00608                 / 1000.);
00609   }
00610
00611   /* Vertical turbulent diffusion... */
00612   if (dz > 0)
00613     atm->p[ip]
00614       += DZ2DP(gsl_ran_gaussian_ziggurat(rng, sqrt(2.0 * dz * fabs(dt)))
00615                / 1000., atm->p[ip]);
00616 }
00617
00618 /*****************************************************************************/
00619
00620 void module_isosurf(
00621   ctl_t * ctl,
00622   met_t * met0,
00623   met_t * met1,
00624   atm_t * atm,
00625   int ip) {
00626
00627   static double *iso, *ps, t, *ts;
00628
00629   static int idx, ip2, n;
00630
00631   FILE *in;
00632
00633   char line[LEN];
00634
00635   /* Initialize... */
00636   if (ip < 0) {
00637
00638     /* Allocate... */
00639     ALLOC(iso, double,
00640           NP);
00641     ALLOC(ps, double,
00642           NP);
```

```
00643     ALLOC(ts, double,
00644           NP);
00645
00646     /* Save pressure... */
00647     if (ctl->isosurf == 1)
00648       for (ip2 = 0; ip2 < atm->np; ip2++)
00649         iso[ip2] = atm->p[ip2];
00650
00651     /* Save density... */
00652     else if (ctl->isosurf == 2)
00653       for (ip2 = 0; ip2 < atm->np; ip2++) {
00654         intpol_met_time(met0, met1, atm->time[ip2], atm->p[ip2],
00655                         atm->lon[ip2], atm->lat[ip2], NULL, NULL, NULL,
00656                         &t, NULL, NULL, NULL, NULL, NULL, NULL);
00657         iso[ip2] = atm->p[ip2] / t;
00658       }
00659
00660     /* Save potential temperature... */
00661     else if (ctl->isosurf == 3)
00662       for (ip2 = 0; ip2 < atm->np; ip2++) {
00663         intpol_met_time(met0, met1, atm->time[ip2], atm->p[ip2],
00664                         atm->lon[ip2], atm->lat[ip2], NULL, NULL, NULL,
00665                         &t, NULL, NULL, NULL, NULL, NULL, NULL);
00666         iso[ip2] = THETA(atm->p[ip2], t);
00667       }
00668
00669     /* Read balloon pressure data... */
00670     else if (ctl->isosurf == 4) {
00671
00672       /* Write info... */
00673       printf("Read balloon pressure data: %s\n", ctl->balloon);
00674
00675       /* Open file... */
00676       if (!(in = fopen(ctl->balloon, "r")))
00677         ERRMSG("Cannot open file!");
00678
00679       /* Read pressure time series... */
00680       while (fgets(line, LEN, in))
00681         if (sscanf(line, "%lg %lg", &ts[n], &ps[n]) == 2)
00682           if ((++n) > NP)
00683             ERRMSG("Too many data points!");
00684
00685       /* Check number of points... */
00686       if (n < 1)
00687         ERRMSG("Could not read any data!");
00688
00689       /* Close file... */
00690       fclose(in);
00691     }
00692
00693     /* Leave initialization... */
00694     return;
00695   }
00696
00697   /* Restore pressure... */
00698   if (ctl->isosurf == 1)
00699     atm->p[ip] = iso[ip];
00700
00701   /* Restore density... */
00702   else if (ctl->isosurf == 2) {
00703     intpol_met_time(met0, met1, atm->time[ip], atm->p[ip], atm->
      lon[ip],
00704                     atm->lat[ip], NULL, NULL, NULL, &t,
00705                     NULL, NULL, NULL, NULL, NULL, NULL);
00706     atm->p[ip] = iso[ip] * t;
00707   }
00708
00709   /* Restore potential temperature... */
00710   else if (ctl->isosurf == 3) {
00711     intpol_met_time(met0, met1, atm->time[ip], atm->p[ip], atm->
      lon[ip],
00712                     atm->lat[ip], NULL, NULL, NULL, &t,
00713                     NULL, NULL, NULL, NULL, NULL, NULL);
00714     atm->p[ip] = 1000. * pow(iso[ip] / t, -1. / 0.286);
00715   }
00716
00717   /* Interpolate pressure... */
00718   else if (ctl->isosurf == 4) {
00719     if (atm->time[ip] <= ts[0])
00720       atm->p[ip] = ps[0];
00721     else if (atm->time[ip] >= ts[n - 1])
00722       atm->p[ip] = ps[n - 1];
00723     else {
00724       idx = locate_irr(ts, n, atm->time[ip]);
00725       atm->p[ip] = LIN(ts[idx], ps[idx],
00726                        ts[idx + 1], ps[idx + 1], atm->time[ip]);
00727     }
```

```
00728   }
00729 }
00730
00731 /*****************************************************************************/
00732
00733 void module_meteo(
00734   ctl_t * ctl,
00735   met_t * met0,
00736   met_t * met1,
00737   atm_t * atm,
00738   int ip) {
00739
00740   double a, b, c, ps, pt, pv, p_hno3, p_h2o, t, u, v, w, x1, x2, h2o, o3, z;
00741
00742   /* Interpolate meteorological data... */
00743   intpol_met_time(met0, met1, atm->time[ip], atm->p[ip], atm->
      lon[ip],
00744                   atm->lat[ip], &ps, &pt, &z, &t, &u, &v, &w, &pv, &h2o, &o3);
00745
00746   /* Set surface pressure... */
00747   if (ctl->qnt_ps >= 0)
00748     atm->q[ctl->qnt_ps][ip] = ps;
00749
00750   /* Set tropopause pressure... */
00751   if (ctl->qnt_pt >= 0)
00752     atm->q[ctl->qnt_pt][ip] = pt;
00753
00754   /* Set pressure... */
00755   if (ctl->qnt_p >= 0)
00756     atm->q[ctl->qnt_p][ip] = atm->p[ip];
00757
00758   /* Set geopotential height... */
00759   if (ctl->qnt_z >= 0)
00760     atm->q[ctl->qnt_z][ip] = z;
00761
00762   /* Set temperature... */
00763   if (ctl->qnt_t >= 0)
00764     atm->q[ctl->qnt_t][ip] = t;
00765
00766   /* Set zonal wind... */
00767   if (ctl->qnt_u >= 0)
00768     atm->q[ctl->qnt_u][ip] = u;
00769
00770   /* Set meridional wind... */
00771   if (ctl->qnt_v >= 0)
00772     atm->q[ctl->qnt_v][ip] = v;
00773
00774   /* Set vertical velocity... */
00775   if (ctl->qnt_w >= 0)
00776     atm->q[ctl->qnt_w][ip] = w;
00777
00778   /* Set water vapor vmr... */
00779   if (ctl->qnt_h2o >= 0)
00780     atm->q[ctl->qnt_h2o][ip] = h2o;
00781
00782   /* Set ozone vmr... */
00783   if (ctl->qnt_o3 >= 0)
00784     atm->q[ctl->qnt_o3][ip] = o3;
00785
00786   /* Calculate horizontal wind... */
00787   if (ctl->qnt_vh >= 0)
00788     atm->q[ctl->qnt_vh][ip] = sqrt(u * u + v * v);
00789
00790   /* Calculate vertical velocity... */
00791   if (ctl->qnt_vz >= 0)
00792     atm->q[ctl->qnt_vz][ip] = -1e3 * H0 / atm->p[ip] * w;
00793
00794   /* Calculate potential temperature... */
00795   if (ctl->qnt_theta >= 0)
00796     atm->q[ctl->qnt_theta][ip] = THETA(atm->p[ip], t);
00797
00798   /* Set potential vorticity... */
00799   if (ctl->qnt_pv >= 0)
00800     atm->q[ctl->qnt_pv][ip] = pv;
00801
00802   /* Calculate T_ice (Marti and Mauersberger, 1993)... */
00803   if (ctl->qnt_tice >= 0)
00804     atm->q[ctl->qnt_tice][ip] =
00805       -2663.5 /
00806       (log10((ctl->psc_h2o > 0 ? ctl->psc_h2o : h2o) * atm->p[ip] * 100.) -
00807        12.537);
00808
00809   /* Calculate T_NAT (Hanson and Mauersberger, 1988)... */
00810   if (ctl->qnt_tnat >= 0) {
00811     if (ctl->psc_hno3 > 0)
00812       p_hno3 = ctl->psc_hno3 * atm->p[ip] / 1.333224;
00813     else
```

```
00814       p_hno3 = clim_hno3(atm->time[ip], atm->lat[ip], atm->p[ip])
00815         * 1e-9 * atm->p[ip] / 1.333224;
00816     p_h2o = (ctl->psc_h2o > 0 ? ctl->psc_h2o : h2o) * atm->p[ip] / 1.333224;
00817     a = 0.009179 - 0.00088 * log10(p_h2o);
00818     b = (38.9855 - log10(p_hno3) - 2.7836 * log10(p_h2o)) / a;
00819     c = -11397.0 / a;
00820     x1 = (-b + sqrt(b * b - 4. * c)) / 2.;
00821     x2 = (-b - sqrt(b * b - 4. * c)) / 2.;
00822     if (x1 > 0)
00823       atm->q[ctl->qnt_tnat][ip] = x1;
00824     if (x2 > 0)
00825       atm->q[ctl->qnt_tnat][ip] = x2;
00826   }
00827
00828   /* Calculate T_STS (mean of T_ice and T_NAT)... */
00829   if (ctl->qnt_tsts >= 0) {
00830     if (ctl->qnt_tice < 0 || ctl->qnt_tnat < 0)
00831       ERRMSG("Need T_ice and T_NAT to calculate T_STS!");
00832     atm->q[ctl->qnt_tsts][ip] = 0.5 * (atm->q[ctl->qnt_tice][ip]
00833                                        + atm->q[ctl->qnt_tnat][ip]);
00834   }
00835 }
00836
00837 /*****************************************************************************/
00838
00839 void module_position(
00840   met_t * met0,
00841   met_t * met1,
00842   atm_t * atm,
00843   int ip) {
00844
00845   double ps;
00846
00847   /* Calculate modulo... */
00848   atm->lon[ip] = fmod(atm->lon[ip], 360);
00849   atm->lat[ip] = fmod(atm->lat[ip], 360);
00850
00851   /* Check latitude... */
00852   while (atm->lat[ip] < -90 || atm->lat[ip] > 90) {
00853     if (atm->lat[ip] > 90) {
00854       atm->lat[ip] = 180 - atm->lat[ip];
00855       atm->lon[ip] += 180;
00856     }
00857     if (atm->lat[ip] < -90) {
00858       atm->lat[ip] = -180 - atm->lat[ip];
00859       atm->lon[ip] += 180;
00860     }
00861   }
00862
00863   /* Check longitude... */
00864   while (atm->lon[ip] < -180)
00865     atm->lon[ip] += 360;
00866   while (atm->lon[ip] >= 180)
00867     atm->lon[ip] -= 360;
00868
00869   /* Get surface pressure... */
00870   intpol_met_time(met0, met1, atm->time[ip], atm->p[ip],
00871                   atm->lon[ip], atm->lat[ip], &ps, NULL, NULL, NULL,
00872                   NULL, NULL, NULL, NULL, NULL, NULL);
00873
00874   /* Check pressure... */
00875   if (atm->p[ip] > ps)
00876     atm->p[ip] = ps;
00877   else if (atm->p[ip] < met0->p[met0->np - 1])
00878     atm->p[ip] = met0->p[met0->np - 1];
00879 }
00880
00881 /*****************************************************************************/
00882
00883 void module_sedi(
00884   ctl_t * ctl,
00885   met_t * met0,
00886   met_t * met1,
00887   atm_t * atm,
00888   int ip,
00889   double dt) {
00890
00891   /* Coefficients for Cunningham slip-flow correction (Kasten, 1968): */
00892   const double A = 1.249, B = 0.42, C = 0.87;
00893
00894   /* Average mass of an air molecule [kg/molec]: */
00895   const double m = 4.8096e-26;
00896
00897   double G, K, eta, lambda, p, r_p, rho, rho_p, T, v, v_p;
00898
00899   /* Convert units... */
00900   p = 100 * atm->p[ip];
```

```
00901   r_p = 1e-6 * atm->q[ctl->qnt_r][ip];
00902   rho_p = atm->q[ctl->qnt_rho][ip];
00903
00904   /* Get temperature... */
00905   intpol_met_time(met0, met1, atm->time[ip], atm->p[ip], atm->
      lon[ip],
00906                   atm->lat[ip], NULL, NULL, NULL, &T,
00907                   NULL, NULL, NULL, NULL, NULL, NULL);
00908
00909   /* Density of dry air... */
00910   rho = p / (RA * T);
00911
00912   /* Dynamic viscosity of air... */
00913   eta = 1.8325e-5 * (416.16 / (T + 120.)) * pow(T / 296.16, 1.5);
00914
00915   /* Thermal velocity of an air molecule... */
00916   v = sqrt(8 * KB * T / (M_PI * m));
00917
00918   /* Mean free path of an air molecule... */
00919   lambda = 2 * eta / (rho * v);
00920
00921   /* Knudsen number for air... */
00922   K = lambda / r_p;
00923
00924   /* Cunningham slip-flow correction... */
00925   G = 1 + K * (A + B * exp(-C / K));
00926
00927   /* Sedimentation (fall) velocity... */
00928   v_p = 2. * SQR(r_p) * (rho_p - rho) * G0 / (9. * eta) * G;
00929
00930   /* Calculate pressure change... */
00931   atm->p[ip] += DZ2DP(v_p * dt / 1000., atm->p[ip]);
00932 }
00933
00934 /*****************************************************************************/
00935
00936 void write_output(
00937   const char *dirname,
00938   ctl_t * ctl,
00939   met_t * met0,
00940   met_t * met1,
00941   atm_t * atm,
00942   double t) {
00943
00944   char filename[2 * LEN];
00945
00946   double r;
00947
00948   int year, mon, day, hour, min, sec;
00949
00950   /* Get time... */
00951   jsec2time(t, &year, &mon, &day, &hour, &min, &sec, &r);
00952
00953   /* Write atmospheric data... */
00954   if (ctl->atm_basename[0] != '-' && fmod(t, ctl->atm_dt_out) == 0) {
00955     sprintf(filename, "%s/%s_%04d_%02d_%02d_%02d_%02d.tab",
00956             dirname, ctl->atm_basename, year, mon, day, hour, min);
00957     write_atm(filename, ctl, atm, t);
00958   }
00959
00960   /* Write CSI data... */
00961   if (ctl->csi_basename[0] != '-') {
00962     sprintf(filename, "%s/%s.tab", dirname, ctl->csi_basename);
00963     write_csi(filename, ctl, atm, t);
00964   }
00965
00966   /* Write ensemble data... */
00967   if (ctl->ens_basename[0] != '-') {
00968     sprintf(filename, "%s/%s.tab", dirname, ctl->ens_basename);
00969     write_ens(filename, ctl, atm, t);
00970   }
00971
00972   /* Write gridded data... */
00973   if (ctl->grid_basename[0] != '-' && fmod(t, ctl->grid_dt_out) == 0) {
00974     sprintf(filename, "%s/%s_%04d_%02d_%02d_%02d_%02d.tab",
00975             dirname, ctl->grid_basename, year, mon, day, hour, min);
00976     write_grid(filename, ctl, met0, met1, atm, t);
00977   }
00978
00979   /* Write profile data... */
00980   if (ctl->prof_basename[0] != '-') {
00981     sprintf(filename, "%s/%s.tab", dirname, ctl->prof_basename);
00982     write_prof(filename, ctl, met0, met1, atm, t);
00983   }
00984
00985   /* Write station data... */
00986   if (ctl->stat_basename[0] != '-') {
```

```
00987     sprintf(filename, "%s/%s.tab", dirname, ctl->stat_basename);
00988     write_station(filename, ctl, atm, t);
00989   }
00990 }
```

5.37 wind.c File Reference

Create meteorological data files with synthetic wind fields.

Functions

- void add_text_attribute (int ncid, char *varname, char *attrname, char *text)
- int main (int argc, char *argv[])

5.37.1 Detailed Description

Create meteorological data files with synthetic wind fields.

Definition in file wind.c.

5.37.2 Function Documentation

5.37.2.1 void add_text_attribute (int *ncid*, char * *varname*, char * *attrname*, char * *text*)

Definition at line 188 of file wind.c.

```
00192              {
00193
00194   int varid;
00195
00196   NC(nc_inq_varid(ncid, varname, &varid));
00197   NC(nc_put_att_text(ncid, varid, attrname, strlen(text), text));
00198 }
```

5.37.2.2 int main (int *argc*, char * *argv[]*)

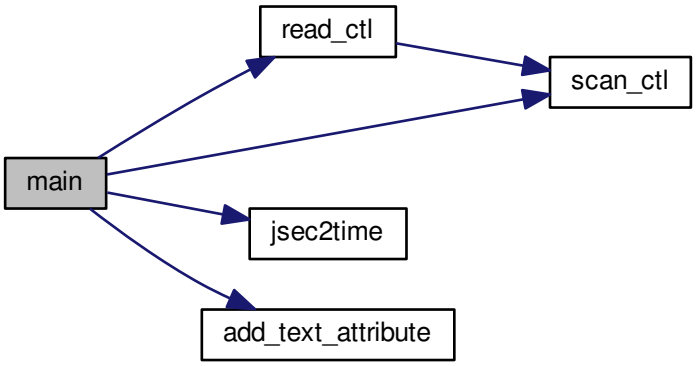
Definition at line 41 of file wind.c.

```
00043                {
00044
00045   ctl_t ctl;
00046
00047   static char filename[LEN];
00048
00049   static double r, t0, z0, z1, dataLon[EX], dataLat[EY], dataZ[EP],
00050     u0, u1, alpha;
00051
00052   static float *dataT, *dataU, *dataV, *dataW;
00053
00054   static int ncid, dims[4], timid, levid, latid, lonid, tid, uid, vid, wid,
00055     idx, ix, iy, iz, nx, ny, nz, year, mon, day, hour, min, sec;
00056
00057   /* Allocate... */
00058   ALLOC(dataT, float,
00059         EP * EY * EX);
00060   ALLOC(dataU, float,
00061         EP * EY * EX);
00062   ALLOC(dataV, float,
00063         EP * EY * EX);
```

```
00064   ALLOC(dataW, float,
00065         EP * EY * EX);
00066
00067   /* Check arguments... */
00068   if (argc < 3)
00069     ERRMSG("Give parameters: <ctl> <metbase>");
00070
00071   /* Read control parameters... */
00072   read_ctl(argv[1], argc, argv, &ctl);
00073   t0 = scan_ctl(argv[1], argc, argv, "WIND_T0", -1, "0", NULL);
00074   nx = (int) scan_ctl(argv[1], argc, argv, "WIND_NX", -1, "360", NULL);
00075   ny = (int) scan_ctl(argv[1], argc, argv, "WIND_NY", -1, "181", NULL);
00076   nz = (int) scan_ctl(argv[1], argc, argv, "WIND_NZ", -1, "61", NULL);
00077   z0 = scan_ctl(argv[1], argc, argv, "WIND_Z0", -1, "0", NULL);
00078   z1 = scan_ctl(argv[1], argc, argv, "WIND_Z1", -1, "60", NULL);
00079   u0 = scan_ctl(argv[1], argc, argv, "WIND_U0", -1, "38.587660177302", NULL);
00080   u1 = scan_ctl(argv[1], argc, argv, "WIND_U1", -1, "38.587660177302", NULL);
00081   alpha = scan_ctl(argv[1], argc, argv, "WIND_ALPHA", -1, "0.0", NULL);
00082
00083   /* Check dimensions... */
00084   if (nx < 1 || nx > EX)
00085     ERRMSG("Set 1 <= NX <= MAX!");
00086   if (ny < 1 || ny > EY)
00087     ERRMSG("Set 1 <= NY <= MAX!");
00088   if (nz < 1 || nz > EP)
00089     ERRMSG("Set 1 <= NZ <= MAX!");
00090
00091   /* Get time... */
00092   jsec2time(t0, &year, &mon, &day, &hour, &min, &sec, &r);
00093   t0 = year * 10000. + mon * 100. + day + hour / 24.;
00094
00095   /* Set filename... */
00096   sprintf(filename, "%s_%d_%02d_%02d_%02d.nc", argv[2], year, mon, day, hour);
00097
00098   /* Create netCDF file... */
00099   NC(nc_create(filename, NC_CLOBBER, &ncid));
00100
00101   /* Create dimensions... */
00102   NC(nc_def_dim(ncid, "time", 1, &dims[0]));
00103   NC(nc_def_dim(ncid, "lev", (size_t) nz, &dims[1]));
00104   NC(nc_def_dim(ncid, "lat", (size_t) ny, &dims[2]));
00105   NC(nc_def_dim(ncid, "lon", (size_t) nx, &dims[3]));
00106
00107   /* Create variables... */
00108   NC(nc_def_var(ncid, "time", NC_DOUBLE, 1, &dims[0], &timid));
00109   NC(nc_def_var(ncid, "lev", NC_DOUBLE, 1, &dims[1], &levid));
00110   NC(nc_def_var(ncid, "lat", NC_DOUBLE, 1, &dims[2], &latid));
00111   NC(nc_def_var(ncid, "lon", NC_DOUBLE, 1, &dims[3], &lonid));
00112   NC(nc_def_var(ncid, "T", NC_FLOAT, 4, &dims[0], &tid));
00113   NC(nc_def_var(ncid, "U", NC_FLOAT, 4, &dims[0], &uid));
00114   NC(nc_def_var(ncid, "V", NC_FLOAT, 4, &dims[0], &vid));
00115   NC(nc_def_var(ncid, "W", NC_FLOAT, 4, &dims[0], &wid));
00116
00117   /* Set attributes... */
00118   add_text_attribute(ncid, "time", "long_name", "time");
00119   add_text_attribute(ncid, "time", "units", "day as %Y%m%d.%f");
00120   add_text_attribute(ncid, "lon", "long_name", "longitude");
00121   add_text_attribute(ncid, "lon", "units", "degrees_east");
00122   add_text_attribute(ncid, "lat", "long_name", "latitude");
00123   add_text_attribute(ncid, "lat", "units", "degrees_north");
00124   add_text_attribute(ncid, "lev", "long_name", "air_pressure");
00125   add_text_attribute(ncid, "lev", "units", "Pa");
00126   add_text_attribute(ncid, "T", "long_name", "Temperature");
00127   add_text_attribute(ncid, "T", "units", "K");
00128   add_text_attribute(ncid, "U", "long_name", "U velocity");
00129   add_text_attribute(ncid, "U", "units", "m s**-1");
00130   add_text_attribute(ncid, "V", "long_name", "V velocity");
00131   add_text_attribute(ncid, "V", "units", "m s**-1");
00132   add_text_attribute(ncid, "W", "long_name", "Vertical velocity");
00133   add_text_attribute(ncid, "W", "units", "Pa s**-1");
00134
00135   /* End definition... */
00136   NC(nc_enddef(ncid));
00137
00138   /* Set coordinates... */
00139   for (ix = 0; ix < nx; ix++)
00140     dataLon[ix] = 360.0 / nx * (double) ix;
00141   for (iy = 0; iy < ny; iy++)
00142     dataLat[iy] = 180.0 / (ny - 1) * (double) iy - 90;
00143   for (iz = 0; iz < nz; iz++)
00144     dataZ[iz] = 100. * P(LIN(0.0, z0, nz - 1.0, z1, iz));
00145
00146   /* Write coordinates... */
00147   NC(nc_put_var_double(ncid, timid, &t0));
00148   NC(nc_put_var_double(ncid, levid, dataZ));
00149   NC(nc_put_var_double(ncid, lonid, dataLon));
00150   NC(nc_put_var_double(ncid, latid, dataLat));
```

```
00151
00152   /* Create wind fields (Williamson et al., 1992)... */
00153   for (ix = 0; ix < nx; ix++)
00154     for (iy = 0; iy < ny; iy++)
00155       for (iz = 0; iz < nz; iz++) {
00156         idx = (iz * ny + iy) * nx + ix;
00157         dataU[idx] = (float) (LIN(0.0, u0, nz - 1.0, u1, iz)
00158                               * (cos(dataLat[iy] * M_PI / 180.0)
00159                                  * cos(alpha * M_PI / 180.0)
00160                                  + sin(dataLat[iy] * M_PI / 180.0)
00161                                  * cos(dataLon[ix] * M_PI / 180.0)
00162                                  * sin(alpha * M_PI / 180.0)));
00163         dataV[idx] = (float) (-LIN(0.0, u0, nz - 1.0, u1, iz)
00164                               * sin(dataLon[ix] * M_PI / 180.0)
00165                               * sin(alpha * M_PI / 180.0));
00166       }
00167
00168   /* Write wind data... */
00169   NC(nc_put_var_float(ncid, tid, dataT));
00170   NC(nc_put_var_float(ncid, uid, dataU));
00171   NC(nc_put_var_float(ncid, vid, dataV));
00172   NC(nc_put_var_float(ncid, wid, dataW));
00173
00174   /* Close file... */
00175   NC(nc_close(ncid));
00176
00177   /* Free... */
00178   free(dataT);
00179   free(dataU);
00180   free(dataV);
00181   free(dataW);
00182
00183   return EXIT_SUCCESS;
00184 }
```

Here is the call graph for this function:



5.38 wind.c

```
00001 /*
00002   This file is part of MPTRAC.
00003
00004   MPTRAC is free software: you can redistribute it and/or modify
00005   it under the terms of the GNU General Public License as published by
00006   the Free Software Foundation, either version 3 of the License, or
00007   (at your option) any later version.
00008
00009   MPTRAC is distributed in the hope that it will be useful,
00010   but WITHOUT ANY WARRANTY; without even the implied warranty of
00011   MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
00012   GNU General Public License for more details.
```

```
00013
00014   You should have received a copy of the GNU General Public License
00015   along with MPTRAC. If not, see <http://www.gnu.org/licenses/>.
00016
00017   Copyright (C) 2013-2019 Forschungszentrum Juelich GmbH
00018 */
00019
00025 #include "libtrac.h"
00026
00027 /* ------------------------------------------------------------
00028    Functions...
00029    ------------------------------------------------------------ */
00030
00031 void add_text_attribute(
00032   int ncid,
00033   char *varname,
00034   char *attrname,
00035   char *text);
00036
00037 /* ------------------------------------------------------------
00038    Main...
00039    ------------------------------------------------------------ */
00040
00041 int main(
00042   int argc,
00043   char *argv[]) {
00044
00045   ctl_t ctl;
00046
00047   static char filename[LEN];
00048
00049   static double r, t0, z0, z1, dataLon[EX], dataLat[EY], dataZ[EP],
00050     u0, u1, alpha;
00051
00052   static float *dataT, *dataU, *dataV, *dataW;
00053
00054   static int ncid, dims[4], timid, levid, latid, lonid, tid, uid, vid, wid,
00055     idx, ix, iy, iz, nx, ny, nz, year, mon, day, hour, min, sec;
00056
00057   /* Allocate... */
00058   ALLOC(dataT, float,
00059         EP * EY * EX);
00060   ALLOC(dataU, float,
00061         EP * EY * EX);
00062   ALLOC(dataV, float,
00063         EP * EY * EX);
00064   ALLOC(dataW, float,
00065         EP * EY * EX);
00066
00067   /* Check arguments... */
00068   if (argc < 3)
00069     ERRMSG("Give parameters: <ctl> <metbase>");
00070
00071   /* Read control parameters... */
00072   read_ctl(argv[1], argc, argv, &ctl);
00073   t0 = scan_ctl(argv[1], argc, argv, "WIND_T0", -1, "0", NULL);
00074   nx = (int) scan_ctl(argv[1], argc, argv, "WIND_NX", -1, "360", NULL);
00075   ny = (int) scan_ctl(argv[1], argc, argv, "WIND_NY", -1, "181", NULL);
00076   nz = (int) scan_ctl(argv[1], argc, argv, "WIND_NZ", -1, "61", NULL);
00077   z0 = scan_ctl(argv[1], argc, argv, "WIND_Z0", -1, "0", NULL);
00078   z1 = scan_ctl(argv[1], argc, argv, "WIND_Z1", -1, "60", NULL);
00079   u0 = scan_ctl(argv[1], argc, argv, "WIND_U0", -1, "38.587660177302", NULL);
00080   u1 = scan_ctl(argv[1], argc, argv, "WIND_U1", -1, "38.587660177302", NULL);
00081   alpha = scan_ctl(argv[1], argc, argv, "WIND_ALPHA", -1, "0.0", NULL);
00082
00083   /* Check dimensions... */
00084   if (nx < 1 || nx > EX)
00085     ERRMSG("Set 1 <= NX <= MAX!");
00086   if (ny < 1 || ny > EY)
00087     ERRMSG("Set 1 <= NY <= MAX!");
00088   if (nz < 1 || nz > EP)
00089     ERRMSG("Set 1 <= NZ <= MAX!");
00090
00091   /* Get time... */
00092   jsec2time(t0, &year, &mon, &day, &hour, &min, &sec, &r);
00093   t0 = year * 10000. + mon * 100. + day + hour / 24.;
00094
00095   /* Set filename... */
00096   sprintf(filename, "%s_%d_%02d_%02d_%02d.nc", argv[2], year, mon, day, hour);
00097
00098   /* Create netCDF file... */
00099   NC(nc_create(filename, NC_CLOBBER, &ncid));
00100
00101   /* Create dimensions... */
00102   NC(nc_def_dim(ncid, "time", 1, &dims[0]));
00103   NC(nc_def_dim(ncid, "lev", (size_t) nz, &dims[1]));
00104   NC(nc_def_dim(ncid, "lat", (size_t) ny, &dims[2]));
```

```
00105   NC(nc_def_dim(ncid, "lon", (size_t) nx, &dims[3]));
00106
00107   /* Create variables... */
00108   NC(nc_def_var(ncid, "time", NC_DOUBLE, 1, &dims[0], &timid));
00109   NC(nc_def_var(ncid, "lev", NC_DOUBLE, 1, &dims[1], &levid));
00110   NC(nc_def_var(ncid, "lat", NC_DOUBLE, 1, &dims[2], &latid));
00111   NC(nc_def_var(ncid, "lon", NC_DOUBLE, 1, &dims[3], &lonid));
00112   NC(nc_def_var(ncid, "T", NC_FLOAT, 4, &dims[0], &tid));
00113   NC(nc_def_var(ncid, "U", NC_FLOAT, 4, &dims[0], &uid));
00114   NC(nc_def_var(ncid, "V", NC_FLOAT, 4, &dims[0], &vid));
00115   NC(nc_def_var(ncid, "W", NC_FLOAT, 4, &dims[0], &wid));
00116
00117   /* Set attributes... */
00118   add_text_attribute(ncid, "time", "long_name", "time");
00119   add_text_attribute(ncid, "time", "units", "day as %Y%m%d.%f");
00120   add_text_attribute(ncid, "lon", "long_name", "longitude");
00121   add_text_attribute(ncid, "lon", "units", "degrees_east");
00122   add_text_attribute(ncid, "lat", "long_name", "latitude");
00123   add_text_attribute(ncid, "lat", "units", "degrees_north");
00124   add_text_attribute(ncid, "lev", "long_name", "air_pressure");
00125   add_text_attribute(ncid, "lev", "units", "Pa");
00126   add_text_attribute(ncid, "T", "long_name", "Temperature");
00127   add_text_attribute(ncid, "T", "units", "K");
00128   add_text_attribute(ncid, "U", "long_name", "U velocity");
00129   add_text_attribute(ncid, "U", "units", "m s**-1");
00130   add_text_attribute(ncid, "V", "long_name", "V velocity");
00131   add_text_attribute(ncid, "V", "units", "m s**-1");
00132   add_text_attribute(ncid, "W", "long_name", "Vertical velocity");
00133   add_text_attribute(ncid, "W", "units", "Pa s**-1");
00134
00135   /* End definition... */
00136   NC(nc_enddef(ncid));
00137
00138   /* Set coordinates... */
00139   for (ix = 0; ix < nx; ix++)
00140     dataLon[ix] = 360.0 / nx * (double) ix;
00141   for (iy = 0; iy < ny; iy++)
00142     dataLat[iy] = 180.0 / (ny - 1) * (double) iy - 90;
00143   for (iz = 0; iz < nz; iz++)
00144     dataZ[iz] = 100. * P(LIN(0.0, z0, nz - 1.0, z1, iz));
00145
00146   /* Write coordinates... */
00147   NC(nc_put_var_double(ncid, timid, &t0));
00148   NC(nc_put_var_double(ncid, levid, dataZ));
00149   NC(nc_put_var_double(ncid, lonid, dataLon));
00150   NC(nc_put_var_double(ncid, latid, dataLat));
00151
00152   /* Create wind fields (Williamson et al., 1992)... */
00153   for (ix = 0; ix < nx; ix++)
00154     for (iy = 0; iy < ny; iy++)
00155       for (iz = 0; iz < nz; iz++) {
00156         idx = (iz * ny + iy) * nx + ix;
00157         dataU[idx] = (float) (LIN(0.0, u0, nz - 1.0, u1, iz)
00158                               * (cos(dataLat[iy] * M_PI / 180.0)
00159                                  * cos(alpha * M_PI / 180.0)
00160                                  + sin(dataLat[iy] * M_PI / 180.0)
00161                                  * cos(dataLon[ix] * M_PI / 180.0)
00162                                  * sin(alpha * M_PI / 180.0)));
00163         dataV[idx] = (float) (-LIN(0.0, u0, nz - 1.0, u1, iz)
00164                               * sin(dataLon[ix] * M_PI / 180.0)
00165                               * sin(alpha * M_PI / 180.0));
00166       }
00167
00168   /* Write wind data... */
00169   NC(nc_put_var_float(ncid, tid, dataT));
00170   NC(nc_put_var_float(ncid, uid, dataU));
00171   NC(nc_put_var_float(ncid, vid, dataV));
00172   NC(nc_put_var_float(ncid, wid, dataW));
00173
00174   /* Close file... */
00175   NC(nc_close(ncid));
00176
00177   /* Free... */
00178   free(dataT);
00179   free(dataU);
00180   free(dataV);
00181   free(dataW);
00182
00183   return EXIT_SUCCESS;
00184 }
00185
00186 /*****************************************************************************/
00187
00188 void add_text_attribute(
00189   int ncid,
00190   char *varname,
00191   char *attrname,
```

```
00192   char *text) {
00193
00194   int varid;
00195
00196   NC(nc_inq_varid(ncid, varname, &varid));
00197   NC(nc_put_att_text(ncid, varid, attrname, strlen(text), text));
00198 }
```

Index