MPTRAC

Generated by Doxygen 1.8.11

ii CONTENTS

Contents

1	Main	Page		2
2	ure Index	2		
	2.1	Data S	Structures	2
3	File Index			
	3.1	File Lis	st	2
4	Data	ure Documentation	3	
	4.1	atm_t	Struct Reference	3
		4.1.1	Detailed Description	4
		4.1.2	Field Documentation	4
	4.2	ctl t St	truct Reference	5
		4.2.1	Detailed Description	9
		4.2.2	Field Documentation	9
	4.3	met t	Struct Reference	19
		4.3.1	Detailed Description	20
		4.3.2	Field Documentation	20
5	File	Docum	entation	22
	5.1	center.	c File Reference	22
		5.1.1	Detailed Description	22
		5.1.2	Function Documentation	23
	5.2	center.	.с	24
	5.3	dist.c F	File Reference	26
		5.3.1	Detailed Description	27
		5.3.2	Function Documentation	27
	5.4	dist.c .		30
	5.5	extract	t.c File Reference	33
		5.5.1	Detailed Description	33
		5.5.2	Function Documentation	33

5.6	extract.c	34
5.7	init.c File Reference	35
	5.7.1 Detailed Description	36
	5.7.2 Function Documentation	36
5.8	init.c	37
5.9	jsec2time.c File Reference	39
	5.9.1 Detailed Description	39
	5.9.2 Function Documentation	39
5.10	jsec2time.c	40
5.11	libtrac.c File Reference	40
	5.11.1 Detailed Description	42
	5.11.2 Function Documentation	42
5.12	libtrac.c	71
5.13	libtrac.h File Reference	95
	5.13.1 Detailed Description	97
	5.13.2 Function Documentation	97
5.14	libtrac.h	126
5.15	match.c File Reference	133
	5.15.1 Detailed Description	133
	5.15.2 Function Documentation	134
5.16	match.c	136
5.17	met_map.c File Reference	138
	5.17.1 Detailed Description	138
	5.17.2 Function Documentation	138
5.18	met map.c	140
5.19	met prof.c File Reference	142
	5.19.1 Detailed Description	
	5.19.2 Function Documentation	
5 20	met prof.c	
	met_sample.c File Reference	
U.E.		

	5.21.1 Detailed Description	14/
	5.21.2 Function Documentation	147
5.22	met_sample.c	148
5.23	met_zm.c File Reference	149
	5.23.1 Detailed Description	150
	5.23.2 Function Documentation	150
5.24	met_zm.c	152
5.25	smago.c File Reference	154
	5.25.1 Detailed Description	154
	5.25.2 Function Documentation	154
5.26	smago.c	156
5.27	split.c File Reference	157
	5.27.1 Detailed Description	157
	5.27.2 Function Documentation	158
5.28	split.c	160
5.29	time2jsec.c File Reference	
5.29		161
5.29	time2jsec.c File Reference	161 161
	time2jsec.c File Reference	161 161 162
5.30	time2jsec.c File Reference	161 161 162 162
5.30	time2jsec.c File Reference	161 161 162 163
5.30	time2jsec.c File Reference 5.29.1 Detailed Description 5.29.2 Function Documentation time2jsec.c trac.c File Reference	161 161 162 163 163
5.30 5.31	time2jsec.c File Reference 5.29.1 Detailed Description 5.29.2 Function Documentation time2jsec.c trac.c File Reference 5.31.1 Detailed Description	161 162 162 163 164
5.30 5.31 5.32	time2jsec.c File Reference 5.29.1 Detailed Description 5.29.2 Function Documentation time2jsec.c trac.c File Reference 5.31.1 Detailed Description 5.31.2 Function Documentation	161 162 163 163 164 182
5.30 5.31 5.32	time2jsec.c File Reference 5.29.1 Detailed Description 5.29.2 Function Documentation time2jsec.c trac.c File Reference 5.31.1 Detailed Description 5.31.2 Function Documentation	161 162 163 163 164 182
5.30 5.31 5.32	time2jsec.c File Reference 5.29.1 Detailed Description 5.29.2 Function Documentation time2jsec.c trac.c File Reference 5.31.1 Detailed Description 5.31.2 Function Documentation trac.c wind.c File Reference	161 162 162 163 164 182 198
5.30 5.31 5.32 5.33	time2jsec.c File Reference 5.29.1 Detailed Description 5.29.2 Function Documentation time2jsec.c trac.c File Reference 5.31.1 Detailed Description 5.31.2 Function Documentation trac.c wind.c File Reference 5.33.1 Detailed Description	161 162 162 163 163 164 182 198 198

205

Index

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: http://www.fz-juelich.de/ias/jsc/mptrac

2 Data Structure Index

2.1 Data Structures

Here are the data structures with brief descriptions:

atm_t	
Atmospheric data	•
ctl t	
Control parameters	
met_t	
Meteorological data	19

3 File Index

3.1 File List

Here is a list of all files with brief descriptions:

center.c Calculate center of mass of air parcels	22
dist.c Calculate transport deviations of trajectories	26
extract.c Extract single trajectory from atmospheric data files	33
init.c Create atmospheric data file with initial air parcel positions	35
jsec2time.c Convert Julian seconds to date	39
libtrac.c MPTRAC library definitions	40
libtrac.h MPTRAC library declarations	95
match.c Calculate deviations between two trajectories	133

met_map.c Extract global map from meteorological data	138
met_prof.c Extract vertical profile from meteorological data	142
met_sample.c Sample meteorological data at given geolocations	146
met_zm.c Extract zonal mean from meteorological data	149
smago.c Estimate horizontal diffusivity based on Smagorinsky theory	154
split.c Split air parcels into a larger number of parcels	157
time2jsec.c Convert date to Julian seconds	161
trac.c Lagrangian particle dispersion model	163
wind.c Create meteorological data files with synthetic wind fields	198
4 Data Structure Documentation	
4.1 atm_t Struct Reference	
Atmospheric data.	
<pre>#include <libtrac.h></libtrac.h></pre>	
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] Quantitiy data (for various, user-defined attributes). double up [NP] Zonal wind perturbation [m/s]. double vp [NP] 	
 double vp [NP] Meridional wind perturbation [m/s]. double wp [NP] 	

Vertical velocity perturbation [hPa/s].

4

```
4.1.1 Detailed Description
Atmospheric data.
Definition at line 459 of file libtrac.h.
4.1.2 Field Documentation
4.1.2.1 int atm_t::np
Number of air pacels.
Definition at line 462 of file libtrac.h.
4.1.2.2 double atm_t::time[NP]
Time [s].
Definition at line 465 of file libtrac.h.
4.1.2.3 double atm_t::p[NP]
Pressure [hPa].
Definition at line 468 of file libtrac.h.
4.1.2.4 double atm_t::lon[NP]
Longitude [deg].
Definition at line 471 of file libtrac.h.
4.1.2.5 double atm_t::lat[NP]
Latitude [deg].
Definition at line 474 of file libtrac.h.
4.1.2.6 double atm_t::q[NQ][NP]
Quantitiy data (for various, user-defined attributes).
Definition at line 477 of file libtrac.h.
4.1.2.7 double atm_t::up[NP]
Zonal wind perturbation [m/s].
Definition at line 480 of file libtrac.h.
```

4.2 ctl_t Struct Reference 4.1.2.8 double atm_t::vp[NP] Meridional wind perturbation [m/s]. Definition at line 483 of file libtrac.h. 4.1.2.9 double atm_t::wp[NP] Vertical velocity perturbation [hPa/s]. Definition at line 486 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_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_pv Quantity array index for potential vorticity. · int ant 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 qnt_gw_u750 Quantity array index for low-level zonal wind. • int qnt_gw_v750 Quantity array index for low-level meridional wind. int qnt_gw_sso Quantity array index for subgrid-scale orography. · int qnt_gw_var Quantity array index for gravity wave variances. · 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 np Number of target pressure levels. double met_p [EP] Target pressure levels [hPa]. · 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_meso

Scaling factor for mesoscale wind fluctuations.

· 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 gw_basename [LEN]

Basename for gravity wave variance data.

• 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).

• 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 177 of file libtrac.h. 4.2.2 Field Documentation 4.2.2.1 int ctl_t::nq Number of quantities. Definition at line 180 of file libtrac.h. 4.2.2.2 char ctl_t::qnt_name[NQ][LEN] Quantity names. Definition at line 183 of file libtrac.h. 4.2.2.3 char ctl_t::qnt_unit[NQ][LEN] Quantity units. Definition at line 186 of file libtrac.h. 4.2.2.4 char ctl_t::qnt_format[NQ][LEN] Quantity output format. Definition at line 189 of file libtrac.h. 4.2.2.5 int ctl_t::qnt_ens Quantity array index for ensemble IDs.

Definition at line 195 of file libtrac.h.

Quantity array index for mass.

4.2.2.6 int ctl_t::qnt_m

Definition at line 192 of file libtrac.h.

```
4.2.2.7 int ctl_t::qnt_rho
Quantity array index for particle density.
Definition at line 198 of file libtrac.h.
4.2.2.8 int ctl_t::qnt_r
Quantity array index for particle radius.
Definition at line 201 of file libtrac.h.
4.2.2.9 int ctl_t::qnt_ps
Quantity array index for surface pressure.
Definition at line 204 of file libtrac.h.
4.2.2.10 int ctl_t::qnt_p
Quantity array index for pressure.
Definition at line 207 of file libtrac.h.
4.2.2.11 int ctl_t::qnt_t
Quantity array index for temperature.
Definition at line 210 of file libtrac.h.
4.2.2.12 int ctl_t::qnt_u
Quantity array index for zonal wind.
Definition at line 213 of file libtrac.h.
4.2.2.13 int ctl_t::qnt_v
Quantity array index for meridional wind.
Definition at line 216 of file libtrac.h.
4.2.2.14 int ctl_t::qnt_w
Quantity array index for vertical velocity.
Definition at line 219 of file libtrac.h.
4.2.2.15 int ctl_t::qnt_h2o
Quantity array index for water vapor vmr.
```

Definition at line 222 of file libtrac.h.

4.2.2.16 int ctl_t::qnt_o3 Quantity array index for ozone vmr. Definition at line 225 of file libtrac.h. 4.2.2.17 int ctl_t::qnt_theta Quantity array index for potential temperature. Definition at line 228 of file libtrac.h. 4.2.2.18 int ctl_t::qnt_pv Quantity array index for potential vorticity. Definition at line 231 of file libtrac.h. 4.2.2.19 int ctl_t::qnt_tice Quantity array index for T_ice. Definition at line 234 of file libtrac.h. 4.2.2.20 int ctl_t::qnt_tsts Quantity array index for T_STS. Definition at line 237 of file libtrac.h. 4.2.2.21 int ctl_t::qnt_tnat Quantity array index for T_NAT. Definition at line 240 of file libtrac.h. 4.2.2.22 int ctl_t::qnt_stat Quantity array index for station flag. Definition at line 243 of file libtrac.h. 4.2.2.23 int ctl_t::qnt_gw_u750 Quantity array index for low-level zonal wind. Definition at line 246 of file libtrac.h. 4.2.2.24 int ctl_t::qnt_gw_v750

Quantity array index for low-level meridional wind.

Definition at line 249 of file libtrac.h.

Generated by Doxygen

```
4.2.2.25 int ctl_t::qnt_gw_sso
Quantity array index for subgrid-scale orography.
Definition at line 252 of file libtrac.h.
4.2.2.26 int ctl_t::qnt_gw_var
Quantity array index for gravity wave variances.
Definition at line 255 of file libtrac.h.
4.2.2.27 int ctl_t::direction
Direction flag (1=forward calculation, -1=backward calculation).
Definition at line 258 of file libtrac.h.
4.2.2.28 double ctl_t::t_start
Start time of simulation [s].
Definition at line 261 of file libtrac.h.
4.2.2.29 double ctl_t::t_stop
Stop time of simulation [s].
Definition at line 264 of file libtrac.h.
4.2.2.30 double ctl_t::dt_mod
Time step of simulation [s].
Definition at line 267 of file libtrac.h.
4.2.2.31 double ctl_t::dt_met
Time step of meteorological data [s].
Definition at line 270 of file libtrac.h.
4.2.2.32 int ctl_t::met_np
Number of target pressure levels.
Definition at line 273 of file libtrac.h.
4.2.2.33 double ctl_t::met_p[EP]
Target pressure levels [hPa].
Definition at line 276 of file libtrac.h.
```

```
4.2.2.34 int ctl_t::isosurf
Isosurface parameter (0=none, 1=pressure, 2=density, 3=theta, 4=balloon).
Definition at line 280 of file libtrac.h.
4.2.2.35 char ctl_t::balloon[LEN]
Balloon position filename.
Definition at line 283 of file libtrac.h.
4.2.2.36 double ctl_t::turb_dx_trop
Horizontal turbulent diffusion coefficient (troposphere) [m^2/s].
Definition at line 286 of file libtrac.h.
4.2.2.37 double ctl_t::turb_dx_strat
Horizontal turbulent diffusion coefficient (stratosphere) [m<sup>2</sup>/s].
Definition at line 289 of file libtrac.h.
4.2.2.38 double ctl_t::turb_dz_trop
Vertical turbulent diffusion coefficient (troposphere) [m<sup>2</sup>/s].
Definition at line 292 of file libtrac.h.
4.2.2.39 double ctl_t::turb_dz_strat
Vertical turbulent diffusion coefficient (stratosphere) [m<sup>2</sup>/s].
Definition at line 295 of file libtrac.h.
4.2.2.40 double ctl_t::turb_meso
Scaling factor for mesoscale wind fluctuations.
Definition at line 298 of file libtrac.h.
4.2.2.41 double ctl_t::tdec_trop
Life time of particles (troposphere) [s].
Definition at line 301 of file libtrac.h.
4.2.2.42 double ctl_t::tdec_strat
Life time of particles (stratosphere) [s].
Definition at line 304 of file libtrac.h.
```

```
4.2.2.43 double ctl_t::psc_h2o
H2O volume mixing ratio for PSC analysis.
Definition at line 307 of file libtrac.h.
4.2.2.44 double ctl_t::psc_hno3
HNO3 volume mixing ratio for PSC analysis.
Definition at line 310 of file libtrac.h.
4.2.2.45 char ctl_t::gw_basename[LEN]
Basename for gravity wave variance data.
Definition at line 313 of file libtrac.h.
4.2.2.46 char ctl_t::atm_basename[LEN]
Basename of atmospheric data files.
Definition at line 316 of file libtrac.h.
4.2.2.47 char ctl_t::atm_gpfile[LEN]
Gnuplot file for atmospheric data.
Definition at line 319 of file libtrac.h.
4.2.2.48 double ctl_t::atm_dt_out
Time step for atmospheric data output [s].
Definition at line 322 of file libtrac.h.
4.2.2.49 int ctl_t::atm_filter
Time filter for atmospheric data output (0=no, 1=yes).
Definition at line 325 of file libtrac.h.
4.2.2.50 char ctl_t::csi_basename[LEN]
Basename of CSI data files.
Definition at line 328 of file libtrac.h.
4.2.2.51 double ctl_t::csi_dt_out
Time step for CSI data output [s].
Definition at line 331 of file libtrac.h.
```

```
4.2.2.52 char ctl_t::csi_obsfile[LEN]
Observation data file for CSI analysis.
Definition at line 334 of file libtrac.h.
4.2.2.53 double ctl_t::csi_obsmin
Minimum observation index to trigger detection.
Definition at line 337 of file libtrac.h.
4.2.2.54 double ctl_t::csi_modmin
Minimum column density to trigger detection [kg/m<sup>2</sup>].
Definition at line 340 of file libtrac.h.
4.2.2.55 int ctl_t::csi_nz
Number of altitudes of gridded CSI data.
Definition at line 343 of file libtrac.h.
4.2.2.56 double ctl_t::csi_z0
Lower altitude of gridded CSI data [km].
Definition at line 346 of file libtrac.h.
4.2.2.57 double ctl_t::csi_z1
Upper altitude of gridded CSI data [km].
Definition at line 349 of file libtrac.h.
4.2.2.58 int ctl_t::csi_nx
Number of longitudes of gridded CSI data.
Definition at line 352 of file libtrac.h.
4.2.2.59 double ctl_t::csi_lon0
Lower longitude of gridded CSI data [deg].
Definition at line 355 of file libtrac.h.
4.2.2.60 double ctl_t::csi_lon1
Upper longitude of gridded CSI data [deg].
Definition at line 358 of file libtrac.h.
```

```
4.2.2.61 int ctl_t::csi_ny
Number of latitudes of gridded CSI data.
Definition at line 361 of file libtrac.h.
4.2.2.62 double ctl_t::csi_lat0
Lower latitude of gridded CSI data [deg].
Definition at line 364 of file libtrac.h.
4.2.2.63 double ctl_t::csi_lat1
Upper latitude of gridded CSI data [deg].
Definition at line 367 of file libtrac.h.
4.2.2.64 char ctl_t::grid_basename[LEN]
Basename of grid data files.
Definition at line 370 of file libtrac.h.
4.2.2.65 char ctl_t::grid_gpfile[LEN]
Gnuplot file for gridded data.
Definition at line 373 of file libtrac.h.
4.2.2.66 double ctl_t::grid_dt_out
Time step for gridded data output [s].
Definition at line 376 of file libtrac.h.
4.2.2.67 int ctl_t::grid_sparse
Sparse output in grid data files (0=no, 1=yes).
Definition at line 379 of file libtrac.h.
4.2.2.68 int ctl_t::grid_nz
Number of altitudes of gridded data.
Definition at line 382 of file libtrac.h.
4.2.2.69 double ctl_t::grid_z0
Lower altitude of gridded data [km].
Definition at line 385 of file libtrac.h.
```

4.2.2.70 double ctl_t::grid_z1 Upper altitude of gridded data [km]. Definition at line 388 of file libtrac.h. 4.2.2.71 int ctl_t::grid_nx Number of longitudes of gridded data. Definition at line 391 of file libtrac.h. 4.2.2.72 double ctl_t::grid_lon0 Lower longitude of gridded data [deg]. Definition at line 394 of file libtrac.h. 4.2.2.73 double ctl_t::grid_lon1 Upper longitude of gridded data [deg]. Definition at line 397 of file libtrac.h. 4.2.2.74 int ctl_t::grid_ny Number of latitudes of gridded data. Definition at line 400 of file libtrac.h. 4.2.2.75 double ctl_t::grid_lat0 Lower latitude of gridded data [deg]. Definition at line 403 of file libtrac.h. 4.2.2.76 double ctl_t::grid_lat1 Upper latitude of gridded data [deg]. Definition at line 406 of file libtrac.h. 4.2.2.77 char ctl_t::prof_basename[LEN] Basename for profile output file. Definition at line 409 of file libtrac.h. 4.2.2.78 char ctl_t::prof_obsfile[LEN] Observation data file for profile output.

Definition at line 412 of file libtrac.h.

```
4.2.2.79 int ctl_t::prof_nz
Number of altitudes of gridded profile data.
Definition at line 415 of file libtrac.h.
4.2.2.80 double ctl_t::prof_z0
Lower altitude of gridded profile data [km].
Definition at line 418 of file libtrac.h.
4.2.2.81 double ctl_t::prof_z1
Upper altitude of gridded profile data [km].
Definition at line 421 of file libtrac.h.
4.2.2.82 int ctl_t::prof_nx
Number of longitudes of gridded profile data.
Definition at line 424 of file libtrac.h.
4.2.2.83 double ctl_t::prof_lon0
Lower longitude of gridded profile data [deg].
Definition at line 427 of file libtrac.h.
4.2.2.84 double ctl_t::prof_lon1
Upper longitude of gridded profile data [deg].
Definition at line 430 of file libtrac.h.
4.2.2.85 int ctl_t::prof_ny
Number of latitudes of gridded profile data.
Definition at line 433 of file libtrac.h.
4.2.2.86 double ctl_t::prof_lat0
Lower latitude of gridded profile data [deg].
Definition at line 436 of file libtrac.h.
4.2.2.87 double ctl_t::prof_lat1
Upper latitude of gridded profile data [deg].
Definition at line 439 of file libtrac.h.
```

```
4.2.2.88 char ctl_t::ens_basename[LEN]
Basename of ensemble data file.
Definition at line 442 of file libtrac.h.
4.2.2.89 char ctl_t::stat_basename[LEN]
Basename of station data file.
Definition at line 445 of file libtrac.h.
4.2.2.90 double ctl_t::stat_lon
Longitude of station [deg].
Definition at line 448 of file libtrac.h.
4.2.2.91 double ctl_t::stat_lat
Latitude of station [deg].
Definition at line 451 of file libtrac.h.
4.2.2.92 double ctl_t::stat_r
Search radius around station [km].
Definition at line 454 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].

float pl [EX][EY][EP]

Pressure on model levels [hPa].

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 h2o [EX][EY][EP]

Water vapor volume mixing ratio [1].

float o3 [EX][EY][EP]

Ozone volume mixing ratio [1].

4.3.1 Detailed Description

Meteorological data.

Definition at line 491 of file libtrac.h.

- 4.3.2 Field Documentation
- 4.3.2.1 double met_t::time

Time [s].

Definition at line 494 of file libtrac.h.

```
4.3.2.2 int met_t::nx
Number of longitudes.
Definition at line 497 of file libtrac.h.
4.3.2.3 int met_t::ny
Number of latitudes.
Definition at line 500 of file libtrac.h.
4.3.2.4 int met_t::np
Number of pressure levels.
Definition at line 503 of file libtrac.h.
4.3.2.5 double met_t::lon[EX]
Longitude [deg].
Definition at line 506 of file libtrac.h.
4.3.2.6 double met_t::lat[EY]
Latitude [deg].
Definition at line 509 of file libtrac.h.
4.3.2.7 double met_t::p[EP]
Pressure [hPa].
Definition at line 512 of file libtrac.h.
4.3.2.8 double met_t::ps[EX][EY]
Surface pressure [hPa].
Definition at line 515 of file libtrac.h.
4.3.2.9 float met_t::pl[EX][EY][EP]
Pressure on model levels [hPa].
Definition at line 518 of file libtrac.h.
4.3.2.10 float met_t::t[EX][EY][EP]
Temperature [K].
Definition at line 521 of file libtrac.h.
```

```
4.3.2.11 float met_t::u[EX][EY][EP]
Zonal wind [m/s].
Definition at line 524 of file libtrac.h.
4.3.2.12 float met_t::v[EX][EY][EP]
Meridional wind [m/s].
Definition at line 527 of file libtrac.h.
4.3.2.13 float met_t::w[EX][EY][EP]
Vertical wind [hPa/s].
Definition at line 530 of file libtrac.h.
4.3.2.14 float met_t::h2o[EX][EY][EP]
Water vapor volume mixing ratio [1].
Definition at line 533 of file libtrac.h.
4.3.2.15 float met_t::o3[EX][EY][EP]
Ozone volume mixing ratio [1].
Definition at line 536 of file libtrac.h.
The documentation for this struct was generated from the following file:
    · libtrac.h
   File Documentation
5.1 center.c File Reference
Calculate center of mass of air parcels.
Functions
    • int main (int argc, char *argv[])
5.1.1 Detailed Description
```

Calculate center of mass of air parcels.

Definition in file center.c.

5.1.2 Function Documentation

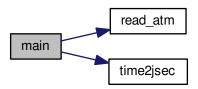
5.1.2.1 int main (int argc, char * argv[])

Definition at line 28 of file center.c.

```
00030
00031
00032
        ctl_t ctl;
00033
00034
        atm t *atm;
00035
00036
        FILE *out;
00037
00038
        char *name, *year, *mon, *day, *hour, *min;
00039
        double latm, lats, lonm, lons, t, zm, zs;
00040
00041
00042
        int i, f, ip;
00043
00044
         /* Allocate... */
00045
        ALLOC(atm, atm_t, 1);
00046
00047
        /* Check arguments... */
00048
            (argc < 3)
00049
          ERRMSG("Give parameters: <outfile> <atml> [<atm2> ...]");
00050
00051
         /\star Write info... \star/
00052
        printf("Write center of mass data: %s\n", argv[1]);
00053
00054
        /\star Create output file...
00055
        if (!(out = fopen(argv[1], "w")))
00056
          ERRMSG("Cannot create file!");
00057
00058
         /* Write header... */
00059
        fprintf(out,
                  "# $1 = time [s]\n"
00060
00061
                 "# $2 = altitude (mean) [km]\n"
                 "# $3 = altitude (sigma) [km]\n"
00062
00063
                 "# $4 = altitude (minimum) [km] n"
                  "# $5 = altitude (10%% percentile) [km]\n"
00064
                 "# $6 = altitude (1st quarter) [km]\n"
00065
                 "# $7 = altitude (median) [km]\n"
00066
                 "# $8 = altitude (3rd quarter) [km]\n"
00067
00068
                 "# $9 = altitude (90%% percentile) [km]\n"
                 "# $10 = altitude (maximum) [km] \n");
00069
        fprintf(out, "# $11 = longitude (mean) [deg]\n"
00070
00071
00072
                 "# $12 = longitude (sigma) [deg]\n"
                 "# $13 = longitude (minimum) [deg]\n"
00073
00074
                 "# $14 = longitude (10%% percentile) [deg]\n"
                 "# $15 = longitude (1st quarter) [deg]\n"
"# $16 = longitude (median) [deg]\n"
00075
00076
                 "# $17 = longitude (3rd quarter) [deg]\n"
"# $18 = longitude (90%% percentile) [deg]\n"
00077
00078
00079
                 "# $19 = longitude (maximum) [deg]\n");
08000
        fprintf(out,
                 "# $20 = latitude (mean) [deg]\n"
"# $21 = latitude (sigma) [deg]\n"
"# $22 = latitude (minimum) [deg]\n"
00081
00082
00083
                 "# $23 = latitude (10%% percentile) [deg]\n"
00084
                 "# $24 = latitude (1st quarter) [deg]\n'
00085
                 "# $25 = latitude (median) [deg] \n"
00086
00087
                 "# $26 = latitude (3rd quarter) [deg]\n"
00088
                 "# $27 = latitude (90% percentile) [deg]\n"
                 "# $28 = latitude (maximum) [deg] \n\n");
00089
00090
00091
        /* Loop over files... */
        for (f = 2; f < argc; f++) {
00092
00093
00094
           /* Read atmopheric data... */
00095
          read_atm(argv[f], &ctl, atm);
00096
00097
          /* Initialize... */
00098
          zm = zs = 0;
           lonm = lons = 0;
00099
00100
           latm = lats = 0;
00101
          /* Calculate mean and standard deviation... */
for (ip = 0; ip < atm->np; ip++) {
00102
00103
00104
            zm += Z(atm->p[ip]) / atm->np;
             lonm += atm->lon[ip] / atm->np;
```

```
00106
                  latm += atm->lat[ip] / atm->np;
00107
                  zs += gsl_pow_2(Z(atm->p[ip])) / atm->np;
                  lons += gsl_pow_2(atm->lon[ip]) / atm->np;
lats += gsl_pow_2(atm->lat[ip]) / atm->np;
00108
00109
00110
00111
00112
                /* Normalize... */
00113
                zs = sqrt(zs - gsl_pow_2(zm));
               lons = sqrt(lons - gsl_pow_2(lonm));
lats = sqrt(lats - gsl_pow_2(latm));
00114
00115
00116
               /* 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);
00117
00118
00119
00120
00121
               /* Get date from filename... */
for (i = (int) strlen(argv[f]) - 1; argv[f][i] != '/' || i == 0; i--);
name = strtok(&(argv[f][i]), "_");
00122
00123
00124
               year = strtok(NULL, "_");
mon = strtok(NULL, "_");
day = strtok(NULL, "_");
00125
00126
00127
               hour = strtok(NULL, "_");
name = strtok(NULL, "_");
min = strtok(name, ".");
00128
                                                            /* TODO: Why another "name" here? */
00129
00130
00131
               time2jsec(atoi(year), atoi(mon), atoi(day), atoi(hour), atoi(min), 0, 0,
00132
00133
               00134
00135
00136
00137
                            Z(atm->p[atm->np - atm->np / 10]),
Z(atm->p[atm->np - atm->np / 4]),
00138
00139
                            Z(atm->p[atm->np - atm->np / =1,,
Z(atm->p[atm->np / 2]), Z(atm->p[atm->np / 4]),
Z(atm->p[atm->np / 10]), Z(atm->p[0]),
00140
00141
                            lonm, lons, atm->lon[0], atm->lon[atm->np / 10], atm->lon[atm->np / 4], atm->lon[atm->np / 2],
00142
00143
                            atm->lon[atm->np - atm->np / 4],
atm->lon[atm->np - atm->np / 4],
atm->lon[atm->np - atm->np / 10],
atm->lon[atm->np - 1],
00144
00145
00146
                            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]);
00147
00148
00149
00150
00151
00152
            /* Close file... */
00153
00154
            fclose(out);
00155
00156
             /* Free... */
00157
            free(atm);
00158
00159
            return EXIT_SUCCESS;
00160 }
```

Here is the call graph for this function:



5.2 center.c

00001 /*

5.2 center.c 25

```
This file is part of MPTRAC.
00003
00004
        MPTRAC is free software: you can redistribute it and/or modify
        it under the terms of the GNU General Public License as published by
00005
        the Free Software Foundation, either version 3 of the License, or
00006
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
        You should have received a copy of the GNU General Public License along with MPTRAC. If not, see <a href="http://www.gnu.org/licenses/">http://www.gnu.org/licenses/</a>>.
00014
00015
00016
00017
        Copright (C) 2013-2015 Forschungszentrum Juelich GmbH
00018 */
00019
00025 #include "libtrac.h"
00026 #include <gsl/gsl_sort.h>
00027
00028 int main(
00029
        int argc,
        char *argv[]) {
00030
00031
00032
        ctl_t ctl;
00033
00034
        atm_t *atm;
00035
00036
        FILE *out;
00037
00038
        char *name, *year, *mon, *day, *hour, *min;
00039
00040
        double latm, lats, lonm, lons, t, zm, zs;
00041
00042
        int i, f, ip;
00043
00044
         /* Allocate... */
00045
        ALLOC(atm, atm_t, 1);
00046
00047
        /* Check arguments... */
00048
        if (argc < 3)
00049
          ERRMSG("Give parameters: <outfile> <atml> [<atm2> ...]");
00050
00051
        /* Write info... */
00052
        printf("Write center of mass data: %s\n", argv[1]);
00053
        /* Create output file... */
if (!(out = fopen(argv[1], "w")))
00054
00055
          ERRMSG("Cannot create file!");
00056
00057
00058
        /* Write header... */
00059
        fprintf(out,
00060
                 "# $1
                        = time [s]\n"
                 "# $2 = altitude (mean) [km]\n"
00061
00062
                 "# $3 = altitude (sigma) [km]\n"
                 "# $4 = altitude (minimum) [km]\n"
00063
00064
                 "# $5 = altitude (10%% percentile) [km]\n"
00065
                 "# $6 = altitude (1st quarter) [km]\n"
                 "# $7 = altitude (median) [km]\n"
00066
                 "# $8 = altitude (3rd quarter) [km]\n"
"# $9 = altitude (90%% percentile) [km]\n"
00067
00068
                 "# $10 = altitude (maximum) [km]n");
00069
00070
        fprintf(out,
00071
                 "# $11 = longitude (mean) [deg] n"
                 "# $12 = longitude (sigma) [deg] \n"
00072
                 "# $13 = longitude (minimum) [deg] \n"
00073
00074
                 "# $14 = longitude (10%% percentile) [deg]\n"
00075
                 "# $15 = longitude (1st quarter) [deg]\n"
                 "# $16 = longitude (median) [deg]\n"
00076
00077
                 "# $17 = longitude (3rd quarter) [deg]\n"
                 "# $18 = longitude (90%% percentile) [deg]\n"
00078
                 "# $19 = longitude (maximum) [deg]\n");
00079
00080
        fprintf(out,
                 "# $20 = latitude (mean) [deg] \n
00081
                 "# $21 = latitude (sigma) [deg]\n"
00082
                 "# $22 = latitude (minimum) [deg]\n"
00083
00084
                 "# $23 = latitude (10%% percentile) [deg]\n"
                 "# $24 = latitude (1st quarter) [deg] n
00085
                 "# $25 = latitude (median) [deg] \n"
00086
                 "# $26 = latitude (3rd quarter) [deg] \n"
00087
                 "# $27 = latitude (90%% percentile) [deg]\n"
00088
00089
                 "# $28 = latitude (maximum) [deg] \n\n");
00090
        /* Loop over files... */
for (f = 2; f < argc; f++) {
00091
00092
00093
```

```
/* Read atmopheric data... */
00095
                read_atm(argv[f], &ctl, atm);
00096
00097
                /* Initialize... */
00098
                zm = zs = 0;

lonm = lons = 0;
00099
                latm = lats = 0;
00100
00101
00102
                 /* 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;
00103
00104
00105
                   latm += atm->lat[ip] / atm->np;
00106
00107
                    zs += gsl_pow_2(Z(atm->p[ip])) / atm->np;
00108
                    lons += gsl_pow_2(atm->lon[ip]) / atm->np;
                   lats += gsl_pow_2(atm->lat[ip]) / atm->np;
00109
00110
00111
00112
                /* Normalize... */
00113
                zs = sqrt(zs - gsl_pow_2(zm));
                lons = sqrt(lons - gsl_pow_2(lonm));
lats = sqrt(lats - gsl_pow_2(latm));
00114
00115
00116
                /* 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);
00117
00118
00119
00120
00121
               /* Get date from filename... */
for (i = (int) strlen(argv[f]) - 1; argv[f][i] != '/' || i == 0; i--);
name = strtok(&(argv[f][i]), "_");
year = strtok(NULL, "_");
mon = strtok(NULL, "_");
day = strtok(NULL, "_");
hour = strtok(NULL, "_");
00122
00123
00124
00125
00126
00127
                hour = strtok(NULL, "_");
name = strtok(NULL, "_");
min = strtok(name, ".");
00128
                                                              /* TODO: Why another "name" here? */
00129
00130
00131
                time2jsec(atoi(year), atoi(mon), atoi(day), atoi(hour), atoi(min), 0, 0,
00132
00133
                00134
00135
00136
00137
                            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 - 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[atm->np / 10],
00138
00139
00140
00141
00142
00143
00144
00145
00146
00147
                             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]);
00148
00149
00151
00152
00153
             /* Close file... */
00154
            fclose(out);
00155
00156
             /* Free... */
00157
            free(atm);
00158
00159
            return EXIT_SUCCESS;
00160 }
```

5.3 dist.c File Reference

Calculate transport deviations of trajectories.

Functions

• int main (int argc, char *argv[])

5.3 dist.c File Reference 27

5.3.1 Detailed Description

Calculate transport deviations of trajectories.

Definition in file dist.c.

5.3.2 Function Documentation

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

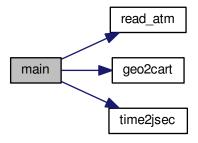
Definition at line 28 of file dist.c.

```
00030
00032
        ctl_t ctl;
00033
00034
        atm_t *atm1, *atm2;
00035
00036
        FILE *out;
00037
00038
        char *name, *year, *mon, *day, *hour, *min;
00039
        double aux, x0[3], x1[3], x2[3], *lon1, *lat1, *p1, *lh1, *lv1, *lon2, *lat2, *p2, *lh2, *lv2, ahtd, avtd, ahtd2, avtd2,
00040
00041
00042
          rhtd, rvtd, rhtd2, rvtd2, t, *dh, *dv;
00043
00044
        int f, i, ip, iph, ipv;
00045
00046
        /* Allocate... */
        ALLOC(atm1, atm_t, 1);
ALLOC(atm2, atm_t, 1);
00047
00048
00049
        ALLOC(lon1, double,
00050
              NP);
00051
        ALLOC(lat1, double,
00052
              NP);
        ALLOC(p1, double,
00053
00054
              NP);
00055
        ALLOC(lh1, double,
00056
              NP);
00057
        ALLOC(lv1, double,
00058
              NP);
00059
       ALLOC(lon2, double,
00060
              NP);
00061
        ALLOC(lat2, double,
00062
              NP);
00063
        ALLOC(p2, double,
00064
              NP);
        ALLOC(lh2, double,
00065
00066
              NP);
00067
        ALLOC(1v2, double,
00068
              NP);
00069
        ALLOC(dh, double,
00070
              NP);
        ALLOC(dv, double,
00071
00072
              NP);
00073
00074
        /* Check arguments... */
00075
        if (argc < 4)
00076
        ERRMSG
00077
             ("Give parameters: <outfile> <atm1a> <atm1b> [<atm2a> <atm2b> ...]");
00078
00079
        /* Write info... */
08000
        printf("Write transport deviations: %s\n", argv[1]);
00081
00082
        /* Create output file... */
        if (!(out = fopen(argv[1], "w")))
    ERRMSG("Cannot create file!");
00083
00084
00085
00086
        /* Write header... */
00087
        fprintf(out,
00088
                 "# $1
                        = time [s]\n"
00089
                 "# $2
                        = AHTD (mean) [km]\n"
                 "# $3 = AHTD (sigma) [km] \n"
00090
                 "# $4 = AHTD (minimum) [km]\n"
00091
00092
                 "# $5 = AHTD (10%% percentile) [km]\n"
00093
                 "# $6 = AHTD (1st quartile) [km]\n'
00094
                 "# $7 = AHTD (median) [km]\n"
```

```
"# $8 = AHTD (3rd quartile) [km]\n"
                   "# $9 = AHTD (90%% percentile) [km]\n"
00096
                   "# $10 = AHTD (maximum) [km] \n"
00097
                   "# $11 = AHTD (maximum trajectory index)\n"  
"# $12 = RHTD (mean) [%^{n}\n"  
# $13 = RHTD (sigma) [%^{n}\n");
00098
00099
00100
         fprintf(out,
                   "# $14 = AVTD (mean) [km] \n"
00102
                   "# $15 = AVTD (sigma) [km] n"
00103
                   "# $16 = AVTD (minimum) [km] \n"
                   "# $17 = AVTD (10%% percentile) [km]\n"
00104
                   "# $18 = AVTD (1st quartile) [km]\n"
00105
                   "# $19 = AVTD (median) [km] \n"
00106
                   "# $20 = AVTD (3rd quartile) [km]\n"
"# $21 = AVTD (90%% percentile) [km]\n"
00107
00108
00109
                   "# $22 = AVTD (maximum) [km] \n"
                   "# $23 = AVTD (maximum trajectory index)\n" "# $24 = RVTD (mean) [%%]\n" "# $25 = RVTD (sigma) [%%]\n\n");
00110
00111
00112
00113
         /* Loop over file pairs... */
00114
         for (f = 2; f < argc; f += 2) {</pre>
00115
00116
            /* Read atmopheric data... */
           read_atm(argv[f], &ctl, atm1);
read_atm(argv[f + 1], &ctl, atm2);
00117
00118
00119
00120
            /* Check if structs match... */
00121
            if (atm1->np != atm2->np)
00122
             ERRMSG("Different numbers of parcels!");
            for (ip = 0; ip < atml->np; ip++)
  if (atml->time[ip] != atm2->time[ip])
00123
00124
00125
                ERRMSG("Times do not match!");
00126
00127
            /* Init... */
           ahtd = ahtd2 = 0;
avtd = avtd2 = 0;
00128
00129
           rhtd = rhtd2 = 0;
00130
00131
           rvtd = rvtd2 = 0;
00132
00133
            /* Loop over air parcels... */
00134
            for (ip = 0; ip < atm1->np; ip++) {
00135
              /* Get Cartesian coordinates... */
00136
              geo2cart(0, atm1->lon[ip], atm1->lat[ip], x1);
geo2cart(0, atm2->lon[ip], atm2->lat[ip], x2);
00137
00138
00139
00140
              /* Calculate absolute transport deviations... */
              dh[ip] = DIST(x1, x2);
ahtd += dh[ip];
00141
00142
              ahtd2 += gsl_pow_2(dh[ip]);
00143
00144
00145
              dv[ip] = fabs(Z(atm1->p[ip]) - Z(atm2->p[ip]));
00146
              avtd += dv[ip];
00147
              avtd2 += gsl_pow_2(dv[ip]);
00148
              /* Calculate relative transport deviations... */
00149
00150
              if (f > 2) {
00152
                 /* Get trajectory lengths... */
00153
                 geo2cart(0, lon1[ip], lat1[ip], x0);
                lh1[ip] += DIST(x0, x1);
lv1[ip] += fabs(Z(p1[ip]) - Z(atm1->p[ip]));
00154
00155
00156
00157
                geo2cart(0, lon2[ip], lat2[ip], x0);
                lh2[ip] += DIST(x0, x2);
lv2[ip] += fabs(Z(p2[ip]) - Z(atm2->p[ip]));
00158
00159
00160
00161
                 /* Get relative transport devations... */
                if (lh1[ip] + lh2[ip] > 0) {
  aux = 200. * DIST(x1, x2) / (lh1[ip] + lh2[ip]);
00162
00163
                   rhtd += aux;
00164
00165
                   rhtd2 += gsl_pow_2(aux);
00166
00167
                if (lv1[ip] + lv2[ip] > 0) {
00168
                   aux =
                     200. * fabs(Z(atm1->p[ip]) - Z(atm2->p[ip])) / (lv1[ip] +
00169
00170
                                                                               lv2[ip]);
00171
                   rvtd += aux;
00172
                   rvtd2 += gsl_pow_2(aux);
00173
00174
00175
              /* Save positions of air parcels... */
              lon1[ip] = atm1->lon[ip];
lat1[ip] = atm1->lat[ip];
00177
00178
00179
              p1[ip] = atm1->p[ip];
00180
00181
              lon2[ip] = atm2->lon[ip];
```

```
lat2[ip] = atm2 -> lat[ip];
00183
               p2[ip] = atm2->p[ip];
00184
00185
00186
             /\star Get indices of trajectories with maximum errors... \star/
             iph = (int) gsl_stats_max_index(dh, 1, (size_t) atm1->np);
ipv = (int) gsl_stats_max_index(dv, 1, (size_t) atm1->np);
00187
00188
00189
             /\star Sort distances to calculate percentiles... \star/
00190
00191
             gsl_sort(dh, 1, (size_t) atm1->np);
             gsl_sort(dv, 1, (size_t) atm1->np);
00192
00193
00194
             /* Get date from filename... */
             for (i = (int) strlen(argv[f]) - 1; argv[f][i] != '/' || i == 0; i--);
name = strtok(&(argv[f][i]), "_");
00195
00196
             year = strtok(NULL, "_");
mon = strtok(NULL, "_");
day = strtok(NULL, "_");
00197
00198
00199
             hour = strtok(NULL, "_");
name = strtok(NULL, "_");
min = strtok(name, ".");
00200
00201
                                                  /* TODO: Why another "name" here? */
00202
00203
             time2jsec(atoi(year), atoi(mon), atoi(day), atoi(hour), atoi(min), 0, 0,
00204
                          &t);
00205
00206
             /* Write output... */
             fprintf(out, "%.2f %g %g %g %g %g %g %g %g %d %g %g"
00208
                        " %g %g %g %g %g %g %g %g %d %g %g\n", t,
00209
                        ahtd / atm1->np,
00210
                        sqrt(ahtd2 / atm1->np - gsl_pow_2(ahtd / atm1->np)),
                        dh[0], dh[atml->np / 10], dh[atml->np / 4], dh[atml->np / 2], dh[atml->np - atml->np / 4], dh[atml->np - atml->np / 10], dh[atml->np - atml->np / 10], dh[atml->np - 1], iph, rhtd / atml->np,
00211
00212
00213
00214
                        sqrt(rhtd2 / atm1->np - gsl_pow_2(rhtd / atm1->np)),
00215
                        avtd / atm1->np,
                       dvtd / dtml >np / gsl_pow_2(avtd / atml->np)),
dv[0], dv[atml->np / 10], dv[atml->np / 4], dv[atml->np / 2],
dv[atml->np - atml->np / 4], dv[atml->np - atml->np / 10],
dv[atml->np - 1], ipv, rvtd / atml->np,
00216
00217
00218
00220
                        sqrt(rvtd2 / atm1->np - gsl_pow_2(rvtd / atm1->np)));
00221
00222
          /* Close file... */
00223
00224
          fclose(out);
00225
00226
00227
          free(atm1);
00228
          free(atm2);
00229
          free(lon1);
00230
          free(lat1);
00231
          free(p1);
00232
          free(lh1);
00233
          free(lv1);
00234
          free(lon2);
00235
          free(lat2);
00236
          free (p2);
00237
          free(lh2);
          free(lv2);
00239
          free (dh);
00240
          free(dv);
00241
00242
          return EXIT SUCCESS;
00243 }
```

Here is the call graph for this function:



5.4 dist.c

```
00001 /*
00002
        This file is part of MPTRAC.
00003
        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
        You should have received a copy of the GNU General Public License along with MPTRAC. If not, see <a href="http://www.gnu.org/licenses/">http://www.gnu.org/licenses/</a>>.
00014
00015
00016
00017
        Copright (C) 2013-2015 Forschungszentrum Juelich GmbH
00018 */
00019
00025 #include "libtrac.h"
00026 #include <gsl/gsl_sort.h>
00027
00028 int main(
00029
        int argc,
00030
        char *argv[]) {
00031
00032
        ctl t ctl;
00033
00034
        atm_t *atm1, *atm2;
00035
00036
        FILE *out;
00037
00038
        char *name, *year, *mon, *day, *hour, *min;
00039
00040
        double aux, x0[3], x1[3], x2[3], *lon1, *lat1, *p1, *lh1, *lv1,
          *lon2, *lat2, *p2, *lh2, *lv2, ahtd, avtd, ahtd2, avtd2, rhtd, rvtd, rhtd2, rvtd2, t, *dh, *dv;
00041
00042
00043
00044
        int f, i, ip, iph, ipv;
00045
00046
         /* Allocate... */
00047
         ALLOC(atm1, atm_t, 1);
00048
        ALLOC(atm2, atm_t, 1);
00049
        ALLOC(lon1, double,
00050
               NP);
00051
        ALLOC(lat1, double,
00052
               NP);
00053
        ALLOC(p1, double,
00054
               NP);
        ALLOC(lh1, double,
00055
00056
               NP);
        ALLOC(lv1, double,
00057
00058
               NP);
00059
        ALLOC(lon2, double,
```

5.4 dist.c 31

```
00060
               NP);
00061
        ALLOC(lat2, double,
00062
              NP);
        ALLOC(p2, double,
00063
00064
              NP);
00065
        ALLOC(1h2, double,
00066
               NP);
00067
        ALLOC(1v2, double,
00068
               NP);
00069
        ALLOC(dh, double,
00070
              NP);
00071
        ALLOC(dv. double.
00072
              NP);
00073
00074
        /* Check arguments... ∗/
00075
        if (argc < 4)</pre>
00076
          ERRMSG
00077
             ("Give parameters: <outfile> <atmlb> [<atm2a> <atm2b> ...]");
00078
00079
        /* Write info... */
08000
        printf("Write transport deviations: %s\n", argv[1]);
00081
00082
        /* Create output file... */
        if (!(out = fopen(argv[1], "w")))
00083
00084
          ERRMSG("Cannot create file!");
00085
00086
        /* Write header... */
00087
        fprintf(out,
00088
                 "# $1
                        = time [s]\n"
                 "# $2 = AHTD (mean) [km]\n"
00089
00090
                 "# $3 = AHTD (sigma) [km] \n"
00091
                 "# $4 = AHTD (minimum) [km] \n"
00092
                 "# $5 = AHTD (10%% percentile) [km]\n"
00093
                 "# $6 = AHTD (1st quartile) [km]\n"
                 "# $7 = AHTD (median) [km]\n"
00094
                 "# $8 = AHTD (3rd quartile) [km]\n"
00095
                 "# $9 = AHTD (90%% percentile) [km]\n"
"# $10 = AHTD (maximum) [km]\n"
00096
                 "# $11 = AHTD (maximum trajectory index)\n"
"# $12 = RHTD (mean) [%%]\n" "# $13 = RHTD (sigma) [%%]\n");
00098
00099
        fprintf(out,
    "# $14 = AVTD (mean) [km]\n"
00100
00101
                 "# $15 = AVTD (sigma) [km] \n"
00102
                 "# $16 = AVTD (minimum) [km]\n"
00103
                 "# $17 = AVTD (10%% percentile) [km]\n"
00105
                 "# $18 = AVTD (1st quartile) [km]\n"
00106
                 "# $19 = AVTD (median) [km] \n"
                 "# $20 = AVTD (3rd quartile) [km]\n"
00107
                 "# $21 = AVTD (90%% percentile) [km]\n"
00108
                 "# $22 = AVTD (maximum) [km]\n"
00109
                 "# $23 = AVTD (maximum trajectory index)\n"
00110
00111
                 "# $24 = RVTD (mean) [%%]\n" "# $25 = RVTD (sigma) [%%]\n\n");
00112
        /* Loop over file pairs... */
for (f = 2; f < argc; f += 2) {</pre>
00113
00114
00115
          /* Read atmopheric data... */
          read_atm(argv[f], &ctl, atml);
read_atm(argv[f + 1], &ctl, atm2);
00117
00118
00119
00120
          /* Check if structs match... */
          if (atm1->np != atm2->np)
00121
00122
            ERRMSG("Different numbers of parcels!");
00123
          for (ip = 0; ip < atml->np; ip++)
00124
                (atm1->time[ip] != atm2->time[ip])
00125
              ERRMSG("Times do not match!");
00126
00127
          /* Init... */
00128
          ahtd = ahtd2 = 0;
          avtd = avtd2 = 0;
00129
00130
          rhtd = rhtd2 = 0;
00131
          rvtd = rvtd2 = 0;
00132
00133
          /* Loop over air parcels... */
00134
          for (ip = 0; ip < atm1->np; ip++) {
00135
00136
             /* Get Cartesian coordinates... */
00137
            geo2cart(0, atm1->lon[ip], atm1->lat[ip], x1);
00138
            geo2cart(0, atm2->lon[ip], atm2->lat[ip], x2);
00139
             /* Calculate absolute transport deviations... */
00140
            dh[ip] = DIST(x1, x2);
ahtd += dh[ip];
00141
00142
00143
             ahtd2 += gsl_pow_2(dh[ip]);
00144
            dv[ip] = fabs(Z(atm1->p[ip]) - Z(atm2->p[ip]));
00145
            avtd += dv[ip];
00146
```

```
00147
              avtd2 += gsl_pow_2(dv[ip]);
00148
00149
               /\star Calculate relative transport deviations... \star/
00150
               if (f > 2) {
00151
                  /* Get trajectory lengths... */
00152
                 geo2cart(0, lon1[ip], lat1[ip], x0);
00153
00154
                  lh1[ip] += DIST(x0, x1);
00155
                 lv1[ip] += fabs(Z(p1[ip]) - Z(atm1->p[ip]));
00156
                  geo2cart(0, lon2[ip], lat2[ip], x0);
00157
                 lh2[ip] += DIST(x0, x2);
lv2[ip] += fabs(Z(p2[ip]) - Z(atm2->p[ip]));
00158
00159
00160
00161
                  /* Get relative transport devations... */
                 if (lh1[ip] + lh2[ip] > 0) {
  aux = 200. * DIST(x1, x2) / (lh1[ip] + lh2[ip]);
00162
00163
                    rhtd += aux;
00164
                    rhtd2 += gsl_pow_2(aux);
00165
00166
00167
                 if (lv1[ip] + 1v2[ip] > 0) {
00168
                      200. * fabs(Z(atm1->p[ip]) - Z(atm2->p[ip])) / (lv1[ip] +
00169
00170
                                                                                     lv2[ip]);
00171
                    rvtd += aux;
00172
                    rvtd2 += gsl_pow_2(aux);
00173
00174
00175
               /\star Save positions of air parcels... \star/
00176
               lon1[ip] = atm1->lon[ip];
lat1[ip] = atm1->lat[ip];
00177
00178
00179
               p1[ip] = atm1->p[ip];
00180
               lon2[ip] = atm2->lon[ip];
lat2[ip] = atm2->lat[ip];
00181
00182
              p2[ip] = atm2->p[ip];
00183
00184
00185
00186
             /\star Get indices of trajectories with maximum errors... \star/
00187
            iph = (int) gsl_stats_max_index(dh, 1, (size_t) atm1->np);
            ipv = (int) gsl_stats_max_index(dv, 1, (size_t) atm1->np);
00188
00189
00190
            /* Sort distances to calculate percentiles... */
            gsl_sort(dh, 1, (size_t) atml->np);
gsl_sort(dv, 1, (size_t) atml->np);
00191
00192
00193
            /* Get date from filename... */
for (i = (int) strlen(argv[f]) - 1; argv[f][i] != '/' || i == 0; i--);
name = strtok(&(argv[f][i]), "_");
00194
00195
00196
            year = strtok(NULL, "_");
mon = strtok(NULL, "_");
day = strtok(NULL, "_");
00197
00198
00199
            hour = strtok(NULL, "_");
name = strtok(NULL, "_");
min = strtok(name, ".");
00200
00201
                                                /* TODO: Why another "name" here? */
00202
            time2jsec(atoi(year), atoi(mon), atoi(day), atoi(hour), atoi(min), 0, 0,
00203
00204
                         &t);
00205
            00206
00207
                       " %g %g %g %g %g %g %g %g %d %g %g\n", t,
00208
00209
                       ahtd / atml->np,
00210
                       sqrt(ahtd2 / atm1->np - gsl_pow_2(ahtd / atm1->np)),
00211
                       dh[0], dh[atm1->np / 10], dh[atm1->np / 4], dh[atm1->np / 2],
                      dh[atml->np - atml->np / 4], dh[atml->np - atml->np / 10],
dh[atml->np - 1], iph, rhtd / atml->np,
sqrt(rhtd2 / atml->np - gsl_pow_2(rhtd / atml->np)),
00212
00213
00214
00215
                       avtd / atm1->np,
00216
                       sqrt(avtd2 / atm1->np - gsl_pow_2(avtd / atm1->np)),
                      dv[0], dv[atml->np / 10], dv[atml->np / 4], dv[atml->np / 2],
dv[atml->np - atml->np / 4], dv[atml->np / 10],
dv[atml->np - atml->np / 4], dv[atml->np - atml->np / 10],
dv[atml->np - 1], ipv, rvtd / atml->np,
sqrt(rvtd2 / atml->np - gsl_pow_2(rvtd / atml->np)));
00217
00218
00219
00220
00221
00222
00223
          /* Close file... */
00224
         fclose(out);
00225
00226
         /* Free... */
00227
         free(atm1);
00228
          free(atm2);
00229
          free (lon1);
00230
          free(lat1);
00231
         free(p1);
00232
          free(lh1):
00233
         free(lv1);
```

```
00234
       free(lon2);
00235
       free(lat2);
00236
       free(p2);
00237
       free(lh2);
00238
       free(lv2);
00239
       free (dh);
       free(dv);
00241
00242
       return EXIT_SUCCESS;
00243 }
```

5.5 extract.c File Reference

Extract single trajectory from atmospheric data files.

Functions

• int main (int argc, char *argv[])

5.5.1 Detailed Description

Extract single trajectory from atmospheric data files.

Definition in file extract.c.

5.5.2 Function Documentation

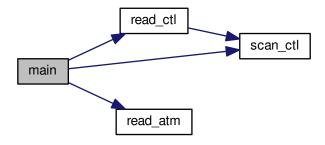
5.5.2.1 int main (int argc, char * argv[])

Definition at line 28 of file extract.c.

```
00030
00031
00032
        ctl_t ctl;
00033
00034
        atm_t *atm;
00035
00036
        FILE *in, *out;
00037
00038
        int f, ip, iq;
00039
00040
        /* Allocate... */
00041
        ALLOC(atm, atm_t, 1);
00042
00043
        /* Check arguments... */
00044
        if (argc < 4)
00045
          ERRMSG("Give parameters: <ctl> <outfile> <atm1> [<atm2> ...]");
00046
        /* Read control parameters... */
read_ctl(argv[1], argc, argv, &ctl);
ip = (int) scan_ctl(argv[1], argc, argv, "EXTRACT_IP", -1, "0", NULL);
00047
00048
00049
00050
00051
        /* Write info... */
00052
        printf("Write trajectory data: sn', argv[2]);
00053
00054
        /* Create output file... */
        if (!(out = fopen(argv[2], "w")))
00055
00056
          ERRMSG("Cannot create file!");
00057
00058
        /* Write header... */
00059 fprintf(out,
                  "# $1 = time [s]\n"
00060
                 "# $2 = altitude [km]\n"
"# $3 = longitude [deg]\n" "# $4 = latitude [deg]\n");
00061
00062
00063
        for (iq = 0; iq < ctl.nq; iq++)</pre>
```

```
fprintf(out, "# $%i = %s [%s]\n", iq + 5, ctl.qnt_name[iq],
        ctl.qnt_unit[iq]);
fprintf(out, "\n");
00065
00066
00067
        /* Loop over files... */
for (f = 3; f < argc; f++) {</pre>
00068
00069
00070
00071
           /* Read atmopheric data... */
          if (!(in = fopen(argv[f], "r")))
00072
00073
            continue;
00074
          else
00075
           fclose(in);
00076
          read_atm(argv[f], &ctl, atm);
00077
          00078
00079
                  Z(atm->p[ip]), atm->lon[ip], atm->lat[ip]);
08000
          for (iq = 0; iq < ctl.nq; iq++) {
  fprintf(out, " ");</pre>
00081
00082
00083
             fprintf(out, ctl.qnt_format[iq], atm->q[iq][ip]);
00084
00085
          fprintf(out, "\n");
00086
00087
00088
        /* Close file... */
00089
        fclose(out);
00090
        /* Free... */
00091
00092
        free(atm);
00093
00094
        return EXIT SUCCESS:
00095 }
```

Here is the call graph for this function:



5.6 extract.c

```
00001 /*
00002
         This file is part of MPTRAC.
00003
00004
         \ensuremath{\mathsf{MPTRAC}} is free software: you can redistribute it and/or modify
         it under the terms of the GNU General Public License as published by
00005
         the Free Software Foundation, either version 3 of the License, or
00006
00007
         (at your option) any later version.
80000
00009
         \ensuremath{\mathsf{MPTRAC}} is distributed in the hope that it will be useful,
         but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
00010
00011
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 <a href="http://www.gnu.org/licenses/">http://www.gnu.org/licenses/</a>.
00016
00017
         Copright (C) 2013-2015 Forschungszentrum Juelich GmbH
00018 */
00019
```

5.7 init.c File Reference 35

```
00025 #include "libtrac.h"
00026 #include <gsl/gsl_sort.h>
00027
00028 int main(
00029
        int argc,
00030
        char *argv[]) {
00031
00032
        ctl_t ctl;
00033
00034
        atm_t *atm;
00035
00036
        FILE *in, *out;
00037
00038
        int f, ip, iq;
00039
00040
        /* Allocate... */
00041
        ALLOC(atm, atm_t, 1);
00042
00043
        /* Check arguments... */
00044
        if (argc < 4)</pre>
00045
          ERRMSG("Give parameters: <ctl> <outfile> <atm1> [<atm2> ...]");
00046
00047
        /* Read control parameters... */
        read_ctl(argv[1], argc, argv, &ctl);
ip = (int) scan_ctl(argv[1], argc, argv, "EXTRACT_IP", -1, "0", NULL);
00048
00049
00050
00051
        /\star Write info... \star/
00052
        printf("Write trajectory data: %s\n", argv[2]);
00053
        /* Create output file... */
00054
        if (!(out = fopen(argv[2], "w")))
00055
00056
          ERRMSG("Cannot create file!");
00057
00058
        /* Write header... */
00059
        fprintf(out,
                  "# $1 = time [s] \n"
00060
                 "# $2 = altitude [km]\n"
"# $3 = longitude [deg]\n" "# $4 = latitude [deg]\n");
00061
00062
        for (iq = 0; iq < ctl.nq; iq++)
    fprintf(out, "# $%i = %s [%s]\n", iq + 5, ctl.qnt_name[iq],</pre>
00063
00064
        ctl.qnt_unit[iq]);
fprintf(out, "\n");
00065
00066
00067
00068
        /* Loop over files... */
00069
        for (f = 3; f < argc; f++) {</pre>
00070
          /* Read atmopheric data... */
if (!(in = fopen(argv[f], "r")))
00071
00072
00073
            continue;
00074
          else
00075
            fclose(in);
00076
          read_atm(argv[f], &ctl, atm);
00077
          00078
00079
08000
           for (iq = 0; iq < ctl.nq; iq++) {
  fprintf(out, " ");</pre>
00082
00083
            fprintf(out, ctl.qnt_format[iq], atm->q[iq][ip]);
00084
          fprintf(out, "\n");
00085
00086
00087
00088
        /* Close file... */
00089
        fclose(out);
00090
00091
        /* Free... */
00092
        free(atm);
00093
00094
        return EXIT_SUCCESS;
00095 }
```

5.7 init.c File Reference

Create atmospheric data file with initial air parcel positions.

Functions

• int main (int argc, char *argv[])

5.7.1 Detailed Description

Create atmospheric data file with initial air parcel positions.

Definition in file init.c.

5.7.2 Function Documentation

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

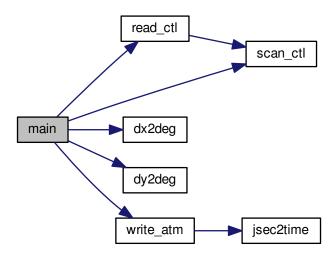
Definition at line 27 of file init.c.

```
00029
00031
               atm_t *atm;
00032
00033
              ctl_t ctl;
00034
00035
              asl rna *rna:
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 ip, irep, rep;
00041
00042
                 /* Allocate... */
00043
               ALLOC(atm, atm_t, 1);
00044
00045
               /\star Check arguments... \star/
00046
               if (argc < 3)
                  ERRMSG("Give parameters: <ctl> <atm_out>");
00047
00048
00049
              /* Read control parameters... */
              /* Read Control parameters... //
read_ctl(argv[1], argc, argv, &ctl);
t0 = scan_ctl(argv[1], argc, argv, "INIT_TO", -1, "0", NULL);
t1 = scan_ctl(argv[1], argc, argv, "INIT_TI", -1, "0", NULL);
dt = scan_ctl(argv[1], argc, argv, "INIT_DT", -1, "1", NULL);
z0 = scan_ctl(argv[1], argc, argv, "INIT_ZO", -1, "0", NULL);
00050
00051
00052
00053
00054
               z1 = scan_ctl(argv[1], argc, argv, "INIT_21", -1, "0", NULL);
dz = scan_ctl(argv[1], argc, argv, "INIT_21", -1, "0", NULL);
00056
              dz = scan_ctl(argv[1], argc, argv, "INIT_DZ", -1, "1", NULL);
lon0 = scan_ctl(argv[1], argc, argv, "INIT_LON0", -1, "0", NULL);
lon1 = scan_ctl(argv[1], argc, argv, "INIT_LON1", -1, "0", NULL);
dlon = scan_ctl(argv[1], argc, argv, "INIT_LON0", -1, "1", NULL);
lat0 = scan_ctl(argv[1], argc, argv, "INIT_LAT0", -1, "0", NULL);
lat1 = scan_ctl(argv[1], argc, argv, "INIT_LAT1", -1, "0", NULL);
dlat = scan_ctl(argv[1], argc, argv, "INIT_DLAT", -1, "1", NULL);
st = scan_ctl(argv[1], argc, argv, "INIT_ST", -1, "0", NULL);
sz = scan_ctl(argv[1], argc, argv, "INIT_SZ", -1, "0", NULL);
slon = scan_ctl(argv[1], argc, argv, "INIT_SLON", -1, "0", NULL);
00057
00058
00059
00060
00061
00062
00063
00064
              slon = scan_ctl(argv[1], argc, argv, "INIT_SZ, -1, "0", NULL);
slat = scan_ctl(argv[1], argc, argv, "INIT_SLAT", -1, "0", NULL);
sx = scan_ctl(argv[1], argc, argv, "INIT_SX, -1, "0", NULL);
ut = scan_ctl(argv[1], argc, argv, "INIT_UT", -1, "0", NULL);
00065
00066
00067
00068
              uz = scan_ctl(argv[1], argc, argv, "INII_OI", -1, "0", NULL);
uz = scan_ctl(argv[1], argc, argv, "INII_UZ", -1, "0", NULL);
ulon = scan_ctl(argv[1], argc, argv, "INII_ULON", -1, "0", NULL);
ulat = scan_ctl(argv[1], argc, argv, "INII_ULAT", -1, "0", NULL);
rep = (int) scan_ctl(argv[1], argc, argv, "INII_REP", -1, "1", NULL);
m = scan_ctl(argv[1], argc, argv, "INII_MASS", -1, "0", NULL);
00069
00070
00071
00072
00073
00074
00075
                /* Initialize random number generator... */
00076
              gsl_rng_env_setup();
00077
              rng = gsl_rng_alloc(gsl_rng_default);
00078
00079
               /* Create grid... */
               for (t = t0; t <= t1; t += dt)
00080
                  for (z = z0; z <= z1; z += dz)
00081
00082
                      for (lon = lon0; lon <= lon1; lon += dlon)</pre>
                          for (lat = lat0; lat <= lat1; lat += dlat)</pre>
00083
                              for (irep = 0; irep < rep; irep++) {</pre>
00084
00085
00086
                                   /* Set position... */
                                  atm->time[atm->np]
00087
00088
                                     = (t + gsl_ran_gaussian_ziggurat(rng, st / 2.3548)
00089
                                           + ut * (gsl_rng_uniform(rng) - 0.5));
00090
                                  atm->p[atm->np]
00091
                                     = P(z + gsl_ran_gaussian_ziggurat(rng, sz / 2.3548)
00092
                                              + uz * (gsl_rng_uniform(rng) - 0.5));
00093
                                  atm->lon[atm->np]
```

5.8 init.c 37

```
= (lon + gsl_ran_gaussian_ziggurat(rng, slon / 2.3548)
                           + gsl_ran_gaussian_ziggurat(rng, dx2deg(sx, lat) / 2.3548)
+ ulon * (gsl_rng_uniform(rng) - 0.5));
00095
00096
00097
                      atm->lat[atm->np]
                        = (lat + gsl_ran_gaussian_ziggurat(rng, slat / 2.3548)
+ gsl_ran_gaussian_ziggurat(rng, dy2deg(sx) / 2.3548)
+ ulat * (gsl_rng_uniform(rng) - 0.5));
00098
00099
00100
00101
00102
                      /* Set particle counter... */
                      if ((++atm->np) >= NP)
00103
                        ERRMSG("Too many particles!");
00104
00105
00106
00107
         /* Check number of air parcels... */
00108
         if (atm->np <= 0)
00109
           ERRMSG("Did not create any air parcels!");
00110
00111
          /* Initialize mass... */
         if (ctl.qnt_m >= 0)
00112
          for (ip = 0; ip < atm->np; ip++)
00113
00114
              atm->q[ctl.qnt_m][ip] = m / atm->np;
00115
         /* Save data... */
write_atm(argv[2], &ctl, atm, t0);
00116
00117
00118
00119
         /* Free... */
00120
         gsl_rng_free(rng);
00121
         free(atm);
00122
00123
         return EXIT_SUCCESS;
00124 }
```

Here is the call graph for this function:



5.8 init.c

```
00001 /*
00002
       This file is part of MPTRAC.
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
       the Free Software Foundation, either version 3 of the License, or
00006
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
```

```
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 <a href="http://www.gnu.org/licenses/">http://www.gnu.org/licenses/</a>.
00016
00017
             Copright (C) 2013-2015 Forschungszentrum Juelich GmbH
00018 */
00019
00025 #include "libtrac.h"
00026
00027 int main(
00028
            int argc,
            char *argv[]) {
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 ip, irep, rep;
00041
             /* Allocate... */
00042
00043
             ALLOC(atm, atm_t, 1);
00044
00045
             /* Check arguments... */
00046
             if (argc < 3)
00047
                ERRMSG("Give parameters: <ctl> <atm_out>");
00048
             /\star Read control parameters... \star/
00049
             read_ctl(argv[1], argc, argv, &ctl);
t0 = scan_ctl(argv[1], argc, argv, "INIT_TO", -1, "0", NULL);
t1 = scan_ctl(argv[1], argc, argv, "INIT_T1", -1, "0", NULL);
dt = scan_ctl(argv[1], argc, argv, "INIT_DT", -1, "1", NULL);
00050
00051
00052
            dt = scan_ctl(argv[1], argc, argv, "INIT_DIT", -1, "1", NULL);
z0 = scan_ctl(argv[1], argc, argv, "INIT_Z0", -1, "0", NULL);
z1 = scan_ctl(argv[1], argc, argv, "INIT_Z1", -1, "0", NULL);
dz = scan_ctl(argv[1], argc, argv, "INIT_DZ", -1, "1", NULL);
lon0 = scan_ctl(argv[1], argc, argv, "INIT_LON0", -1, "0", NULL);
dlon1 = scan_ctl(argv[1], argc, argv, "INIT_LON1", -1, "0", NULL);
dlon2 = scan_ctl(argv[1], argc, argv, "INIT_LON1", -1, "0", NULL);
lat0 = scan_ctl(argv[1], argc, argv, "INIT_LAT0", -1, "0", NULL);
lat1 = scan_ctl(argv[1], argc, argv, "INIT_LAT1", -1, "0", NULL);
dlat = scan_ctl(argv[1], argc, argv, "INIT_DLAT", -1, "1", NULL);
st = scan_ctl(argv[1], argc, argv, "INIT_ST", -1, "0", NULL);
sz = scan_ctl(argv[1], argc, argv, "INIT_SZ", -1, "0", NULL);
slon = scan_ctl(argv[1], argc, argv, "INIT_SLAT", -1, "0", NULL);
sx = scan_ctl(argv[1], argc, argv, "INIT_SLAT", -1, "0", NULL);
ut = scan_ctl(argv[1], argc, argv, "INIT_SLAT", -1, "0", NULL);
ut = scan_ctl(argv[1], argc, argv, "INIT_UT", -1, "0", NULL);
ut = scan_ctl(argv[1], argc, argv, "INIT_UT", -1, "0", NULL);
ulon = scan_ctl(argv[1], argc, argv, "INIT_UT", -1, "0", NULL);
ulat = scan_ctl(argv[1], argc, argv, "INIT_ULAT", -1, "0", NULL);
ulat = scan_ctl(argv[1], argc, argv, "INIT_ULAT", -1, "0", NULL);
m = scan_ctl(argv[1], argc, argv, "INIT_MASS", -1, "0", NULL);
00054
             z0 = scan_ctl(argv[1], argc, argv, "INIT_ZO", -1, "0", NULL);
00055
00056
00057
00058
00059
00060
00061
00062
00063
00064
00065
00067
00068
00069
00070
00071
00072
00073
00074
00075
             /* Initialize random number generator... */
00076
             gsl_rng_env_setup();
00077
             rng = gsl_rng_alloc(gsl_rng_default);
00078
00079
00080
             for (t = t0; t <= t1; t += dt)
00081
                for (z = z0; z \le z1; z += dz)
00082
                    for (lon = lon0; lon <= lon1; lon += dlon)
                       for (lat = lat0; lat <= lat1; lat += dlat)</pre>
00083
00084
                          for (irep = 0; irep < rep; irep++) {</pre>
00085
00086
                               /* Set position... */
00087
                              atm->time[atm->np]
00088
                                  = (t + gsl_ran_gaussian_ziggurat(rng, st / 2.3548)
00089
                                      + ut * (gsl_rng_uniform(rng) - 0.5));
00090
                              atm->p[atm->np]
00091
                                 = P(z + gsl_ran_gaussian_ziggurat(rng, sz / 2.3548)
00092
                                         + uz * (gsl_rng_uniform(rng) - 0.5));
00093
                               atm->lon[atm->np]
                                  = (lon + gsl_ran_gaussian_ziggurat(rng, slon / 2.3548)
00094
00095
                                       + gsl_ran_gaussian_ziggurat(rng, dx2deg(sx, lat) / 2.3548)
+ ulon * (gsl_rng_uniform(rng) - 0.5));
00096
00097
                              atm->lat[atm->np]
00098
                                 = (lat + gsl_ran_gaussian_ziggurat(rng, slat / 2.3548)
00099
                                       + gsl_ran_gaussian_ziggurat(rng, dy2deg(sx) / 2.3548)
00100
                                        + ulat * (gsl_rng_uniform(rng) - 0.5));
00101
00102
                              /* Set particle counter... */
```

```
if ((++atm->np) >= NP)
00104
                      ERRMSG("Too many particles!");
00105
00106
00107
        /* Check number of air parcels... */
00108
        if (atm->np <= 0)</pre>
         ERRMSG("Did not create any air parcels!");
00109
00110
00111
        /* Initialize mass... */
        if (ctl.qnt_m >= 0)
  for (ip = 0; ip < atm->np; ip++)
    atm->q[ctl.qnt_m][ip] = m / atm->np;
00112
00113
00114
00115
00116
00117
        write_atm(argv[2], &ctl, atm, t0);
00118
00119
        /* Free... */
00120
        gsl_rng_free(rng);
        free (atm);
00122
00123
        return EXIT_SUCCESS;
00124 }
```

5.9 jsec2time.c File Reference

Convert Julian seconds to date.

Functions

• int main (int argc, char *argv[])

5.9.1 Detailed Description

Convert Julian seconds to date.

Definition in file jsec2time.c.

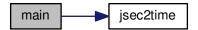
5.9.2 Function Documentation

5.9.2.1 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
         ERRMSG("Give parameters: <jsec>");
00037
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 %g\n", year, mon, day, hour, min, sec, remain);
00045
00046
       return EXIT_SUCCESS;
00047 }
```

Here is the call graph for this function:



5.10 jsec2time.c

```
00001 /*
00002
         This file is part of MPTRAC.
00003
00004
         MPTRAC is free software: you can redistribute it and/or modify
         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
         \ensuremath{\mathsf{MPTRAC}} is distributed in the hope that it will be useful,
         but WITHOUT ANY WARRANTY; without even the implied warranty of
00010
00011
         MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
00012
         GNU General Public License for more details.
00013
         You should have received a copy of the GNU General Public License along with MPTRAC. If not, see <a href="http://www.gnu.org/licenses/">http://www.gnu.org/licenses/</a>>.
00014
00015
00016
00017
         Copright (C) 2013-2015 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
00037
           ERRMSG("Give parameters: <jsec>");
00038
00039
         /* Read arguments... */
00040
         jsec = atof(argv[1]);
00041
00042
         jsec2time(jsec, &year, &mon, &day, &hour, &min, &sec, &remain);
printf("%d %d %d %d %d %d %g\n", year, mon, day, hour, min, sec, remain);
00043
00044
00045
         return EXIT_SUCCESS;
00046
00047 }
```

5.11 libtrac.c File Reference

MPTRAC library definitions.

Functions

- void cart2geo (double *x, double *z, double *lon, double *lat)
 - Convert Cartesian coordinates to geolocation.
- double deg2dx (double dlon, double lat)

Convert degrees to horizontal distance.

double deg2dy (double dlat)

Convert degrees to horizontal distance.

double dp2dz (double dp, double p)

Convert pressure to vertical distance.

• double dx2deg (double dx, double lat)

Convert horizontal distance to degrees.

double dy2deg (double dy)

Convert horizontal distance to degrees.

• double dz2dp (double dz, double p)

Convert vertical distance to pressure.

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 *t, double *u, double *v, double *w, 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 *t, double *u, double *v, double *w, 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 (double *xx, int n, double x)

Find array index.

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_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.

 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.

- double tropopause (double t, double lat)
- 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.

5.11.1 Detailed Description

MPTRAC library definitions.

Definition in file libtrac.c.

5.11.2 Function Documentation

```
5.11.2.1 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 }
```

5.11.2.2 double deg2dx (double dlon, double lat)

Convert degrees to horizontal distance.

Definition at line 45 of file libtrac.c.

5.11.2.3 double deg2dy (double dlat)

Convert degrees to horizontal distance.

Definition at line 54 of file libtrac.c.

```
00055 {
00056
00057 return dlat * M_PI * RE / 180.;
00058 }
```

5.11.2.4 double dp2dz (double dp, double p)

Convert pressure to vertical distance.

Definition at line 62 of file libtrac.c.

5.11.2.5 double dx2deg (double dx, double lat)

Convert horizontal distance to degrees.

Definition at line 71 of file libtrac.c.

5.11.2.6 double dy2deg (double dy)

Convert horizontal distance to degrees.

Definition at line 84 of file libtrac.c.

5.11.2.7 double dz2dp (double dz, double p)

Convert vertical distance to pressure.

Definition at line 92 of file libtrac.c.

```
00094 {
00095
00096 return -dz * p / H0;
00097 }
```

```
5.11.2.8 void geo2cart (double z, double lon, double lat, double *x)
```

Convert geolocation to Cartesian coordinates.

Definition at line 101 of file libtrac.c.

```
00105 {
00106
00107 double radius;
00108
00109 radius = z + RE;
00110 x[0] = radius * cos(lat / 180 * M_PI) * cos(lon / 180 * M_PI);
00111 x[1] = radius * cos(lat / 180 * M_PI) * sin(lon / 180 * M_PI);
00112 x[2] = radius * sin(lat / 180 * M_PI);
```

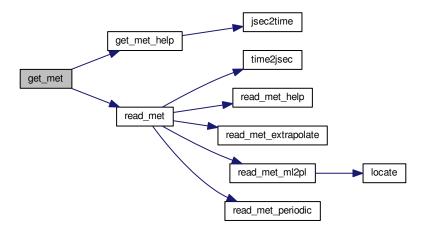
```
5.11.2.9 void get_met ( ctl_t * ctl, char * metbase, double t, met_t * met0, met_t * met1 )
```

Get meteorological data for given timestep.

Definition at line 117 of file libtrac.c.

```
00122
00123
00124
        char filename[LEN];
00125
00126
        static int init;
00127
00128
        /* Init... */
00129
        if (!init) {
00130
          init = 1;
00131
          get_met_help(t, -1, metbase, ctl->dt_met, filename);
00132
          read_met(ctl, filename, met0);
00133
00134
00135
          get_met_help(t + 1.0 * ctl->direction, 1, metbase, ctl->
      dt_met, filename);
00136
          read_met(ctl, filename, met1);
00137
00138
00139
        /* Read new data for forward trajectories... */
00140
        if (t > met1->time && ctl->direction == 1) {
00141
        memcpy(met0, met1, sizeof(met_t));
          get_met_help(t, 1, metbase, ctl->dt_met, filename);
read_met(ctl, filename, met1);
00142
00143
00144
00145
00146
        /* Read new data for backward trajectories... */
00147
        if (t < met0->time && ctl->direction == -1) {
00148
        memcpy(met1, met0, sizeof(met_t));
          get_met_help(t, -1, metbase, ctl->dt_met, filename);
read_met(ctl, filename, met0);
00149
00150
00151
00152 }
```

Here is the call graph for this function:



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

Get meteorological data for timestep.

Definition at line 156 of file libtrac.c.

```
00161
00162
00163
        double t6, r;
00164
00165
        int year, mon, day, hour, min, sec;
00166
        /* Round time to fixed intervals... */
if (direct == -1)
00167
00168
00169
          t6 = floor(t / dt_met) * dt_met;
00170
00171
          t6 = ceil(t / dt_met) * dt_met;
00172
00173
        /* Decode time... */
00174
        jsec2time(t6, &year, &mon, &day, &hour, &min, &sec, &r);
00175
        /* Set filename... */
sprintf(filename, "%s_%d_%02d_%02d_%02d.nc", metbase, year, mon, day, hour);
00176
00177
00178 }
```

Here is the call graph for this function:



5.11.2.11 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 182 of file libtrac.c.

```
{
00189
00190
         double aux00, aux01, aux10, aux11;
00191
00192
        /* Set variables...
00193
        aux00 = array[ix][iy];
        aux01 = array[ix][iy + 1];
aux10 = array[ix + 1][iy];
00195
00196
        aux11 = array[ix + 1][iy + 1];
00197
        /* Interpolate horizontally... */
00198
        aux00 = wy * (aux00 - aux01) + aux01;

aux11 = wy * (aux10 - aux11) + aux11;
00199
00200
         *var = wx * (aux00 - aux11) + aux11;
00201
00202 }
```

5.11.2.12 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 206 of file libtrac.c.

```
00214
                         {
00216
         double aux00, aux01, aux10, aux11;
00217
00218
         /* Interpolate vertically... */
         aux00 = wp * (array[ix][iy][ip] - array[ix][iy][ip + 1])
00219
         + array[ix][iy][ip + 1];
aux01 = wp * (array[ix][iy + 1][ip] - array[ix][iy + 1][ip + 1])
+ array[ix][iy + 1][ip + 1];
00220
00221
00222
00223
         aux10 = wp * (array[ix + 1][iy][ip] - array[ix + 1][iy][ip + 1])
         + array[ix + 1][iy][ip + 1];
aux11 = wp * (array[ix + 1][iy + 1][ip] - array[ix + 1][iy + 1][ip + 1])
00224
00225
00226
           + array[ix + 1][iy + 1][ip + 1];
00227
         /* Interpolate horizontally... */
         aux00 = wy * (aux00 - aux01) + aux01;
aux11 = wy * (aux10 - aux11) + aux11;
00229
00230
00231
         *var = wx * (aux00 - aux11) + aux11;
00232 }
```

5.11.2.13 void intpol_met_space ($met_t * met$, double p, double lon, double lo

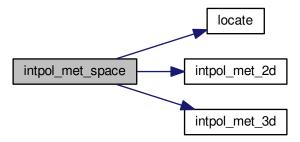
Spatial interpolation of meteorological data.

Definition at line 236 of file libtrac.c.

```
00248
00249
        double wp, wx, wy;
00250
00251
        int ip, ix, iy;
00252
        /* Check longitude... */
if (met->lon[met->nx - 1] > 180 && lon < 0)
00253
00254
00255
          lon += 360;
00256
00257
        /* Get indices... */
00258
        ip = locate(met->p, met->np, p);
00259
        ix = locate(met->lon, met->nx, lon);
00260
        iy = locate(met->lat, met->ny, lat);
```

```
00261
00262
        wp = (met->p[ip + 1] - p) / (met->p[ip + 1] - met->p[ip]);
00263
        wx = (met->lon[ix + 1] - lon) / (met->lon[ix + 1] - met->lon[ix]);
wy = (met->lat[iy + 1] - lat) / (met->lat[iy + 1] - met->lat[iy]);
00264
00265
00266
00267
        /* Interpolate... */
00268
        if (ps != NULL)
00269
          intpol_met_2d(met->ps, ix, iy, wx, wy, ps);
00270
        if (t != NULL)
00271
          intpol_met_3d(met->t, ip, ix, iy, wp, wx, wy, t);
00272
        if (u != NULL)
00273
          intpol_met_3d(met->u, ip, ix, iy, wp, wx, wy, u);
00274
        if (v != NULL)
00275
          intpol_met_3d(met->v, ip, ix, iy, wp, wx, wy, v);
00276
        if (w != NULL)
00277
          intpol_met_3d(met->w, ip, ix, iy, wp, wx, wy, w);
00278
        if (h2o != NULL)
          intpol_met_3d(met->h2o, ip, ix, iy, wp, wx, wy, h2o);
00280
        if (o3 != NULL)
00281
          intpol_met_3d(met->o3, ip, ix, iy, wp, wx, wy, o3);
00282 }
```

Here is the call graph for this function:



5.11.2.14 void intpol_met_time (met_t * met0, met_t * met1, double ts, double p, double lon, double lat, double * ps, double * t, double * u, double * v, double * w, double * b2o, double * o3)

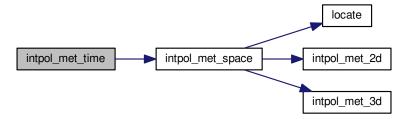
Temporal interpolation of meteorological data.

Definition at line 286 of file libtrac.c.

```
00300
00301
      double h200, h201, o30, o31, ps0, ps1, t0, t1, u0, u1, v0, v1, w0, w1, wt;
00302
00303
       /* Spatial interpolation... */
      00304
00305
00306
                      t == NULL ? NULL : &t0,
00307
                      u == NULL ? NULL : &u0,
00308
                     v == NULL ? NULL : &v0,
00309
                      w == NULL ? NULL : &w0,
                     h2o == NULL ? NULL : &h2o0, o3 == NULL ? NULL : &o30);
00310
      00311
00312
                      t == NULL ? NULL : &t1,
00313
00314
                      u == NULL ? NULL : &u1,
                      v == NULL ? NULL : &v1,
00315
00316
                      w == NULL ? NULL : &w1,
00317
                     h2o == NULL ? NULL : &h2o1, o3 == NULL ? NULL : &o31);
00318
```

```
00319
        /* Get weighting factor... */
00320
       wt = (met1->time - ts) / (met1->time - met0->time);
00321
00322
        /\star Interpolate... \star/
00323
        if (ps != NULL)
        *ps = wt * (ps0 - ps1) + ps1;
if (t != NULL)
00324
00326
          *t = wt * (t0 - t1) + t1;
00327
        if (u != NULL)
        *u = wt * (u0 - u1) + u1;
if (v != NULL)
00328
00329
          *v = wt * (v0 - v1) + v1;
00330
        if (w != NULL)
00331
00332
          *w = wt * (w0 - w1) + w1;
        if (h2o != NULL)
00333
        *h2o = wt * (h2o0 - h2o1) + h2o1;
if (o3 != NULL)
00334
00335
          *o3 = wt * (o30 - o31) + o31;
00336
00337 }
```

Here is the call graph for this function:



5.11.2.15 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 341 of file libtrac.c.

```
00349
                        {
00350
00351
       struct tm t0, *t1;
00352
00353
       time_t jsec0;
00354
       t0.tm_year = 100;
00355
        t0.tm_mon = 0;
00356
00357
        t0.tm_mday = 1;
00358
        t0.tm\_hour = 0;
00359
        t0.tm_min = 0;
00360
       t0.tm\_sec = 0;
00361
00362
        jsec0 = (time_t) jsec + timegm(&t0);
00363
       t1 = gmtime(&jsec0);
00364
00365
        *year = t1->tm_year + 1900;
00366
        *mon = t1->tm_mon + 1;
00367
        *day = t1->tm_mday;
00368
        *hour = t1->tm_hour;
        *min = t1->tm_min;
00369
00370
        *sec = t1->tm_sec;
00371
        *remain = jsec - floor(jsec);
00372 }
```

```
5.11.2.16 int locate ( double *xx, int n, double x )
```

Find array index.

Definition at line 376 of file libtrac.c.

```
00379
                    {
00380
00381
        int i, ilo, ihi;
00382
00383
        ilo = 0;
        ihi = n - 1;
i = (ihi + ilo) >> 1;
00384
00385
00386
00387
        if (xx[i] < xx[i + 1])
         while (ihi > ilo + 1) {
   i = (ihi + ilo) >> 1;
00388
00389
00390
             if (xx[i] > x)
00391
              ihi = i;
00392
             else
00393
               ilo = i;
00394
        } else
00395
          while (ihi > ilo + 1) {
00396
           i = (ihi + ilo) >> 1;
            <u>if</u> (xx[i] <= x)
00397
00398
              ihi = i;
            else
00399
00400
               ilo = i;
00401
         }
00402
00403
        return ilo;
00404 }
```

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

Read atmospheric data.

Definition at line 408 of file libtrac.c.

```
00411
00412
00413
          FILE *in;
00414
00415
          char line[LEN], *tok;
00416
00417
          int iq;
00418
         /* Init... */
atm->np = 0;
00419
00420
00421
00422
          /* Write info... */
00423
          printf("Read atmospheric data: %s\n", filename);
00424
00425
          /* Open file... */
00426
          if (!(in = fopen(filename, "r")))
            ERRMSG("Cannot open file!");
00428
00429
          /* Read line... */
00430
          while (fgets(line, LEN, in)) {
00431
            /* Read data... */
TOK(line, tok, "%lg", atm->time[atm->np]);
TOK(NULL, tok, "%lg", atm->p[atm->np]);
TOK(NULL, tok, "%lg", atm->lon[atm->np]);
TOK(NULL, tok, "%lg", atm->lat[atm->np]);
for (iq = 0; iq < ctl->nq; iq++)
    TOK(NULL, tok, "%lg", atm->q[iq][atm->np]);
00432
00433
00434
00435
00436
00437
00438
00439
00440
             /* Convert altitude to pressure... */
00441
             atm->p[atm->np] = P(atm->p[atm->np]);
00442
            /* Increment data point counter... */
if ((++atm->np) > NP)
00443
00444
               ERRMSG("Too many data points!");
00445
00446
00447
00448
          /* Close file... */
00449
          fclose(in);
00450
00451
          /\star Check number of points... \star/
00452
          if (atm->np < 1)
00453
             ERRMSG("Can not read any data!");
00454 }
```

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

Read control parameters.

Definition at line 458 of file libtrac.c.

```
00462
00463
00464
        int ip, iq;
00465
00466
        /* Write info... */
        printf("\nMassive-Parallel\ Trajectory\ Calculations\ (MPTRAC)\n"
00467
                "(executable: %s | compiled: %s, %s)\n\n",
00468
                argv[0], __DATE__, __TIME__);
00470
00471
        /* Initialize quantity indices... */
        ctl->qnt_ens = -1;
ctl->qnt_m = -1;
00472
00473
00474
        ctl->qnt_r = -1;
00475
        ctl->qnt_rho = -1;
        ctl->qnt_ps = -1;
00476
00477
        ctl->qnt_p = -1;
        ctl->qnt_t = -1;
00478
        ctl \rightarrow qnt_u = -1;
00479
00480
        ctl->ant v = -1:
00481
        ctl->qnt_w = -1;
00482
        ct1->qnt_h2o = -1;
00483
        ctl->qnt_o3 = -1;
00484
        ctl->qnt\_theta = -1;
        ctl->qnt_pv = -1;
00485
        ctl->qnt\_tice = -1;
00486
00487
        ctl->qnt\_tsts = -1;
00488
        ctl->qnt_tnat = -1;
00489
        ctl->qnt_gw_var = -1;
00490
        ctl->qnt\_stat = -1;
00491
00492
        /* Read quantities... */
00493
        ctl->nq = (int) scan_ctl(filename, argc, argv, "NQ", -1, "0", NULL);
        if (ctl->nq > NQ)
00494
          ERRMSG("Too many quantities!");
00495
00496
        for (iq = 0; iq < ctl->nq; iq++) {
00497
          /★ Read quantity name and format... ★/
00498
          scan_ctl(filename, argc, argv, "QNT_NAME", iq, "", ctl->qnt_name[iq]);
scan_ctl(filename, argc, argv, "QNT_FORMAT", iq, "%g",
00499
00500
                    ctl->qnt_format[iq]);
00501
00502
          /* Try to identify quantity... */
if (strcmp(ctl->qnt_name[iq], "ens") == 0) {
00503
00504
00505
            ctl->qnt_ens = iq;
00506
            sprintf(ctl->qnt_unit[iq], "-");
00507
          } else if (strcmp(ctl->qnt_name[iq], "m") == 0) {
            ctl->qnt_m = iq;
00508
00509
            sprintf(ctl->qnt_unit[iq], "kg");
          } else if (strcmp(ctl->qnt_name[iq], "r") == 0) {
ctl->qnt_r = iq;
00510
00511
            sprintf(ctl->qnt_unit[iq], "m");
00513
          } else if (strcmp(ctl->qnt_name[iq], "rho") == 0) {
00514
            ctl->qnt_rho = iq;
00515
            sprintf(ctl->qnt_unit[iq], "kg/m^3");
          } else if (strcmp(ctl->qnt_name[iq], "ps") == 0) {
ctl->qnt_ps = iq;
00516
00517
            sprintf(ctl->qnt_unit[iq], "hPa");
00518
          } else if (strcmp(ctl->qnt_name[iq], "p") == 0) {
00520
           ctl->qnt_p = iq;
00521
            sprintf(ctl->qnt_unit[iq], "hPa");
          } else if (strcmp(ctl->qnt_name[iq], "t") == 0) {
00522
            ctl->qnt_t = iq;
sprintf(ctl->qnt_unit[iq], "K");
00523
00524
00525
          } else if (strcmp(ctl->qnt_name[iq], "u") == 0) {
00526
            ctl->qnt_u = iq;
00527
            sprintf(ctl->qnt_unit[iq], "m/s");
          } else if (strcmp(ctl->qnt_name[iq], "v") == 0) {
00528
            ctl->qnt_v = iq;
00529
            sprintf(ctl->qnt_unit[iq], "m/s");
00530
          } else if (strcmp(ctl->qnt_name[iq], "w") == 0) {
           ctl->qnt_w = iq;
00532
00533
            sprintf(ctl->qnt_unit[iq], "hPa/s");
00534
          } else if (strcmp(ctl->qnt_name[iq], "h2o") == 0) {
00535
            ctl->qnt_h2o = iq;
            sprintf(ctl->qnt_unit[iq], "1");
00536
00537
          } else if (strcmp(ctl->qnt_name[iq], "o3") == 0) {
            ctl->qnt_o3 = iq;
```

```
sprintf(ctl->qnt_unit[iq], "1");
00540
          } else if (strcmp(ctl->qnt_name[iq], "theta") == 0) {
00541
            ctl->qnt_theta = iq;
            sprintf(ctl->qnt_unit[iq], "K");
00542
           } else if (strcmp(ctl->qnt_name[iq], "pv") == 0) {
  ctl->qnt_pv = iq;
  sprintf(ctl->qnt_unit[iq], "PVU");
00543
00544
          } else if (strcmp(ctl->qnt_name[iq], "tice") == 0) {
00546
            ctl->qnt_tice = iq;
00547
00548
             sprintf(ctl->qnt_unit[iq], "K");
          } else if (strcmp(ctl->qnt_name[iq], "tsts") == 0) {
00549
00550
            ctl->qnt_tsts = iq;
            sprintf(ctl->qnt_unit[iq], "K");
00551
00552
          } else if (strcmp(ctl->qnt_name[iq], "tnat") == 0) {
00553
             ctl->qnt_tnat = iq;
            sprintf(ctl->qnt_unit[iq], "K");
00554
          } else if (strcmp(ctl->qnt_name[iq], "gw_var") == 0) {
  ctl->qnt_gw_var = iq;
  sprintf(ctl->qnt_unit[iq], "K^2");
00555
00556
00558
          } else if (strcmp(ctl->qnt_name[iq], "stat") == 0) {
00559
             ctl->qnt_stat = iq;
00560
             sprintf(ctl->qnt_unit[iq], "-");
00561
           } else
             scan_ctl(filename, argc, argv, "QNT_UNIT", iq, "", ctl->qnt_unit[iq]);
00562
00563
00564
00565
         /* Time steps of simulation... */
00566
        ctl->direction =
        (int) scan_ctl(filename, argc, argv, "DIRECTION", -1, "1", NULL);
if (ctl->direction != -1 && ctl->direction != 1)
00567
00568
          ERRMSG("Set DIRECTION to -1 or 1!");
00569
00570
        ctl->t_start
00571
          scan_ctl(filename, argc, argv, "T_START", -1, "-1e100", NULL);
        ctl->t_stop = scan_ctl(filename, argc, argv, "T_STOP", -1, "-1e100", NULL);
ctl->dt_mod = scan_ctl(filename, argc, argv, "DT_MOD", -1, "600", NULL);
00572
00573
00574
00575
        /* Meteorological data... */
00576
        ctl->dt_met = scan_ctl(filename, argc, argv, "DT_MET", -1, "21600", NULL);
00577
        ctl->met_np = (int) scan_ctl(filename, argc, argv, "MET_NP", -1, "0", NULL);
00578
        if (ctl->met_np > EP)
00579
          ERRMSG("Too many levels!");
        for (ip = 0; ip < ctl->met_np; ip++)
  ctl->met_p[ip] = scan_ctl(filename, argc, argv, "MET_P", ip, "", NULL);
00580
00581
00582
00583
         /* Isosurface parameters... */
00584
        ctl->isosurf
        = (int) scan_ctl(filename, argc, argv, "ISOSURF", -1, "0", NULL); scan_ctl(filename, argc, argv, "BALLOON", -1, "-", ctl->balloon);
00585
00586
00587
00588
        /* Diffusion parameters... */
00589
        ctl->turb_dx_trop
00590
           = scan_ctl(filename, argc, argv, "TURB_DX_TROP", -1, "50.0", NULL);
00591
        ctl->turb_dx_strat
00592
          = scan_ctl(filename, argc, argv, "TURB_DX_STRAT", -1, "0.0", NULL);
00593
        ctl->turb dz trop
00594
           = scan ctl(filename, argc, argv, "TURB DZ TROP", -1, "0.0", NULL);
00595
        ctl->turb_dz_strat
00596
           = scan_ctl(filename, argc, argv, "TURB_DZ_STRAT", -1, "0.1", NULL);
00597
        ctl->turb_meso =
           scan_ctl(filename, argc, argv, "TURB_MESO", -1, "0.16", NULL);
00598
00599
00600
        /* Life time of particles... */
        ctl->tdec_trop = scan_ctl(filename, argc, argv, "TDEC_TROP", -1, "0", NULL);
ctl->tdec_strat =
00601
00602
00603
           scan_ctl(filename, argc, argv, "TDEC_STRAT", -1, "0", NULL);
00604
00605
        /* PSC analysis... */
        ctl->psc_h2o = scan_ctl(filename, argc, argv, "PSC_H2O", -1, "4e-6", NULL);
00606
        ctl->psc_hno3 =
00607
00608
          scan_ctl(filename, argc, argv, "PSC_HNO3", -1, "9e-9", NULL);
00609
00610
        /* Gravity wave analysis... */
        scan_ctl(filename, argc, argv, "GW_BASENAME", -1, "-", ctl->
00611
      gw_basename);
00612
00613
         /\star Output of atmospheric data... \star/
         scan_ctl(filename, argc, argv, "ATM_BASENAME", -1, "-", ctl->
00614
      atm_basename);
00615
        scan_ctl(filename, argc, argv, "ATM_GPFILE", -1, "-", ctl->atm_gpfile);
00616
        ctl->atm dt out :
          scan_ctl(filename, argc, argv, "ATM_DT_OUT", -1, "86400", NULL);
00617
00618
        ctl->atm_filter
00619
           (int) scan_ctl(filename, argc, argv, "ATM_FILTER", -1, "0", NULL);
00620
00621
         /\star Output of CSI data... \star/
        scan_ctl(filename, argc, argv, "CSI_BASENAME", -1, "-", ctl->
00622
      csi basename);
```

```
00623
        ctl->csi dt out =
         scan_ctl(filename, argc, argv, "CSI_DT_OUT", -1, "86400", NULL);
scan_ctl(filename, argc, argv, "CSI_OBSFILE", -1, "obs.tab",
00624
00625
00626
                   ctl->csi_obsfile);
00627
         ct.1->csi obsmin =
           scan_ctl(filename, argc, argv, "CSI_OBSMIN", -1, "0", NULL);
00628
00629
         ctl->csi modmin =
00630
           scan_ctl(filename, argc, argv, "CSI_MODMIN", -1, "0", NULL);
         ctl->csi_z0 = scan_ctl(filename, argc, argv, "CSI_Z0", -1, "0", NULL);
ctl->csi_z1 = scan_ctl(filename, argc, argv, "CSI_Z1", -1, "100", NULL);
ctl->csi_nz = (int) scan_ctl(filename, argc, argv, "CSI_NZ", -1, "1", NULL);
00631
00632
00633
         ctl->csi_lon0 =
00634
         scan_ctl(filename, argc, argv, "CSI_LONO", -1, "-180", NULL);
ctl->csi_lon1 = scan_ctl(filename, argc, argv, "CSI_LON1", -1, "180", NULL);
00635
00636
00637
         ctl->csi_nx =
         (int) scan_ctl(filename, argc, argv, "CSI_NX", -1, "360", NULL);
ctl->csi_lat0 = scan_ctl(filename, argc, argv, "CSI_LAT0", -1, "-90", NULL);
ctl->csi_lat1 = scan_ctl(filename, argc, argv, "CSI_LAT1", -1, "90", NULL);
00638
00639
00640
00641
         ctl->csi_ny =
00642
           (int) scan_ctl(filename, argc, argv, "CSI_NY", -1, "180", NULL);
00643
00644
         /* Output of ensemble data... */
        scan_ctl(filename, argc, argv, "ENS_BASENAME", -1, "-", ctl->
00645
      ens basename);
00646
00647
         /* Output of grid data... */
         scan_ctl(filename, argc, argv, "GRID_BASENAME", -1, "-",
00648
00649
                    ctl->grid_basename);
         scan_ctl(filename, argc, argv, "GRID_GPFILE", -1, "-", ctl->
00650
grid_gpfile);
00651 ctl->grid_dt_out =
00652
           scan_ctl(filename, argc, argv, "GRID_DT_OUT", -1, "86400", NULL);
00653
         ctl->grid_sparse
00654
           (int) scan_ctl(filename, argc, argv, "GRID_SPARSE", -1, "0", NULL);
         ctl->grid_z0 = scan_ctl(filename, argc, argv, "GRID_Z0", -1, "0", NULL); ctl->grid_z1 = scan_ctl(filename, argc, argv, "GRID_Z1", -1, "100", NULL);
00655
00656
00657
         ctl->grid nz =
00658
            (int) scan_ctl(filename, argc, argv, "GRID_NZ", -1, "1", NULL);
00659
         ctl->grid lon0 =
00660
           scan_ctl(filename, argc, argv, "GRID_LONO", -1, "-180", NULL);
00661
         ctl->grid_lon1 =
           scan_ctl(filename, argc, argv, "GRID_LON1", -1, "180", NULL);
00662
00663
         ct1->arid nx =
00664
           (int) scan_ctl(filename, argc, argv, "GRID_NX", -1, "360", NULL);
00665
         ctl->grid lat0 =
00666
           scan_ctl(filename, argc, argv, "GRID_LATO", -1, "-90", NULL);
00667
         ctl->grid lat1 =
           scan_ctl(filename, argc, argv, "GRID_LAT1", -1, "90", NULL);
00668
         ctl->grid_ny =
00669
00670
           (int) scan_ctl(filename, argc, argv, "GRID_NY", -1, "180", NULL);
00671
00672
         /* Output of profile data... */
         scan_ctl(filename, argc, argv, "PROF_BASENAME", -1, "-",
00673
00674
                    ctl->prof_basename);
         scan_ctl(filename, argc, argv, "PROF_OBSFILE", -1, "-", ctl->
00675
      prof_obsfile);
00676
       ctl->prof_z0 = scan_ctl(filename, argc, argv, "PROF_Z0", -1, "0", NULL);
00677
         ctl->prof_z1 = scan_ctl(filename, argc, argv, "PROF_Z1", -1, "60", NULL);
00678
         ctl->prof_nz =
00679
           (int) scan_ctl(filename, argc, argv, "PROF_NZ", -1, "60", NULL);
         ctl->prof_lon0 =
00680
00681
           scan ctl(filename, argc, argv, "PROF LONO", -1, "-180", NULL);
00682
         ctl->prof_lon1 =
00683
           scan_ctl(filename, argc, argv, "PROF_LON1", -1, "180", NULL);
         ctl->prof_nx =
00684
00685
           (int) scan_ctl(filename, argc, argv, "PROF_NX", -1, "360", NULL);
00686
         ctl->prof lat0 =
           scan ctl(filename, argc, argv, "PROF LATO", -1, "-90", NULL);
00687
00688
         ctl->prof lat1 =
00689
           scan_ctl(filename, argc, argv, "PROF_LAT1", -1, "90", NULL);
00690
         ctl->prof_ny :
00691
           (int) scan_ctl(filename, argc, argv, "PROF_NY", -1, "180", NULL);
00692
         /* Output of station data... */
00693
        00694
00695
         ctl->stat_lon = scan_ctl(filename, argc, argv, "STAT_LON", -1, "0", NULL);
ctl->stat_lat = scan_ctl(filename, argc, argv, "STAT_LAT", -1, "0", NULL);
ctl->stat_r = scan_ctl(filename, argc, argv, "STAT_R", -1, "50", NULL);
00696
00697
00698
00699 }
```

Here is the call graph for this function:



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

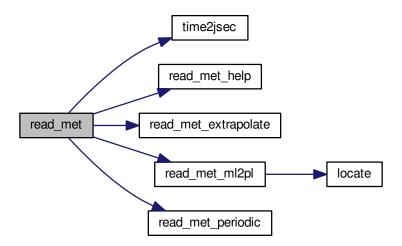
Read meteorological data file.

Definition at line 703 of file libtrac.c.

```
00706
00707
00708
        char tstr[10];
00709
00710
        static float help[EX * EY];
00711
00712
        int ix, iy, ip, dimid, ncid, varid, year, mon, day, hour;
00713
00714
        size_t np, nx, ny;
00715
00716
        /* Write info... */
00717
        printf("Read meteorological data: %s\n", filename);
00718
00719
         /* Get time from filename... */
00720
        sprintf(tstr, "%.4s", &filename[strlen(filename) - 16]);
        year = atoi(tstr);
00721
00722
        sprintf(tstr, "%.2s", &filename[strlen(filename) - 11]);
00723
        mon = atoi(tstr);
00724
        sprintf(tstr, "%.2s", &filename[strlen(filename) - 8]);
00725
        day = atoi(tstr);
00726
        sprintf(tstr, "%.2s", &filename[strlen(filename) - 5]);
00727
        hour = atoi(tstr);
00728
        time2jsec(year, mon, day, hour, 0, 0, 0, &met->time);
00729
         /* Open netCDF file...
00730
00731
        NC(nc_open(filename, NC_NOWRITE, &ncid));
00732
        /* Get dimensions... */
NC(nc_inq_dimid(ncid, "lon", &dimid));
00733
00734
00735
        NC(nc_inq_dimlen(ncid, dimid, &nx));
00736
        if (nx > EX)
00737
          ERRMSG("Too many longitudes!");
00738
00739
        NC(nc_inq_dimid(ncid, "lat", &dimid));
        NC(nc_inq_dimlen(ncid, dimid, &ny));
if (ny > EY)
00740
00741
00742
          ERRMSG("Too many latitudes!");
00743
00744
        NC(nc_inq_dimid(ncid, "lev", &dimid));
00745
        NC(nc_inq_dimlen(ncid, dimid, &np));
00746
        if (np > EP)
00747
          ERRMSG("Too many levels!");
00748
00749
        /* Store dimensions... */
        met->np = (int) np;
met->nx = (int) nx;
00750
00751
00752
        met->ny = (int) ny;
00753
00754
        /* Get horizontal grid... */
NC(nc_inq_varid(ncid, "lon", &varid));
00755
00756
        NC(nc_get_var_double(ncid, varid, met->lon));
00757
        NC(nc_inq_varid(ncid, "lat", &varid));
00758
        NC(nc_get_var_double(ncid, varid, met->lat));
00759
00760
        /* Read meteorological data... */
        read_met_help(ncid, "t", "T", met, met->t, 1.0);
read_met_help(ncid, "u", "U", met, met->u, 1.0);
00761
00762
```

```
read_met_help(ncid, "v", "V", met, met->v, 1.0);
read_met_help(ncid, "w", "W", met, met->w, 0.01f);
read_met_help(ncid, "q", "Q", met, met->help(ncid, "o3", "03", met, met->o3, 0.602f);
00763
00764
00765
00766
00767
00768
          /\star Meteo data on pressure levels... \star/
00769
          if (ctl->met_np <= 0) {</pre>
00770
            /* Read pressure levels from file... */
NC(nc_inq_varid(ncid, "lev", &varid));
00771
00772
00773
            NC(nc_get_var_double(ncid, varid, met->p));
00774
            for (ip = 0; ip < met->np; ip++)
  met->p[ip] /= 100.;
00775
00776
00777
            /\star Extrapolate data for lower boundary... \star/
00778
            read_met_extrapolate(met);
00779
00780
          /* Meteo data on model levels... */
00782
          else {
00783
            /* Read pressure data from file... */
read_met_help(ncid, "pl", "PL", met, met->pl, 0.01f);
00784
00785
00786
00787
             /* Interpolate from model levels to pressure levels... */
00788
            read_met_ml2pl(ctl, met, met->t);
00789
            read_met_ml2pl(ctl, met, met->u);
00790
            read_met_ml2pl(ctl, met, met->v);
00791
            read_met_ml2pl(ctl, met, met->w);
00792
            read_met_ml2p1(ct1, met, met->h2o);
00793
            read met m12p1(ctl, met, met->o3);
00794
00795
             /* Set pressure levels... */
            met->np = ctl->met_np;
for (ip = 0; ip < met->np; ip++)
00796
00797
00798
               met->p[ip] = ctl->met_p[ip];
00799
00800
00801
          /* Check ordering of pressure levels... */
          for (ip = 1; ip < met->np; ip++)
  if (met->p[ip - 1] < met->p[ip])
00802
00803
00804
               ERRMSG("Pressure levels must be descending!");
00805
          /* Read surface pressure... */
if (nc_ing_varid(ncid, "PS", &varid) == NC_NOERR) {
   NC(nc_get_var_float(ncid, varid, help));
00806
00807
00808
00809
             for (iy = 0; iy < met->ny; iy++)
               for (ix = 0; ix < met \rightarrow nx; ix++)
00810
          met->ps[ix][iy] = help[iy * met->nx + ix] / 100.;
} else if (nc_inq_varid(ncid, "LNSP", &varid) == NC_NOERR) {
00811
00812
00813
            NC(nc_get_var_float(ncid, varid, help));
00814
            for (iy = 0; iy < met->ny; iy++)
00815
               for (ix = 0; ix < met->nx; ix++)
00816
                 met->ps[ix][iy] = exp(help[iy * met->nx + ix]) / 100.;
00817
          } else
00818
            for (ix = 0; ix < met->nx; ix++)
              for (iy = 0; iy < met->ny; iy++)
00820
                 met \rightarrow ps[ix][iy] = met \rightarrow p[0];
00821
00822
          /\star Create periodic boundary conditions... \star/
00823
         read_met_periodic(met);
00824
00825
          /* Close file...
         NC(nc_close(ncid));
00826
00827 1
```

Here is the call graph for this function:



5.11.2.20 void read_met_extrapolate (met_t * met)

Extrapolate meteorological data at lower boundary.

Definition at line 831 of file libtrac.c.

```
00832
00833
00834
        int ip, ip0, ix, iy;
00836
        /* Loop over columns... */
00837
        for (ix = 0; ix < met->nx; ix++)
          for (iy = 0; iy < met->ny; iy++) {
00838
00839
00840
             /* Find lowest valid data point... */
             for (ip0 = met->np - 1; ip0 >= 0; ip0--)
00841
00842
               if (!gsl_finite(met->t[ix][iy][ip0])
00843
                    || !gsl_finite(met->u[ix][iy][ip0])
00844
                    || !gsl_finite(met->v[ix][iy][ip0])
00845
                    || !gsl_finite(met->w[ix][iy][ip0]))
00846
                 break;
00847
00848
             /* Extrapolate... */
             for (ip = ip0; ip >= 0; ip--) {
  met->t[ix][iy][ip] = met->t[ix][iy][ip + 1];
  met->u[ix][iy][ip] = met->u[ix][iy][ip + 1];
00849
00850
00851
               met->v[ix][iy][ip] = met->v[ix][iy][ip + 1];
00852
               met->w[ix][iy][ip] = met->w[ix][iy][ip + 1];
00853
00854
               met->h2o[ix][iy][ip] = met->h2o[ix][iy][ip + 1];
00855
               met->o3[ix][iy][ip] = met->o3[ix][iy][ip + 1];
00856
00857
           }
00858 }
```

5.11.2.21 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 862 of file libtrac.c.

```
00868
                     {
00869
00870
         static float help[EX * EY * EP];
00871
         int ip, ix, iy, n = 0, varid;
00872
00873
         /* Check if variable exists... */
00875
         if (nc_inq_varid(ncid, varname, &varid) != NC_NOERR)
00876
         if (nc_inq_varid(ncid, varname2, &varid) != NC_NOERR)
00877
00878
00879
         /* Read data... */
         NC(nc_get_var_float(ncid, varid, help));
00880
00881
00882
         /* Copy and check data... */
00883
         for (ip = 0; ip < met->np; ip++)
           for (iy = 0; iy < met->ny; iy++)
for (ix = 0; ix < met->nx; ix++) {
00884
00885
               dest[ix][iy][ip] = scl * help[n++];
00886
                if (fabs(dest[ix][iy][ip] / scl) > 1e14)
  dest[ix][iy][ip] = GSL_NAN;
00888
00889
00890 }
```

5.11.2.22 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 894 of file libtrac.c.

```
00897
00898
00899
        double aux[EP], p[EP], pt;
00900
00901
        int ip, ip2, ix, iy;
00902
00903
         /* Loop over columns... ∗/
00904
        for (ix = 0; ix < met->nx; ix++)
00905
          for (iy = 0; iy < met->ny; iy++) {
00906
00907
             /* Copy pressure profile... */
for (ip = 0; ip < met->np; ip++)
00908
00909
               p[ip] = met \rightarrow pl[ix][iy][ip];
00910
             /* Interpolate... */
for (ip = 0; ip < ctl->met_np; ip++) {
   pt = ctl->met_p[ip];
00911
00912
00913
               if ((pt > p[0] && p[0] > p[1]) || (pt < p[0] && p[0] < p[1]))
00915
                 pt = p[0];
00916
               else if ((pt > p[met->np - 1] && p[1] > p[0])
                        || (pt < p[met->np - 1] && p[1] < p[0]))
00917
               00918
00919
00920
00921
00922
00923
             /* Copy data... */
for (ip = 0; ip < ctl->met_np; ip++)
00924
00925
00926
               var[ix][iy][ip] = (float) aux[ip];
00927
00928 }
```

Here is the call graph for this function:



```
5.11.2.23 void read_met_periodic ( met_t * met )
```

Create meteorological data with periodic boundary conditions.

Definition at line 932 of file libtrac.c.

```
00933
00934
00935
         int ip, iy;
00936
00937
         /* Check longitudes... */
         if (!(fabs(met->lon[met->nx - 1] - met->lon[0]
00939
                       + met -> lon[1] - met -> lon[0] - 360) < 0.01))
00940
00941
00942
          /* Increase longitude counter... */
         if ((++met->nx) > EX)
00943
00944
           ERRMSG("Cannot create periodic boundary conditions!");
00945
00946
         /* Set longitude... */
00947
         met->lon[met->nx - 1] = met->lon[met->nx - 2] + met->lon[1] - met->
      lon[0];
00948
00949
          /\star Loop over latitudes and pressure levels... \star/
00950
         for (iy = 0; iy < met->ny; iy++)
00951
          for (ip = 0; ip < met->np; ip++) {
00952
              met \rightarrow ps[met \rightarrow nx - 1][iy] = met \rightarrow ps[0][iy];
              met->u[met->nx - 1][iy][ip] = met->u[0][iy][ip];
met->v[met->nx - 1][iy][ip] = met->v[0][iy][ip];
00953
00954
             met->w[met->nx - 1][iy][ip] = met->w[0][iy][ip];
met->t[met->nx - 1][iy][ip] = met->t[0][iy][ip];
00955
00957
              met \rightarrow h2o[met \rightarrow nx - 1][iy][ip] = met \rightarrow h2o[0][iy][ip];
00958
              met->o3[met->nx - 1][iy][ip] = met->o3[0][iy][ip];
00959
00960 }
```

5.11.2.24 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 964 of file libtrac.c.

```
00971
                        {
00972
00973
        FILE *in = NULL;
00974
00975
        char dummy[LEN], fullname1[LEN], fullname2[LEN], line[LEN],
00976
          msg[LEN], rvarname[LEN], rval[LEN];
00977
00978
        int contain = 0, i;
00979
00980
         /* Open file... */
        if (filename[strlen(filename) - 1] != '-')
if (!(in = fopen(filename, "r")))
00981
00982
             ERRMSG("Cannot open file!");
00983
00984
00985
        /* Set full variable name... */
00986
        if (arridx >= 0) {
         sprintf(fullname1, "%s[%d]", varname, arridx);
sprintf(fullname2, "%s[*]", varname);
00987
00988
00989
        } else {
         sprintf(fullname1, "%s", varname);
sprintf(fullname2, "%s", varname);
00990
00991
00992
00993
00994
        /* Read data... */
00995
         if (in != NULL)
00996
          while (fgets(line, LEN, in))
00997
            if (sscanf(line, "%s %s %s", rvarname, dummy, rval) == 3)
00998
               if (strcasecmp(rvarname, fullname1) == 0 ||
00999
                    strcasecmp(rvarname, fullname2) == 0) {
01000
                  contain = 1;
01001
                 break:
01002
01003
        for (i = 1; i < argc - 1; i++)</pre>
```

```
if (strcasecmp(argv[i], fullname1) == 0 ||
           strcasecmp(argv[i], fullname2) == 0) {
sprintf(rval, "%s", argv[i + 1]);
01005
01006
01007
            contain = 1;
01008
            break;
01009
         }
01010
01011
       /* Close file... */
01012
       if (in != NULL)
01013
         fclose(in);
01014
01015
       /* Check for missing variables... */
01016
       if (!contain) {
01017
        if (strlen(defvalue) > 0)
01018
           sprintf(rval, "%s", defvalue);
01019
           sprintf(msg, "Missing variable %s!\n", fullname1);
01020
01021
            ERRMSG(msg);
01022
01023
01024
01025
       /* Write info... */
01026 printf("%s = %s\n", fullname1, rval);
01027
01028
       /* Return values... */
       if (value != NULL)
01030
         sprintf(value, "%s", rval);
01031
       return atof(rval);
01032 }
```

5.11.2.25 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 1036 of file libtrac.c.

```
01044
01045
01046
       struct tm t0, t1;
01047
01048
        t0.tm_year = 100;
01049
        t0.tm_mon = 0;
01050
       t0.tm_mday = 1;
        t0.tm_hour = 0;
01051
        t0.tm_min = 0;
01052
        t0.tm\_sec = 0;
01053
01054
01055
        t1.tm_year = year - 1900;
01056
        t1.tm_mon = mon - 1;
        t1.tm_mday = day;
01057
       t1.tm_hour = hour;
01058
01059
        t1.tm_min = min;
       t1.tm_sec = sec;
01061
01062
       *jsec = (double) timegm(&t1) - (double) timegm(&t0) + remain;
01063 }
```

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

Measure wall-clock time.

Definition at line 1067 of file libtrac.c.

```
01070
01071
01072
        static double starttime[NTIMER], runtime[NTIMER];
01074
        if (id < 0 || id >= NTIMER)
01075
         ERRMSG("Too many timers!");
01076
01077
01078
       /* Start timer... */
01079
       if (mode == 1) {
01080
        if (starttime[id] <= 0)</pre>
```

```
starttime[id] = omp_get_wtime();
01082
01083
            ERRMSG("Timer already started!");
01084
        }
01085
        /* Stop timer... */
01086
        else if (mode == 2) {
         if (starttime[id] > 0) {
01088
01089
           runtime[id] = runtime[id] + omp_get_wtime() - starttime[id];
01090
            starttime[id] = -1;
         } else
01091
            ERRMSG("Timer not started!");
01092
01093
01094
01095
        /\star Print timer...
       else if (mode == 3)
  printf("%s = %g s\n", name, runtime[id]);
01096
01097
01098 }
```

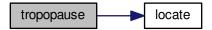
5.11.2.27 double tropopause (double t, double lat)

Definition at line 1102 of file libtrac.c.

```
01105
01106
          static double doys[12]
01107
          = { 1, 32, 60, 91, 121, 152, 182, 213, 244, 274, 305, 335 };
01108
01109
          static double lats[73]
            = { -90, -87.5, -85, -82.5, -80, -77.5, -75, -72.5, -70, -67.5, -65, -62.5, -60, -57.5, -55, -52.5, -50, -47.5, -45, -42.5,
01110
             -40, -37.5, -35, -32.5, -30, -27.5, -25, -22.5, -20, -17.5,
01112
01113
             -15, -12.5, -10, -7.5, -5, -2.5, 0, 2.5, 5, 7.5, 10, 12.5,
            15, 17.5, 20, 22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5, 45, 47.5, 50, 52.5, 55, 57.5, 60, 62.5, 65, 67.5, 70, 72.5, 75, 77.5, 80, 82.5, 85, 87.5, 90
01114
01115
01116
01117
01119
          static double tps[12][73]
             = { {324.1, 325.6, 325, 324.3, 322.5, 319.7, 314, 307.2, 301.8, 299.6, 297.1, 292.2, 285.6, 276.1, 264, 248.9, 231.9, 213.5, 194.4, 175.3, 157, 140.4, 126.7, 116.3, 109.5, 105.4, 103, 101.4, 100.4,
01120
01121
01122
                    99.69, 99.19, 98.84, 98.56, 98.39, 98.39, 98.42, 98.44, 98.54, 98.68, 98.81, 98.89, 98.96, 99.12, 99.65, 101.4, 105.4, 113.5,
01124
01125
                    152.1, 184.7, 214, 234.1, 247.3, 255.8, 262.6, 267.7, 271.7, 275,
         277.2, 279, 280.1, 280.4, 280.6, 280.1, 279.3, 278.3, 276.8, 275.8, 275.3, 275.6, 275.4, 274.1, 273.5}, {337.3, 338.7, 337.8, 336.4, 333, 328.8, 321.1, 312.6, 306.6, 303.7, 300.2, 293.8, 285.4, 273.8, 259.6, 242.7, 224.4, 205.2, 186, 167.5,
01126
01127
01128
01129
            150.3, 135, 122.8, 113.9, 108.2, 104.7, 102.5, 101.1, 100.2, 99.42,
01131
            98.88, 98.52, 98.25, 98.09, 98.07, 98.1, 98.12, 98.2, 98.25, 98.27,
01132
            98.26, 98.27, 98.36, 98.79, 100.2, 104.2, 113.7, 131.2, 159.5, 193,
           220.4, 238.1, 250.2, 258.1, 264.7, 269.7, 273.7, 277.3, 280.2, 282.8, 284.9, 286.5, 288.1, 288.8, 289, 288.5, 287.2, 286.3, 286.1, 287.2, 287.5, 286.2, 285.8},
01133
01134
01135
          {335, 336, 335.7, 335.1, 332.3, 328.1, 320.6, 311.8, 305.1, 301.9,
01136
            297.6, 290, 280.4, 268.3, 254.6, 239.6, 223.9, 207.9, 192.2, 176.9,
01138
           161.7, 146.4, 132.2, 120.6, 112.3, 107.2, 104.3, 102.4, 101.3,
01139
            100.4, 99.86, 99.47, 99.16, 98.97, 98.94, 98.97, 99, 99.09, 99.2,
           99.31, 99.35, 99.41, 99.51, 99.86, 101.1, 104.9, 114.3, 131, 156.8, 186.3, 209.3, 224.6, 236.8, 246.3, 254.9, 262.3, 268.8, 274.8,
01140
01141
01142
            279.9, 284.6, 288.6, 291.6, 294.9, 297.5, 299.8, 301.8, 303.1,
            304.3, 304.9, 306, 306.6, 306.2, 306},
01143
01144
           {306.2, 306.7, 305.7, 307.1, 307.3, 306.4, 301.8, 296.2, 292.4
           290.3, 287.1, 280.9, 273.4, 264.3, 254.1, 242.8, 231, 219, 207.2, 195.5, 183.3, 169.7, 154.7, 138.7, 124.1, 113.6, 107.8, 104.7,
01145
01146
            102.8, 101.7, 100.9, 100.4, 100, 99.79, 99.7, 99.66, 99.68, 99.79, 99.94, 100.2, 100.5, 100.9, 101.4, 102.1, 103.4, 107, 115.2, 129.1,
01147
01148
            148.7, 171, 190.8, 205.6, 218.4, 229.4, 239.6, 248.6, 256.5,
01149
            263.7, 270.3, 276.6, 282.6, 288.1, 294.5, 300.4, 306.3, 311.4, 315.1, 318.3, 320.3, 322.2, 322.8, 321.5, 321.1},
01150
01151
          {266.5, 264.9, 260.8, 261, 262, 263, 261.3, 259.7, 259.2, 259.8, 260.1, 258.6, 256.7, 253.6, 249.5, 243.9, 237.4, 230, 222.1, 213.9,
01152
01153
            205, 194.4, 180.4, 161.8, 140.7, 122.9, 112.1, 106.7,
                                                                                     104.1.
01155
            101.8, 101.4, 101.1, 101, 101, 101.1, 101.2, 101.5, 101.9,
            102.4, 103, 103.8, 104.9, 106.8, 110.1, 115.6, 124, 135.2, 148.9,
01156
01157
           165.2, 181.3, 198, 211.8, 223.5, 233.8, 242.9, 251.5, 259, 266.2,
01158
            273.1, 279.2, 286.2, 292.8, 299.6, 306, 311.1, 315.5, 318.8, 322.6,
01159
            325.3, 325.8, 325.8},
01160
          {220.1, 218.1, 210.8, 207.2, 207.6, 210.5, 211.4, 213.5, 217.3,
            222.4, 227.9, 232.8, 237.4, 240.8, 242.8, 243, 241.5, 238.6, 234.2,
```

```
228.5, 221, 210.7, 195.1, 172.9, 147.8, 127.6, 115.6, 109.9, 107.1,
                   105.7, 105, 104.8, 104.8, 104.9, 105, 105.1, 105.3, 105.5, 105.8, 106.4, 107, 107.6, 108.1, 108.8, 110, 111.8, 114.2, 117.4, 121.6,
01163
01164
                 127.9, 137.3, 151.2, 169.5, 189, 205.8, 218.9, 229.1, 237.8, 245, 251.5, 257.1, 262.3, 268.2, 274, 280.4, 286.7, 292.4, 297.9, 302.9, 308.5, 312.2, 313.1, 313.3}, {187.4, 184.5, 173.3, 166.1, 165.4, 167.8, 169.6, 173.6, 179.6,
01165
01166
01167
01168
                    187.9, 198.9, 210, 220.5, 229.2, 235.7, 239.9, 241.8, 241.6, 239.6,
01169
01170
                   235.8, 229.4, 218.6, 200.9, 175.9, 149.4, 129.4, 118.3, 113.1,
                  110.8, 109.7, 109.3, 109.4, 109.7, 110, 110.2, 110.4, 110.5, 110.7, 111, 111.4, 111.8, 112.1, 112.3, 112.7, 113.2, 113.9, 115, 116.4, 117.9, 120.4, 124.1, 130.9, 142.2, 159.6, 179.6, 198.5, 212.9, 224.2, 232.7, 239.1, 243.8, 247.7, 252.4, 257.3, 263.2, 269.5, 275.4, 281.1, 286.3, 292, 296.3, 298.2, 298.8),
01171
01172
01173
01174
01175
01176
                 {166, 166.4, 155.7, 148.3, 147.1, 149, 152.1, 157, 163.6, 172.4,
                  185.3, 199.2, 212.6, 224, 233.2, 239.6, 243.3, 244.6, 243.6, 240.3, 233.9, 222.6, 203.7, 177, 149.5, 129.7, 119, 114, 111.7, 110.7, 110.3, 110.3, 110.6, 110.9, 111.1, 111.3, 111.5, 111.6, 111.9, 112.2, 112.5, 112.6, 112.8, 113, 113.4, 114, 115.1, 116.5, 118.3,
01177
01178
01179
                   120.9, 124.4, 130.2, 139.4, 154.6, 173.8, 193.1, 208.1, 220.4,
                   230.1, 238.2, 244.7, 249.5, 254.5, 259.3, 264.5, 269.4, 273.7,
01182
01183
                   278.2, 282.6, 287.4, 290.9, 292.5, 293},
01184
                 {171.9, 172.8, 166.2, 162.3, 161.4, 162.5, 165.2, 169.6, 175.3,
                  183.1, 193.8, 205.9, 218.3, 229.6, 238.5, 244.3, 246.9, 246.7, 243.8, 238.4, 230.2, 217.9, 199.6, 174.9, 148.9, 129.8, 119.5,
01185
01186
                   114.8, 112.3, 110.9, 110.3, 110.1, 110.2, 110.3, 110.4, 110.5,
01187
                   110.6, 110.8, 111, 111.4, 111.8, 112, 112.2, 112.4, 112.9, 113.6,
01188
01189
                   114.7, 116.3, 118.4, 121.9, 127.1, 136.1, 149.8, 168.4, 186.9,
                 203.3, 217, 229.1, 238.7, 247, 254, 259.3, 264.3, 268.3, 272.5, 276.6, 280.4, 284.4, 288.4, 293.3, 297.2, 298.7, 299.1}, {191.6, 192.2, 189, 188.1, 190.2, 193.7, 197.8, 202.9, 208.5,
01190
01191
01192
01193
                   215.6, 224.2, 233.1, 241.2, 247.3, 250.8, 251.3, 248.9, 244.2,
                   237.3, 228.4, 217.2, 202.9, 184.5, 162.5, 140.7, 124.8, 116.2,
01194
01195
                   111.8, 109.4, 107.9, 107, 106.7, 106.6, 106.6, 106.7, 106.7,
                  106.8, 107, 107.4, 108, 108.7, 109.3, 109.8, 110.4, 111.2, 112.4, 114.2, 116.9, 121.1, 127.9, 139.3, 155.2, 173.6, 190.7, 206.1, 220.1, 232.3, 243, 251.8, 259.2, 265.7, 270.6, 275.3, 279.3, 283.3, 286.9, 289.7, 292.8, 296.1, 300.5, 303.9, 304.8,
01196
01197
01198
01200
                    305.1},
                  {241.5, 239.6, 236.8, 237.4, 239.4, 242.3, 244.2, 246.4, 249.2,
01201
01202
                   253.6, 258.6, 262.7, 264.8, 264.2, 260.6, 254.1, 245.5, 235.3,
                   223.9, 211.7, 198.3, 183.1, 165.6, 147.1, 130.5, 118.7, 111.9,
01203
                   108.1, 105.8, 104.3, 103.4, 102.8, 102.5, 102.4, 102.5, 102.5, 102.5, 102.5, 102.7, 103.1, 103.8, 104.6, 105.4, 106.1, 107, 108.2,
01204
01205
                   109.9, 112.8, 117.5, 126, 140.4, 161, 181.9, 201.2, 216.8, 230.4,
01206
01207
                   241.8, 251.4, 259.9, 266.9, 272.8, 277.4, 280.4, 282.9, 284.6,
01208
                   286.1, 287.4, 288.3, 289.5, 290.9, 294.2, 296.9, 297.5, 297.6}
                286.1, 287.4, 288.3, 289.5, 290.9, 294.2, 296.9, 297.5, 297.5), (301.2, 300.3, 296.6, 295.4, 295., 294.3, 291.2, 287.4, 284.9, 284.7, 284.1, 281.5, 277.1, 270.4, 261.7, 250.6, 237.6, 223.1, 207.9, 192, 175.8, 158.8, 142.1, 127.6, 116.8, 109.9, 106, 103.6, 102.1, 101.1, 100.4, 99.96, 99.6, 99.37, 99.32, 99.31, 99.46, 99.77, 100.2, 100.7, 101.3, 101.8, 102.7, 104.1, 106.8, 111.9, 121, 136.7, 160, 186.9, 209.9, 228.1, 241.2, 251.5, 259.5, 265.7, 270.9, 274.8, 278, 200.3, 201.9, 203.3, 203.3, 203.3, 203.3, 203.3, 203.4, 203.4, 203.4, 203.3, 203.3, 203.3, 203.3, 203.4, 203.4, 203.3, 203.3, 203.3, 203.3, 203.3, 203.4, 203.4, 203.4, 203.3, 203.3, 203.3, 203.3, 203.4, 203.4, 203.4, 203.3, 203.3, 203.3, 203.3, 203.4, 203.4, 203.4, 203.4, 203.4, 203.3, 203.3, 203.3, 203.3, 203.3, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4
01209
01210
01211
01213
01214
01215
                   280.3, 281.8, 283, 283.3, 283.7, 283.8, 283, 282.2, 281.2, 281.4,
01216
                   281.7, 281.1, 281.2}
01217
                };
01218
01219
                double doy, p0, p1, pt;
01220
01221
                int imon, ilat;
01222
                /* Get day of year... */
doy = fmod(t / 86400., 365.25);
01223
01224
                while (doy < 0)
01225
                     doy += 365.25;
01226
01227
                 /* Get indices... */
01228
                imon = locate(doys, 12, doy);
ilat = locate(lats, 73, lat);
01229
01230
01232
                  /* Get tropopause pressure... */
01233
                p0 = LIN(lats[ilat], tps[imon][ilat],
01234
                                   lats[ilat + 1], tps[imon][ilat + 1], lat);
                01235
01236
                pt = LIN(doys[imon], p0, doys[imon + 1], p1, doy);
01237
01238
01239
                 /* Return tropopause pressure... */
01240
                return pt;
01241 }
```

Here is the call graph for this function:



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

Write atmospheric data.

Definition at line 1245 of file libtrac.c.

```
01249
01250
01251
         FILE *in, *out;
01252
01253
         char line[LEN];
01254
         double r, t0, t1;
01256
01257
         int ip, iq, year, mon, day, hour, min, sec;
01258
         /* Set time interval for output... */
01259
         t0 = t - 0.5 * ctl->dt_mod;
01260
01261
         t1 = t + 0.5 * ctl -> dt_mod;
01262
         /* Check if gnuplot output is requested... */ if (ctl->atm_gpfile[0] != '-') {
01263
01264
01265
01266
           /* Write info... */
01267
           printf("Plot atmospheric data: %s.png\n", filename);
01268
01269
            /\star Create gnuplot pipe... \star/
           if (!(out = popen("gnuplot", "w")))
    ERRMSG("Cannot create pipe to gnuplot!");
01270
01271
01272
           /* Set plot filename... */ fprintf(out, "set out \"%s.png\"\n", filename);
01273
01274
01275
01276
            /* Set time string... */
           jsec2time(t, &year, &mon, &day, &hour, &min, &sec, &r);
fprintf(out, "timestr=\"%d-%02d-%02d, %02d:%02d UTC\"\n",
01277
01278
                     year, mon, day, hour, min);
01280
01281
            /* Dump gnuplot file to pipe... */
           if (!(in = fopen(ctl->atm_gpfile, "r")))
ERRMSG("Cannot open file!");
01282
01283
           while (fgets(line, LEN, in))
fprintf(out, "%s", line);
01284
01285
01286
           fclose(in);
01287
01288
         else {
01289
01290
01291
           /* Write info... */
           printf("Write atmospheric data: %s\n", filename);
01292
01293
01294
            /* Create file... */
           if (!(out = fopen(filename, "w")))
01295
              ERRMSG("Cannot create file!");
01296
01297
01298
01299
          /* Write header... */
01300
         fprintf(out,
01301
                   "# $1 = time [s] \n"
                   "# $2 = altitude [km]\n"
"# $3 = longitude [deg]\n" "# $4 = latitude [deg]\n");
01302
01303
         for (iq = 0; iq < ctl->nq; iq+1)
fprintf(out, "# $%i = %s [%s]\n", iq + 5, ctl->qnt_name[iq],
01304
01305
```

```
01306
              ctl->qnt_unit[iq]);
01307
      fprintf(out, "\n");
01308
      /* Write data... */
for (ip = 0; ip < atm->np; ip++) {
01309
01310
01311
01312
        /* Check time... */
01313
       01314
        continue;
01315
       01316
01317
01318
01319
01320
01321
         fprintf(out, ctl->qnt\_format[iq], atm->q[iq][ip]);\\
01322
01323
       fprintf(out, "\n");
01324
01325
01326
      /* Close file... */
01327
      fclose(out);
01328 }
```

Here is the call graph for this function:



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

Write CSI data.

Definition at line 1332 of file libtrac.c.

```
01336
01337
01338
        static FILE *in, *out;
01339
01340
        static char line[LEN];
01341
01342
        static double modmean[GX][GY][GZ], obsmean[GX][GY][GZ],
01343
          rt, rz, rlon, rlat, robs, t0, t1, area, dlon, dlat, lat;
01344
01345
        static int init, obscount[GX][GY][GZ], cx, cy, cz, ip, ix, iy, iz;
01346
01347
         /* Init... */
01348
         if (!init) {
01349
           init = 1;
01350
          /* Check quantity index for mass... */
if (ctl->qnt_m < 0)</pre>
01351
01352
01353
             ERRMSG("Need quantity mass to analyze CSI!");
01354
01355
           /* Open observation data file... */
           printf("Read CSI observation data: %s\n", ctl->csi_obsfile);
if (!(in = fopen(ctl->csi_obsfile, "r")))
01356
01357
01358
             ERRMSG("Cannot open file!");
01359
01360
           /* Create new file... */
           printf("Write CSI data: %s\n", filename);
if (!(out = fopen(filename, "w")))
01361
01362
             ERRMSG("Cannot create file!");
01363
01364
01365
           /* Write header... */
```

```
01366
          fprintf(out,
                   "# $1 = time [s] \n"
01367
01368
                   "# $2 = number of hits (cx) n"
                   "# $3 = number of misses (cy) \n"
01369
                   "# $4 = number of false alarms (cz)n"
01370
                  "# $5 = number of observations (cx + cy)\n"
"# $6 = number of forecasts (cx + cz)\n"
01371
01372
01373
                   "# $7 = bias (forecasts/observations) [%] \n"
                  01374
01375
                   "# $10 = critical success index (CSI) [%%]\n\n");
01376
01377
01378
        /* Set time interval... */
01379
01380
        t0 = t - 0.5 * ctl->dt_mod;
        t1 = t + 0.5 * ctl->dt_mod;
01381
01382
01383
        /* Initialize grid cells... */
01384
        for (ix = 0; ix < ctl->csi_nx; ix++)
         for (iy = 0; iy < ctl->csi_ny; iy++)
01385
01386
            for (iz = 0; iz < ctl->csi_nz; iz++)
01387
              modmean[ix][iy][iz] = obsmean[ix][iy][iz] = obscount[ix][iy][iz] = 0;
01388
01389
        /* Read data... */
01390
        while (fgets(line, LEN, in)) {
01391
          /* Read data... */
01392
          if (sscanf(line, "%lg %lg %lg %lg %lg", &rt, &rz, &rlon, &rlat, &robs) !=
01393
01394
              5)
01395
            continue:
01396
01397
          /* Check time... */
01398
          <u>if</u> (rt < t0)
01399
            continue;
01400
          if (rt > t1)
01401
            break:
01402
01403
          /* Calculate indices... */
          ix = (int) ((rlon - ctl->csi_lon0)
01404
01405
                       / (ctl->csi_lon1 - ctl->csi_lon0) * ctl->csi_nx);
01406
          iy = (int) ((rlat - ctl->csi_lat0))
                       / (ctl->csi_lat1 - ctl->csi_lat0) * ctl->csi_ny);
01407
01408
          iz = (int) ((rz - ctl->csi_z0)
01409
                       / (ctl->csi_z1 - ctl->csi_z0) * ctl->csi_nz);
01410
          /* Check indices... */
01411
01412
          if (ix < 0 || ix >= ctl->csi_nx ||
01413
              iy < 0 || iy >= ctl->csi_ny || iz < 0 || iz >= ctl->csi_nz)
01414
            continue:
01415
01416
          /* Get mean observation index... */
01417
          obsmean[ix][iy][iz] += robs;
01418
          obscount[ix][iy][iz]++;
01419
01420
        /* Analyze model data... */
01421
        for (ip = 0; ip < atm->np; ip++) {
01423
01424
           /* Check time... */
01425
          if (atm->time[ip] < t0 || atm->time[ip] > t1)
01426
            continue;
01427
01428
          /* Get indices... */
          ix = (int) ((atm->lon[ip] - ctl->csi_lon0)
01429
01430
                        (ctl->csi_lon1 - ctl->csi_lon0) * ctl->csi_nx);
01431
          iy = (int) ((atm->lat[ip] - ctl->csi_lat0)
          / (ctl->csi_lat1 - ctl->csi_lat0) * ctl->csi_ny);
iz = (int) ((Z(atm->p[ip]) - ctl->csi_z0)
/ (ctl->csi_z1 - ctl->csi_z0) * ctl->csi_nz);
01432
01433
01434
01435
01436
          /* Check indices... */
01437
          if (ix < 0 || ix >= ctl->csi_nx ||
              iy < 0 || iy >= ctl->csi_ny || iz < 0 || iz >= ctl->csi_nz)
01438
01439
            continue:
01440
01441
          /* Get total mass in grid cell... */
01442
          modmean[ix][iy][iz] += atm->q[ctl->qnt_m][ip];
01443
01444
        /* Analyze all grid cells... */
01445
        for (ix = 0; ix < ctl->csi_nx; ix++)
  for (iy = 0; iy < ctl->csi_ny; iy++)
01446
01447
01448
            for (iz = 0; iz < ctl->csi_nz; iz++) {
01449
01450
               /* Calculate mean observation index... */
01451
              if (obscount[ix][iy][iz] > 0)
                 obsmean[ix][iy][iz] /= obscount[ix][iy][iz];
01452
```

```
01454
                 /* Calculate column density... */
                 /* Calculate Column Gensity... */
if (modmean[ix][iy][iz] > 0) {
  dlon = (ctl->csi_lon1 - ctl->csi_lon0) / ctl->csi_nx;
  dlat = (ctl->csi_lat1 - ctl->csi_lat0) / ctl->csi_ny;
  lat = ctl->csi_lat0 + dlat * (iy + 0.5);
01455
01456
01457
01458
                   area = dlat * M_PI * RE / 180. * dlon * M_PI * RE / 180. * cos(lat * M_PI / 180.);
01459
01460
01461
                    modmean[ix][iy][iz] /= (1e6 * area);
01462
01463
                 /* Calculate CSI... */
01464
01465
                 if (obscount[ix][iy][iz] > 0) {
01466
                   if (obsmean[ix][iy][iz] >= ctl->csi_obsmin &&
01467
                         modmean[ix][iy][iz] >= ctl->csi_modmin)
01468
                    else if (obsmean[ix][iy][iz] >= ctl->csi_obsmin &&
01469
                               modmean[ix][iy][iz] < ctl->csi_modmin)
01470
01471
                      су++;
01472
                    else if (obsmean[ix][iy][iz] < ctl->csi_obsmin &&
01473
                               modmean[ix][iy][iz] >= ctl->csi_modmin)
01474
                      cz++;
01475
                 }
01476
01477
01478
         /* Write output... */
01479
          if (fmod(t, ctl->csi_dt_out) == 0) {
01480
            01481
01482
                      t, cx, cy, cz, cx + cy, cx + cz, (cx + cy > 0) ? 100. * (cx + cz) / (cx + cy) : GSL_NAN, (cx + cy > 0) ? (100. * cx) / (cx + cy) : GSL_NAN, (cx + cz > 0) ? (100. * cz) / (cx + cz) : GSL_NAN,
01483
01484
01485
01486
01487
                       (cx + cy + cz > 0) ? (100. * cx) / (cx + cy + cz) : GSL_NAN);
01488
01489
            /* Set counters to zero... */
            cx = cy = cz = 0;
01490
01491
01492
01493
          /\star Close file... \star/
          if (t == ctl->t_stop)
01494
01495
           fclose(out);
01496 }
```

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

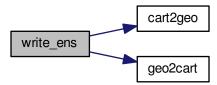
Write ensemble data.

Definition at line 1500 of file libtrac.c.

```
01504
                  {
01505
       static FILE *out;
01507
01508
       static double dummy, ens, lat, lon, p[NENS], q[NQ][NENS],
01509
        t0, t1, x[NENS][3], xm[3];
01510
01511
        static int init, ip, iq;
01512
       static size_t i, n;
01514
01515
        /* Init... */
01516
       if (!init) {
01517
         init = 1:
01518
          /* Check quantities... */
01519
01520
          if (ctl->qnt_ens < 0)</pre>
01521
           ERRMSG("Missing ensemble IDs!");
01522
01523
          /* Create new file... */
          printf("Write ensemble data: %s\n", filename);
if (!(out = fopen(filename, "w")))
01524
01525
01526
            ERRMSG("Cannot create file!");
01527
          /* Write header... */
01528
          01529
01530
01531
                  "# $2 = altitude [km] \n"
01532
                   "# $3 = longitude [deg]\n" "# <math>$4 = latitude [deg]\n");
```

```
01534
01535
           01536
01537
01538
01539
01540
01541
         /* Set time interval... */
t0 = t - 0.5 * ctl->dt_mod;
t1 = t + 0.5 * ctl->dt_mod;
01542
01543
01544
01545
01546
         /* Init... */
01547
         ens = GSL_NAN;
         n = 0;
01548
01549
         /* Loop over air parcels... */
for (ip = 0; ip < atm->np; ip++) {
01550
01551
01553
            /* Check time... */
01554
           if (atm->time[ip] < t0 || atm->time[ip] > t1)
01555
             continue;
01556
01557
            /* Check ensemble id... */
           if (atm->q[ctl->qnt_ens][ip] != ens) {
01558
01559
01560
              /* Write results... */
01561
              if (n > 0) {
01562
01563
                /* Get mean position... */ xm[0] = xm[1] = xm[2] = 0; for (i = 0; i < n; i++) {
01564
01565
                  xm[0] += x[i][0] / (double) n;
xm[1] += x[i][1] / (double) n;
xm[2] += x[i][2] / (double) n;
01566
01567
01568
01569
                cart2geo(xm, &dummy, &lon, &lat);
fprintf(out, "%.2f %g %g %g", t, Z(gsl_stats_mean(p, 1, n)), lon,
01570
01571
01572
01573
01574
                /* Get quantity statistics... */
                for (iq = 0; iq < ctl->nq; iq++) {
  fprintf(out, " ");
01575
01576
01577
                  fprintf(out, ctl->qnt_format[iq], gsl_stats_mean(q[iq], 1, n));
01578
                for (iq = 0; iq < ctl->nq; iq++) {
  fprintf(out, " ");
01579
01580
                  fprintf(out, ctl->qnt_format[iq], gsl_stats_sd(q[iq], 1, n));
01581
01582
01583
                fprintf(out, " %lu\n", n);
01584
01585
01586
              /* Init new ensemble... */
01587
             ens = atm->q[ctl->qnt_ens][ip];
             n = 0;
01588
01589
01590
01591
            /* Save data...
01592
           p[n] = atm->p[ip];
            geo2cart(0, atm->lon[ip], atm->lat[ip], x[n]);
01593
           01594
01595
01596
01597
              ERRMSG("Too many data points!");
01598
01599
         /* Write results... */
01600
01601
         if (n > 0) {
01603
            /\star Get mean position... \star/
           for (i = 0; i < n; i++) {
    xm[0] += x[i][0] / (double) n;
    xm[1] += x[i][1] / (double) n;</pre>
01604
01605
01606
01607
             xm[2] += x[i][2] / (double) n;
01608
01609
           cart2geo(xm, &dummy, &lon, &lat);
fprintf(out, "%.2f %g %g %g", t, Z(gsl_stats_mean(p, 1, n)), lon, lat);
01610
01611
01612
            /* Get quantity statistics... */
01613
           for (iq = 0; iq < ctl->nq; iq++) {
  fprintf(out, " ");
  fprintf(out, ctl->qnt_format[iq], gsl_stats_mean(q[iq], 1, n));
01614
01615
01616
01617
           for (iq = 0; iq < ctl->nq; iq++) {
  fprintf(out, " ");
01618
01619
```

Here is the call graph for this function:



5.11.2.31 void write grid (const char * filename, ctl t * ctl, met t * met0, met t * met1, atm t * atm, double t)

Write gridded data.

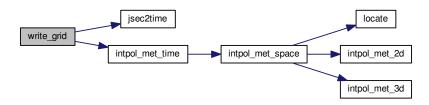
Definition at line 1632 of file libtrac.c.

```
01638
                        {
01639
          FILE *in, *out;
01640
01641
01642
          char line[LEN];
01643
01644
          static double grid_m[GX][GY][GZ], z, dz, lon, dlon, lat, dlat,
01645
            area, rho_air, press, temp, cd, mmr, t0, t1, r;
01646
01647
          static int ip, ix, iy, iz, year, mon, day, hour, min, sec;
01648
          /* Check dimensions... */
if (ctl->grid_nx > GX || ctl->grid_ny > GY || ctl->grid_nz > GZ)
    ERRMSG("Grid dimensions too large!");
01649
01650
01651
01652
          /* Check quantity index for mass... */ if (ctl->qnt_m < 0)
01653
01654
            ERRMSG("Need quantity mass to write grid data!");
01655
01656
          /\star Set time interval for output... \star/
01657
          t0 = t - 0.5 * ctl->dt_mod;
t1 = t + 0.5 * ctl->dt_mod;
01658
01659
01660
01661
          /\star Set grid box size... \star/
          dz = (ctl->grid_z1 - ctl->grid_z0) / ctl->grid_nz;
dlon = (ctl->grid_lon1 - ctl->grid_lon0) / ctl->grid_nx;
dlat = (ctl->grid_lat1 - ctl->grid_lat0) / ctl->grid_ny;
01662
01663
01664
01665
01666
           /* Initialize grid... */
          for (ix = 0; ix < ctl->grid_nx; ix++)
01667
           for (iy = 0; iy < ctl->grid_ny; iy++)
    for (iz = 0; iz < ctl->grid_nz; iz++)
01668
01669
01670
                  grid_m[ix][iy][iz] = 0;
01671
01672
           /* Average data... */
          for (ip = 0; ip < atm->np; ip++)
  if (atm->time[ip] >= t0 && atm->time[ip] <= t1) {</pre>
01673
01674
01675
01676
                /* Get index... */
01677
               ix = (int) ((atm->lon[ip] - ctl->grid_lon0) / dlon);
```

```
iy = (int) ((atm->lat[ip] - ctl->grid_lat0) / dlat);
iz = (int) ((Z(atm->p[ip]) - ctl->grid_z0) / dz);
01679
01680
              /* Check indices... */
if (ix < 0 || ix >= ctl->grid_nx ||
    iy < 0 || iy >= ctl->grid_ny || iz < 0 || iz >= ctl->grid_nz)
01681
01682
01683
01684
01685
               /* Add mass... */
01686
              grid_m[ix][iy][iz] += atm->q[ctl->qnt_m][ip];
01687
01688
01689
         /* Check if gnuplot output is requested... */
if (ctl->grid_gpfile[0] != '-') {
01690
01691
01692
01693
            /* Write info... */
            printf("Plot grid data: %s.png\n", filename);
01694
01695
01696
            /* Create gnuplot pipe... */
            if (!(out = popen("gnuplot", "w")))
01697
01698
              ERRMSG("Cannot create pipe to gnuplot!");
01699
            /* Set plot filename... */ fprintf(out, "set out \"%s.png\"\n", filename);
01700
01701
01702
01703
            /* Set time string... */
            jsec2time(t, &year, &mon, &day, &hour, &min, &sec, &r);
fprintf(out, "timestr=\"%d-%02d-%02d, %02d:%02d UTC\"\n",
01704
01705
01706
                      year, mon, day, hour, min);
01707
            /* Dump gnuplot file to pipe... */
if (!(in = fopen(ctl->grid_gpfile, "r")))
    ERRMSG("Cannot open file!");
01708
01709
01710
            while (fgets(line, LEN, in))
fprintf(out, "%s", line);
01711
01712
01713
            fclose(in);
01714
         }
01715
01716
         else {
01717
01718
            /* Write info... */
          printf("Write grid data: %s\n", filename);
01719
01720
01721
            /* Create file... */
01722
           if (!(out = fopen(filename, "w")))
01723
               ERRMSG("Cannot create file!");
01724
01725
         /* Write header... */
01726
01727
         fprintf(out,
                    "# $1 = time [s]\n"
01728
01729
                    "# $2 = altitude [km] \n"
01730
                    "# $3 = longitude [deg] \n"
                    "# $4 = latitude [deg]\n"
01731
                    "# $5 = surface area [km^2]\n"
01732
                    "# $6 = layer width [km]\n"
"# $7 = temperature [K]\n"
01733
01734
01735
                    "# $8 = \text{column density } [kg/m^2] \n"
01736
                    "# $9 = mass mixing ratio [1]\n\n");
01737
         /* Write data... */
01738
         for (ix = 0; ix < ctl->grid_nx; ix++) {
   if (ix > 0 && ctl->grid_ny > 1 && !ctl->grid_sparse)
01739
01741
               fprintf(out, "\n");
01742
                 (iy = 0; iy < ctl->grid_ny; iy++) {
01743
              if (iy > 0 && ctl->grid_nz > 1 && !ctl->grid_sparse)
               fprintf(out, "\n");
for (iz = 0; iz < ctl->grid_nz; iz++)
01744
01745
01746
                if (!ctl->grid_sparse
01747
                      || ix == 0 || iy == 0 || iz == 0 || grid_m[ix][iy][iz] > 0) {
01748
01749
                   /* Set coordinates... */
                   z = ctl->grid_z0 + dz * (iz + 0.5);
lon = ctl->grid_lon0 + dlon * (ix + 0.5);
01750
01751
01752
                    lat = ctl - > grid_lat0 + dlat * (iy + 0.5);
01753
01754
                    /* Get pressure and temperature... */
01755
                    press = P(z);
                    intpol_met_time(met0, met1, t, press, lon, lat,
    NULL, &temp, NULL, NULL, NULL, NULL, NULL);
01756
01757
01758
                    /* Calculate surface area... */
                   area = dlat * dlon * gsl_pow_2(RE * M_PI / 180.)
 * cos(lat * M_PI / 180.);
01760
01761
01762
                   /* Calculate column density... */
cd = grid_m[ix][iy][iz] / (1e6 * area);
01763
01764
```

```
/* Calculate mass mixing ratio... */
rho_air = 100. * press / (287.058 * temp);
mmr = grid_m[ix][iy][iz] / (rho_air * 1e6 * area * 1e3 * dz);
01766
01767
01768
01769
                 01770
01771
01772
01773
01774
           }
01775
        }
01776
01777
         /* Close file... */
01778
        fclose(out);
01779 }
```

Here is the call graph for this function:



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

Write profile data.

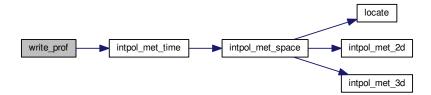
Definition at line 1783 of file libtrac.c.

```
01789
                       {
01790
01791
          static FILE *in, *out;
01792
01793
          static char line[LEN];
01794
01795
          static double mass[GX][GY][GZ], obsmean[GX][GY], tmean[GX][GY],
01796
            rt, rlon, rlat, robs, t0, t1, area, dz, dlon, dlat, lon, lat, z, press, temp, rho_air, mmr, h2o, o3;
01797
01798
01799
          static int init, obscount[GX][GY], ip, ix, iy, iz;
01800
          /* Init... */
01801
          if (!init) {
01802
01803
            init = 1;
01804
01805
             /\star Check quantity index for mass... \star/
01806
            if (ctl->qnt_m < 0)
01807
               ERRMSG("Need quantity mass!");
01808
            /* Check dimensions... */    if (ctl->prof_nx > GX || ctl->prof_ny > GY || ctl->prof_nz > GZ)
01809
01810
               ERRMSG("Grid dimensions too large!");
01811
01812
01813
             /\star Open observation data file... \star/
            printf("Read profile observation data: %s\n", ctl->prof_obsfile);
if (!(in = fopen(ctl->prof_obsfile, "r")))
    ERRMSG("Cannot open file!");
01814
01815
01816
01817
01818
             /* Create new file... */
            printf("Write profile data: %s\n", filename);
if (!(out = fopen(filename, "w")))
    ERRMSG("Cannot create file!");
01819
01820
01821
01822
01823
             /* Write header... */
01824
            fprintf(out,
```

```
"# $1 = time [s] \n"
                      "# $2 = altitude [km] \n"
01826
01827
                      "# $3 = longitude [deg] \n"
                      "# $4 = latitude [deg]\n"
01828
                      "# $5
                             = pressure [hPa]\n"
01829
                      "# $6 = temperature [K]\n"
01830
                             = mass mixing ratio [1]\n"
01831
01832
                      "# $8 = H2O volume mixing ratio [1]\n"
01833
                      "# $9 = 03 volume mixing ratio [1]\n"
01834
                      "# $10 = mean BT index [K]\n");
01835
           /* Set grid box size... */
01836
           dz = (ctl->prof_z1 - ctl->prof_z0) / ctl->prof_nz;
dlon = (ctl->prof_lon1 - ctl->prof_lon0) / ctl->prof_nx;
dlat = (ctl->prof_lat1 - ctl->prof_lat0) / ctl->prof_ny;
01837
01838
01839
01840
01841
01842
         /* Set time interval... */
         t0 = t - 0.5 * ctl->dt_mod;
t1 = t + 0.5 * ctl->dt_mod;
01843
01844
01845
         /* Initialize... */
for (ix = 0; ix < ctl->prof_nx; ix++)
  for (iy = 0; iy < ctl->prof_ny; iy++) {
   obsmean[ix][iy] = 0;
01846
01847
01848
01849
              obscount[ix][iy] = 0;
01850
               tmean[ix][iy] = 0;
01851
01852
               for (iz = 0; iz < ctl->prof_nz; iz++)
01853
                mass[ix][iy][iz] = 0;
01854
01855
01856
         /* Read data... */
01857
         while (fgets(line, LEN, in)) {
01858
           /* Read data... */ if (sscanf(line, "%lg %lg %lg %lg", &rt, &rlon, &rlat, &robs) != 4)
01859
01860
01861
             continue;
01862
01863
            /* Check time... */
01864
           if (rt < t0)</pre>
01865
            continue;
if (rt > t1)
01866
01867
              break:
01868
01869
            /* Calculate indices... */
           ix = (int) ((rlon - ctl->prof_lon0) / dlon);
iy = (int) ((rlat - ctl->prof_lat0) / dlat);
01870
01871
01872
           /* Check indices... */
if (ix < 0 || ix >= ctl->prof_nx || iy < 0 || iy >= ctl->prof_ny)
01873
01874
01875
             continue;
01876
01877
            /\star Get mean observation index... \star/
           obsmean[ix][iy] += robs;
tmean[ix][iy] += rt;
01878
01879
            obscount[ix][iy]++;
01880
01881
01882
01883
          /* Analyze model data... */
01884
          for (ip = 0; ip < atm->np; ip++) {
01885
01886
            /* Check time... */
            if (atm->time[ip] < t0 || atm->time[ip] > t1)
01887
01888
              continue;
01889
            /* Get indices... */
01890
01891
           ix = (int) ((atm->lon[ip] - ctl->prof_lon0) / dlon);
iy = (int) ((atm->lat[ip] - ctl->prof_lat0) / dlat);
01892
            iz = (int) ((Z(atm->p[ip]) - ctl->prof_z0) / dz);
01893
01895
            /* Check indices... */
01896
            if (ix < 0 || ix \geq ctl-\geqprof_nx ||
                iy < 0 || iy >= ctl->prof_ny || iz < 0 || iz >= ctl->prof_nz)
01897
01898
              continue:
01899
01900
            /* Get total mass in grid cell... */
01901
            mass[ix][iy][iz] += atm->q[ctl->qnt_m][ip];
01902
01903
01904
         /* Extract profiles... */
         for (ix = 0; ix < ctl->prof_nx; ix++)
  for (iy = 0; iy < ctl->prof_ny; iy++)
01905
01906
01907
              if (obscount[ix][iy] > 0) {
01908
                 /* Write output... */
fprintf(out, "\n");
01909
01910
01911
```

```
/* Loop over altitudes... */
01913
                  for (iz = 0; iz < ctl->prof_nz; iz++) {
01914
                     /* Set coordinates... */
01915
                     z = ctl->prof_z0 + dz * (iz + 0.5);
lon = ctl->prof_lon0 + dlon * (ix + 0.5);
lat = ctl->prof_lat0 + dlat * (iy + 0.5);
01916
01917
01918
01919
01920
                     /\star Get meteorological data... \star/
01921
                     press = P(z);
                     intpol_met_time(met0, met1, t, press, lon, lat,
    NULL, &temp, NULL, NULL, NULL, &h2o, &o3);
01922
01923
01924
                    /* Calculate mass mixing ratio... */
rho_air = 100. * press / (287.058 * temp);
area = dlat * dlon * gsl_pow_2(M_PI * RE / 180.)
* cos(lat * M_PI / 180.);
01925
01926
01927
01928
01929
                     mmr = mass[ix][iy][iz] / (rho_air * area * dz * 1e9);
01930
                     01931
01932
01933
                                z, lon, lat, press, temp, mmr, h2o, o3, obsmean[ix][iy] / obscount[ix][iy]);
01934
01935
01936
01937
01938
01939
           /* Close file... */
          if (t == ctl->t_stop)
01940
01941
             fclose(out);
01942 }
```

Here is the call graph for this function:



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

Write station data.

Definition at line 1946 of file libtrac.c.

```
{
01951
01952
        static FILE *out;
01953
        static double rmax2, t0, t1, x0[3], x1[3];
01954
01955
01956
       static int init, ip, iq;
01957
01958
        /* Init... */
        if (!init) {
01959
01960
         init = 1;
01961
01962
          /* Write info... */
01963
         printf("Write station data: %s\n", filename);
01964
01965
          /* Create new file... */
          if (!(out = fopen(filename, "w")))
01966
            ERRMSG("Cannot create file!");
01967
01968
01969
          /* Write header... */
```

```
fprintf(out,
01971
                  "# $1 = time [s] \n"
                 "# $2 = altitude [km]\n"
"# $3 = longitude [deg]\n" "# $4 = latitude [deg]\n");
01972
01973
          01974
01975
01976
01977
         fprintf(out, "\n");
01978
01979
          /\star Set geolocation and search radius... \star/
01980
         geo2cart(0, ctl->stat_lon, ctl->stat_lat, x0);
         rmax2 = gsl_pow_2(ctl->stat_r);
01981
01982
01983
01984
        /\star Set time interval for output... \star/
       t0 = t - 0.5 * ctl->dt_mod;
t1 = t + 0.5 * ctl->dt_mod;
01985
01986
01987
01988
       /* Loop over air parcels... */
01989
       for (ip = 0; ip < atm->np; ip++) {
01990
          /* Check time... */
01991
         if (atm->time[ip] < t0 || atm->time[ip] > t1)
01992
01993
           continue;
01994
01995
          /* Check station flag... */
01996
          if (ctl->qnt_stat >= 0)
01997
           if (atm->q[ctl->qnt_stat][ip])
01998
             continue;
01999
02000
          /* Get Cartesian coordinates... */
02001
         geo2cart(0, atm->lon[ip], atm->lat[ip], x1);
02002
02003
          /\star Check horizontal distance... \star/
02004
         if (DIST2(x0, x1) > rmax2)
02005
           continue;
02006
02007
         /* Set station flag... */
02008
         if (ctl->qnt_stat >= 0)
02009
           atm->q[ctl->qnt_stat][ip] = 1;
02010
         02011
02012
02013
          for (iq = 0; iq < ctl->nq; iq++) {
   fprintf(out, " ");
02014
02015
02016
            fprintf(out, ctl->qnt_format[iq], atm->q[iq][ip]);
02017
02018
         fprintf(out, "\n");
02019
02020
02021
        /* Close file... */
02022
        if (t == ctl->t\_stop)
02023
         fclose(out);
02024 }
```

Here is the call graph for this function:



```
00001 /\star
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
      \ensuremath{\mathsf{MPTRAC}} is distributed in the hope that it will be useful,
      but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
00010
00011
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 <a href="http://www.gnu.org/licenses/">http://www.gnu.org/licenses/</a>.
00016
00017
      Copright (C) 2013-2015 Forschungszentrum Juelich GmbH
00018 */
00019
00025 #include "libtrac.h"
00026
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
00044
00045 double deg2dx(
00046
      double dlon,
00047
      double lat) {
00049
      return dlon * M_PI * RE / 180. * cos(lat / 180. * M_PI);
00050 }
00051
00053
00054 double deg2dy(
00055
      double dlat) {
00056
00057
      return dlat * M_PI * RE / 180.;
00058 }
00059
00061
00062 double dp2dz(
00063
      double dp,
00064
      double p) {
00065
00066
      return -dp * H0 / p;
00067 }
00068
00070
00071 double dx2deg(
00072
      double dx,
00073
      double lat) {
00074
00075
      /\star Avoid singularity at poles... \star/
00076
      if (lat < -89.999 || lat > 89.999)
00077
       return 0;
00078
      else
00079
       return dx * 180. / (M_PI * RE * cos(lat / 180. * M_PI));
00080 }
00081
00083
00084 double dy2deg(
00085
      double dv) {
00086
00087
      return dy * 180. / (M_PI * RE);
00088 }
00089
00091
00092 double dz2dp(
      double dz,
00093
00094
      double p) {
00095
00096
      return -dz * p / H0;
00097 }
```

```
00100
00101 void geo2cart(
00102
       double z,
       double lon,
00103
00104
       double lat,
00105
       double *x) {
00106
00107
       double radius;
00108
00109
       radius = z + RE;
       x[0] = radius * cos(lat / 180 * M_PI) * cos(lon / 180 * M_PI);
x[1] = radius * cos(lat / 180 * M_PI) * sin(lon / 180 * M_PI);
x[2] = radius * sin(lat / 180 * M_PI);
00110
00111
00112
00113 }
00114
00116
00117 void get_met(
      ctl_t * ctl,
char *metbase,
00118
00119
00120
       double t,
      met_t * met0,
met_t * met1) {
00121
00122
00123
00124
       char filename[LEN];
00125
00126
       static int init;
00127
00128
       /* Init... */
00129
       if (!init) {
00130
        init = 1;
00131
         get_met_help(t, -1, metbase, ctl->dt_met, filename);
read_met(ctl, filename, met0);
00132
00133
00134
00135
         get_met_help(t + 1.0 * ctl->direction, 1, metbase, ctl->
     dt_met, filename);
00136
        read_met(ctl, filename, met1);
00137
00138
00139
       /* Read new data for forward trajectories... */
00140
       if (t > met1->time && ctl->direction == 1) {
       memcpy(met0, met1, sizeof(met_t));
00141
00142
         get_met_help(t, 1, metbase, ctl->dt_met, filename);
00143
        read_met(ctl, filename, met1);
00144
00145
00146
       /* Read new data for backward trajectories... */
       if (t < met0->time && ctl->direction == -1) {
00147
00148
        memcpy(met1, met0, sizeof(met_t));
00149
         get_met_help(t, -1, metbase, ctl->dt_met, filename);
00150
        read_met(ctl, filename, met0);
00151
00152 }
00155
00156 void get_met_help(
00157
       double t.
00158
       int direct,
00159
       char *metbase,
00160
       double dt_met,
00161
       char *filename) {
00162
00163
       double t6, r;
00164
00165
       int year, mon, day, hour, min, sec;
00166
00167
       /\star Round time to fixed intervals... \star/
00168
       if (direct == -1)
00169
        t6 = floor(t / dt_met) * dt_met;
00170
       else
00171
        t6 = ceil(t / dt_met) * dt_met;
00172
00173
       /* Decode time... */
00174
       jsec2time(t6, &year, &mon, &day, &hour, &min, &sec, &r);
00175
00176
       /* Set filename... */
00177
       sprintf(filename, "%s_%d_%02d_%02d_%02d.nc", metbase, year, mon, day, hour);
00178 }
00179
00181
00182 void intpol_met_2d(
      double array[EX][EY],
00183
```

```
00184
         int ix,
00185
         int iy,
00186
         double wx,
00187
         double wy,
00188
         double *var) {
00189
00190
         double aux00, aux01, aux10, aux11;
00191
00192
          /* Set variables...
         aux00 = array[ix][iy];
aux01 = array[ix][iy + 1];
aux10 = array[ix + 1][iy];
00193
00194
00195
00196
         aux11 = array[ix + 1][iy + 1];
00197
00198
         /* Interpolate horizontally... */
         aux00 = wy * (aux00 - aux01) + aux01;

aux11 = wy * (aux10 - aux11) + aux11;
00199
00200
00201
         *var = wx * (aux00 - aux11) + aux11;
00202 }
00203
00205
00206 void intpol_met_3d(
00207
        float array[EX][EY][EP],
00208
         int ip,
         int ix,
00210
         int iy,
00211
         double wp,
00212
         double wx,
00213
         double wy,
00214
         double *var) {
00215
00216
         double aux00, aux01, aux10, aux11;
00217
00218
         /* Interpolate vertically...
         aux00 = wp * (array[ix][iy][ip] - array[ix][iy][ip + 1])
00219
         + array[ix][iy][ip + 1];

aux01 = wp * (array[ix][iy + 1][ip] - array[ix][iy + 1][ip + 1])

+ array[ix][iy + 1][ip + 1];
00220
00222
00223
         aux10 = wp * (array[ix + 1][iy][ip] - array[ix + 1][iy][ip + 1])
         + array[ix + 1][iy][ip + 1];
aux11 = wp * (array[ix + 1][iy + 1][ip] - array[ix + 1][iy + 1][ip + 1])
+ array[ix + 1][iy + 1][ip + 1];
00224
00225
00226
00227
         /* Interpolate horizontally... */
aux00 = wy * (aux00 - aux01) + aux01;
aux11 = wy * (aux10 - aux11) + aux11;
00228
00229
00230
         *var = wx * (aux00 - aux11) + aux11;
00231
00232 }
00233
00235
00236 void intpol_met_space(
         met_t * met,
double p,
00237
00238
00239
         double lon,
00240
         double lat,
         double *ps,
00241
00242
         double *t,
         double *u,
00243
00244
         double *v.
00245
         double *w,
00246
         double *h2o,
00247
         double *o3) {
00248
00249
         double wp, wx, wy;
00250
00251
         int ip, ix, iv;
00252
         /* Check longitude... */
if (met->lon[met->nx - 1] > 180 && lon < 0)
00253
00254
00255
           lon += 360;
00256
00257
         /* Get indices... */
         ip = locate(met->p, met->np, p);
ix = locate(met->lon, met->nx, lon);
00258
00259
00260
         iy = locate(met->lat, met->ny, lat);
00261
         /* Get weights... */
wp = (met->p[ip + 1] - p) / (met->p[ip + 1] - met->p[ip]);
wx = (met->lon[ix + 1] - lon) / (met->lon[ix + 1] - met->lon[ix]);
wy = (met->lat[iy + 1] - lat) / (met->lat[iy + 1] - met->lat[iy]);
00262
00263
00264
00265
00266
00267
         /* Interpolate..
         if (ps != NULL)
  intpol_met_2d(met->ps, ix, iy, wx, wy, ps);
if (t != NULL)
00268
00269
00270
```

```
intpol_met_3d(met->t, ip, ix, iy, wp, wx, wy, t);
00272
       if (u != NULL)
00273
         intpol_met_3d(met->u, ip, ix, iy, wp, wx, wy, u);
       if (v != NULL)
00274
00275
        intpol_met_3d(met->v, ip, ix, iy, wp, wx, wy, v);
00276
       if (w != NULL)
00277
        intpol_met_3d(met->w, ip, ix, iy, wp, wx, wy, w);
00278
       if (h2o != NULL)
00279
        intpol_met_3d(met->h2o, ip, ix, iy, wp, wx, wy, h2o);
00280
       if (o3 != NULL)
00281
        intpol_met_3d(met->o3, ip, ix, iy, wp, wx, wy, o3);
00282 }
00283
00285
00286 void intpol_met_time(
00287
      met_t * met0,
met_t * met1,
00288
00289
       double ts,
00290
       double p,
00291
       double lon,
00292
       double lat,
00293
       double *ps,
00294
       double *t.
00295
       double *u,
00296
       double *v,
00297
       double *w,
00298
       double *h2o,
00299
       double *o3) {
00300
00301
       double h200, h201, o30, o31, ps0, ps1, t0, t1, u0, u1, v0, v1, w0, w1, wt;
00302
00303
       /* Spatial interpolation... */
       00304
00305
                       t == NULL ? NULL : &t0,
00306
00307
                       u == NULL ? NULL : &u0,
                       v == NULL ? NULL : &v0,
00308
00309
                       w == NULL ? NULL : &w0,
00310
                       h2o == NULL ? NULL : &h2o0, o3 == NULL ? NULL : &o30);
       00311
00312
00313
00314
                       u == NULL ? NULL : &u1,
                       v == NULL ? NULL : &v1,
00315
00316
                       w == NULL ? NULL : &w1,
00317
                       h2o == NULL ? NULL : &h2o1, o3 == NULL ? NULL : &o31);
00318
       /\star Get weighting factor... \star/
00319
      wt = (met1->time - ts) / (met1->time - met0->time);
00320
00321
00322
       /* Interpolate... */
00323
       if (ps != NULL)
       *ps = wt * (ps0 - ps1) + ps1;
if (t != NULL)
00324
00325
00326
        *t = wt * (t0 - t1) + t1;
       if (u != NULL)
00328
        *u = wt * (u0 - u1) + u1;
00329
       if (v != NULL)
00330
         *v = wt * (v0 - v1) + v1;
       if (w != NULL)
00331
        *w = wt * (w0 - w1) + w1;
00332
00333
       if (h2o != NULL)
00334
        *h2o = wt * (h2o0 - h2o1) + h2o1;
00335
       if (o3 != NULL)
00336
        *o3 = wt * (o30 - o31) + o31;
00337 }
00338
00340
00341 void jsec2time(
00342
      double jsec,
00343
       int *year,
00344
       int *mon.
00345
       int *day,
00346
       int *hour,
00347
       int *min,
00348
       int *sec,
00349
      double *remain) {
00350
00351
      struct tm t0, *t1;
00352
00353
       time_t jsec0;
00354
00355
       t0.tm_year = 100;
       t0.tm\_mon = 0;
00356
       t0.tm_mday = 1;
00357
```

```
00358
        t0.tm\_hour = 0;
00359
        t0.tm_min = 0;
        t0.tm\_sec = 0;
00360
00361
         jsec0 = (time_t) jsec + timegm(&t0);
00362
00363
        t1 = qmtime(&jsec0);
00364
00365
        *year = t1->tm_year + 1900;
        *mon = t1->tm_mon + 1;
*day = t1->tm_mday;
00366
00367
        *hour = t1->tm_hour;
00368
00369
        *min = t1->tm_min;
        *sec = t1->tm_sec;
00370
00371
        *remain = jsec - floor(jsec);
00372 }
00373
00375
00376 int locate(
00377
        double *xx,
00378
        int n,
00379
        double x) {
00380
00381
        int i, ilo, ihi;
00382
00383
        ilo = 0;
        ihi = n - 1;
i = (ihi + ilo) >> 1;
00384
00385
00386
00387
        if (xx[i] < xx[i + 1])
         while (ihi > ilo + 1) {
  i = (ihi + ilo) >> 1;
00388
00389
00390
             if (xx[i] > x)
00391
               ihi = i;
00392
             else
               ilo = i;
00393
00394
        } else
          while (ihi > ilo + 1) {
00396
            i = (ihi + ilo) >> 1;
00397
             if (xx[i] \le x)
00398
               ihi = i;
             else
00399
00400
               ilo = i:
00401
           }
00402
00403
        return ilo;
00404 }
00405
00407
00408 void read_atm(
00409
       const char *filename,
00410
        ctl_t * ctl,
00411
        atm_t * atm) {
00412
00413
        FILE *in;
00414
00415
        char line[LEN], *tok;
00416
00417
        int iq;
00418
        /* Init... */
atm->np = 0;
00419
00420
00421
00422
        /* Write info... */
00423
        printf("Read atmospheric data: %s\n", filename);
00424
00425
        /* Open file... */
        if (!(in = fopen(filename, "r")))
00426
00427
           ERRMSG("Cannot open file!");
00428
00429
        /* Read line... */
00430
        while (fgets(line, LEN, in)) {
00431
           /* Read data... */
TOK(line, tok, "%lg", atm->time[atm->np]);
TOK(NULL, tok, "%lg", atm->p[atm->np]);
TOK(NULL, tok, "%lg", atm->lon[atm->np]);
TOK(NULL, tok, "%lg", atm->lat[atm->np]);
for (iq = 0; iq < ctl->nq; iq++)
    TOK(NULL, tok, "%lg", atm->q[iq][atm->np]);
00432
00433
00434
00435
00436
00437
00438
00439
00440
           /* Convert altitude to pressure... */
00441
           atm \rightarrow p[atm \rightarrow np] = P(atm \rightarrow p[atm \rightarrow np]);
00442
           /* Increment data point counter... */
if ((++atm->np) > NP)
00443
00444
```

```
00445
           ERRMSG("Too many data points!");
00446
00447
00448
       /* Close file... */
00449
       fclose(in);
00450
        /* Check number of points... */
00452
       if (atm->np < 1)
00453
         ERRMSG("Can not read any data!");
00454 }
00455
00457
00458 void read_ctl(
00459
       const char *filename,
00460
       int argc,
       char *argv[],
ctl_t * ctl) {
00461
00462
00463
00464
       int ip, iq;
00465
       /* Write info... */
00466
       00467
00468
00469
              argv[0], __DATE__, __TIME__);
00470
00471
       /* Initialize quantity indices... */
       ctl->qnt_ens = -1;
ctl->qnt_m = -1;
00472
00473
       ctl->qnt_r = -1;
00474
00475
       ctl->gnt rho = -1;
00476
       ctl->qnt_ps = -1;
00477
       ctl->qnt_p = -1;
00478
       ct1->qnt_t = -1;
       ct1->qnt_u = -1;
00479
       ctl->qnt_v = -1;
00480
       ctl->qnt_w = -1;
00481
       ctl->qnt_h2o = -1;
00482
00483
       ctl->qnt_o3 = -1;
00484
       ctl->qnt\_theta = -1;
00485
       ctl->qnt_pv = -1;
       ctl->qnt\_tice = -1;
00486
       ctl->qnt\_tsts = -1;
00487
00488
       ctl->qnt_tnat = -1;
00489
       ctl->qnt_gw_var = -1;
00490
       ctl->qnt\_stat = -1;
00491
00492
       /* Read quantities... */
       \label{eq:ctl-nq}  \mbox{ctl->nq = (int) } \mbox{scan\_ctl(filename, argc, argv, "NQ", -1, "0", NULL);} 
00493
       if (ctl->ng > NQ)
00494
00495
         ERRMSG("Too many quantities!");
00496
       for (iq = 0; iq < ctl->nq; iq++) {
00497
         00498
00499
00500
00501
00502
         /* Try to identify quantity... */
if (strcmp(ctl->qnt_name[iq], "ens") == 0) {
00503
00504
           ctl->qnt_ens = iq;
00505
           sprintf(ctl->qnt_unit[iq], "-");
00506
         | else if (strcmp(ctl->qnt_name[iq], "m") == 0) {
| ctl->qnt_m = iq;
00507
00508
00509
           sprintf(ctl->qnt_unit[iq], "kg");
00510
         } else if (strcmp(ctl->qnt_name[iq], "r") == 0) {
00511
           ctl->qnt_r = iq;
           sprintf(ctl->qnt_unit[iq], "m");
00512
         } else if (stromp(ctl->qnt_name[iq], "rho") == 0) {
ctl->qnt_rho = iq;
00513
00515
           sprintf(ctl->qnt_unit[iq], "kg/m^3");
00516
          } else if (strcmp(ctl->qnt_name[iq], "ps") == 0) {
           ctl->qnt_ps = iq;
sprintf(ctl->qnt_unit[iq], "hPa");
00517
00518
         } else if (strcmp(ctl->qnt_name[iq], "p") == 0) {
  ctl->qnt_p = iq;
00519
00520
00521
           sprintf(ctl->qnt_unit[iq], "hPa");
00522
         } else if (strcmp(ctl->qnt_name[iq], "t") == 0) {
           ctl->qnt_t = iq;
00523
           sprintf(ctl->qnt_unit[iq], "K");
00524
         } else if (strcmp(ctl->qnt_name[iq], "u") == 0) {
00525
           ctl->qnt_u = iq;
00527
           sprintf(ctl->qnt_unit[iq], "m/s");
         } else if (strcmp(ctl->qnt_name[iq], "v") == 0) {
00528
           ctl->qnt_v = iq;
00529
           sprintf(ctl->qnt_unit[iq], "m/s");
00530
00531
         } else if (strcmp(ctl->qnt_name[iq], "w") == 0) {
```

```
ctl->qnt_w = iq;
             sprintf(ctl->qnt_unit[iq], "hPa/s");
00533
00534
           } else if (strcmp(ctl->qnt_name[iq], "h2o") == 0) {
             ctl->qnt_h2o = iq;
00535
00536
             sprintf(ctl->qnt_unit[iq], "1");
           } else if (strcmp(ctl->qnt_name[iq], "o3") == 0) {
ctl->qnt_o3 = iq;
00537
00539
             sprintf(ctl->qnt_unit[iq], "1");
00540
           } else if (strcmp(ctl->qnt_name[iq], "theta") == 0) {
             ctl->qnt_theta = iq;
00541
             sprintf(ctl->qnt_unit[iq], "K");
00542
00543
           } else if (strcmp(ctl->qnt_name[iq], "pv") == 0) {
             ctl->qnt_pv = iq;
00544
00545
             sprintf(ctl->qnt_unit[iq], "PVU");
           } else if (strcmp(ctl->qnt_name[iq], "tice") == 0) {
00546
             ctl->qnt_tice = iq;
00547
             sprintf(ctl->qnt_unit[iq], "K");
00548
           } else if (strcmp(ctl->qnt_name[iq], "tsts") == 0) {
  ctl->qnt_tsts = iq;
00549
             sprintf(ctl->qnt_unit[iq], "K");
00551
00552
           } else if (strcmp(ctl->qnt_name[iq], "tnat") == 0) {
             ctl->qnt_tnat = iq;
sprintf(ctl->qnt_unit[iq], "K");
00553
00554
           } else if (strcmp(ctl->qnt_name[iq], "gw_var") == 0) {
00555
             ctl->qnt_gw_var = iq;
sprintf(ctl->qnt_unit[iq], "K^2");
00556
00557
00558
           } else if (strcmp(ctl->qnt_name[iq], "stat") == 0) {
00559
              ctl->qnt_stat = iq;
00560
             sprintf(ctl->qnt_unit[iq], "-");
00561
           } else
00562
             scan_ctl(filename, argc, argv, "QNT_UNIT", iq, "", ctl->qnt_unit[iq]);
00563
00564
00565
         /* Time steps of simulation... */
00566
         ctl->direction =
           (int) scan_ctl(filename, argc, argv, "DIRECTION", -1, "1", NULL);
f (ctl->direction != -1 && ctl->direction != 1)
00567
00568
           ERRMSG("Set DIRECTION to -1 or 1!");
00570
         ctl->t_start =
        scan_ctl(filename, argc, argv, "T_START", -1, "-1e100", NULL);
ctl->t_stop = scan_ctl(filename, argc, argv, "T_STOP", -1, "-1e100", NULL);
ctl->dt_mod = scan_ctl(filename, argc, argv, "DT_MOD", -1, "600", NULL);
00571
00572
00573
00574
00575
         /* Meteorological data... */
00576
         ctl->dt_met = scan_ctl(filename, argc, argv, "DT_MET", -1, "21600", NULL);
         ctl->met_np = (int) scan_ctl(filename, argc, argv, "MET_NP", -1, "0", NULL);
00577
00578
         if (ctl->met_np > EP)
00579
          ERRMSG("Too many levels!");
         for (ip = 0; ip < ctl->met_np; ip++)
  ctl->met_p[ip] = scan_ctl(filename, argc, argv, "MET_P", ip, "", NULL);
00580
00581
00583
         /* Isosurface parameters... */
00584
         ctl->isosurf
         = (int) scan_ctl(filename, argc, argv, "ISOSURF", -1, "0", NULL); scan_ctl(filename, argc, argv, "BALLOON", -1, "-", ctl->balloon);
00585
00586
00587
00588
        /* Diffusion parameters... ∗/
00589
        ctl->turb dx trop
00590
           = scan_ctl(filename, argc, argv, "TURB_DX_TROP", -1, "50.0", NULL);
00591
         ctl->turb_dx_strat
00592
          = scan ctl(filename, argc, argv, "TURB DX STRAT", -1, "0.0", NULL);
00593
         ctl->turb dz trop
00594
           = scan_ctl(filename, argc, argv, "TURB_DZ_TROP", -1, "0.0", NULL);
00595
         ctl->turb dz strat
00596
           = scan_ctl(filename, argc, argv, "TURB_DZ_STRAT", -1, "0.1", NULL);
00597
         ctl->turb_meso =
           scan_ctl(filename, argc, argv, "TURB_MESO", -1, "0.16", NULL);
00598
00599
00600
        /* Life time of particles... */
00601
         ctl->tdec_trop = scan_ctl(filename, argc, argv, "TDEC_TROP", -1, "0", NULL);
00602
         ctl->tdec_strat =
00603
           scan_ctl(filename, argc, argv, "TDEC_STRAT", -1, "0", NULL);
00604
00605
         /* PSC analysis... */
        ctl->psc_h2o = scan_ctl(filename, argc, argv, "PSC_H2O", -1, "4e-6", NULL);
00606
         ctl->psc_hno3 =
00607
           scan_ctl(filename, argc, argv, "PSC_HNO3", -1, "9e-9", NULL);
00608
00609
        /* Gravity wave analysis... */
scan_ctl(filename, argc, argv, "GW_BASENAME", -1, "-", ctl->
00610
00611
      gw_basename);
00612
         /* Output of atmospheric data... */
scan_ctl(filename, argc, argv, "ATM_BASENAME", -1, "-", ctl->
00613
00614
      atm_basename);
00615 scan_ctl(filename, argc, argv, "ATM_GPFILE", -1, "-", ctl->atm_gpfile);
00616
        ctl->atm dt out =
```

```
scan_ctl(filename, argc, argv, "ATM_DT_OUT", -1, "86400", NULL);
00618
         ctl->atm filter
00619
            (int) scan_ctl(filename, argc, argv, "ATM_FILTER", -1, "0", NULL);
00620
00621
         /* Output of CSI data... */
         scan_ctl(filename, argc, argv, "CSI_BASENAME", -1, "-", ctl->
00622
       csi basename);
00623
         ctl->csi_dt_out =
         scan_ctl(filename, argc, argv, "CSI_DT_OUT", -1, "86400", NULL);
scan_ctl(filename, argc, argv, "CSI_OBSFILE", -1, "obs.tab",
00624
00625
                    ctl->csi_obsfile);
00626
00627
         ctl->csi obsmin =
00628
            scan_ctl(filename, argc, argv, "CSI_OBSMIN", -1, "0", NULL);
00629
         ctl->csi_modmin =
00630
            scan_ctl(filename, argc, argv, "CSI_MODMIN", -1, "0", NULL);
         ctl->csi_z0 = scan_ctl(filename, argo, argv, "CSI_ZO", -1, "0", NULL);
ctl->csi_z1 = scan_ctl(filename, argo, argv, "CSI_Z1", -1, "100", NULL);
ctl->csi_nz = (int) scan_ctl(filename, argo, argv, "CSI_NZ", -1, "1", NULL);
00631
00632
00633
         ctl->csi_lon0 =
00634
         scan_ctl(filename, argc, argv, "CSI_LONO", -1, "-180", NULL);
ctl->csi_lon1 = scan_ctl(filename, argc, argv, "CSI_LON1", -1, "180", NULL);
00635
00636
00637
         ctl->csi_nx =
         (int) scan_ctl(filename, argc, argv, "CSI_NX", -1, "360", NULL);
ctl->csi_lat0 = scan_ctl(filename, argc, argv, "CSI_LAT0", -1, "-90", NULL);
ctl->csi_lat1 = scan_ctl(filename, argc, argv, "CSI_LAT1", -1, "90", NULL);
00638
00639
00640
00641
         ctl->csi nv =
00642
            (int) scan_ctl(filename, argc, argv, "CSI_NY", -1, "180", NULL);
00643
         /* Output of ensemble data... */
scan_ctl(filename, argc, argv, "ENS_BASENAME", -1, "-", ctl->
00644
00645
       ens basename):
00646
00647
          /* Output of grid data... */
00648
         scan_ctl(filename, argc, argv, "GRID_BASENAME", -1, "-",
00649
                     ctl->grid_basename);
         scan_ctl(filename, argc, argv, "GRID_GPFILE", -1, "-", ctl->
00650
      grid_gpfile);
00651 ctl->grid_dt_out =
00652
            scan_ctl(filename, argc, argv, "GRID_DT_OUT", -1, "86400", NULL);
00653
         ctl->grid_sparse
         (int) scan_ctl(filename, argc, argv, "GRID_SPARSE", -1, "0", NULL);
ctl->grid_z0 = scan_ctl(filename, argc, argv, "GRID_Z0", -1, "0", NULL);
ctl->grid_z1 = scan_ctl(filename, argc, argv, "GRID_Z1", -1, "100", NULL);
00654
00655
00656
00657
         ctl->grid_nz =
00658
            (int) scan_ctl(filename, argc, argv, "GRID_NZ", -1, "1", NULL);
00659
         ctl->grid_lon0
00660
           scan_ctl(filename, argc, argv, "GRID_LONO", -1, "-180", NULL);
00661
         ctl->grid lon1 =
            scan ctl(filename, argc, argv, "GRID LON1", -1, "180", NULL);
00662
         ctl->grid_nx =
00663
00664
            (int) scan_ctl(filename, argc, argv, "GRID_NX", -1, "360", NULL);
         ctl->grid_lat0 =
00665
00666
            scan_ctl(filename, argc, argv, "GRID_LATO", -1, "-90", NULL);
00667
         ctl->grid lat1
            scan_ctl(filename, argc, argv, "GRID_LAT1", -1, "90", NULL);
00668
00669
         ctl->grid ny =
00670
            (int) scan_ctl(filename, argc, argv, "GRID_NY", -1, "180", NULL);
00671
00672
          /* Output of profile data... */
         scan_ctl(filename, argc, argv, "PROF_BASENAME", -1, "-",
00673
00674
                     ctl->prof basename);
          scan_ctl(filename, argc, argv, "PROF_OBSFILE", -1, "-", ctl->
00675
      prof_obsfile);
       ctl->prof_z0 = scan_ctl(filename, argc, argv, "PROF_Z0", -1, "0", NULL);
ctl->prof_z1 = scan_ctl(filename, argc, argv, "PROF_Z1", -1, "60", NULL);
00676
00677
00678
         ctl->prof_nz =
00679
            (int) scan_ctl(filename, argc, argv, "PROF_NZ", -1, "60", NULL);
00680
         ctl->prof lon0 =
           scan_ctl(filename, argc, argv, "PROF_LONO", -1, "-180", NULL);
00681
00682
         ctl->prof_lon1
00683
            scan_ctl(filename, argc, argv, "PROF_LON1", -1, "180", NULL);
         ctl->prof_nx =
00684
00685
            (int) scan_ctl(filename, argc, argv, "PROF_NX", -1, "360", NULL);
00686
         ctl->prof_lat0 =
00687
            scan ctl(filename, argc, argv, "PROF LATO", -1, "-90", NULL);
00688
         ctl->prof lat1 =
00689
            scan_ctl(filename, argc, argv, "PROF_LAT1", -1, "90", NULL);
00690
         ctl->prof_ny =
            (int) scan_ctl(filename, argc, argv, "PROF_NY", -1, "180", NULL);
00691
00692
         /* Output of station data... */
00693
00694
         scan_ctl(filename, argc, argv, "STAT_BASENAME", -1, "-",
                    ctl->stat_basename);
00695
         ctl->stat_lon = scan_ctl(filename, argc, argv, "STAT_LON", -1, "0", NULL);
ctl->stat_lat = scan_ctl(filename, argc, argv, "STAT_LAT", -1, "0", NULL);
ctl->stat_r = scan_ctl(filename, argc, argv, "STAT_R", -1, "50", NULL);
00696
00697
00698
00699 }
```

```
00702
00703 void read_met(
00704
         ctl_t * ctl,
char *filename,
00705
00706
         met_t * met) {
00707
00708
         char tstr[10];
00709
00710
         static float help[EX * EY];
00711
00712
         int ix, iy, ip, dimid, ncid, varid, year, mon, day, hour;
00713
00714
00715
00716
         /* Write info... */
00717
         printf("Read meteorological data: %s\n", filename);
00719
          /* Get time from filename... */
00720
          sprintf(tstr, "%.4s", &filename[strlen(filename) - 16]);
00721
          year = atoi(tstr);
          sprintf(tstr, "%.2s", &filename[strlen(filename) - 11]);
00722
00723
          mon = atoi(tstr);
sprintf(tstr, "%.2s", &filename[strlen(filename) - 8]);
00724
00725
          day = atoi(tstr);
00726
          sprintf(tstr, "%.2s", &filename[strlen(filename) - 5]);
00727
          hour = atoi(tstr);
00728
          time2jsec(year, mon, day, hour, 0, 0, 0, &met->time);
00729
         /* Open netCDF file... */
NC(nc_open(filename, NC_NOWRITE, &ncid));
00730
00731
00732
          /* Get dimensions... */
NC(nc_inq_dimid(ncid, "lon", &dimid));
NC(nc_inq_dimlen(ncid, dimid, &nx));
00733
00734
00735
00736
          if (nx > EX)
00737
            ERRMSG("Too many longitudes!");
00738
00739
          NC(nc_inq_dimid(ncid, "lat", &dimid));
00740
          NC(nc_inq_dimlen(ncid, dimid, &ny));
00741
          if (nv > EY)
00742
            ERRMSG("Too many latitudes!"):
00743
00744
          NC(nc_inq_dimid(ncid, "lev", &dimid));
00745
          NC(nc_inq_dimlen(ncid, dimid, &np));
00746
          if (np > EP)
00747
            ERRMSG("Too many levels!");
00748
00749
          /* Store dimensions... */
         met->np = (int) np;
met->nx = (int) nx;
00750
00751
00752
          met->ny = (int) ny;
00753
00754
          /* Get horizontal grid... */
00755
          NC(nc_inq_varid(ncid, "lon", &varid));
          NC(nc_get_var_double(ncid, varid, met->lon));
NC(nc_inq_varid(ncid, "lat", &varid));
00756
00757
00758
          NC(nc_get_var_double(ncid, varid, met->lat));
00759
         /* Read meteorological data... */
read_met_help(ncid, "t", "T", met, met->t, 1.0);
read_met_help(ncid, "u", "U", met, met->u, 1.0);
read_met_help(ncid, "v", "V", met, met->v, 1.0);
read_met_help(ncid, "v", "V", met, met->v, 1.0);
read_met_help(ncid, "w", "W", met, met->w, 0.01f);
read_met_help(ncid, "q", "Q", met, met->help(ncid, "o3", "03", met, met->o3, 0.602f);
00760
00761
00762
00763
00764
00765
00766
00767
00768
          /* Meteo data on pressure levels... */
00769
          if (ctl->met_np <= 0) {</pre>
00770
            /* Read pressure levels from file... */
NC(nc_inq_varid(ncid, "lev", &varid));
00771
00772
            NC(nc_get_var_double(ncid, varid, met->p));
for (ip = 0; ip < met->np; ip++)
  met->p[ip] /= 100.;
00773
00774
00775
00776
00777
             /* Extrapolate data for lower boundary... */
00778
            read_met_extrapolate(met);
00779
00780
00781
          /* Meteo data on model levels... */
00782
          else {
00783
            /* Read pressure data from file... */
read_met_help(ncid, "pl", "PL", met, met->pl, 0.01f);
00784
00785
00786
```

```
/* Interpolate from model levels to pressure levels... */
00788
           read_met_ml2pl(ctl, met, met->t);
00789
           read_met_ml2pl(ctl, met, met->u);
00790
           read_met_ml2pl(ctl, met, met->v);
00791
           read_met_ml2pl(ctl, met, met->w);
           read_met_ml2pl(ctl, met, met->h2o);
00792
00793
           read_met_ml2pl(ctl, met, met->o3);
00794
00795
           /* Set pressure levels... */
          met->np = ctl->met_np;
for (ip = 0; ip < met->np; ip++)
00796
00797
00798
             met->p[ip] = ctl->met_p[ip];
00799
00800
00801
         /\star Check ordering of pressure levels... \star/
        for (ip = 1; ip < met->np; ip++)
  if (met->p[ip - 1] < met->p[ip])
00802
00803
00804
             ERRMSG("Pressure levels must be descending!");
00805
        /* Read surface pressure... */
if (nc_inq_varid(ncid, "PS", &varid) == NC_NOERR) {
   NC(nc_get_var_float(ncid, varid, help));
00806
00807
00808
        for (iy = 0; iy < met->ny; iy++)
  for (ix = 0; ix < met->nx; ix++)
    met->ps[ix][iy] = help[iy * met->nx + ix] / 100.;
} else if (nc_inq_varid(ncid, "LNSP", &varid) == NC_NOERR) {
00809
00810
00811
00812
00813
           NC(nc_get_var_float(ncid, varid, help));
           for (iy = 0; iy < met->ny; iy++)
  for (ix = 0; ix < met->nx; ix++)
00814
00815
00816
               met->ps[ix][iy] = exp(help[iy * met->nx + ix]) / 100.;
00817
        } else
00818
          for (ix = 0; ix < met->nx; ix++)
00819
             for (iy = 0; iy < met->ny; iy++)
00820
               met \rightarrow ps[ix][iy] = met \rightarrow p[0];
00821
00822
        /* Create periodic boundary conditions... */
00823
        read_met_periodic(met);
00824
00825
         /* Close file...
00826
        NC(nc_close(ncid));
00827 }
00828
00830
00831 void read_met_extrapolate(
00832
        met_t * met) {
00833
00834
        int ip, ip0, ix, iy;
00835
00836
        /* Loop over columns... */
00837
        for (ix = 0; ix < met->nx; ix++)
00838
           for (iy = 0; iy < met->ny; iy++) {
00839
             /* Find lowest valid data point... */
for (ip0 = met->np - 1; ip0 >= 0; ip0--)
  if (!gsl_finite(met->t[ix][iy][ip0])
00840
00841
00842
                    || !gsl_finite(met->u[ix][iy][ip0])
00844
                    || !gsl_finite(met->v[ix][iy][ip0])
00845
                    || !gsl_finite(met->w[ix][iy][ip0]))
00846
                 break;
00847
             /* Extrapolate... */
for (ip = ip0; ip >= 0; ip--) {
00848
00849
00850
              met->t[ix][iy][ip] = met->t[ix][iy][ip + 1];
00851
               met->u[ix][iy][ip] = met->u[ix][iy][ip + 1];
00852
               met->v[ix][iy][ip] = met->v[ix][iy][ip + 1];
               met->w[ix][iy][ip] = met->h2o[ix][iy][ip + 1];
00853
00854
               met->o3[ix][iy][ip] = met->o3[ix][iy][ip + 1];
00855
00856
00857
00858 }
00859
00861
00862 void read_met_help(
00863
        int ncid,
00864
        char *varname
00865
        char *varname2
00866
        met t * met,
        float dest[EX][EY][EP],
00867
00868
        float scl) {
00869
00870
        static float help[EX * EY * EP];
00871
        int ip, ix, iy, n = 0, varid;
00872
00873
```

```
/* Check if variable exists... */
00875
          if (nc_inq_varid(ncid, varname, &varid) != NC_NOERR)
00876
           if (nc_inq_varid(ncid, varname2, &varid) != NC_NOERR)
00877
               return;
00878
00879
          /* Read data... */
          NC(nc_get_var_float(ncid, varid, help));
00881
00882
          /\star Copy and check data... \star/
          for (ip = 0; ip < met->np; ip++)
  for (iy = 0; iy < met->ny; iy++)
00883
00884
               for (ix = 0; ix < met->nx; ix++) {
  dest[ix][iy][ip] = scl * help[n++];
00885
00886
00887
                  if (fabs(dest[ix][iy][ip] / scl) > 1e14)
00888
                    dest[ix][iy][ip] = GSL_NAN;
00889
00890 }
00891
00892 /
00893
00894 void read_met_ml2pl(
         ctl_t * ctl,
met_t * met,
00895
00896
         float var[EX][EY][EP]) {
00897
00898
00899
          double aux[EP], p[EP], pt;
00900
00901
         int ip, ip2, ix, iy;
00902
00903
          /* Loop over columns... */
          for (ix = 0; ix < met->nx; ix++)
  for (iy = 0; iy < met->ny; iy++) {
00904
00905
00906
00907
                /\star Copy pressure profile... \star/
               for (ip = 0; ip < met->np; ip++)
  p[ip] = met->pl[ix][iy][ip];
00908
00909
00910
00911
                /* Interpolate... */
00912
                for (ip = 0; ip < ctl->met_np; ip++) {
00913
                 pt = ctl->met_p[ip];
00914
                  if ((pt > p[0] && p[0] > p[1]) || (pt < p[0] && p[0] < p[1]))
                    pt = p[0];
00915
                  00916
00917
00918
00919
                  ip2 = locate(p, met->np, pt);
                  aux[ip] = LIN(p[ip2], var[ix][iy][ip2],
p[ip2 + 1], var[ix][iy][ip2 + 1], pt);
00920
00921
00922
00923
00924
                /* Copy data... */
00925
               for (ip = 0; ip < ctl->met_np; ip++)
00926
                  var[ix][iy][ip] = (float) aux[ip];
00927
00928 }
00929
00930 /
00931
00932 void read_met_periodic(
00933
         met_t * met) {
00934
00935
          int ip, iy;
00936
00937
          /* Check longitudes... */
          if (!(fabs(met->lon[met->nx - 1] - met->lon[0]
00938
00939
                        + met->lon[1] - met->lon[0] - 360) < 0.01))
00940
            return:
00941
00942
          /* Increase longitude counter... */
          if ((++met->nx) > EX)
00943
00944
            ERRMSG("Cannot create periodic boundary conditions!");
00945
         /* Set longitude... */
met->lon[met->nx - 1] = met->lon[met->nx - 2] + met->lon[1] - met->
00946
00947
       lon[0];
00948
           /\star Loop over latitudes and pressure levels... \star/
00949
00950
          for (iy = 0; iy < met->ny; iy++)
            for (ip = 0; ip < met->np; ip++) {
    met->ps[met->nx - 1][iy] = met->ps[0][iy];
    met->u[met->nx - 1][iy][ip] = met->u[0][iy][ip];
    met->v[met->nx - 1][iy][ip] = met->v[0][iy][ip];
    met->w[met->nx - 1][iy][ip] = met->v[0][iy][ip];
    met->t[met->nx - 1][iy][ip] = met->t[0][iy][ip];
    met->t[met->nx - 1][iy][ip] = met->t[0][iy][ip];
    met->t[met->nx - 1][iy][ip] = met->t[0][iy][ip];
00951
00952
00953
00954
00955
00956
               met->h2o[met->nx - 1][iy][ip] = met->h2o[0][iy][ip];
met->o3[met->nx - 1][iy][ip] = met->o3[0][iy][ip];
00957
00958
00959
```

```
00960 }
00961
00963
00964 double scan_ctl(
00965
        const char *filename.
00966
        int argc,
00967
        char *argv[],
00968
        const char *varname,
00969
        int arridx,
00970
        const char *defvalue,
00971
       char *value) {
00972
00973
       FILE *in = NULL;
00974
00975
        char dummy[LEN], fullname1[LEN], fullname2[LEN], line[LEN],
00976
         msg[LEN], rvarname[LEN], rval[LEN];
00977
00978
        int contain = 0, i;
00979
        /* Open file... */
00980
        if (filename[strlen(filename) - 1] != '-')
if (!(in = fopen(filename, "r")))
00981
00982
            ERRMSG("Cannot open file!");
00983
00984
00985
        /* Set full variable name... */
00986
        if (arridx >= 0) {
        sprintf(fullname1, "%s[%d]", varname, arridx);
sprintf(fullname2, "%s[*]", varname);
00987
00988
00989
       } else {
        sprintf(fullname1, "%s", varname);
sprintf(fullname2, "%s", varname);
00990
00991
00992
00993
00994
        /* Read data... */
00995
        if (in != NULL)
         while (fgets(line, LEN, in))
  if (sscanf(line, "%s %s %s", rvarname, dummy, rval) == 3)
00996
00998
             if (strcasecmp(rvarname, fullname1) == 0 ||
00999
                  strcasecmp(rvarname, fullname2) == 0) {
01000
                contain = 1;
01001
                break;
01002
              }
        for (i = 1; i < argc - 1; i++)</pre>
01003
        if (strcasecmp(argv[i], fullname1) == 0 ||
    strcasecmp(argv[i], fullname2) == 0) {
01004
01005
01006
            sprintf(rval, "%s", argv[i + 1]);
01007
            contain = 1;
01008
           break:
01009
01010
01011
        /* Close file... */
01012
        if (in != NULL)
01013
         fclose(in);
01014
01015
        /* Check for missing variables... */
01016
       if (!contain) {
01017
        if (strlen(defvalue) > 0)
01018
           sprintf(rval, "%s", defvalue);
01019
          else (
01020
            sprintf(msg, "Missing variable %s!\n", fullname1);
01021
            ERRMSG (msg);
01022
          }
01023
01024
       /* Write info... */
printf("%s = %s\n", fullname1, rval);
01025
01026
01027
01028
       /* Return values... */
       if (value != NULL)
         sprintf(value, "%s", rval);
01030
01031
        return atof(rval);
01032 }
01033
01036 void time2jsec(
01037
       int year,
01038
        int mon,
        int day,
01039
01040
        int hour,
01041
        int min,
        int sec,
01042
01043
        double remain,
01044
       double *jsec) {
01045
01046
       struct tm t0, t1:
```

```
t0.tm_year = 100;
01048
01049
                t0.tm_mon = 0;
                t0.tm_mday = 1;
01050
                t0.tm\_hour = 0;
01051
                t0.tm_min = 0;
01052
01053
                t0.tm_sec = 0;
01054
01055
                t1.tm_year = year - 1900;
               t1.tm_{mon} = mon - 1;
01056
                t1.tm_mday = day;
01057
                t1.tm hour = hour;
01058
01059
                t1.tm_min = min;
01060
                t1.tm_sec = sec;
01061
01062
               *jsec = (double) timegm(&t1) - (double) timegm(&t0) + remain;
01063 }
01064
01066
01067 void timer(
01068
               const char *name,
01069
                int id,
01070
               int mode) {
01071
01072
               static double starttime[NTIMER], runtime[NTIMER];
01073
               /* Check id... */
if (id < 0 || id >= NTIMER)
01074
01075
                   ERRMSG("Too many timers!");
01076
01077
01078
                /* Start timer... */
01079
               if (mode == 1) {
                if (starttime[id] <= 0)</pre>
01080
01081
                        starttime[id] = omp_get_wtime();
01082
                    else
01083
                        ERRMSG("Timer already started!");
01084
01085
01086
                /* Stop timer... */
01087
                else if (mode == 2) {
                  if (starttime[id] > 0) {
01088
01089
                       runtime[id] = runtime[id] + omp_get_wtime() - starttime[id];
01090
                        starttime[id] = -1;
01091
01092
                        ERRMSG("Timer not started!");
01093
01094
01095
                /* Print timer... */
               else if (mode == 3)
01096
                 printf("%s = %g s\n", name, runtime[id]);
01097
01098 }
01099
01101
01102 double tropopause(
01103
               double t,
01104
                double lat) {
01105
01106
               static double doys[12]
               = { 1, 32, 60, 91, 121, 152, 182, 213, 244, 274, 305, 335 };
01107
01108
01109
               static double lats[73]
                 static double lats[73]
= { -90, -87.5, -85, -85, -82.5, -80, -77.5, -75, -72.5, -70, -67.5, -65, -62.5, -60, -57.5, -55, -52.5, -50, -47.5, -45, -42.5, -40, -37.5, -35, -32.5, -30, -27.5, -25, -22.5, -20, -17.5, -15, -12.5, -10, -7.5, -5, -2.5, 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5, 45, 47.5, 50, 52.5, 55, 57.5, 60, 62.5, 65, 67.5, 70, 72.5,
01110
01111
01112
01113
01114
01115
                     75, 77.5, 80, 82.5, 85, 87.5, 90
01116
01117
01118
01119
               static double tps[12][73]
                   = { 324.1, 325.6, 325, 324.3, 322.5, 319.7, 314, 307.2, 301.8, 299.6, 297.1, 292.2, 285.6, 276.1, 264, 248.9, 231.9, 213.5, 194.4, 175.3, 157, 140.4, 126.7, 116.3, 109.5, 105.4, 103, 101.4, 100.4,
01120
01121
01122
                               99.69, 99.19, 98.84, 98.56, 98.39, 98.39, 98.42, 98.44, 98.54,
01123
               99.69, 99.19, 98.84, 98.56, 98.39, 98.39, 98.42, 98.44, 98.54, 98.68, 98.81, 98.89, 98.96, 99.12, 99.65, 101.4, 105.4, 113.5, 128, 152.1, 184.7, 214, 234.1, 247.3, 255.8, 262.6, 267.7, 271.7, 275, 277.2, 279, 280.1, 280.4, 280.6, 280.1, 279.3, 278.3, 276.8, 275.8, 275.3, 275.6, 275.4, 274.1, 273.5}, [337.3, 338.7, 337.8, 336.4, 333, 328.8, 321.1, 312.6, 306.6, 303.7, 300.2, 293.8, 285.4, 273.8, 259.6, 242.7, 224.4, 205.2, 186, 167.5, 160.2, 136.132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 132.8, 1
01124
01125
01126
01127
01128
01129
01130
                  150.3, 135, 122.8, 113.9, 108.2, 104.7, 102.5, 101.1, 100.2, 99.42,
01131
                  98.88, 98.52, 98.25, 98.09, 98.07, 98.1, 98.12, 98.2, 98.25, 98.27,
                  98.26, 98.27, 98.36, 98.79, 100.2, 104.2, 113.7, 131.2, 159.5, 193, 220.4, 238.1, 250.2, 258.1, 264.7, 269.7, 273.7, 277.3, 280.2, 282.8,
01132
01133
```

```
284.9, 286.5, 288.1, 288.8, 289, 288.5, 287.2, 286.3, 286.1, 287.2,
01135
            287.5, 286.2, 285.8},
01136
           {335, 336, 335.7, 335.1, 332.3, 328.1, 320.6, 311.8, 305.1, 301.9,
01137
            297.6, 290, 280.4, 268.3, 254.6, 239.6, 223.9, 207.9, 192.2, 176.9,
01138
            161.7, 146.4, 132.2, 120.6, 112.3, 107.2, 104.3, 102.4, 101.3,
            100.4, 99.86, 99.47, 99.16, 98.97, 98.94, 98.97, 99, 99.09, 99.2,
01139
            99.31, 99.35, 99.41, 99.51, 99.86, 101.1, 104.9, 114.3, 131, 156.8,
01140
            186.3, 209.3, 224.6, 236.8, 246.3, 254.9, 262.3, 268.8, 274.8,
01141
01142
            279.9, 284.6, 288.6, 291.6, 294.9, 297.5, 299.8, 301.8, 303.1
           304.3, 304.9, 306, 306.6, 306.2, 306}, {306.2, 306.7, 305.7, 307.1, 307.3, 306.4, 301.8, 296.2, 292.4,
01143
01144
            290.3, 287.1, 280.9, 273.4, 264.3, 254.1, 242.8, 231, 219, 207.2,
01145
            195.5, 183.3, 169.7, 154.7, 138.7, 124.1, 113.6, 107.8, 104.7, 102.8, 101.7, 100.9, 100.4, 100, 99.79, 99.7, 99.66, 99.68, 99.79,
01146
01147
01148
            99.94, 100.2, 100.5, 100.9, 101.4, 102.1, 103.4, 107, 115.2, 129.1,
01149
            148.7, 171, 190.8, 205.6, 218.4, 229.4, 239.6, 248.6, 256.5,
01150
            263.7, 270.3, 276.6, 282.6, 288.1, 294.5, 300.4, 306.3, 311.4,
           315.1, 318.3, 320.3, 322.2, 322.8, 321.5, 321.1, {266.5, 264.9, 260.8, 261, 262, 263, 261.3, 259.7, 259.2, 259.8,
01151
            260.1, 258.6, 256.7, 253.6, 249.5, 243.9, 237.4, 230, 222.1, 213.9,
            205, 194.4, 180.4, 161.8, 140.7, 122.9, 112.1, 106.7, 104.1, 102.7,
01154
01155
            101.8, 101.4, 101.1, 101, 101, 101, 101.1, 101.2, 101.5, 101.9,
            102.4, 103, 103.8, 104.9, 106.8, 110.1, 115.6, 124, 135.2, 148.9, 165.2, 181.3, 198, 211.8, 223.5, 233.8, 242.9, 251.5, 259, 266.2, 273.1, 279.2, 286.2, 292.8, 299.6, 306, 311.1, 315.5, 318.8, 322.6,
01156
01157
01158
01159
            325.3, 325.8, 325.8},
           {220.1, 218.1, 210.8, 207.2, 207.6, 210.5, 211.4, 213.5, 217.3,
01160
01161
            222.4, 227.9, 232.8, 237.4, 240.8, 242.8, 243, 241.5, 238.6, 234.2,
01162
            228.5, 221, 210.7, 195.1, 172.9, 147.8, 127.6, 115.6, 109.9, 107.1,
            105.7, 105, 104.8, 104.8, 104.9, 105, 105.1, 105.3, 105.5, 105.8, 106.4, 107, 107.6, 108.1, 108.8, 110, 111.8, 114.2, 117.4, 121.6,
01163
01164
            127.9, 137.3, 151.2, 169.5, 189, 205.8, 218.9, 229.1, 237.8, 245,
01165
            251.5, 257.1, 262.3, 268.2, 274, 280.4, 286.7, 292.4, 297.9, 302.9,
01166
01167
            308.5, 312.2, 313.1, 313.3},
           {187.4, 184.5, 173.3, 166.1, 165.4, 167.8, 169.6, 173.6, 179.6, 187.9, 198.9, 210, 220.5, 229.2, 235.7, 239.9, 241.8, 241.6, 239.6, 235.8, 229.4, 218.6, 200.9, 175.9, 149.4, 129.4, 118.3, 113.1, 110.8, 109.7, 109.3, 109.4, 109.7, 110, 110.2, 110.4, 110.5, 110.7,
01168
01169
01170
01172
            111, 111.4, 111.8, 112.1, 112.3, 112.7, 113.2, 113.9, 115, 116.4,
            117.9, 120.4, 124.1, 130.9, 142.2, 159.6, 179.6, 198.5, 212.9, 224.2, 232.7, 239.1, 243.8, 247.7, 252.4, 257.3, 263.2, 269.5,
01173
01174
           275.4, 281.1, 286.3, 292, 296.3, 298.2, 298.8}, {166, 166.4, 155.7, 148.3, 147.1, 149, 152.1, 157, 163.6, 172.4, 185.3, 199.2, 212.6, 224, 233.2, 239.6, 243.3, 244.6, 243.6, 240.3,
01175
01176
01177
            233.9, 222.6, 203.7, 177, 149.5, 129.7, 119, 114, 111.7, 110.7,
01178
01179
            110.3, 110.3, 110.6, 110.9, 111.1, 111.3, 111.5, 111.6,
01180
            112.2, 112.5, 112.6, 112.8, 113, 113.4, 114, 115.1, 116.5, 118.3,
01181
            120.9, 124.4, 130.2, 139.4, 154.6, 173.8, 193.1, 208.1, 220.4,
            230.1, 238.2, 244.7, 249.5, 254.5, 259.3, 264.5, 269.4, 273.7, 278.2, 282.6, 287.4, 290.9, 292.5, 293},
01182
01183
           {171.9, 172.8, 166.2, 162.3, 161.4, 162.5, 165.2, 169.6, 175.3,
            183.1, 193.8, 205.9, 218.3, 229.6, 238.5, 244.3, 246.9, 246.7,
01185
01186
            243.8, 238.4, 230.2, 217.9, 199.6, 174.9, 148.9, 129.8, 119.5,
           114.8, 112.3, 110.9, 110.3, 110.1, 110.2, 110.3, 110.4, 110.5, 110.6, 110.8, 111, 111.4, 111.8, 112, 112.2, 112.4, 112.9, 113.6, 114.7, 116.3, 118.4, 121.9, 127.1, 136.1, 149.8, 168.4, 186.9, 203.3, 217, 229.1, 238.7, 247, 254, 259.3, 264.3, 268.3, 272.5,
01187
01188
01189
            276.6, 280.4, 284.4, 288.4, 293.3, 297.2, 298.7, 299.1},
01191
01192
           {191.6, 192.2, 189, 188.1, 190.2, 193.7, 197.8, 202.9, 208.5
            215.6, 224.2, 233.1, 241.2, 247.3, 250.8, 251.3, 248.9, 244.2,
01193
            237.3, 228.4, 217.2, 202.9, 184.5, 162.5, 140.7, 124.8, 116.2, 111.8, 109.4, 107.9, 107, 106.7, 106.6, 106.6, 106.7, 106.7,
01194
01195
01196
            106.8, 107, 107.4, 108, 108.7, 109.3, 109.8, 110.4, 111.2,
            112.4, 114.2, 116.9, 121.1, 127.9, 139.3, 155.2, 173.6, 190.7,
01197
01198
            206.1, 220.1, 232.3, 243, 251.8, 259.2, 265.7, 270.6, 275.3,
01199
            279.3, 283.3, 286.9, 289.7, 292.8, 296.1, 300.5, 303.9, 304.8,
01200
            305.1},
           241.5, 239.6, 236.8, 237.4, 239.4, 242.3, 244.2, 246.4, 249.2, 253.6, 258.6, 262.7, 264.8, 264.2, 260.6, 254.1, 245.5, 235.3,
01201
01202
            223.9, 211.7, 198.3, 183.1, 165.6, 147.1, 130.5, 118.7, 111.9,
            108.1, 105.8, 104.3, 103.4, 102.8, 102.5, 102.4, 102.5,
01204
01205
            102.5, 102.7, 103.1, 103.8, 104.6, 105.4, 106.1, 107, 108.2,
            109.9, 112.8, 117.5, 126, 140.4, 161, 181.9, 201.2, 216.8, 230.4, 241.8, 251.4, 259.9, 266.9, 272.8, 277.4, 280.4, 282.9, 284.6,
01206
01207
           286.1, 287.4, 288.3, 289.5, 290.9, 294.2, 296.9, 297.5, 297.6], {301.2, 300.3, 296.6, 295.4, 295, 294.3, 291.2, 287.4, 284.9, 284.7,
01208
01209
            284.1, 281.5, 277.1, 270.4, 261.7, 250.6, 237.6, 223.1, 207.9, 192,
01210
           175.8, 158.8, 142.1, 127.6, 116.8, 109.9, 106, 103.6, 102.1, 101.1, 100.4, 99.96, 99.6, 99.37, 99.32, 99.32, 99.31, 99.46, 99.77, 100.2, 100.7, 101.3, 101.8, 102.7, 104.1, 106.8, 111.9, 121, 136.7, 160, 186.9, 209.9, 228.1, 241.2, 251.5, 259.5, 265.7, 270.9, 274.8, 278,
01211
01212
01213
01214
            280.3, 281.8, 283, 283.3, 283.7, 283.8, 283, 282.2, 281.2, 281.4,
01216
            281.7, 281.1, 281.2}
01217
01218
01219
          double doy, p0, p1, pt;
01220
```

```
01221
        int imon, ilat;
01222
01223
        /* Get day of year... */
        doy = fmod(t / 86400., 365.25);
01224
        while (doy < 0)
  doy += 365.25;</pre>
01225
01226
01227
01228
        /* Get indices... */
        imon = locate(doys, 12, doy);
ilat = locate(lats, 73, lat);
01229
01230
01231
01232
        /* Get tropopause pressure... */
       p0 = LIN(lats[ilat], tps[imon][ilat],
lats[ilat + 1], tps[imon][ilat + 1], lat);
01233
01234
01235
        p1 = LIN(lats[ilat], tps[imon + 1][ilat],
01236
                  lats[ilat + 1], tps[imon + 1][ilat + 1], lat);
        pt = LIN(doys[imon], p0, doys[imon + 1], p1, doy);
01237
01238
01239
        /* Return tropopause pressure... */
01240
        return pt;
01241 }
01242
01244
01245 void write_atm(
01246
      const char *filename,
01247
        ctl_t * ctl,
01248
        atm_t * atm,
01249
        double t) {
01250
01251
       FILE *in, *out;
01252
01253
        char line[LEN];
01254
01255
        double r, t0, t1;
01256
01257
        int ip, iq, year, mon, day, hour, min, sec;
01258
01259
         /* Set time interval for output... */
        t0 = t - 0.5 * ctl->dt_mod;

t1 = t + 0.5 * ctl->dt_mod;
01260
01261
01262
        /* Check if gnuplot output is requested... */
if (ctl->atm_gpfile[0] != '-') {
01263
01264
01265
01266
          /* Write info... */
01267
          printf("Plot atmospheric data: %s.png\n", filename);
01268
01269
          /* Create gnuplot pipe... */
if (!(out = popen("gnuplot", "w")))
01270
            ERRMSG("Cannot create pipe to gnuplot!");
01272
          /* Set plot filename... */ fprintf(out, "set out \"%s.png\"\n", filename);
01273
01274
01275
01276
          /* Set time string... */
          jsec2time(t, &year, &mon, &day, &hour, &min, &sec, &r);
fprintf(out, "timestr=\"%d-%02d-%02d, %02d:%02d UTC\"\n",
01277
01278
01279
                   year, mon, day, hour, min);
01280
          /\star Dump gnuplot file to pipe... \star/
01281
          if (!(in = fopen(ctl->atm_gpfile, "r")))
    ERRMSG("Cannot open file!");
01282
01283
01284
          while (fgets(line, LEN, in))
01285
            fprintf(out, "%s", line);
01286
          fclose(in);
01287
01288
01289
        else {
01291
           /* Write info... */
01292
          printf("Write atmospheric data: %s\n", filename);
01293
01294
          /* Create file... */
01295
          if (!(out = fopen(filename, "w")))
01296
             ERRMSG("Cannot create file!");
01297
01298
01299
         /* Write header... */
01300
        fprintf(out.
                 "# $1 = time [s]\n"
01301
                 "# $2 = altitude [km] \n"
01302
01303
                "# $3 = longitude [deg] \n" "# <math>$4 = latitude [deg] \n");
01304
        for (iq = 0; iq < ctl->nq; iq++)
01305
01306
01307
```

```
01308
01309
         /* Write data... */
01310
        for (ip = 0; ip < atm->np; ip++) {
01311
01312
           /* Check time... */
          if (ctl->atm_filter && (atm->time[ip] < t0 || atm->time[ip] > t1))
01313
01314
            continue;
01315
           /* Write output... */
01316
          fprintf(out, "%.2f %g %g %g", atm->time[ip], Z(atm->p[ip]),
    atm->lon[ip], atm->lat[ip]);
01317
01318
           for (iq = 0; iq < ctl->nq; iq++) {
  fprintf(out, " ");
01319
01320
01321
            fprintf(out, ctl->qnt_format[iq], atm->q[iq][ip]);
01322
01323
          fprintf(out, "\n");
01324
01325
01326
         /* Close file... */
01327
        fclose(out);
01328 }
01329
01331
01332 void write_csi(
01333
        const char *filename,
        ctl_t * ctl,
01334
01335
        atm_t * atm,
01336
        double t) {
01337
01338
        static FILE *in, *out;
01339
01340
        static char line[LEN];
01341
01342
        static double modmean[GX][GY][GZ], obsmean[GX][GY][GZ],
01343
          rt, rz, rlon, rlat, robs, t0, t1, area, dlon, dlat, lat;
01344
01345
        static int init, obscount[GX][GY][GZ], cx, cy, cz, ip, ix, iy, iz;
01346
01347
         /* Init... */
01348
        if (!init) {
01349
          init = 1;
01350
           /\star Check quantity index for mass... \star/
01351
          if (ctl->qnt_m < 0)
01352
01353
             ERRMSG("Need quantity mass to analyze CSI!");
01354
01355
           /\star Open observation data file... \star/
          printf("Read CSI observation data: %s\n", ctl->csi_obsfile);
if (!(in = fopen(ctl->csi_obsfile, "r")))
01356
01357
            ERRMSG("Cannot open file!");
01358
01359
01360
           /* Create new file... */
          printf("Write CSI data: %s\n", filename);
if (!(out = fopen(filename, "w")))
01361
01362
            ERRMSG("Cannot create file!");
01363
01364
01365
           /* Write header... */
01366
          fprintf(out,
                   "# $1 = time [s]\n"
"# $2 = number of hits (cx)\n"
"# $3 = number of misses (cy)\n"
01367
01368
01369
01370
                   "# $4 = number of false alarms (cz)\n"
01371
                   "# $5 = number of observations (cx + cy) \n"
01372
                   "# $6 = number of forecasts (cx + cz)\n"
01373
                   "# \$7 = bias (forecasts/observations) [%%] \n"
                   "# $8 = probability of detection (POD) [%%]\n" # $9 = false alarm rate (FAR) [%%]\n"
01374
01375
01376
                    "# $10 = critical success index (CSI) [%%]\n\n");
        }
01378
01379
        /* Set time interval... */
        t0 = t - 0.5 * ctl->dt_mod;
t1 = t + 0.5 * ctl->dt_mod;
01380
01381
01382
01383
         /* Initialize grid cells... */
01384
        for (ix = 0; ix < ctl->csi_nx; ix++)
         for (iy = 0; iy < ctl->csi_ny; iy++)
for (iz = 0; iz < ctl->csi_nz; iz++)
01385
01386
               modmean[ix][iy][iz] = obsmean[ix][iy][iz] = obscount[ix][iy][iz] = 0;
01387
01388
01389
        /* Read data... */
01390
        while (fgets(line, LEN, in)) {
01391
           /* Read data... */
01392
           if (sscanf(line, "%lg %lg %lg %lg", &rt, &rz, &rlon, &rlat, &robs) !=
01393
01394
```

```
01395
             continue;
01396
01397
           /* Check time... */
           if (rt < t0)
01398
01399
             continue;
           if (rt > t1)
01400
01401
             break;
01402
01403
           /* Calculate indices... */
01404
           ix = (int) ((rlon - ctl->csi_lon0))
           / (ctl->csi_lon1 - ctl->csi_lon0) * ctl->csi_nx);
iy = (int) ((rlat - ctl->csi_lat0) * ctl->csi_ny);
/ (ctl->csi_lat1 - ctl->csi_lat0) * ctl->csi_ny);
01405
01406
01407
01408
           iz = (int) ((rz - ctl -> csi_z0))
01409
                         / (ctl->csi_z1 - ctl->csi_z0) * ctl->csi_nz);
01410
           /* Check indices... */
if (ix < 0 || ix >= ctl->csi_nx ||
    iy < 0 || iy >= ctl->csi_ny || iz < 0 || iz >= ctl->csi_nz)
01411
01412
01413
01414
              continue:
01415
01416
           /\star Get mean observation index... \star/
01417
           obsmean[ix][iy][iz] += robs;
01418
           obscount[ix][iy][iz]++;
01419
01420
         /* Analyze model data... */
01421
01422
         for (ip = 0; ip < atm->np; ip++) {
01423
           /* Check time... */
if (atm->time[ip] < t0 || atm->time[ip] > t1)
01424
01425
01426
             continue;
01427
01428
           /\star Get indices... \star/
01429
           ix = (int) ((atm->lon[ip] - ctl->csi_lon0)
                          / (ctl->csi_lon1 - ctl->csi_lon0) * ctl->csi_nx);
01430
           iy = (int) ((atm->lat[ip] - ctl->csi_lat0)
01431
                           (ctl->csi_lat1 - ctl->csi_lat0) * ctl->csi_ny);
01432
           01433
01434
01435
           /* Check indices... */
01436
           if (ix < 0 || ix >= ctl->csi_nx ||
01437
01438
               iy < 0 || iy >= ctl->csi_ny || iz < 0 || iz >= ctl->csi_nz)
01439
              continue;
01440
01441
           /\star Get total mass in grid cell... \star/
01442
           modmean[ix][iy][iz] += atm->q[ctl->qnt_m][ip];
01443
01444
01445
         /* Analyze all grid cells... */
01446
         for (ix = 0; ix < ctl->csi_nx; ix++)
01447
           for (iy = 0; iy < ctl->csi_ny; iy++)
01448
             for (iz = 0; iz < ctl->csi_nz; iz++) {
01449
01450
                /* Calculate mean observation index... */
                if (obscount[ix][iy][iz] > 0)
01452
                  obsmean[ix][iy][iz] /= obscount[ix][iy][iz];
01453
                /* Calculate column density... */
01454
                if (modmean[ix][iy][iz] > 0) {
  dlon = (ctl->csi_lon1 - ctl->csi_lon0) / ctl->csi_nx;
  dlat = (ctl->csi_lat1 - ctl->csi_lat0) / ctl->csi_ny;
01455
01456
01457
                  lat = ctl -> csi_lat0 + dlat * (iy + 0.5);
01458
                  area = dlat * M_PI * RE / 180. * dlon * M_PI * RE / 180.
  * cos(lat * M_PI / 180.);
modmean[ix][iy][iz] /= (1e6 * area);
01459
01460
01461
                }
01462
01463
01464
                /* Calculate CSI... */
01465
                if (obscount[ix][iy][iz] > 0) {
                  if (obsmean[ix][iy][iz] >= ctl->csi_obsmin &&
    modmean[ix][iy][iz] >= ctl->csi_modmin)
01466
01467
01468
                    cx++;
                  else if (obsmean[ix][iy][iz] >= ctl->csi_obsmin &&
01469
01470
                             modmean[ix][iy][iz] < ctl->csi_modmin)
01471
                    cy++;
01472
                  else if (obsmean[ix][iy][iz] < ctl->csi_obsmin &&
                            modmean[ix][iy][iz] >= ctl->csi_modmin)
01473
01474
                    CZ++:
01475
               }
01477
01478
         /* Write output... */
01479
         if (fmod(t, ctl->csi_dt_out) == 0) {
01480
01481
           /* Write... */
```

```
fprintf(out, "%.2f %d %d %d %d %d %g %g %g %g\n",
                   t, cx, cy, cz, cx + cy, cx + cz,

(cx + cy > 0) ? 100. * (cx + cz) / (cx + cy) : GSL_NAN,

(cx + cy > 0) ? (100. * cx) / (cx + cy) : GSL_NAN,

(cx + cz > 0) ? (100. * cz) / (cx + cz) : GSL_NAN,

(cx + cy + cz > 0) ? (100. * cx) / (cx + cy + cz) : GSL_NAN);
01484
01485
01486
01487
01488
01489
           /* Set counters to zero... */
01490
          cx = cy = cz = 0;
01491
01492
        /* Close file... */
if (t == ctl->t_stop)
01493
01494
01495
          fclose(out);
01496 }
01497
01499
01500 void write_ens(
01501
        const char *filename,
01502
        ctl_t * ctl,
        atm_t * atm,
01503
01504
        double t) {
01505
01506
        static FILE *out;
01507
01508
       static double dummy, ens, lat, lon, p[NENS], q[NQ][NENS],
01509
        t0, t1, x[NENS][3], xm[3];
01510
01511
        static int init, ip, iq;
01512
01513
        static size_t i, n;
01514
01515
        /* Init... */
01516
        if (!init) {
01517
          init = 1;
01518
01519
          /* Check quantities... */
01520
          if (ctl->qnt_ens < 0)</pre>
01521
           ERRMSG("Missing ensemble IDs!");
01522
01523
          /* Create new file... */
          printf("Write ensemble data: %s\n", filename);
if (!(out = fopen(filename, "w")))
01524
01525
            ERRMSG("Cannot create file!");
01526
01527
           /* Write header... */
01528
          01529
01530
                   "# $2 = altitude [km] \n"
01531
                   "# $3 = longitude [deg]\n" "# $4 = latitude [deg]\n");
01532
           for (iq = 0; iq < ctl->nq; iq++)
  fprintf(out, "# $%d = %s (mean) [%s]\n", 5 + iq,
01533
01534
          01535
01536
01537
01539
          fprintf(out, "# \$%d = number of membersn\n", 5 + 2 * ctl->nq);
01540
01541
01542
        /* Set time interval... */
        t0 = t - 0.5 * ctl->dt_mod;
01543
01544
        t1 = t + 0.5 * ctl->dt_mod;
01545
01546
        /* Init... */
01547
        ens = GSL_NAN;
        n = 0:
01548
01549
        /* Loop over air parcels... */
01550
        for (ip = 0; ip < atm->np; ip++) {
01552
01553
          /* Check time... */
01554
         if (atm->time[ip] < t0 || atm->time[ip] > t1)
01555
            continue:
01556
          /* Check ensemble id... */
01558
          if (atm->q[ctl->qnt_ens][ip] != ens) {
01559
01560
            /* Write results... */
            if (n > 0) {
01561
01562
01563
               /* Get mean position... */
01564
               xm[0] = xm[1] = xm[2] = 0;
01565
               for (i = 0; i < n; i++) {</pre>
                xm[0] += x[i][0] / (double) n;
xm[1] += x[i][1] / (double) n;
xm[2] += x[i][2] / (double) n;
01566
01567
01568
```

```
cart2geo(xm, &dummy, &lon, &lat);
fprintf(out, "%.2f %g %g %g", t, Z(gsl_stats_mean(p, 1, n)), lon,
01570
01571
01572
                        lat);
01573
01574
                /* Get quantity statistics... */
               for (iq = 0; iq < ctl->nq; iq++) {
   fprintf(out, " ");
01575
01576
01577
                  fprintf(out, ctl->qnt_format[iq], gsl_stats_mean(q[iq], 1, n));
01578
               for (iq = 0; iq < ctl->nq; iq++) {
  fprintf(out, " ");
01579
01580
01581
                  fprintf(out, ctl->qnt_format[iq], gsl_stats_sd(q[iq], 1, n));
01582
01583
               fprintf(out, " lu\n", n);
01584
01585
01586
             /* Init new ensemble... */
01587
             ens = atm->q[ctl->qnt_ens][ip];
             n = 0;
01588
01589
01590
           /\star Save data... \star/
01591
           p[n] = atm->p[ip];
01592
01593
           geo2cart(0, atm->lon[ip], atm->lat[ip], x[n]);
           for (iq = 0; iq < ctl->nq; iq++)
01594
01595
             q[iq][n] = atm->q[iq][ip];
           if ((++n) >= NENS)

ERRMSG("Too many data points!");
01596
01597
01598
01599
01600
         /* Write results... */
01601
        if (n > 0) {
01602
01603
           /* Get mean position...
           xm[0] = xm[1] = xm[2] = 0;
for (i = 0; i < n; i++) {
  xm[0] += x[i][0] / (double) n;</pre>
01604
01605
01606
01607
             xm[1] += x[i][1] / (double) n;
01608
             xm[2] += x[i][2] / (double) n;
01609
           cart2geo(xm, &dummy, &lon, &lat);
fprintf(out, "%.2f %g %g %g", t, Z(gsl_stats_mean(p, 1, n)), lon, lat);
01610
01611
01612
01613
           /* Get quantity statistics... */
           for (iq = 0; iq < ctl->nq; iq++) {
   fprintf(out, " ");
01614
01615
01616
             fprintf(out, ctl->qnt\_format[iq], gsl\_stats\_mean(q[iq], 1, n));\\
01617
           for (iq = 0; iq < ctl->nq; iq++) {
  fprintf(out, " ");
  fprintf(out, ctl->qnt_format[iq], gsl_stats_sd(q[iq], 1, n));
01618
01619
01620
01621
01622
           fprintf(out, " lu\n", n);
01623
01624
01625
         /* Close file... */
        if (t == ctl->t_stop)
01626
01627
           fclose(out);
01628 3
01629
01631
01632 void write_grid(
01633
        const char *filename,
01634
        ctl_t * ctl,
        met_t * met0,
01635
        met t * met1.
01636
01637
        atm_t * atm,
        double t) {
01638
01639
01640
        FILE *in, *out;
01641
        char line[LEN];
01642
01643
01644
        static double grid_m[GX][GY][GZ], z, dz, lon, dlon, lat, dlat,
01645
           area, rho_air, press, temp, cd, mmr, t0, t1, r;
01646
01647
        static int ip, ix, iy, iz, year, mon, day, hour, min, sec;
01648
01649
        /* Check dimensions... */
        if (ctl->grid_nx > GX || ctl->grid_ny > GY || ctl->grid_nz > GZ)
    ERRMSG("Grid dimensions too large!");
01650
01651
01652
01653
         /\star Check quantity index for mass... \star/
        if (ctl->qnt m < 0)
01654
01655
           ERRMSG("Need quantity mass to write grid data!");
```

```
/\star Set time interval for output... \star/
01657
         t0 = t - 0.5 * ctl->dt_mod;
t1 = t + 0.5 * ctl->dt_mod;
01658
01659
01660
01661
          /* Set grid box size... */
         dz = (ctl->grid_z1 - ctl->grid_z0) / ctl->grid_nz;
01662
         dlon = (ctl->grid_lon1 - ctl->grid_lon0) / ctl->grid_nx;
01663
         dlat = (ctl->grid_lat1 - ctl->grid_lat0) / ctl->grid_ny;
01664
01665
01666
          /* Initialize grid... */
         for (ix = 0; ix < ctl->grid_nx; ix++)
01667
           for (iy = 0; iy < ctl->grid_ny; iy++)
for (iz = 0; iz < ctl->grid_nz; iz++)
01668
01669
01670
                 grid_m[ix][iy][iz] = 0;
01671
         /* Average data... */
for (ip = 0; ip < atm->np; ip++)
  if (atm->time[ip] >= t0 && atm->time[ip] <= t1) {</pre>
01672
01673
01674
01676
              ix = (int) ((atm->lon[ip] - ctl->grid_lon0) / dlon);
iy = (int) ((atm->lat[ip] - ctl->grid_lat0) / dlat);
iz = (int) ((Z(atm->p[ip]) - ctl->grid_z0) / dz);
01677
01678
01679
01680
01681
               /* Check indices... */
01682
               if (ix < 0 || ix >= ctl->grid_nx ||
01683
                   iy < 0 || iy >= ctl->grid_ny || iz < 0 || iz >= ctl->grid_nz)
01684
                 continue;
01685
01686
               /* Add mass... */
              grid_m[ix][iy][iz] += atm->q[ctl->qnt_m][ip];
01687
01688
01689
         /* Check if gnuplot output is requested... */
if (ctl->grid_gpfile[0] != '-') {
01690
01691
01692
01693
            /* Write info... */
01694
           printf("Plot grid data: %s.png\n", filename);
01695
            /* Create gnuplot pipe... */
if (!(out = popen("gnuplot", "w")))
01696
01697
             ERRMSG("Cannot create pipe to gnuplot!");
01698
01699
            /* Set plot filename... */ fprintf(out, "set out \"%s.png\"\n", filename);
01700
01701
01702
01703
            /* Set time string... */
            jsec2time(t, &year, &mon, &day, &hour, &min, &sec, &r);
fprintf(out, "timestr=\"%d-%02d-%02d, %02d:%02d UTC\"\n",
01704
01705
                      year, mon, day, hour, min);
01707
01708
            /* Dump gnuplot file to pipe... */
           if (!(in = fopen(ctl->grid_gpfile, "r")))
    ERRMSG("Cannot open file!");
01709
01710
            while (fgets(line, LEN, in))
fprintf(out, "%s", line);
01711
01712
01713
           fclose(in);
01714
01715
01716
         else {
01717
            /* Write info... */
01719
           printf("Write grid data: %s\n", filename);
01720
            /* Create file... */
01721
            if (!(out = fopen(filename, "w")))
01722
              ERRMSG("Cannot create file!");
01723
01724
01725
01726
         /* Write header... */
01727
         fprintf(out,
01728
                   "# $1 = time [s] \n"
                   "# $2 = altitude [km] \n"
01729
01730
                   "# $3 = longitude [deg]\n"
01731
                   "# $4 = latitude [deg]\n"
01732
                   "# $5 = surface area [km^2]\n"
01733
                   "# $6 = layer width [km] \n"
                    "# $7 = temperature [K] \n"
01734
                   01735
01736
01738
          /* Write data... */
01739
         for (ix = 0; ix < ctl->grid_nx; ix++) {
          if (ix > 0 && ctl->grid_ny > 1 && !ctl->grid_sparse)
    fprintf(out, "\n");
for (iy = 0; iy < ctl->grid_ny; iy++) {
01740
01741
01742
```

```
01743
             if (iy > 0 && ctl->grid_nz > 1 && !ctl->grid_sparse)
             fprintf(out, "\n");
for (iz = 0; iz < ctl->grid_nz; iz++)
01744
01745
               if (!ctl->grid_sparse
01746
                    || ix == 0 || iy == 0 || iz == 0 || grid_m[ix][iy][iz] > 0) 
01747
01748
01749
                 /* Set coordinates... */
01750
                  z = ctl->grid_z0 + dz * (iz + 0.5);
01751
                  lon = ctl->grid_lon0 + dlon * (ix + 0.5);
                 lat = ctl->grid_lat0 + dlat * (iy + 0.5);
01752
01753
01754
                 /* Get pressure and temperature... */
press = P(z);
01755
01756
                  intpol_met_time(met0, met1, t, press, lon, lat,
01757
                                   NULL, &temp, NULL, NULL, NULL, NULL, NULL);
01758
                 /* Calculate surface area... */
area = dlat * dlon * gsl_pow_2(RE * M_PI / 180.)
    * cos(lat * M_PI / 180.);
01759
01760
01761
01762
                  /* Calculate column density... ∗/
01763
01764
                 cd = grid_m[ix][iy][iz] / (1e6 * area);
01765
01766
                 /* Calculate mass mixing ratio... */
rho_air = 100. * press / (287.058 * temp);
mmr = grid_m[ix][iy][iz] / (rho_air * 1e6 * area * 1e3 * dz);
01767
01768
01769
                 01770
01771
01772
01773
               }
          }
01775
01776
01777
        /* Close file... */
01778
        fclose(out);
01779 }
01780
01782
01783 void write_prof(
01784
        const char *filename,
        ctl_t * ctl,
met_t * met0,
01785
01786
01787
        met_t * met1,
01788
        atm_t * atm,
01789
        double t) {
01790
01791
        static FILE *in, *out;
01792
01793
        static char line[LEN];
01794
01795
        static double mass[GX][GY][GZ], obsmean[GX][GY], tmean[GX][GY],
         rt, rlon, rlat, robs, t0, t1, area, dz, dlon, dlat, lon, lat, z, press, temp, rho_air, mmr, h2o, o3;
01796
01797
01798
01799
        static int init, obscount[GX][GY], ip, ix, iy, iz;
01800
01801
         /* Init... */
01802
        if (!init) {
01803
          init = 1;
01804
01805
           /* Check quantity index for mass... */
01806
          if (ctl->qnt_m < 0)
01807
             ERRMSG("Need quantity mass!");
01808
          /* Check dimensions... */
if (ctl->prof_nx > GX || ctl->prof_ny > GY || ctl->prof_nz > GZ)
    ERRMSG("Grid dimensions too large!");
01809
01810
01811
01813
           /* Open observation data file... */
01814
           printf("Read profile observation data: %s\n", ctl->prof_obsfile);
           if (!(in = fopen(ctl->prof_obsfile, "r")))
    ERRMSG("Cannot open file!");
01815
01816
01817
01818
           /* Create new file... */
01819
          printf("Write profile data: %s\n", filename);
          if (!(out = fopen(filename, "w")))
    ERRMSG("Cannot create file!");
01820
01821
01822
01823
           /* Write header... */
01824
           fprintf(out,
                           = time [s]\n"
01825
                    "# $1
01826
                    "# $2
                           = altitude [km] \n"
01827
                    "# $3 = longitude [deg] \n"
                    "# $4 = latitude [deg]\n"
"# $5 = pressure [hPa]\n"
01828
01829
```

```
"# $6 = temperature [K] \n"
                    "# $7 = mass mixing ratio [1]\n"
01832
                    "# $8 = H20 volume mixing ratio [1]\n"
                    "# $9 = 03 volume mixing ratio [1] n"
01833
                    "# $10 = mean BT index [K] \n");
01834
01835
01836
           /* Set grid box size... */
01837
           dz = (ctl->prof_z1 - ctl->prof_z0) / ctl->prof_nz;
          dlon = (ctl->prof_lon1 - ctl->prof_lon0) / ctl->prof_nx;
dlat = (ctl->prof_lat1 - ctl->prof_lat0) / ctl->prof_ny;
01838
01839
01840
01841
01842
         /\star Set time interval... \star/
01843
        t0 = t - 0.5 * ct1->dt_mod;
         t1 = t + 0.5 * ctl -> dt_mod;
01844
01845
         /* Initialize... */
01846
        for (ix = 0; ix < ctl->prof_nx; ix++)
01847
          for (iy = 0; iy < ctl->prof_ny; iy++) {
01848
             obsmean[ix][iy] = 0;
01849
01850
             obscount[ix][iy] = 0;
01851
             tmean[ix][iy] = 0;
             for (iz = 0; iz < ctl->prof_nz; iz++)
01852
01853
               mass[ix][iy][iz] = 0;
01854
01855
        /* Read data... */
01856
01857
        while (fgets(line, LEN, in)) {
01858
01859
           /* \ {\tt Read \ data...} \ */
          if (sscanf(line, "%lg %lg %lg %lg", &rt, &rlon, &rlat, &robs) != 4)
01860
01861
            continue;
01862
01863
           /\star Check time... \star/
01864
           if (rt < t0)
01865
             continue;
           if (rt > t1)
01866
01867
            break;
01868
01869
           /* Calculate indices... */
          ix = (int) ((rlon - ctl->prof_lon0) / dlon);
iy = (int) ((rlat - ctl->prof_lat0) / dlat);
01870
01871
01872
01873
           /* Check indices... */
01874
           if (ix < 0 || ix >= ctl->prof_nx || iy < 0 || iy >= ctl->prof_ny)
01875
             continue;
01876
01877
           /* Get mean observation index... */
01878
           obsmean[ix][iy] += robs;
tmean[ix][iy] += rt;
01879
01880
          obscount[ix][iy]++;
01881
01882
01883
         /* Analyze model data... */
         for (ip = 0; ip < atm->np; ip++) {
01884
01885
          /* Check time... */
01887
          if (atm->time[ip] < t0 || atm->time[ip] > t1)
01888
01889
          /* Get indices... */
ix = (int) ((atm->lon[ip] - ctl->prof_lon0) / dlon);
iy = (int) ((atm->lat[ip] - ctl->prof_lat0) / dlat);
01890
01891
01892
01893
           iz = (int) ((Z(atm->p[ip]) - ctl->prof_z0) / dz);
01894
           /* Check indices... */
if (ix < 0 || ix >= ctl->prof_nx ||
01895
01896
               iy < 0 || iy >= ctl->prof_ny || iz < 0 || iz >= ctl->prof_nz)
01897
01898
             continue:
01900
           /\star Get total mass in grid cell... \star/
01901
          mass[ix][iy][iz] += atm->q[ctl->qnt_m][ip];
01902
01903
01904
         /* Extract profiles... */
01905
         for (ix = 0; ix < ctl->prof_nx; ix++)
01906
          for (iy = 0; iy < ctl->prof_ny; iy++)
01907
             if (obscount[ix][iy] > 0) {
01908
01909
                /* Write output... */
               fprintf(out, "\n");
01910
01911
01912
                /* Loop over altitudes... */
01913
                for (iz = 0; iz < ctl->prof_nz; iz++) {
01914
                 /* Set coordinates... */
z = ctl->prof_z0 + dz * (iz + 0.5);
01915
01916
```

```
lon = ctl - prof_lon0 + dlon * (ix + 0.5);
01918
               lat = ctl->prof_lat0 + dlat * (iy + 0.5);
01919
01920
               /* Get meteorological data... */
                press = P(z);
01921
                intpol_met_time(met0, met1, t, press, lon, lat,
01922
                               NULL, &temp, NULL, NULL, NULL, &h2o, &o3);
01923
01924
               /* Calculate mass mixing ratio... */
rho_air = 100. * press / (287.058 * temp);
area = dlat * dlon * gsl_pow_2(M_PI * RE / 180.)
* cos(lat * M_PI / 180.);
01925
01926
01927
01928
01929
               mmr = mass[ix][iy][iz] / (rho_air * area * dz * 1e9);
01930
01931
                /* Write output... */
               01932
01933
                       z, lon, lat, press, temp, mmr, h2o, o3, obsmean[ix][iy] / obscount[ix][iy]);
01934
01935
01936
             }
01937
01938
       /* Close file... */
01939
       if (t == ctl->t_stop)
01940
01941
         fclose(out);
01942 }
01943
01945
01946 void write station(
01947 const char *filename,
       ctl_t * ctl,
atm_t * atm,
01948
01949
01950
       double t) {
01951
       static FILE *out:
01952
01953
01954
       static double rmax2, t0, t1, x0[3], x1[3];
01955
01956
       static int init, ip, iq;
01957
01958
       /* Init... */
       if (!init) {
01959
01960
         init = 1;
01961
01962
          /* Write info... */
01963
         printf("Write station data: %s\n", filename);
01964
01965
          /* Create new file... */
         if (!(out = fopen(filename, "w")))
01966
           ERRMSG("Cannot create file!");
01967
01968
01969
         /* Write header... */
         01970
01971
                 "# $2 = altitude [km]\n"
"# $3 = longitude [deg]\n" "# $4 = latitude [deg]\n");
01972
01973
         01974
01975
01976
01977
01978
01979
          /* Set geolocation and search radius... */
01980
         geo2cart(0, ctl->stat_lon, ctl->stat_lat, x0);
01981
          rmax2 = gsl_pow_2(ctl->stat_r);
01982
01983
       /\star Set time interval for output... \star/
01984
       t0 = t - 0.5 * ct1->dt_mod;
01985
       t1 = t + 0.5 * ct1 -> dt_mod;
01987
01988
       /* Loop over air parcels... */
01989
       for (ip = 0; ip < atm->np; ip++) {
01990
         /* Check time... */
if (atm->time[ip] < t0 || atm->time[ip] > t1)
01991
01992
01993
           continue;
01994
01995
          /* Check station flag... */
         if (ctl->qnt_stat)[ip])
01996
01997
01998
             continue;
01999
02000
          /* Get Cartesian coordinates... */
02001
         geo2cart(0, atm->lon[ip], atm->lat[ip], x1);
02002
02003
         /* Check horizontal distance... */
```

```
if (DIST2(x0, x1) > rmax2)
02005
          continue;
02006
        /* Set station flag... */
if (ctl->qnt_stat >= 0)
  atm->q[ctl->qnt_stat][ip] = 1;
02007
02008
02009
02010
         /* Write data... */
02011
        02012
02013
02014
02015
           fprintf(out, ctl->qnt_format[iq], atm->q[iq][ip]);
02016
02017
02018
         fprintf(out, "\n");
02019 }
02020
       /* Close file... */
if (t == ctl->t_stop)
02021
02022
02023
         fclose(out);
02024 }
```

5.13 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 deg2dx (double dlon, double lat)

Convert degrees to horizontal distance.

double deg2dy (double dlat)

Convert degrees to horizontal distance.

double dp2dz (double dp, double p)

Convert pressure to vertical distance.

double dx2deg (double dx, double lat)

Convert horizontal distance to degrees.

• double dy2deg (double dy)

Convert horizontal distance to degrees.

• double dz2dp (double dz, double p)

Convert vertical distance to pressure.

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 *t, double *u, double *v, double *v, 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 *t, double *u, double *v, double *w, 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 (double *xx, int n, double x)

Find array index.

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_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.

 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.

- double tropopause (double t, double lat)
- 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.

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

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.

5.13.1 Detailed Description

MPTRAC library declarations.

Definition in file libtrac.h.

5.13.2 Function Documentation

```
5.13.2.1 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;
```

5.13.2.2 double deg2dx (double dlon, double lat)

Convert degrees to horizontal distance.

Definition at line 45 of file libtrac.c.

5.13.2.3 double deg2dy (double dlat)

Convert degrees to horizontal distance.

Definition at line 54 of file libtrac.c.

```
00055 {
00056
00057 return dlat * M_PI * RE / 180.;
00058 }
```

5.13.2.4 double dp2dz (double dp, double p)

Convert pressure to vertical distance.

Definition at line 62 of file libtrac.c.

```
00064 {
00065
00066 return -dp * H0 / p;
00067 }
```

```
5.13.2.5 double dx2deg ( double dx, double lat )
```

Convert horizontal distance to degrees.

Definition at line 71 of file libtrac.c.

5.13.2.6 double dy2deg (double dy)

Convert horizontal distance to degrees.

Definition at line 84 of file libtrac.c.

```
00085 {
00086
00087 return dy * 180. / (M_PI * RE);
00088 }
```

5.13.2.7 double dz2dp (double dz, double p)

Convert vertical distance to pressure.

Definition at line 92 of file libtrac.c.

```
00094 {
00095
00096 return -dz * p / H0;
00097 }
```

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

Convert geolocation to Cartesian coordinates.

Definition at line 101 of file libtrac.c.

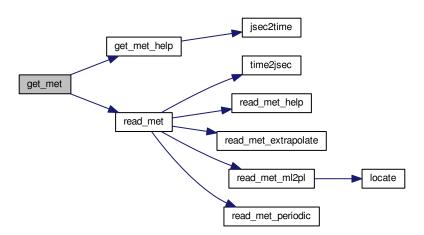
5.13.2.9 void get_met(ctl_t * *ctl*, char * *metbase*, double *t*, met_t * *met0*, met_t * *met1*)

Get meteorological data for given timestep.

Definition at line 117 of file libtrac.c.

```
00122
00123
00124
        char filename[LEN];
00125
00126
        static int init;
00127
        /* Init... */
00128
        if (!init) {
00129
00130
         init = 1;
00132
          get_met_help(t, -1, metbase, ctl->dt_met, filename);
00133
          read_met(ctl, filename, met0);
00134
          get_met_help(t + 1.0 * ctl->direction, 1, metbase, ctl->
00135
      dt_met, filename);
00136
         read_met(ctl, filename, met1);
00137
00138
        /\star Read new data for forward trajectories... \star/
00139
00140
        if (t > met1->time && ct1->direction == 1) {
        memcpy(met0, met1, sizeof(met_t));
00141
         get_met_help(t, 1, metbase, ctl->dt_met, filename);
read_met(ctl, filename, met1);
00143
00144
00145
00146
        /* Read new data for backward trajectories... */
        if (t < met0->time && ctl->direction == -1) {
00147
         memcpy(met1, met0, sizeof(met_t));
00149
          get_met_help(t, -1, metbase, ctl->dt_met, filename);
00150
         read_met(ctl, filename, met0);
00151
00152 }
```

Here is the call graph for this function:



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

Get meteorological data for timestep.

Definition at line 156 of file libtrac.c.

```
00161
                          {
00162
00163
        double t6, r;
00164
00165
        int year, mon, day, hour, min, sec;
00166
00167
        /\star Round time to fixed intervals... \star/
00168
        if (direct == -1)
00169
          t6 = floor(t / dt_met) * dt_met;
00170
        else
00171
          t6 = ceil(t / dt_met) * dt_met;
00172
00173
        /* Decode time... */
00174
        jsec2time(t6, &year, &mon, &day, &hour, &min, &sec, &r);
00175
        /* Set filename... */
sprintf(filename, "%s_%d_%02d_%02d_%02d.nc", metbase, year, mon, day, hour);
00176
00177
00178 }
```

Here is the call graph for this function:



5.13.2.11 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 182 of file libtrac.c.

```
00188
00189
00190
           double aux00, aux01, aux10, aux11;
00191
00192
           /* Set variables...
          /* Set Variables...*/
aux00 = array[ix][iy];
aux01 = array[ix][iy + 1];
aux10 = array[ix + 1][iy];
aux11 = array[ix + 1][iy + 1];
00193
00194
00195
00196
00197
00198
           /* Interpolate horizontally... */
          aux00 = wy * (aux00 - aux01) + aux01;
aux11 = wy * (aux10 - aux11) + aux11;
00199
00200
00201
           *var = wx * (aux00 - aux11) + aux11;
00202 }
```

5.13.2.12 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 206 of file libtrac.c.

```
00214
00215
00216
         double aux00, aux01, aux10, aux11;
00217
00218
        /* Interpolate vertically... */
        aux00 = wp * (array[ix][iy][ip] - array[ix][iy][ip + 1])
00219
          + array[ix][iy][ip + 1];
00220
00221
        aux01 = wp * (array[ix][iy + 1][ip] - array[ix][iy + 1][ip + 1])
        + array[ix][iy + 1][ip + 1];
aux10 = wp * (array[ix + 1][iy][ip] - array[ix + 1][iy][ip + 1])
00222
00223
        + array[ix + 1][iy][ip + 1];
aux11 = wp * (array[ix + 1][iy + 1][ip] - array[ix + 1][iy + 1][ip + 1])
00224
00225
00226
         + array[ix + 1][iy + 1][ip + 1];
00227
00228
        /* Interpolate horizontally... */
       aux00 = wy * (aux00 - aux01) + aux01;

aux11 = wy * (aux10 - aux11) + aux11;
00229
00230
00231
        *var = wx * (aux00 - aux11) + aux11;
00232 }
```

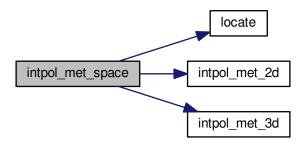
5.13.2.13 void intpol_met_space (met_t * met, double p, double lon, double lon

Spatial interpolation of meteorological data.

Definition at line 236 of file libtrac.c.

```
00247
00248
00249
        double wp, wx, wv;
00250
00251
        int ip, ix, iy;
00252
00253
        /* Check longitude... */
        if (met->lon[met->nx - 1] > 180 && lon < 0)
00254
00255
          lon += 360;
00256
00257
        /* Get indices... */
00258
        ip = locate(met->p, met->np, p);
00259
        ix = locate(met->lon, met->nx, lon);
00260
        iy = locate(met->lat, met->ny, lat);
00261
00262
        /* Get weights... */
        wp = (met->p[ip + 1] - p) / (met->p[ip + 1] - met->p[ip]);
wx = (met->lon[ix + 1] - lon) / (met->lon[ix + 1] - met->lon[ix]);
wy = (met->lat[iy + 1] - lat) / (met->lat[iy + 1] - met->lat[iy]);
00263
00264
00265
00266
00267
        /* Interpolate... */
00268
        if (ps != NULL)
           intpol_met_2d(met->ps, ix, iy, wx, wy, ps);
00269
00270
        if (t != NULL)
00271
           intpol_met_3d(met->t, ip, ix, iy, wp, wx, wy, t);
00272
        if (u != NULL)
00273
          intpol_met_3d(met->u, ip, ix, iy, wp, wx, wy, u);
00274
         if (v != NULL)
00275
           intpol_met_3d(met->v, ip, ix, iy, wp, wx, wy, v);
         if (w != NULL)
00276
           intpol_met_3d(met->w, ip, ix, iy, wp, wx, wy, w);
00277
00278
        if (h2o != NULL)
        intpol_met_3d(met->h2o, ip, ix, iy, wp, wx, wy, h2o);
if (o3 != NULL)
00279
00280
00281
          intpol_met_3d(met->o3, ip, ix, iy, wp, wx, wy, o3);
00282 }
```

Here is the call graph for this function:



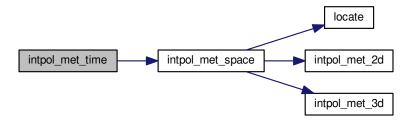
5.13.2.14 void intpol_met_time (met_t * met0, met_t * met1, double ts, double p, double lon, double lat, double * ps, double * t, double * u, double * v, double * w, double * b2o, double * o3)

Temporal interpolation of meteorological data.

Definition at line 286 of file libtrac.c.

```
00299
00300
00301
       double h2o0, h2o1, o30, o31, ps0, ps1, t0, t1, u0, u1, v0, v1, w0, w1, wt;
00302
00303
        /* Spatial interpolation... */
00304
       00305
00306
                         t == NULL ? NULL : &t0,
00307
                        u == NULL ? NULL : &u0,
00308
                        v == NULL ? NULL : &v0,
00309
                        w == NULL ? NULL : &w0,
                        h2o == NULL ? NULL : &h2o0, o3 == NULL ? NULL : &o30);
00310
       00311
00312
00313
                         t == NULL ? NULL : &t1,
00314
                        u == NULL ? NULL : &u1,
00315
                        v == NULL ? NULL : &v1,
00316
                        w == NULL ? NULL : &w1,
00317
                        h2o == NULL ? NULL : &h2o1, o3 == NULL ? NULL : &o31);
00318
       /* Get weighting factor... */ wt = (met1->time - ts) / (met1->time - met0->time);
00319
00320
00321
00322
       /* Interpolate... */
00323
       if (ps != NULL)
         *ps = wt * (ps0 - ps1) + ps1;
00324
       if (t != NULL)
00325
       *t = wt * (t0 - t1) + t1;
if (u != NULL)
00326
00327
         *u = wt * (u0 - u1) + u1;
00328
       if (v != NULL)
00329
         *v = wt * (v0 - v1) + v1;
00330
       if (w != NULL)
00331
00332
          \star w = wt \star (w0 - w1) + w1;
       if (h2o != NULL)
00333
00334
         *h2o = wt * (h2o0 - h2o1) + h2o1;
       if (o3 != NULL)
00335
00336
         *o3 = wt * (o30 - o31) + o31;
00337 }
```

Here is the call graph for this function:



5.13.2.15 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 341 of file libtrac.c.

```
00349
                         {
00350
       struct tm t0, *t1;
00352
00353
       time_t jsec0;
00354
00355
       t0.tm_year = 100;
        t0.tm_mon = 0;
00356
00357
        t0.tm_mday = 1;
00358
        t0.tm\_hour = 0;
00359
        t0.tm_min = 0;
       t0.tm\_sec = 0;
00360
00361
        jsec0 = (time_t) jsec + timegm(&t0);
00362
00363
       t1 = gmtime(&jsec0);
00364
00365
        *year = t1->tm_year + 1900;
       *mon = t1->tm_mon + 1;
*day = t1->tm_mday;
00366
00367
00368
       *hour = t1->tm_hour;
       *min = t1->tm_min;
00369
00370
       *sec = t1->tm_sec;
00371
       *remain = jsec - floor(jsec);
00372 }
```

5.13.2.16 int locate (double *xx, int n, double x)

Find array index.

Definition at line 376 of file libtrac.c.

```
00379
00380
00381
          int i, ilo, ihi;
00382
00383
          ilo = 0;
00384
         ihi = n - 1;
00385
         i = (ihi + ilo) >> 1;
00386
         if (xx[i] < xx[i + 1])
  while (ihi > ilo + 1) {
   i = (ihi + ilo) >> 1;
00387
00388
00389
00390
               if (xx[i] > x)
```

```
ihi = i;
00392
             else
00393
               ilo = i;
00394
        } else
          while (ihi > ilo + 1) {
  i = (ihi + ilo) >> 1;
00395
00396
             if (xx[i] <= x)
00398
               ihi = i;
00399
             else
00400
               ilo = i;
          }
00401
00402
00403
        return ilo;
00404 }
```

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

Read atmospheric data.

Definition at line 408 of file libtrac.c.

```
00411
00412
00413
          FILE *in:
00414
          char line[LEN], *tok;
00416
00417
          int iq;
00418
          /* Init... */
atm->np = 0;
00419
00420
00421
00422
00423
          printf("Read atmospheric data: %s\n", filename);
00424
          /* Open file... */
if (!(in = fopen(filename, "r")))
00425
00426
             ERRMSG("Cannot open file!");
00428
00429
           /* Read line... */
          while (fgets(line, LEN, in)) {
00430
00431
             /* Read data... */
TOK(line, tok, "%lg", atm->time[atm->np]);
TOK(NULL, tok, "%lg", atm->p[atm->np]);
TOK(NULL, tok, "%lg", atm->lon[atm->np]);
TOK(NULL, tok, "%lg", atm->lat[atm->np]);
for (iq = 0; iq < ctl->nq; iq++)
TOK(NULL, tok, "%lg", atm->q[iq][atm->np]);
00432
00433
00434
00435
00436
00437
00438
00439
00440
              /\star Convert altitude to pressure... \star/
00441
              atm->p[atm->np] = P(atm->p[atm->np]);
00442
             /* Increment data point counter... */
if ((++atm->np) > NP)
00443
00444
                ERRMSG("Too many data points!");
00445
00447
00448
           /* Close file... */
00449
          fclose(in);
00450
00451
           /* Check number of points... */
           if (atm->np < 1)</pre>
00452
00453
              ERRMSG("Can not read any data!");
00454 }
```

5.13.2.18 void read_ctl (const char * filename, int argc, char * argv[], ctl_t * ctl_)

Read control parameters.

Definition at line 458 of file libtrac.c.

```
00462
00463
00464
        int ip, iq;
00465
00466
        /* Write info... */
         printf("\nMassive-Parallel Trajectory Calculations (MPTRAC)\n"
00467
                 "(executable: %s \mid compiled: %s, %s)\n\n",
00468
00469
                 argv[0], __DATE__, __TIME__);
00470
00471
         /* Initialize quantity indices... */
00472
        ctl->qnt_ens = -1;
        ctl->qnt_m = -1;
00473
        ctl->qnt_r = -1;
00474
00475
         ctl->qnt_rho = -1;
00476
         ctl->qnt_ps = -1;
         ctl \rightarrow qnt_p = -1;
00477
        ctl \rightarrow qnt_t = -1;
00478
        ctl->qnt_u = -1;
00479
00480
        ctl->qnt_v = -1;
         ctl->qnt_w = -1;
00481
00482
         ctl->qnt_h2o = -1;
         ct1->qnt_o3 = -1;
00483
00484
        ctl->qnt\_theta = -1;
00485
        ctl->qnt\_pv = -1;
        ctl->qnt\_tice = -1;
00486
        ctl \rightarrow qnt_tsts = -1;
00487
         ctl->qnt\_tnat = -1;
00488
00489
         ctl->qnt_gw_var = -1;
00490
        ctl->qnt\_stat = -1;
00491
00492
         /* Read quantities... */
00493
         ctl->nq = (int) scan_ctl(filename, argc, argv, "NQ", -1, "0", NULL);
00494
         if (ctl->nq > NQ)
00495
          ERRMSG("Too many quantities!");
00496
         for (iq = 0; iq < ctl->nq; iq++) {
00497
           /* Read quantity name and format... */
scan_ctl(filename, argc, argv, "QNT_NAME", iq, "", ctl->qnt_name[iq]);
scan_ctl(filename, argc, argv, "QNT_FORMAT", iq, "%g",
00498
00500
00501
                     ctl->qnt_format[iq]);
00502
           /* Try to identify quantity... */
if (strcmp(ctl->qnt_name[iq], "ens") == 0) {
00503
00504
00505
             ctl->qnt_ens = iq;
             sprintf(ctl->qnt_unit[iq], "-");
00506
00507
           } else if (strcmp(ctl->qnt_name[iq], "m") == 0) {
            ctl->qnt_m = iq;
00508
00509
             sprintf(ctl->qnt_unit[iq], "kg");
           } else if (strcmp(ctl->qnt_name[iq], "r") == 0) {
  ctl->qnt_r = iq;
00510
00511
             sprintf(ctl->qnt_unit[iq], "m");
00512
00513
           } else if (strcmp(ctl->qnt_name[iq], "rho") == 0) {
00514
             ctl->qnt_rho = iq;
00515
             sprintf(ctl->qnt_unit[iq], "kg/m^3");
           } else if (strcmp(ctl->qnt_name[iq], "ps") == 0) {
  ctl->qnt_ps = iq;
  sprintf(ctl->qnt_unit[iq], "hPa");
00516
00517
00519
           } else if (strcmp(ctl->qnt_name[iq], "p") == 0) {
00520
              ctl->qnt_p = iq;
00521
              sprintf(ctl->qnt_unit[iq], "hPa");
           } else if (strcmp(ctl->qnt_name[iq], "t") == 0) {
ctl->qnt_t = iq;
00522
00523
             sprintf(ctl->qnt_unit[iq], "K");
           } else if (strcmp(ctl->qnt_name[iq], "u") == 0) {
00525
             ctl->qnt_u = iq;
00526
00527
             sprintf(ctl->qnt_unit[iq], "m/s");
           } else if (strcmp(ctl->qnt_name[iq], "v") == 0) {
  ctl->qnt_v = iq;
00528
00529
             sprintf(ctl->qnt_unit[iq], "m/s");
00530
           } else if (strcmp(ctl->qnt_name[iq], "w") == 0) {
00532
             ctl->qnt_w = iq;
00533
             sprintf(ctl->qnt_unit[iq], "hPa/s");
00534
           } else if (strcmp(ctl->qnt_name[iq], "h2o") == 0) {
             ctl->qnt_h2o = iq;
sprintf(ctl->qnt_unit[iq], "1");
00535
00536
           } else if (strcmp(ctl->qnt_name[iq], "o3") == 0) {
00538
              ctl->qnt_o3 = iq;
00539
              sprintf(ctl->qnt_unit[iq], "1");
           } else if (strcmp(ctl->qnt_name[iq], "theta") == 0) {
  ctl->qnt_theta = iq;
  sprintf(ctl->qnt_unit[iq], "K");
00540
00541
00542
           } else if (strcmp(ctl->qnt_name[iq], "pv") == 0) {
  ctl->qnt_pv = iq;
00543
00544
00545
             sprintf(ctl->qnt_unit[iq], "PVU");
           } else if (strcmp(ctl->qnt_name[iq], "tice") == 0) {
  ctl->qnt_tice = iq;
  sprintf(ctl->qnt_unit[iq], "K");
00546
00547
00548
```

```
} else if (strcmp(ctl->qnt_name[iq], "tsts") == 0) {
             ctl->qnt_tsts = iq;
00550
00551
             sprintf(ctl->qnt_unit[iq], "K");
           } else if (strcmp(ctl->qnt_name[iq], "tnat") == 0) {
00552
00553
             ctl->qnt_tnat = iq;
             sprintf(ctl->qnt_unit[iq], "K");
00554
00555
           } else if (strcmp(ctl->qnt_name[iq], "gw_var") == 0) {
00556
              ctl->qnt_gw_var = iq;
00557
             sprintf(ctl->qnt_unit[iq], "K^2");
           } else if (strcmp(ctl->qnt_name[iq], "stat") == 0) {
  ctl->qnt_stat = iq;
00558
00559
00560
             sprintf(ctl->qnt_unit[iq], "-");
00561
           } else
             scan_ctl(filename, argc, argv, "QNT_UNIT", iq, "", ctl->qnt_unit[iq]);
00562
00563
00564
00565
         /* Time steps of simulation... */
00566
         ctl->direction =
           (int) scan_ctl(filename, argc, argv, "DIRECTION", -1, "1", NULL);
00567
00568
             (ctl->direction != -1 && ctl->direction != 1)
00569
           ERRMSG("Set DIRECTION to -1 or 1!");
00570
         ctl->t_start =
         scan_ctl(filename, argc, argv, "T_START", -1, "-1e100", NULL);
ctl->t_stop = scan_ctl(filename, argc, argv, "T_STOP", -1, "-1e100", NULL);
ctl->dt_mod = scan_ctl(filename, argc, argv, "DT_MOD", -1, "600", NULL);
00571
00572
00573
00574
00575
         /* Meteorological data... */
         ctl->dt_met = scan_ctl(filename, argc, argv, "DT_MET", -1, "21600", NULL);
ctl->met_np = (int) scan_ctl(filename, argc, argv, "MET_NP", -1, "0", NULL);
00576
00577
         if (ctl->met_np > EP)
00578
           ERRMSG("Too many levels!");
00579
00580
         for (ip = 0; ip < ctl->met_np; ip++)
00581
           ctl->met_p[ip] = scan_ctl(filename, argc, argv, "MET_P", ip, "", NULL);
00582
00583
         /* Isosurface parameters... */
00584
         ctl->isosurf
         = (int) scan_ctl(filename, argc, argv, "ISOSURF", -1, "0", NULL); scan_ctl(filename, argc, argv, "BALLOON", -1, "-", ctl->balloon);
00585
00587
00588
         /* Diffusion parameters... */
00589
         ctl->turb_dx_trop
           = scan_ctl(filename, argc, argv, "TURB_DX_TROP", -1, "50.0", NULL);
00590
00591
         ct.1->turb dx st.rat.
00592
           = scan_ctl(filename, argc, argv, "TURB_DX_STRAT", -1, "0.0", NULL);
         ctl->turb_dz_trop
00593
00594
           = scan_ctl(filename, argc, argv, "TURB_DZ_TROP", -1, "0.0", NULL);
00595
         ctl->turb_dz_strat
           = scan_ctl(filename, argc, argv, "TURB_DZ_STRAT", -1, "0.1", NULL);
00596
00597
         ctl->turb meso =
00598
           scan_ctl(filename, argc, argv, "TURB_MESO", -1, "0.16", NULL);
00600
         /* Life time of particles... */
        ctl->tdec_trop = scan_ctl(filename, argc, argv, "TDEC_TROP", -1, "0", NULL);
ctl->tdec_strat =
00601
00602
           scan_ctl(filename, argc, argv, "TDEC_STRAT", -1, "0", NULL);
00603
00604
00605
         /* PSC analysis... */
00606
         ctl->psc_h2o = scan_ctl(filename, argc, argv, "PSC_H2O", -1, "4e-6", NULL);
00607
         ctl->psc_hno3 =
           scan_ctl(filename, argc, argv, "PSC_HNO3", -1, "9e-9", NULL);
00608
00609
00610
         /* Gravity wave analysis... */
         scan_ctl(filename, argc, argv, "GW_BASENAME", -1, "-", ctl->
00611
      gw_basename);
00612
         /* Output of atmospheric data... */
scan_ctl(filename, argc, argv, "ATM_BASENAME", -1, "-", ctl->
00613
00614
      atm basename);
00615
        scan_ctl(filename, argc, argv, "ATM_GPFILE", -1, "-", ctl->atm_gpfile);
         ctl->atm_dt_out
00617
           scan_ctl(filename, argc, argv, "ATM_DT_OUT", -1, "86400", NULL);
00618
         ctl->atm filter
00619
           (int) scan_ctl(filename, argc, argv, "ATM_FILTER", -1, "0", NULL);
00620
         /* Output of CSI data... */
00621
         scan_ctl(filename, argc, argv, "CSI_BASENAME", -1, "-", ctl->
      csi_basename);
00623
        ctl->csi_dt_out =
        scan_ctl(filename, argc, argv, "CSI_DT_OUT", -1, "86400", NULL);
scan_ctl(filename, argc, argv, "CSI_DBSFILE", -1, "obs.tab",
00624
00625
00626
                   ctl->csi obsfile);
00627
        ctl->csi_obsmin =
           scan_ctl(filename, argc, argv, "CSI_OBSMIN", -1, "0", NULL);
00628
00629
         ctl->csi_modmin =
        scan_ctl(filename, argc, argv, "CSI_MODMIN", -1, "0", NULL);
ctl->csi_z0 = scan_ctl(filename, argc, argv, "CSI_Z0", -1, "0", NULL);
ctl->csi_z1 = scan_ctl(filename, argc, argv, "CSI_Z1", -1, "100", NULL);
00630
00631
00632
```

```
ctl->csi_nz = (int) scan_ctl(filename, argc, argv, "CSI_NZ", -1, "1", NULL);
00634
           scan_ctl(filename, argc, argv, "CSI_LONO", -1, "-180", NULL);
00635
         ctl->csi_lon1 = scan_ctl(filename, argc, argv, "CSI_LON1", -1, "180", NULL);
00636
00637
         ctl->csi nx =
         (int) scan_ctl(filename, argc, argv, "CSI_NX", -1, "360", NULL);
ctl->csi_lat0 = scan_ctl(filename, argc, argv, "CSI_LAT0", -1, "-90", NULL);
ctl->csi_lat1 = scan_ctl(filename, argc, argv, "CSI_LAT1", -1, "90", NULL);
00638
00639
00640
         ctl->csi_ny =
00641
00642
           (int) scan_ctl(filename, argc, argv, "CSI_NY", -1, "180", NULL);
00643
        /* Output of ensemble data... */
scan_ctl(filename, argc, argv, "ENS_BASENAME", -1, "-", ctl->
00644
00645
       ens_basename);
00646
         /* Output of grid data... */
00647
        scan_ctl(filename, argc, argv, "GRID_BASENAME", -1, "-",
00648
00649
                    ctl->grid basename);
        scan_ctl(filename, argc, argv, "GRID_GPFILE", -1, "-", ctl->
00650
      grid_gpfile);
00651 ctl->grid_dt_out =
00652
           scan_ctl(filename, argc, argv, "GRID_DT_OUT", -1, "86400", NULL);
00653
         ctl->grid_sparse =
         (int) scan_ctl(filename, argc, argv, "GRID_SPARSE", -1, "0", NULL);
ctl->grid_z0 = scan_ctl(filename, argc, argv, "GRID_Z0", -1, "0", NULL);
ctl->grid_z1 = scan_ctl(filename, argc, argv, "GRID_Z1", -1, "100", NULL);
00654
00655
00657
         ctl->grid_nz =
00658
           (int) scan_ctl(filename, argc, argv, "GRID_NZ", -1, "1", NULL);
00659
         ctl->grid lon0 :
           scan_ctl(filename, argc, argv, "GRID_LONO", -1, "-180", NULL);
00660
00661
         ctl->grid lon1 =
00662
           scan_ctl(filename, argc, argv, "GRID_LON1", -1, "180", NULL);
00663
         ctl->grid_nx =
00664
           (int) scan_ctl(filename, argc, argv, "GRID_NX", -1, "360", NULL);
00665
         ctl->grid lat0 =
           scan_ctl(filename, argc, argv, "GRID_LATO", -1, "-90", NULL);
00666
00667
         ctl->grid lat1 =
00668
           scan_ctl(filename, argc, argv, "GRID_LAT1", -1, "90", NULL);
00669
         ctl->grid_ny =
00670
           (int) scan_ctl(filename, argc, argv, "GRID_NY", -1, "180", NULL);
00671
00672
        /* Output of profile data... */
        00673
00674
         scan_ctl(filename, argc, argv, "PROF_OBSFILE", -1, "-", ctl->
00675
      prof_obsfile);
00676 ctl->prof_z0 = scan_ctl(filename, argc, argv, "PROF_Z0", -1, "0", NULL);
00677 ctl->prof_z1 = scan_ctl(filename, argc, argv, "PROF_Z1", -1, "60", NULL);
00678
         ctl->prof nz =
00679
           (int) scan_ctl(filename, argc, argv, "PROF_NZ", -1, "60", NULL);
00680
         ctl->prof_lon0 =
00681
           scan_ctl(filename, argc, argv, "PROF_LONO", -1, "-180", NULL);
         ctl->prof_lon1
00682
00683
           scan_ctl(filename, argc, argv, "PROF_LON1", -1, "180", NULL);
00684
         ctl->prof nx =
00685
           (int) scan ctl(filename, argc, argv, "PROF NX", -1, "360", NULL);
         ctl->prof_lat0 =
00686
00687
           scan_ctl(filename, argc, argv, "PROF_LATO", -1, "-90", NULL);
00688
         ctl->prof_lat1 =
00689
           scan_ctl(filename, argc, argv, "PROF_LAT1", -1, "90", NULL);
00690
        ctl->prof ny =
00691
           (int) scan_ctl(filename, argc, argv, "PROF_NY", -1, "180", NULL);
00692
00693
        /* Output of station data... */
        scan_ctl(filename, argc, argv, "STAT_BASENAME", -1, "-",
00694
00695
                   ctl->stat_basename);
         ctl->stat_lon = scan_ctl(filename, argc, argv, "STAT_LON", -1, "0", NULL);
ctl->stat_lat = scan_ctl(filename, argc, argv, "STAT_LAT", -1, "0", NULL);
ctl->stat_r = scan_ctl(filename, argc, argv, "STAT_R", -1, "50", NULL);
00696
00697
00698
00699 }
```

Here is the call graph for this function:



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

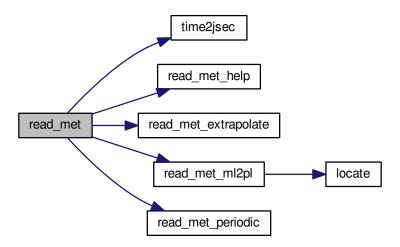
Read meteorological data file.

Definition at line 703 of file libtrac.c.

```
00706
00707
00708
         char tstr[10];
00709
00710
         static float help[EX * EY];
00711
00712
         int ix, iy, ip, dimid, ncid, varid, year, mon, day, hour;
00713
00714
         size_t np, nx, ny;
00715
00716
         /* Write info... */
00717
        printf("Read meteorological data: %s\n", filename);
00718
00719
         /* Get time from filename... */
00720
         sprintf(tstr, "%.4s", &filename[strlen(filename) - 16]);
         year = atoi(tstr);
sprintf(tstr, "%.2s", &filename[strlen(filename) - 11]);
00721
00722
00723
         mon = atoi(tstr);
00724
         sprintf(tstr, "%.2s", &filename[strlen(filename) - 8]);
00725
         day = atoi(tstr);
00726
         sprintf(tstr, "%.2s", &filename[strlen(filename) - 5]);
00727
         hour = atoi(tstr);
00728
         time2jsec(year, mon, day, hour, 0, 0, 0, &met->time);
00729
00730
         /* Open netCDF file... */
00731
         NC(nc_open(filename, NC_NOWRITE, &ncid));
00732
         /* Get dimensions... */
NC(nc_inq_dimid(ncid, "lon", &dimid));
NC(nc_inq_dimlen(ncid, dimid, &nx));
00733
00734
00735
00736
         if (nx > EX)
00737
           ERRMSG("Too many longitudes!");
00738
         NC(nc_inq_dimid(ncid, "lat", &dimid));
NC(nc_inq_dimlen(ncid, dimid, &ny));
if (ny > EY)
00739
00740
00741
00742
           ERRMSG("Too many latitudes!");
00743
00744
         NC(nc_inq_dimid(ncid, "lev", &dimid));
00745
         NC(nc_inq_dimlen(ncid, dimid, &np));
         if (np > EP)
00746
00747
           ERRMSG("Too many levels!");
00748
00749
         /* Store dimensions... */
         met->np = (int) np;
met->nx = (int) nx;
00750
00751
00752
         met->ny = (int) ny;
00753
00754
         /* Get horizontal grid... */
NC(nc_inq_varid(ncid, "lon", &varid));
00755
00756
         NC(nc_get_var_double(ncid, varid, met->lon));
00757
         NC(nc_inq_varid(ncid, "lat", &varid));
00758
         NC(nc_get_var_double(ncid, varid, met->lat));
00759
00760
         /* Read meteorological data... */
        read_met_help(ncid, "t", "T", met, met->t, 1.0);
read_met_help(ncid, "u", "U", met, met->u, 1.0);
00761
00762
```

```
read_met_help(ncid, "v", "V", met, met->v, 1.0);
read_met_help(ncid, "w", "W", met, met->w, 0.01f);
read_met_help(ncid, "q", "Q", met, met->help(ncid, "o3", "03", met, met->o3, 0.602f);
00764
00765
00766
00767
00768
          /* Meteo data on pressure levels... */
00769
          if (ctl->met_np <= 0) {</pre>
00770
            /* Read pressure levels from file... */
NC(nc_inq_varid(ncid, "lev", &varid));
00771
00772
00773
            NC(nc_get_var_double(ncid, varid, met->p));
00774
            for (ip = 0; ip < met->np; ip++)
  met->p[ip] /= 100.;
00775
00776
00777
             /\star Extrapolate data for lower boundary... \star/
00778
            read_met_extrapolate(met);
00779
00780
00781
          /* Meteo data on model levels... */
00782
          else {
00783
00784
             /* Read pressure data from file... */
00785
            read_met_help(ncid, "pl", "PL", met, met->pl, 0.01f);
00786
00787
             /* Interpolate from model levels to pressure levels... */
00788
            read_met_ml2pl(ctl, met, met->t);
00789
             read_met_ml2pl(ctl, met, met->u);
00790
             read_met_ml2pl(ctl, met, met->v);
00791
             read_met_ml2pl(ctl, met, met->w);
00792
             read_met_ml2pl(ctl, met, met->h2o);
00793
            read met m12p1(ctl, met, met->o3);
00794
00795
             /* Set pressure levels... */
            met->np = ctl->met_np;
for (ip = 0; ip < met->np; ip++)
00796
00797
00798
               met->p[ip] = ctl->met_p[ip];
00799
00801
          /* Check ordering of pressure levels... */
          for (ip = 1; ip < met->np; ip++)
  if (met->p[ip - 1] < met->p[ip])
00802
00803
00804
               {\tt ERRMSG("Pressure levels must be descending!");}
00805
          /* Read surface pressure... */
if (nc_inq_varid(ncid, "PS", &varid) == NC_NOERR) {
   NC(nc_get_var_float(ncid, varid, help));
00806
00807
00808
00809
             for (iy = 0; iy < met->ny; iy++)
          for (ix = 0; ix < met->nx; ix++)
   met->ps[ix][iy] = help[iy * met->nx + ix] / 100.;
} else if (nc_inq_varid(ncid, "LNSP", &varid) == NC_NOERR) {
00810
00811
00812
00813
            NC(nc_get_var_float(ncid, varid, help));
            for (iy = 0; iy < met->ny; iy++)
  for (ix = 0; ix < met->nx; ix++)
00814
00815
00816
                 met->ps[ix][iy] = exp(help[iy * met->nx + ix]) / 100.;
00817
          } else
00818
            for (ix = 0; ix < met->nx; ix++)
               for (iy = 0; iy < met->ny; iy++)
00820
                  met \rightarrow ps[ix][iy] = met \rightarrow p[0];
00821
00822
          /\star Create periodic boundary conditions... \star/
00823
          read_met_periodic(met);
00824
00825
           /* Close file...
          NC(nc_close(ncid));
00827 }
```

Here is the call graph for this function:



5.13.2.20 void read_met_extrapolate (met_t * met)

Extrapolate meteorological data at lower boundary.

Definition at line 831 of file libtrac.c.

```
00832
00833
00834
         int ip, ip0, ix, iy;
00835
00836
         /* Loop over columns... */
00837
         for (ix = 0; ix < met->nx; ix++)
           for (iy = 0; iy < met->ny; iy++) {
00838
00839
00840
               /* Find lowest valid data point... */
00841
              for (ip0 = met->np - 1; ip0 >= 0; ip0--)
00842
                 if (!gsl_finite(met->t[ix][iy][ip0])
00843
                      || !gsl_finite(met->u[ix][iy][ip0])
00844
                      || !gsl_finite(met->v[ix][iy][ip0])
00845
                      || !gsl_finite(met->w[ix][iy][ip0]))
00846
                   break;
00847
00848
               /* Extrapolate... */
              for (ip = ip0; ip >= 0; ip--) {
  met->t[ix][iy][ip] = met->t[ix][iy][ip + 1];
  met->u[ix][iy][ip] = met->u[ix][iy][ip + 1];
00849
00850
00851
                met->v[ix][iy][ip] = met->v[ix][iy][ip + 1];
met->w[ix][iy][ip] = met->w[ix][iy][ip + 1];
00852
00853
00854
                 met \rightarrow h2o[ix][iy][ip] = met \rightarrow h2o[ix][iy][ip + 1];
00855
                 met->o3[ix][iy][ip] = met->o3[ix][iy][ip + 1];
00856
00857
            }
00858 }
```

5.13.2.21 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 862 of file libtrac.c.

```
{
00869
00870
         static float help[EX * EY * EP];
00871
         int ip, ix, iy, n = 0, varid;
00872
00873
         /* Check if variable exists... */
00875
         if (nc_inq_varid(ncid, varname, &varid) != NC_NOERR)
00876
         if (nc_inq_varid(ncid, varname2, &varid) != NC_NOERR)
00877
00878
00879
         /* Read data... */
        NC(nc_get_var_float(ncid, varid, help));
00880
00881
00882
         /* Copy and check data... */
00883
         for (ip = 0; ip < met->np; ip++)
           for (iy = 0; iy < met->ny; iy++)
  for (ix = 0; ix < met->nx; ix++) {
00884
00885
               dest[ix][iy][ip] = scl * help[n++];
00886
                if (fabs(dest[ix][iy][ip] / scl) > 1e14)
  dest[ix][iy][ip] = GSL_NAN;
00888
00889
00890 }
```

5.13.2.22 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 894 of file libtrac.c.

```
00897
00898
00899
        double aux[EP], p[EP], pt;
00900
00901
       int ip, ip2, ix, iy;
00902
00903
        /* Loop over columns... */
00904
        for (ix = 0; ix < met->nx; ix++)
00905
         for (iy = 0; iy < met->ny; iy++) {
00906
00907
            /* Copy pressure profile... */
for (ip = 0; ip < met->np; ip++)
00908
00909
             p[ip] = met \rightarrow pl[ix][iy][ip];
00910
            /* Interpolate... */
for (ip = 0; ip < ctl->met_np; ip++) {
   pt = ctl->met_p[ip];
00911
00912
00913
              00915
               pt = p[0];
00916
              else if ((pt > p[met->np - 1] && p[1] > p[0])
                      || (pt < p[met->np - 1] && p[1] < p[0]))
00917
             00918
00919
00920
00921
00922
00923
            /* Copy data... */
for (ip = 0; ip < ctl->met_np; ip++)
00924
00925
00926
             var[ix][iy][ip] = (float) aux[ip];
00927
00928 }
```

Here is the call graph for this function:



```
5.13.2.23 void read_met_periodic ( met_t * met )
```

Create meteorological data with periodic boundary conditions.

Definition at line 932 of file libtrac.c.

```
00933
00934
00935
         int ip, iy;
00936
00937
          /* Check longitudes... */
         if (!(fabs(met->lon[met->nx - 1] - met->lon[0]
00939
                        + met -> lon[1] - met -> lon[0] - 360) < 0.01))
00940
00941
00942
          /* Increase longitude counter... */
         if ((++met->nx) > EX)
00943
00944
            ERRMSG("Cannot create periodic boundary conditions!");
00945
00946
          /* Set longitude... */
00947
         met \rightarrow lon[met \rightarrow nx - 1] = met \rightarrow lon[met \rightarrow nx - 2] + met \rightarrow lon[1] - met \rightarrow
       lon[0];
00948
00949
          /\star Loop over latitudes and pressure levels... \star/
00950
         for (iy = 0; iy < met->ny; iy++)
00951
           for (ip = 0; ip < met->np; ip++) {
00952
              met->ps[met->nx - 1][iy] = met->ps[0][iy];
              met->u[met->nx - 1][iy][ip] = met->u[0][iy][ip];
met->v[met->nx - 1][iy][ip] = met->v[0][iy][ip];
00953
00954
              met->w[met->nx - 1][iy][ip] = met->w[0][iy][ip];
met->t[met->nx - 1][iy][ip] = met->t[0][iy][ip];
00955
00957
              met \rightarrow h2o[met \rightarrow nx - 1][iy][ip] = met \rightarrow h2o[0][iy][ip];
00958
              met->o3[met->nx - 1][iy][ip] = met->o3[0][iy][ip];
00959
00960 }
```

5.13.2.24 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 964 of file libtrac.c.

```
00971
                        {
00972
00973
        FILE *in = NULL;
00974
00975
        char dummy[LEN], fullname1[LEN], fullname2[LEN], line[LEN],
00976
          msg[LEN], rvarname[LEN], rval[LEN];
00977
00978
        int contain = 0, i;
00979
00980
         /* Open file... */
         if (filename[strlen(filename) - 1] != '-')
if (!(in = fopen(filename, "r")))
00981
00982
             ERRMSG("Cannot open file!");
00983
00984
00985
         /* Set full variable name... */
00986
         if (arridx >= 0) {
         sprintf(fullname1, "%s[%d]", varname, arridx);
sprintf(fullname2, "%s[*]", varname);
00987
00988
00989
        } else {
         sprintf(fullname1, "%s", varname);
sprintf(fullname2, "%s", varname);
00990
00991
00992
00993
00994
         /* Read data... */
00995
         if (in != NULL)
           while (fgets(line, LEN, in))
00997
             if (sscanf(line, "%s %s %s", rvarname, dummy, rval) == 3)
00998
               if (strcasecmp(rvarname, fullname1) == 0 ||
00999
                    strcasecmp(rvarname, fullname2) == 0) {
01000
                  contain = 1;
01001
                 break:
01002
01003
        for (i = 1; i < argc - 1; i++)</pre>
```

```
if (strcasecmp(argv[i], fullname1) == 0 ||
           strcasecmp(argv[i], fullname2) == 0) {
sprintf(rval, "%s", argv[i + 1]);
01005
01006
01007
            contain = 1;
01008
            break;
01009
         }
01010
01011
       /* Close file... ∗/
01012
       if (in != NULL)
01013
         fclose(in);
01014
01015
       /* Check for missing variables... */
01016
       if (!contain) {
01017
        if (strlen(defvalue) > 0)
01018
           sprintf(rval, "%s", defvalue);
01019
          sprintf(msg, "Missing variable %s!\n", fullname1);
01020
01021
            ERRMSG(msg);
01022
01024
01025
       /* Write info... */
01026 printf("%s = %s\n", fullname1, rval);
01027
01028
       /* Return values... */
       if (value != NULL)
01030
         sprintf(value, "%s", rval);
01031
       return atof(rval);
01032 }
```

5.13.2.25 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 1036 of file libtrac.c.

```
01044
01045
01046
       struct tm t0, t1;
01047
01048
       t0.tm_year = 100;
01049
        t0.tm_mon = 0;
01050
       t0.tm_mday = 1;
       t0.tm_hour = 0;
01051
       t0.tm_min = 0;
01052
       t0.tm\_sec = 0;
01053
01054
01055
       t1.tm_year = year - 1900;
01056
       t1.tm_mon = mon - 1;
       t1.tm_mday = day;
01057
       t1.tm_hour = hour;
01058
01059
       t1.tm_min = min;
       t1.tm_sec = sec;
01061
01062
       *jsec = (double) timegm(&t1) - (double) timegm(&t0) + remain;
01063 }
```

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

Measure wall-clock time.

Definition at line 1067 of file libtrac.c.

```
01070
01071
        static double starttime[NTIMER], runtime[NTIMER];
01072
01074
01075
        if (id < 0 || id >= NTIMER)
01076
         ERRMSG("Too many timers!");
01077
01078
       /* Start timer... */
01079
       if (mode == 1) {
01080
         if (starttime[id] <= 0)</pre>
```

```
starttime[id] = omp_get_wtime();
01082
01083
            ERRMSG("Timer already started!");
01084
        }
01085
01086
        /* Stop timer... */
        else if (mode == 2) {
         if (starttime[id] > 0) {
01088
01089
           runtime[id] = runtime[id] + omp_get_wtime() - starttime[id];
01090
            starttime[id] = -1;
          } else
01091
            ERRMSG("Timer not started!");
01092
01093
01094
01095
        /\star Print timer...
        else if (mode == 3)
  printf("%s = %g s\n", name, runtime[id]);
01096
01097
01098 }
```

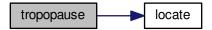
5.13.2.27 double tropopause (double t, double lat)

Definition at line 1102 of file libtrac.c.

```
01105
01106
          static double doys[12]
01107
         = { 1, 32, 60, 91, 121, 152, 182, 213, 244, 274, 305, 335 };
01108
          static double lats[73]
01109
            = { -90, -87.5, -85, -82.5, -80, -77.5, -75, -72.5, -70, -67.5, -65, -62.5, -60, -57.5, -55, -52.5, -50, -47.5, -45, -42.5,
01110
01112
             -40, -37.5, -35, -32.5, -30, -27.5, -25, -22.5, -20, -17.5,
01113
             -15, -12.5, -10, -7.5, -5, -2.5, 0, 2.5, 5, 7.5, 10, 12.5,
            15, 17.5, 20, 22.5, 25, 27.5, 30, 32.5, 35, 37.5, 40, 42.5, 45, 47.5, 50, 52.5, 55, 57.5, 60, 62.5, 65, 67.5, 70, 72.5, 75, 77.5, 80, 82.5, 85, 87.5, 90
01114
01115
01116
01117
01119
          static double tps[12][73]
            = { {324.1, 325.6, 325, 324.3, 322.5, 319.7, 314, 307.2, 301.8, 299.6, 297.1, 292.2, 285.6, 276.1, 264, 248.9, 231.9, 213.5, 194.4, 175.3, 157, 140.4, 126.7, 116.3, 109.5, 105.4, 103, 101.4, 100.4,
01120
01121
01122
                    99.69, 99.19, 98.84, 98.56, 98.39, 98.39, 98.42, 98.44, 98.54, 98.68, 98.81, 98.89, 98.96, 99.12, 99.65, 101.4, 105.4, 113.5,
01124
01125
                    152.1, 184.7, 214, 234.1, 247.3, 255.8, 262.6, 267.7, 271.7, 275,
         277.2, 279, 280.1, 280.4, 280.6, 280.1, 279.3, 278.3, 276.8, 275.8, 275.3, 275.6, 275.4, 274.1, 273.5}, {337.3, 338.7, 337.8, 336.4, 333, 328.8, 321.1, 312.6, 306.6, 303.7, 300.2, 293.8, 285.4, 273.8, 259.6, 242.7, 224.4, 205.2, 186, 167.5,
01126
01127
01128
01129
           150.3, 135, 122.8, 113.9, 108.2, 104.7, 102.5, 101.1, 100.2, 99.42,
01131
           98.88, 98.52, 98.25, 98.09, 98.07, 98.1, 98.12, 98.2, 98.25, 98.27,
01132
           98.26, 98.27, 98.36, 98.79, 100.2, 104.2, 113.7, 131.2, 159.5, 193,
           220.4, 238.1, 250.2, 258.1, 264.7, 269.7, 273.7, 277.3, 280.2, 282.8, 284.9, 286.5, 288.1, 288.8, 289, 288.5, 287.2, 286.3, 286.1, 287.2, 287.5, 286.2, 285.8},
01133
01134
01135
          {335, 336, 335.7, 335.1, 332.3, 328.1, 320.6, 311.8, 305.1, 301.9,
01136
           297.6, 290, 280.4, 268.3, 254.6, 239.6, 223.9, 207.9, 192.2, 176.9,
01138
           161.7, 146.4, 132.2, 120.6, 112.3, 107.2, 104.3, 102.4, 101.3,
01139
           100.4, 99.86, 99.47, 99.16, 98.97, 98.94, 98.97, 99, 99.09, 99.2,
           99.31, 99.35, 99.41, 99.51, 99.86, 101.1, 104.9, 114.3, 131, 156.8, 186.3, 209.3, 224.6, 236.8, 246.3, 254.9, 262.3, 268.8, 274.8,
01140
01141
01142
           279.9, 284.6, 288.6, 291.6, 294.9, 297.5, 299.8, 301.8, 303.1,
           304.3, 304.9, 306, 306.6, 306.2, 306},
01143
01144
          {306.2, 306.7, 305.7, 307.1, 307.3, 306.4, 301.8, 296.2, 292.4,
           290.3, 287.1, 280.9, 273.4, 264.3, 254.1, 242.8, 231, 219, 207.2, 195.5, 183.3, 169.7, 154.7, 138.7, 124.1, 113.6, 107.8, 104.7,
01145
01146
           102.8, 101.7, 100.9, 100.4, 100, 99.79, 99.7, 99.66, 99.68, 99.79,
01147
           99.94, 100.2, 100.5, 100.9, 101.4, 102.1, 103.4, 107, 115.2, 129.1,
01148
           148.7, 171, 190.8, 205.6, 218.4, 229.4, 239.6, 248.6, 256.5,
01149
           263.7, 270.3, 276.6, 282.6, 288.1, 294.5, 300.4, 306.3, 311.4, 315.1, 318.3, 320.3, 322.2, 322.8, 321.5, 321.1},
01150
01151
          266.5, 264.9, 260.8, 261, 262, 263, 261.3, 259.7, 259.2, 259.8, 260.1, 258.6, 256.7, 253.6, 249.5, 243.9, 237.4, 230, 222.1, 213.9,
01152
01153
           205, 194.4, 180.4, 161.8, 140.7, 122.9, 112.1, 106.7,
                                                                                   104.1,
01155
           101.8, 101.4, 101.1, 101, 101, 101.1, 101.2, 101.5, 101.9,
           102.4, 103, 103.8, 104.9, 106.8, 110.1, 115.6, 124, 135.2, 148.9,
01156
01157
           165.2, 181.3, 198, 211.8, 223.5, 233.8, 242.9, 251.5, 259, 266.2,
01158
           273.1, 279.2, 286.2, 292.8, 299.6, 306, 311.1, 315.5, 318.8, 322.6,
01159
            325.3, 325.8, 325.8},
01160
         {220.1, 218.1, 210.8, 207.2, 207.6, 210.5, 211.4, 213.5, 217.3,
           222.4, 227.9, 232.8, 237.4, 240.8, 242.8, 243, 241.5, 238.6, 234.2,
```

```
228.5, 221, 210.7, 195.1, 172.9, 147.8, 127.6, 115.6, 109.9, 107.1,
                  105.7, 105, 104.8, 104.8, 104.9, 105, 105.1, 105.3, 105.5, 105.8, 106.4, 107, 107.6, 108.1, 108.8, 110, 111.8, 114.2, 117.4, 121.6,
01163
01164
                  127.9, 137.3, 151.2, 169.5, 189, 205.8, 218.9, 229.1, 237.8, 245,
01165
                251.5, 257.1, 262.3, 268.2, 274, 280.4, 286.7, 292.4, 297.9, 302.9, 308.5, 312.2, 313.1, 313.3}, {187.4, 184.5, 173.3, 166.1, 165.4, 167.8, 169.6, 173.6, 179.6,
01166
01167
01168
                  187.9, 198.9, 210, 220.5, 229.2, 235.7, 239.9, 241.8, 241.6, 239.6,
01169
01170
                  235.8, 229.4, 218.6, 200.9, 175.9, 149.4, 129.4, 118.3, 113.1,
                 110.8, 109.7, 109.3, 109.4, 109.7, 110, 110.2, 110.4, 110.5, 110.7, 111, 111.4, 111.8, 112.1, 112.3, 112.7, 113.2, 113.9, 115, 116.4, 117.9, 120.4, 124.1, 130.9, 142.2, 159.6, 179.6, 198.5, 212.9, 224.2, 232.7, 239.1, 243.8, 247.7, 252.4, 257.3, 263.2, 269.5, 275.4, 281.1, 286.3, 292, 296.3, 298.2, 298.8),
01171
01172
01173
01174
01175
01176
                {166, 166.4, 155.7, 148.3, 147.1, 149, 152.1, 157, 163.6, 172.4,
                 185.3, 199.2, 212.6, 224, 233.2, 239.6, 243.3, 244.6, 243.6, 240.3, 233.9, 222.6, 203.7, 177, 149.5, 129.7, 119, 114, 111.7, 110.7, 110.3, 110.3, 110.6, 110.9, 111.1, 111.3, 111.5, 111.6, 111.9, 112.2, 112.5, 112.6, 112.8, 113, 113.4, 114, 115.1, 116.5, 118.3,
01177
01178
01179
                  120.9, 124.4, 130.2, 139.4, 154.6, 173.8, 193.1, 208.1, 220.4,
                  230.1, 238.2, 244.7, 249.5, 254.5, 259.3, 264.5, 269.4, 273.7,
01182
01183
                  278.2, 282.6, 287.4, 290.9, 292.5, 293},
01184
                {171.9, 172.8, 166.2, 162.3, 161.4, 162.5, 165.2, 169.6, 175.3,
                 183.1, 193.8, 205.9, 218.3, 229.6, 238.5, 244.3, 246.9, 246.7, 243.8, 238.4, 230.2, 217.9, 199.6, 174.9, 148.9, 129.8, 119.5,
01185
01186
                  114.8, 112.3, 110.9, 110.3, 110.1, 110.2, 110.3, 110.4, 110.5,
01187
                  110.6, 110.8, 111, 111.4, 111.8, 112, 112.2, 112.4, 112.9, 113.6,
01188
01189
                  114.7, 116.3, 118.4, 121.9, 127.1, 136.1, 149.8, 168.4, 186.9,
                203.3, 217, 229.1, 238.7, 247, 254, 259.3, 264.3, 268.3, 272.5, 276.6, 280.4, 284.4, 288.4, 293.3, 297.2, 298.7, 299.1}, {191.6, 192.2, 189, 188.1, 190.2, 193.7, 197.8, 202.9, 208.5,
01190
01191
01192
01193
                  215.6, 224.2, 233.1, 241.2, 247.3, 250.8, 251.3, 248.9, 244.2,
                  237.3, 228.4, 217.2, 202.9, 184.5, 162.5, 140.7, 124.8, 116.2,
01194
01195
                  111.8, 109.4, 107.9, 107, 106.7, 106.6, 106.6, 106.7, 106.7,
                 106.8, 107, 107.4, 108, 108.7, 109.3, 109.8, 110.4, 111.2, 112.4, 114.2, 116.9, 121.1, 127.9, 139.3, 155.2, 173.6, 190.7,
01196
01197
                  206.1, 220.1, 232.3, 243, 251.8, 259.2, 265.7, 270.6, 275.3,
01198
                  279.3, 283.3, 286.9, 289.7, 292.8, 296.1, 300.5, 303.9, 304.8,
01200
                  305.1},
                {241.5, 239.6, 236.8, 237.4, 239.4, 242.3, 244.2, 246.4, 249.2,
01201
01202
                  253.6, 258.6, 262.7, 264.8, 264.2, 260.6, 254.1, 245.5, 235.3,
                  223.9, 211.7, 198.3, 183.1, 165.6, 147.1, 130.5, 118.7, 111.9,
01203
                 108.1, 105.8, 104.3, 103.4, 102.8, 102.5, 102.4, 102.5, 102.5, 102.5, 102.5, 102.5, 102.7, 103.1, 103.8, 104.6, 105.4, 106.1, 107, 108.2,
01204
01205
                  109.9, 112.8, 117.5, 126, 140.4, 161, 181.9, 201.2, 216.8, 230.4,
01206
01207
                  241.8, 251.4, 259.9, 266.9, 272.8, 277.4, 280.4, 282.9, 284.6,
01208
                  286.1, 287.4, 288.3, 289.5, 290.9, 294.2, 296.9, 297.5, 297.6}
               286.1, 287.4, 288.3, 289.5, 290.9, 294.2, 296.9, 297.5, 297.5), (301.2, 300.3, 296.6, 295.4, 295., 294.3, 291.2, 287.4, 284.9, 284.7, 284.1, 281.5, 277.1, 270.4, 261.7, 250.6, 237.6, 223.1, 207.9, 192, 175.8, 158.8, 142.1, 127.6, 116.8, 109.9, 106, 103.6, 102.1, 101.1, 100.4, 99.96, 99.6, 99.37, 99.32, 99.31, 99.46, 99.77, 100.2, 100.7, 101.3, 101.8, 102.7, 104.1, 106.8, 111.9, 121, 136.7, 160, 186.9, 209.9, 228.1, 241.2, 251.5, 259.5, 265.7, 270.9, 274.8, 278, 200.3, 201.9, 203.3, 203.3, 203.3, 203.3, 203.3, 203.4, 203.4, 203.4, 203.3, 203.3, 203.3, 203.3, 203.4, 203.4, 203.3, 203.3, 203.3, 203.3, 203.3, 203.4, 203.4, 203.4, 203.3, 203.3, 203.3, 203.3, 203.4, 203.4, 203.4, 203.3, 203.3, 203.3, 203.3, 203.4, 203.4, 203.4, 203.4, 203.4, 203.3, 203.3, 203.3, 203.3, 203.3, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4, 203.4
01209
01210
01211
01213
01214
01215
                  280.3, 281.8, 283, 283.3, 283.7, 283.8, 283, 282.2, 281.2, 281.4,
01216
                  281.7, 281.1, 281.2}
01217
               };
01218
01219
               double doy, p0, p1, pt;
01220
01221
               int imon, ilat;
01222
               /* Get day of year... */
doy = fmod(t / 86400., 365.25);
01223
01224
               while (doy < 0)
01225
                    doy += 365.25;
01226
01227
               /* Get indices... */
01228
               imon = locate(doys, 12, doy);
ilat = locate(lats, 73, lat);
01229
01230
01232
                /* Get tropopause pressure... */
01233
               p0 = LIN(lats[ilat], tps[imon][ilat],
01234
                                 lats[ilat + 1], tps[imon][ilat + 1], lat);
               01235
01236
               pt = LIN(doys[imon], p0, doys[imon + 1], p1, doy);
01238
01239
                /* Return tropopause pressure... */
01240
               return pt;
01241 }
```

Here is the call graph for this function:



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

Write atmospheric data.

Definition at line 1245 of file libtrac.c.

```
01249
01250
01251
         FILE *in, *out;
01252
01253
         char line[LEN];
01254
         double r, t0, t1;
01256
01257
         int ip, iq, year, mon, day, hour, min, sec;
01258
         /* Set time interval for output... */
01259
         t0 = t - 0.5 * ctl -> dt_mod;
01260
01261
         t1 = t + 0.5 * ctl -> dt_mod;
01262
         /* Check if gnuplot output is requested... */ if (ctl->atm_gpfile[0] != '-') {
01263
01264
01265
01266
            /* Write info... */
           printf("Plot atmospheric data: %s.png\n", filename);
01267
01268
01269
            /* Create gnuplot pipe... */
            if (!(out = popen("gnuplot", "w")))
    ERRMSG("Cannot create pipe to gnuplot!");
01270
01271
01272
            /* Set plot filename... */ fprintf(out, "set out \"%s.png\"\n", filename);
01273
01274
01275
01276
            /\star Set time string... \star/
            jsec2time(t, &year, &mon, &day, &hour, &min, &sec, &r);
fprintf(out, "timestr=\"%d-%02d-%02d, %02d:%02d UTC\"\n",
01277
01278
                     year, mon, day, hour, min);
01280
01281
            /* Dump gnuplot file to pipe... */
            if (!(in = fopen(ctl->atm_gpfile, "r")))
ERRMSG("Cannot open file!");
01282
01283
            while (fgets(line, LEN, in))
fprintf(out, "%s", line);
01284
01285
01286
            fclose(in);
01287
01288
01289
         else {
01290
01291
            /* Write info... */
           printf("Write atmospheric data: %s\n", filename);
01292
01293
01294
            /* Create file... */
            if (!(out = fopen(filename, "w")))
01295
              ERRMSG("Cannot create file!");
01296
01297
01298
01299
          /* Write header... */
01300
         fprintf(out,
01301
                    "# $1 = time [s]\n"
                   "# $2 = altitude [km]\n"
"# $3 = longitude [deg]\n" "# $4 = latitude [deg]\n");
01302
01303
         for (iq = 0; iq < ctl->nq; iq++)
  fprintf(out, "# $%i = %s [%s]\n", iq + 5, ctl->qnt_name[iq],
01304
01305
```

```
01306
                ctl->qnt_unit[iq]);
01307
       fprintf(out, "\n");
01308
       /* Write data... */
for (ip = 0; ip < atm->np; ip++) {
01309
01310
01311
01312
         /* Check time... */
01313
         if (ctl->atm_filter && (atm->time[ip] < t0 || atm->time[ip] > t1))
01314
01315
        01316
01317
01318
01319
01320
01321
           fprintf(out, ctl->qnt_format[iq], atm->q[iq][ip]);
01322
01323
         fprintf(out, "\n");
01324
01325
01326
       /* Close file... */
01327
       fclose(out);
01328 }
```

Here is the call graph for this function:



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

Write CSI data.

Definition at line 1332 of file libtrac.c.

```
01336
01337
01338
        static FILE *in, *out;
01339
01340
        static char line[LEN];
01341
01342
        static double modmean[GX][GY][GZ], obsmean[GX][GY][GZ],
01343
          rt, rz, rlon, rlat, robs, t0, t1, area, dlon, dlat, lat;
01344
01345
        static int init, obscount[GX][GY][GZ], cx, cy, cz, ip, ix, iy, iz;
01346
01347
         /* Init... */
01348
         if (!init) {
01349
          init = 1;
01350
          /* Check quantity index for mass... */
if (ctl->qnt_m < 0)</pre>
01351
01352
01353
             ERRMSG("Need quantity mass to analyze CSI!");
01354
01355
           /* Open observation data file... */
           printf("Read CSI observation data: %s\n", ctl->csi_obsfile);
if (!(in = fopen(ctl->csi_obsfile, "r")))
01356
01357
             ERRMSG("Cannot open file!");
01358
01359
01360
           /* Create new file... */
           printf("Write CSI data: %s\n", filename);
if (!(out = fopen(filename, "w")))
01361
01362
01363
             ERRMSG("Cannot create file!");
01364
01365
           /* Write header... */
```

```
01366
         fprintf(out,
                  "# $1 = time [s] \n"
01367
01368
                   "# $2 = number of hits (cx) n"
                   "# $3 = number of misses (cy) \n"
01369
                   "# $4 = number of false alarms (cz)\n"
01370
                  "# $5 = number of observations (cx + cy)\n"
"# $6 = number of forecasts (cx + cz)\n"
01371
01372
01373
                   "# \$7 = bias (forecasts/observations) [\%] \n"
                  "# $8 = probability of detection (POD) [%%]\n" # $9 = false alarm rate (FAR) [%%]\n"
01374
01375
                   "# $10 = critical success index (CSI) [%%]\n\n");
01376
01377
01378
        /* Set time interval... */
01379
01380
        t0 = t - 0.5 * ctl->dt_mod;
        t1 = t + 0.5 * ctl->dt_mod;
01381
01382
01383
        /* Initialize grid cells... */
01384
        for (ix = 0; ix < ctl->csi_nx; ix++)
         for (iy = 0; iy < ctl->csi_ny; iy++)
01385
01386
            for (iz = 0; iz < ctl->csi_nz; iz++)
01387
              modmean[ix][iy][iz] = obsmean[ix][iy][iz] = obscount[ix][iy][iz] = 0;
01388
01389
        /* Read data... */
01390
       while (fgets(line, LEN, in)) {
01391
          /* Read data... */
01392
          if (sscanf(line, "%lg %lg %lg %lg %lg", &rt, &rz, &rlon, &rlat, &robs) !=
01393
01394
              5)
01395
            continue:
01396
01397
          /* Check time... */
01398
          <u>if</u> (rt < t0)
01399
            continue;
          if (rt > t1)
01400
01401
            break:
01402
01403
          /* Calculate indices... */
01404
          ix = (int) ((rlon - ctl->csi_lon0))
01405
                       / (ctl->csi_lon1 - ctl->csi_lon0) * ctl->csi_nx);
01406
          iy = (int) ((rlat - ctl->csi_lat0))
                       / (ctl->csi_lat1 - ctl->csi_lat0) * ctl->csi_ny);
01407
          iz = (int) ((rz - ctl->csi_z0)
01408
01409
                       / (ctl->csi_z1 - ctl->csi_z0) * ctl->csi_nz);
01410
          /* Check indices... */
01411
01412
          if (ix < 0 || ix >= ctl->csi_nx ||
              iy < 0 || iy >= ctl->csi_ny || iz < 0 || iz >= ctl->csi_nz)
01413
01414
            continue:
01415
01416
          /* Get mean observation index... */
01417
          obsmean[ix][iy][iz] += robs;
01418
          obscount[ix][iy][iz]++;
01419
01420
01421
        /* Analyze model data... */
        for (ip = 0; ip < atm->np; ip++) {
01423
01424
          /* Check time... */
01425
          if (atm->time[ip] < t0 || atm->time[ip] > t1)
01426
           continue:
01427
01428
          /* Get indices... */
          ix = (int) ((atm->lon[ip] - ctl->csi_lon0)
01429
01430
                       / (ctl->csi_lon1 - ctl->csi_lon0) * ctl->csi_nx);
01431
          iy = (int) ((atm->lat[ip] - ctl->csi_lat0)
          01432
01433
01434
01435
01436
          /* Check indices... */
          if (ix < 0 || ix >= ctl->csi_nx ||
01437
              iy < 0 || iy >= ctl->csi_ny || iz < 0 || iz >= ctl->csi_nz)
01438
01439
            continue:
01440
01441
          /* Get total mass in grid cell... */
01442
          modmean[ix][iy][iz] += atm->q[ctl->qnt_m][ip];
01443
01444
01445
        /* Analyze all grid cells... */
        for (ix = 0; ix < ctl->csi_nx; ix++)
  for (iy = 0; iy < ctl->csi_ny; iy++)
01446
01447
01448
            for (iz = 0; iz < ctl->csi_nz; iz++) {
01449
01450
               /* Calculate mean observation index... */
              if (obscount[ix][iy][iz] > 0)
01451
01452
                obsmean[ix][iy][iz] /= obscount[ix][iy][iz];
```

```
/* Calculate column density... */
01454
                 /* Calculate Column Gensity... */
if (modmean[ix][iy][iz] > 0) {
  dlon = (ctl->csi_lon1 - ctl->csi_lon0) / ctl->csi_nx;
  dlat = (ctl->csi_lat1 - ctl->csi_lat0) / ctl->csi_ny;
  lat = ctl->csi_lat0 + dlat * (iy + 0.5);
01455
01456
01457
01458
                   area = dlat * M_PI * RE / 180. * dlon * M_PI * RE / 180. * cos(lat * M_PI / 180.);
01459
01460
01461
                    modmean[ix][iy][iz] /= (1e6 * area);
01462
01463
                 /* Calculate CSI... */
01464
01465
                 if (obscount[ix][iy][iz] > 0) {
01466
                   if (obsmean[ix][iy][iz] >= ctl->csi_obsmin &&
01467
                         modmean[ix][iy][iz] >= ctl->csi_modmin)
01468
                   else if (obsmean[ix][iy][iz] >= ctl->csi_obsmin &&
01469
                               modmean[ix][iy][iz] < ctl->csi_modmin)
01470
01471
                      cy++;
01472
                   else if (obsmean[ix][iy][iz] < ctl->csi_obsmin &&
01473
                               modmean[ix][iy][iz] >= ctl->csi_modmin)
01474
                      cz++;
01475
                }
01476
01477
01478
         /* Write output... */
01479
          if (fmod(t, ctl->csi_dt_out) == 0) {
01480
           /* Write... */ fprintf(out, "%.2f %d %d %d %d %d %g %g %g %g\n",
01481
01482
01483
                      t, cx, cy, cz, cx + cy, cx + cz, (cx + cy > 0) ? 100. * (cx + cz) / (cx + cy) : GSL_NAN,
01484
                       (cx + cy > 0) ? (100. * cx) / (cx + cy) : GSL_NAN,
(cx + cz > 0) ? (100. * cz) / (cx + cz) : GSL_NAN,
01485
01486
01487
                       (cx + cy + cz > 0) ? (100. * cx) / (cx + cy + cz) : GSL_NAN);
01488
01489
            /* Set counters to zero... */
            cx = cy = cz = 0;
01490
01491
01492
01493
          /* Close file... */
         if (t == ctl->t_stop)
01494
01495
           fclose(out);
01496 }
```

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

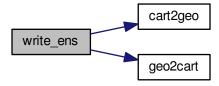
Write ensemble data.

Definition at line 1500 of file libtrac.c.

```
01504
                  {
01505
       static FILE *out;
01508
       static double dummy, ens, lat, lon, p[NENS], q[NQ][NENS],
01509
        t0, t1, x[NENS][3], xm[3];
01510
01511
       static int init, ip, iq;
01512
       static size_t i, n;
01514
01515
       /* Init... */
01516
       if (!init) {
01517
         init = 1:
01518
         /* Check quantities... */
01519
         if (ctl->qnt_ens < 0)
01520
01521
          ERRMSG("Missing ensemble IDs!");
01522
01523
          /* Create new file... */
         printf("Write ensemble data: %s\n", filename);
if (!(out = fopen(filename, "w")))
01524
01525
01526
           ERRMSG("Cannot create file!");
01527
          /* Write header... */
01528
          01529
01530
01531
                  "# $2 = altitude [km] \n"
01532
                  "# $3 = longitude [deg]\n" "# <math>$4 = latitude [deg]\n");
```

```
01534
01535
            01536
01537
01538
01539
01540
01541
         /* Set time interval... */
t0 = t - 0.5 * ctl->dt_mod;
t1 = t + 0.5 * ctl->dt_mod;
01542
01543
01544
01545
01546
          /* Init... */
01547
         ens = GSL_NAN;
01548
         n = 0;
01549
         /* Loop over air parcels... */
for (ip = 0; ip < atm->np; ip++) {
01550
01551
01552
01553
            /* Check time... */
01554
            if (atm->time[ip] < t0 || atm->time[ip] > t1)
01555
             continue;
01556
01557
            /* Check ensemble id... */
            if (atm->q[ctl->qnt_ens][ip] != ens) {
01558
01559
01560
               /* Write results... */
01561
              if (n > 0) {
01562
                 /* Get mean position... */
xm[0] = xm[1] = xm[2] = 0;
for (i = 0; i < n; i++) {
01563
01564
01565
                   xm[0] += x[i][0] / (double) n;
xm[1] += x[i][1] / (double) n;
xm[2] += x[i][2] / (double) n;
01566
01567
01568
01569
                 cart2geo(xm, &dummy, &lon, &lat);
fprintf(out, "%.2f %g %g %g", t, Z(gsl_stats_mean(p, 1, n)), lon,
01570
01571
01572
                          lat);
01573
01574
                 /* Get quantity statistics... */
                 for (iq = 0; iq < ctl->nq; iq++) {
  fprintf(out, " ");
01575
01576
01577
                   fprintf(out, ctl->qnt_format[iq], gsl_stats_mean(q[iq], 1, n));
01578
                 for (iq = 0; iq < ctl->nq; iq++) {
  fprintf(out, " ");
01579
01580
                   fprintf(out, ctl->qnt_format[iq], gsl_stats_sd(q[iq], 1, n));
01581
01582
01583
                 fprintf(out, " %lu\n", n);
01584
01585
01586
              /* Init new ensemble... */
01587
              ens = atm->q[ctl->qnt_ens][ip];
01588
              n = 0;
01589
01590
01591
            /* Save data...
01592
            p[n] = atm->p[ip];
01593
            geo2cart(0, atm->lon[ip], atm->lat[ip], x[n]);
            for (iq = 0; iq < ctl->nq; iq++) q[iq][n] = atm->q[iq][ip]; if ((++n) >= NENS)
01594
01595
01596
01597
              ERRMSG("Too many data points!");
01598
01599
         /* Write results... */
01600
01601
         if (n > 0) {
01603
            /* Get mean position... */
            for (i = 0; i < n; i++) {
    xm[0] += x[i][0] / (double) n;
    xm[1] += x[i][1] / (double) n;</pre>
01604
01605
01606
01607
01608
              xm[2] += x[i][2] / (double) n;
01609
            cart2geo(xm, &dummy, &lon, &lat);
fprintf(out, "%.2f %g %g %g", t, Z(gsl_stats_mean(p, 1, n)), lon, lat);
01610
01611
01612
            /* Get quantity statistics... */
01613
            for (iq = 0; iq < ctl->nq; iq++) {
  fprintf(out, " ");
  fprintf(out, ctl->qnt_format[iq], gsl_stats_mean(q[iq], 1, n));
01614
01615
01616
01617
            for (iq = 0; iq < ctl->nq; iq++) {
  fprintf(out, " ");
01618
01619
```

Here is the call graph for this function:



5.13.2.31 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 1632 of file libtrac.c.

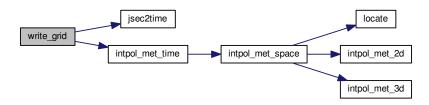
```
01638
                      {
01639
         FILE *in, *out;
01640
01641
01642
         char line[LEN];
01643
         static double grid_m[GX][GY][GZ], z, dz, lon, dlon, lat, dlat,
01644
           area, rho_air, press, temp, cd, mmr, t0, t1, r;
01645
01646
01647
         static int ip, ix, iy, iz, year, mon, day, hour, min, sec;
01648
         /* Check dimensions... */
if (ctl->grid_nx > GX || ctl->grid_ny > GY || ctl->grid_nz > GZ)
    ERRMSG("Grid dimensions too large!");
01649
01650
01651
01652
        /* Check quantity index for mass... */
if (ctl->qnt_m < 0)</pre>
01653
01654
           ERRMSG("Need quantity mass to write grid data!");
01655
01656
         /* Set time interval for output... */
01657
         t0 = t - 0.5 * ctl->dt_mod;

t1 = t + 0.5 * ctl->dt_mod;
01658
01659
01660
01661
         /\star Set grid box size... \star/
         dz = (ctl->grid_z1 - ctl->grid_z0) / ctl->grid_nz;
dlon = (ctl->grid_lon1 - ctl->grid_lon0) / ctl->grid_nx;
01662
01663
         dlat = (ctl->grid_lat1 - ctl->grid_lat0) / ctl->grid_ny;
01664
01665
01666
          /* Initialize grid... */
         for (ix = 0; ix < ctl->grid_nx; ix++)
01667
          for (iy = 0; iy < ctl->grid_ny; iy++)
    for (iz = 0; iz < ctl->grid_nz; iz++)
01668
01669
01670
                grid_m[ix][iy][iz] = 0;
01671
01672
          /* Average data... */
01673
         for (ip = 0; ip < atm->np; ip++)
01674
           if (atm->time[ip] >= t0 && atm->time[ip] <= t1) {</pre>
01675
01676
              /* Get index... */
01677
              ix = (int) ((atm->lon[ip] - ctl->grid_lon0) / dlon);
```

```
iy = (int) ((atm->lat[ip] - ctl->grid_lat0) / dlat);
iz = (int) ((Z(atm->p[ip]) - ctl->grid_z0) / dz);
01679
01680
              /* Check indices... */
if (ix < 0 || ix >= ctl->grid_nx ||
    iy < 0 || iy >= ctl->grid_ny || iz < 0 || iz >= ctl->grid_nz)
01681
01682
01683
01684
01685
              /* Add mass... */
grid_m[ix][iy][iz] += atm->q[ctl->qnt_m][ip];
01686
01687
01688
01689
         /* Check if gnuplot output is requested... */
if (ctl->grid_gpfile[0] != '-') {
01690
01691
01692
01693
            /* Write info... */
            printf("Plot grid data: %s.png\n", filename);
01694
01695
01696
            /* Create gnuplot pipe... */
            if (!(out = popen("gnuplot", "w")))
01697
01698
              ERRMSG("Cannot create pipe to gnuplot!");
01699
            /* Set plot filename... */ fprintf(out, "set out \"%s.png\"\n", filename);
01700
01701
01702
01703
            /* Set time string... */
            jsec2time(t, &year, &mon, &day, &hour, &min, &sec, &r);
fprintf(out, "timestr=\"%d-%02d-%02d, %02d:%02d UTC\"\n",
01704
01705
01706
                      year, mon, day, hour, min);
01707
            /* Dump gnuplot file to pipe... */
if (!(in = fopen(ctl->grid_gpfile, "r")))
    ERRMSG("Cannot open file!");
01708
01709
01710
            while (fgets(line, LEN, in))
fprintf(out, "%s", line);
01711
01712
01713
            fclose(in);
01714
         }
01715
01716
         else {
01717
01718
            /* Write info... */
           printf("Write grid data: %s\n", filename);
01719
01720
01721
            /* Create file... */
01722
           if (!(out = fopen(filename, "w")))
01723
               ERRMSG("Cannot create file!");
01724
01725
         /* Write header... */
01726
01727
         fprintf(out,
                    "# $1 = time [s]\n"
01728
01729
                    "# $2 = altitude [km] \n"
01730
                    "# $3 = longitude [deg] \n"
                    "# $4 = latitude [deg]\n"
01731
                    "# $5 = surface area [km^2]\n"
01732
01733
                    "# $6 = layer width [km] \n"
01734
                    "# $7 = temperature [K]\n"
01735
                    "# $8 = \text{column density } [kg/m^2] \n"
01736
                    "# $9 = mass mixing ratio [1]\n\n");
01737
01738
         /* Write data... */
         /* white data... */
for (ix = 0; ix < ctl->grid_nx; ix++) {
    if (ix > 0 && ctl->grid_ny > 1 && !ctl->grid_sparse)
01739
01741
               fprintf(out, "\n");
01742
                 (iy = 0; iy < ctl->grid_ny; iy++) {
01743
              if (iy > 0 && ctl->grid_nz > 1 && !ctl->grid_sparse)
               fprintf(out, "\n");
for (iz = 0; iz < ctl->grid_nz; iz++)
01744
01745
01746
                 if (!ctl->grid_sparse
01747
                      || ix == 0 || iy == 0 || iz == 0 || grid_m[ix][iy][iz] > 0) {
01748
01749
                    /* Set coordinates... */
                    z = ctl->grid_z0 + dz * (iz + 0.5);
lon = ctl->grid_lon0 + dlon * (ix + 0.5);
01750
01751
                    lat = ctl->grid_lat0 + dlat * (iy + 0.5);
01752
01753
01754
                    /* Get pressure and temperature... */
01755
                    press = P(z);
                    intpol_met_time(met0, met1, t, press, lon, lat,
    NULL, &temp, NULL, NULL, NULL, NULL, NULL);
01756
01757
01758
                    /* Calculate surface area... */
                   area = dlat * dlon * gsl_pow_2(RE * M_PI / 180.)
 * cos(lat * M_PI / 180.);
01760
01761
01762
                   /* Calculate column density... */
cd = grid_m[ix][iy][iz] / (le6 * area);
01763
01764
```

```
/* Calculate mass mixing ratio... */
rho_air = 100. * press / (287.058 * temp);
mmr = grid_m[ix][iy][iz] / (rho_air * 1e6 * area * 1e3 * dz);
01766
01767
01768
01769
                 01770
01771
01772
01773
01774
           }
01775
        }
01776
01777
         /* Close file... */
01778
        fclose(out);
01779 }
```

Here is the call graph for this function:



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

Write profile data.

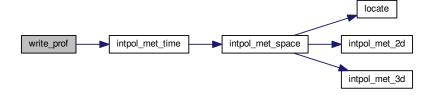
Definition at line 1783 of file libtrac.c.

```
01789
                      {
01790
01791
         static FILE *in, *out;
01792
01793
         static char line[LEN];
01794
01795
         static double mass[GX][GY][GZ], obsmean[GX][GY], tmean[GX][GY],
           rt, rlon, rlat, robs, t0, t1, area, dz, dlon, dlat, lon, lat, z, press, temp, rho_air, mmr, h2o, o3;
01796
01797
01798
01799
         static int init, obscount[GX][GY], ip, ix, iy, iz;
01800
          /* Init... */
01801
01802
          if (!init) {
01803
            init = 1;
01804
01805
            /\star Check quantity index for mass... \star/
01806
            if (ctl->qnt_m < 0)
01807
               ERRMSG("Need quantity mass!");
01808
            /* Check dimensions... */    if (ctl->prof_nx > GX || ctl->prof_ny > GY || ctl->prof_nz > GZ)
01809
01810
              ERRMSG("Grid dimensions too large!");
01811
01812
01813
            /\star Open observation data file... \star/
            \label{lem:condition} printf("Read profile observation data: %s\n", ctl->prof_obsfile);
01814
            if (!(in = fopen(ctl->prof_obsfile, "r")))
    ERRMSG("Cannot open file!");
01815
01816
01817
01818
             /* Create new file... */
            printf("Write profile data: %s\n", filename);
if (!(out = fopen(filename, "w")))
    ERRMSG("Cannot create file!");
01819
01820
01821
01822
01823
            /* Write header... */
01824
            fprintf(out,
```

```
"# $1 = time [s] \n"
                      "# $2 = altitude [km] \n"
01826
01827
                      "# $3 = longitude [deg] \n"
                      "# $4 = latitude [deg]\n"
01828
                      "# $5
                              = pressure [hPa]\n"
01829
                      "# $6 = temperature [K]\n"
01830
                              = mass mixing ratio [1]\n"
01831
01832
                      "# $8 = H20 volume mixing ratio [1]\n"
01833
                      "# $9 = 03 volume mixing ratio [1]\n"
01834
                      "# $10 = mean BT index [K]\n");
01835
            /* Set grid box size... */
01836
            dz = (ctl->prof_z1 - ctl->prof_z0) / ctl->prof_nz;
dlon = (ctl->prof_lon1 - ctl->prof_lon0) / ctl->prof_nx;
dlat = (ctl->prof_lat1 - ctl->prof_lat0) / ctl->prof_ny;
01837
01838
01839
01840
01841
01842
         /\star Set time interval... \star/
         t0 = t - 0.5 * ctl->dt_mod;
t1 = t + 0.5 * ctl->dt_mod;
01843
01844
01845
         /* Initialize... */
for (ix = 0; ix < ctl->prof_nx; ix++)
  for (iy = 0; iy < ctl->prof_ny; iy++) {
   obsmean[ix][iy] = 0;
01846
01847
01848
01849
               obscount[ix][iy] = 0;
01850
01851
               tmean[ix][iy] = 0;
01852
               for (iz = 0; iz < ctl->prof_nz; iz++)
01853
                 mass[ix][iy][iz] = 0;
01854
01855
01856
         /* Read data... */
01857
         while (fgets(line, LEN, in)) {
01858
            /* Read data... */
if (sscanf(line, "%lg %lg %lg %lg", &rt, &rlon, &rlat, &robs) != 4)
01859
01860
01861
             continue;
01862
01863
            /* Check time... */
01864
            if (rt < t0)</pre>
01865
            continue;
if (rt > t1)
01866
01867
              break:
01868
01869
            /* Calculate indices... */
           ix = (int) ((rlon - ctl->prof_lon0) / dlon);
iy = (int) ((rlat - ctl->prof_lat0) / dlat);
01870
01871
01872
            /* Check indices... */
if (ix < 0 || ix >= ctl->prof_nx || iy < 0 || iy >= ctl->prof_ny)
01873
01874
01875
             continue;
01876
01877
            /\star Get mean observation index... \star/
            obsmean[ix][iy] += robs;
tmean[ix][iy] += rt;
01878
01879
            obscount[ix][iy]++;
01880
01881
01882
01883
          /* Analyze model data... */
01884
          for (ip = 0; ip < atm->np; ip++) {
01885
01886
            /* Check time... */
01887
            if (atm->time[ip] < t0 || atm->time[ip] > t1)
01888
              continue;
01889
            /* Get indices... */
01890
           ix = (int) ((atm->lon[ip] - ctl->prof_lon0) / dlon);
iy = (int) ((atm->lat[ip] - ctl->prof_lat0) / dlat);
01891
01892
            iz = (int) ((Z(atm->p[ip]) - ctl->prof_z0) / dz);
01893
01894
01895
            /* Check indices... */
            if (ix < 0 || ix >= ctl->prof_nx ||
01896
                iy < 0 || iy >= ctl->prof_ny || iz < 0 || iz >= ctl->prof_nz)
01897
01898
               continue:
01899
01900
            /* Get total mass in grid cell... */
01901
            mass[ix][iy][iz] += atm->q[ctl->qnt_m][ip];
01902
01903
01904
         /* Extract profiles... */
         for (ix = 0; ix < ctl->prof_nx; ix++)
  for (iy = 0; iy < ctl->prof_ny; iy++)
01905
01906
01907
              if (obscount[ix][iy] > 0) {
01908
                 /* Write output... */
fprintf(out, "\n");
01909
01910
01911
```

```
/* Loop over altitudes... */
01913
                for (iz = 0; iz < ctl->prof_nz; iz++) {
01914
                  /* Set coordinates... */
01915
                  z = ctl->prof_z0 + dz * (iz + 0.5);
lon = ctl->prof_lon0 + dlon * (ix + 0.5);
01916
01917
01918
                  lat = ctl->prof_lat0 + dlat * (iy + 0.5);
01919
01920
                  /\star Get meteorological data... \star/
01921
                  press = P(z);
                  intpol_met_time(met0, met1, t, press, lon, lat,
    NULL, &temp, NULL, NULL, NULL, &h2o, &o3);
01922
01923
01924
01925
                  /* Calculate mass mixing ratio... */
                 rho_air = 100. * press / (287.058 * temp);
area = dlat * dlon * gsl_pow_2(M_PI * RE / 180.)
* cos(lat * M_PI / 180.);
01926
01927
01928
01929
                  mmr = mass[ix][iy][iz] / (rho_air * area * dz * 1e9);
01930
                  01932
01933
                           z, lon, lat, press, temp, mmr, h2o, o3,
01934
01935
                           obsmean[ix][iy] / obscount[ix][iy]);
01936
01937
             }
01938
01939
         /* Close file... */
         if (t == ctl->t_stop)
01940
01941
           fclose(out);
01942 }
```

Here is the call graph for this function:



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

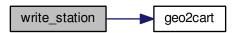
Write station data.

Definition at line 1946 of file libtrac.c.

```
{
01951
01952
       static FILE *out;
01953
       static double rmax2, t0, t1, x0[3], x1[3];
01954
01955
01956
       static int init, ip, iq;
01957
01958
        /* Init... */
       if (!init) {
01959
         init = 1;
01960
01961
01962
          /* Write info... */
01963
         printf("Write station data: %s\n", filename);
01964
01965
          /* Create new file... */
         if (!(out = fopen(filename, "w")))
01966
01967
           ERRMSG("Cannot create file!");
01968
01969
          /* Write header... */
```

```
fprintf(out,
01971
                  "# $1 = time [s] \n"
                  "# \$2 = altitude [km]\n"
"# \$3 = longitude [deg]\n" "# \$4 = latitude [deg]\n");
01972
01973
          for (iq = 0; iq < ctl->nq; iq++)
  fprintf(out, "# $%i = %s [%s]\n", (iq + 5),
01974
          01975
01976
01977
01978
01979
          /\star Set geolocation and search radius... \star/
         geo2cart(0, ctl->stat_lon, ctl->stat_lat, x0);
rmax2 = gsl_pow_2(ctl->stat_r);
01980
01981
01982
01983
01984
        /\star Set time interval for output... \star/
       t0 = t - 0.5 * ctl->dt_mod;
t1 = t + 0.5 * ctl->dt_mod;
01985
01986
01987
01988
        /* Loop over air parcels... */
01989
        for (ip = 0; ip < atm->np; ip++) {
01990
         01991
01992
01993
            continue;
01994
01995
          /* Check station flag... */
01996
          if (ctl->qnt_stat >= 0)
01997
           if (atm->q[ctl->qnt_stat][ip])
01998
              continue;
01999
02000
          /* Get Cartesian coordinates... */
02001
         geo2cart(0, atm->lon[ip], atm->lat[ip], x1);
02002
02003
          /\star Check horizontal distance... \star/
02004
          if (DIST2(x0, x1) > rmax2)
02005
            continue;
02006
02007
          /* Set station flag... */
02008
          if (ctl->qnt_stat >= 0)
02009
           atm->q[ctl->qnt_stat][ip] = 1;
02010
         02011
02012
02013
          for (iq = 0; iq < ctl->nq; iq++) {
   fprintf(out, " ");
02014
02015
02016
            fprintf(out, ctl->qnt_format[iq], atm->q[iq][ip]);
02017
02018
          fprintf(out, "\n");
02019
02020
02021
        /* Close file... */
02022
        if (t == ctl->t\_stop)
02023
          fclose(out);
02024 }
```

Here is the call graph for this function:



5.14 libtrac.h

```
00001 /\star
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
```

5.14 libtrac.h 127

```
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,
         but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
00010
00011
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 <a href="http://www.gnu.org/licenses/">http://www.gnu.org/licenses/</a>.
00016
00017
         Copright (C) 2013-2015 Forschungszentrum Juelich GmbH
00018 */
00019
00034 #include <ctype.h>
00035 #include <gsl/gsl_const_mksa.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_statistics.h>
00041 #include <math.h>
00042 #include <netcdf.h>
00043 #include <omp.h>
00044 #include <stdio.h>
00045 #include <stdlib.h>
00046 #include <string.h>
00047 #include <time.h>
00048 #include <sys/time.h>
00049
00050 /*
00051
         Macros...
00052
00053
00055 #define ALLOC(ptr, type, n)
00056  if((ptr=calloc((size_t)(n), sizeof(type))) ==NULL)
         ERRMSG("Out of memory!");
00057
00060 #define DIST(a, b) sqrt(DIST2(a, b))
00061
00063 #define DIST2(a, b)
       ((a[0]-b[0])*(a[0]-b[0])+(a[1]-b[1])*(a[1]-b[1])+(a[2]-b[2])*(a[2]-b[2]))
00064
00065
00067 #define DOTP(a, b) (a[0]*b[0]+a[1]*b[1]+a[2]*b[2])
00070 #define ERRMSG(msg)
00071 printf("\nError (%s, %s, 1%d): %s\n\n",
           __FILE__, __func__, __LINE__, msg);
exit(EXIT_FAILURE);
00072
00073
00074 }
00075
00077 #define LIN(x0, y0, x1, y1, x)
00078 \qquad (\,(y0)+(\,(y1)-(y0)\,)\,/\,(\,(x1)-(x0)\,)\,\star\,(\,(x)-(x0)\,)\,)
00079
00081 #define NC(cmd) {
        if((cmd)!=NC_NOERR)
00082
             ERRMSG(nc_strerror(cmd));
00084
00085
00087 #define NORM(a) sqrt(DOTP(a, a))
00088
00090 #define PRINT(format, var)

00091 printf("Print (%s, %s, 1%d): %s= "format"\n",

00092 __FILE__, __func__, __LINE__, #var, var);
00093
00095 #define P(z) (P0*exp(-(z)/H0))
00096
00098 #define TOK(line, tok, format, var) {
00099         if(((tok)=strtok((line), " \t"))) {
00100             if(sscanf(tok, format, &(var))!=1) continue;
00101
           } else ERRMSG("Error while reading!");
00102
00103
00105 #define Z(p) (H0*log(P0/(p)))
00106
00108 #define START_TIMER(id) timer(#id, id, 1)
00109
00111 #define STOP_TIMER(id) timer(#id, id, 2)
00112
00114 #define PRINT_TIMER(id) timer(#id, id, 3)
00115
00116 /
00117
00118
00119
00121 #define G0 9.80665
00122
```

```
00124 #define H0 7.0
00125
00127 #define P0 1013.25
00128
00130 #define RE 6367.421
00131
00132 /*
00133
        Dimensions...
00134
00135
00137 #define LEN 5000
00138
00140 #define NP 10000000
00141
00143 #define NQ 12
00144
00146 #define EP 73
00147
00149 #define EX 721
00150
00152 #define EY 361
00153
00155 #define GX 720
00156
00158 #define GY 360
00159
00161 #define GZ 100
00162
00164 #define NENS 2000
00165
00167 #define NTHREADS 128
00168
00170 #define NTIMER 20
00171
00172 /* -----
00173
        Structs...
00174
00175
00177 typedef struct {
00178
00180
        int nq;
00181
00183
       char qnt_name[NQ][LEN];
00184
00186
       char qnt_unit[NQ][LEN];
00187
00189
        char qnt_format[NQ][LEN];
00190
00192
        int qnt_ens;
00193
00195
        int qnt_m;
00196
00198
        int qnt_rho;
00199
00201
        int qnt_r;
00202
        int qnt_ps;
00205
00207
        int qnt_p;
00208
00210
        int qnt_t;
00211
00213
        int qnt_u;
00214
00216
        int qnt_v;
00217
00219
        int qnt_w;
00220
00222
        int qnt_h2o;
00223
00225
        int qnt_o3;
00226
00228
        int qnt_theta;
00229
00231
        int qnt_pv;
00232
00234
        int qnt_tice;
00235
00237
        int qnt_tsts;
00238
00240
        int qnt_tnat;
00241
00243
        int qnt_stat;
00244
00246
        int qnt_gw_u750;
00247
       int qnt_gw_v750;
00249
```

5.14 libtrac.h 129

```
00250
00252
        int qnt_gw_sso;
00253
00255
        int qnt_gw_var;
00256
00258
        int direction:
00259
00261
        double t_start;
00262
00264
        double t_stop;
00265
00267
        double dt_mod;
00268
00270
        double dt_met;
00271
00273
00274
        int met_np;
00276
        double met_p[EP];
00277
00280
        int isosurf;
00281
00283
        char balloon[LEN];
00284
        double turb_dx_trop;
00286
00287
00289
        double turb_dx_strat;
00290
00292
        double turb_dz_trop;
00293
00295
        double turb_dz_strat;
00296
00298
        double turb_meso;
00299
00301
        double tdec_trop;
00302
        double tdec_strat;
00304
00305
00307
        double psc_h2o;
00308
00310
        double psc_hno3;
00311
00313
        char gw_basename[LEN];
00314
00316
        char atm_basename[LEN];
00317
00319
        char atm_gpfile[LEN];
00320
00322
        double atm_dt_out;
00323
00325
        int atm filter:
00326
00328
        char csi_basename[LEN];
00329
00331
        double csi_dt_out;
00332
00334
        char csi obsfile[LEN];
00335
00337
        double csi_obsmin;
00338
00340
        double csi_modmin;
00341
00343
        int csi_nz;
00344
00346
        double csi_z0;
00347
00349
        double csi_z1;
00350
00352
        int csi nx:
00353
        double csi_lon0;
00356
00358
        double csi_lon1;
00359
00361
        int csi_ny;
00362
        double csi_lat0;
00365
00367
        double csi_lat1;
00368
00370
        char grid basename[LEN];
00371
00373
        char grid_gpfile[LEN];
00374
00376
        double grid_dt_out;
00377
00379
        int grid_sparse;
00380
```

```
00382
        int grid_nz;
00383
00385
        double grid_z0;
00386
00388
        double grid_z1;
00389
00391
        int grid_nx;
00392
00394
        double grid_lon0;
00395
00397
        double grid_lon1;
00398
00400
        int grid_ny;
00401
00403
        double grid_lat0;
00404
        double grid_lat1;
00406
00407
00409
        char prof_basename[LEN];
00410
00412
        char prof_obsfile[LEN];
00413
00415
        int prof_nz;
00416
00418
        double prof_z0;
00419
00421
        double prof_z1;
00422
00424
        int prof_nx;
00425
00427
        double prof_lon0;
00428
00430
        double prof_lon1;
00431
00433
        int prof_ny;
00434
00436
        double prof_lat0;
00437
00439
        double prof_lat1;
00440
        char ens_basename[LEN];
00442
00443
00445
        char stat basename[LEN];
00446
00448
        double stat_lon;
00449
00451
        double stat_lat;
00452
00454
        double stat_r;
00455
00456 } ctl_t;
00457
00459 typedef struct {
00460
00462
        int np;
00463
        double time[NP];
00466
00468
        double p[NP];
00469
00471
        double lon[NP];
00472
00474
        double lat[NP];
00475
00477
        double q[NQ][NP];
00478
00480
        double up[NP];
00481
00483
        double vp[NP];
00484
00486
        double wp[NP];
00487
00488 } atm_t;
00489
00491 typedef struct {
00492
00494
        double time;
00495
00497
        int nx;
00498
00500
        int ny;
00501
00503
        int np;
00504
00506
        double lon[EX];
00507
00509
        double lat[EY];
```

5.14 libtrac.h 131

```
00510
00512
        double p[EP];
00513
00515
        double ps[EX][EY];
00516
00518
        float pl[EX][EY][EP];
00519
00521
        float t[EX][EY][EP];
00522
00524
        float u[EX][EY][EP];
00525
00527
        float v[EX][EY][EP];
00528
00530
        float w[EX][EY][EP];
00531
00533
00534
        float h2o[EX][EY][EP];
        float o3[EX][EY][EP];
00536
00538 } met_t;
00539
00540 /* -----
00541
        Functions...
00542
00543
00545 void cart2geo(
00546
        double *x,
00547
        double *z,
00548
        double *lon,
00549
        double *lat);
00550
00552 double deg2dx(
00553
       double dlon,
00554
        double lat);
00555
00557 double deg2dy(
00558
        double dlat);
00559
00561 double dp2dz(
00562
       double dp,
00563
        double p);
00564
00566 double dx2deg(
00567
        double dx,
00568
       double lat);
00569
00571 double dy2deg(
00572
       double dy);
00573
00575 double dz2dp(
00576
        double dz,
00577
        double p);
00578
00580 void geo2cart(
00581
       double z,
00582
        double lon,
00583
        double lat,
00584
        double *x);
00585
00587 void get_met(
        ctl_t * ctl,
char *metbase,
00588
00589
00590
        double t,
00591
        met_t * met0,
00592
        met_t * met1);
00593
00595 void get_met_help(
00596
        double t.
00597
        int direct,
00598
        char *metbase,
00599
        double dt_met,
00600
        char *filename);
00601
00603 void intpol_met_2d(
00604
        double array[EX][EY],
00605
        int ix,
00606
        int iy,
00607
        double wx,
00608
        double wy,
        double *var);
00609
00610
00612 void intpol_met_3d(
00613
        float array[EX][EY][EP],
00614
        int ip,
00615
        int ix,
        int iy,
double wp,
00616
00617
```

```
00618
        double wx,
00619
        double wy,
00620
        double *var);
00621
00623 void intpol_met_space(
        met_t * met,
double p,
double lon,
00624
00625
00626
00627
        double lat,
00628
        double *ps,
00629
        double *t,
00630
        double *u.
00631
        double *v,
00632
        double *w,
00633
        double *h2o,
00634
        double *o3);
00635
00637 void intpol_met_time(
       met_t * met0,
met_t * met1,
00638
00639
00640
        double ts,
00641
        double p,
00642
        double lon,
00643
        double lat,
00644
        double *ps,
00645
        double *t,
00646
        double *u,
00647
        double *v,
00648
        double *w,
00649
        double *h2o,
00650
        double *o3);
00651
00653 void jsec2time(
00654
       double jsec,
00655
        int *year,
00656
        int *mon,
00657
        int *day,
00658
        int *hour,
00659
        int *min,
00660
        int *sec,
00661
        double *remain);
00662
00664 int locate(
00665
        double *xx,
00666
        int n,
00667
        double x);
00668
00670 void read_atm(
        const char *filename,
ctl_t * ctl,
00671
00672
00673
        atm_t * atm);
00674
00676 void read_ctl(
00677
       const char *filename,
00678
        int argc,
00679
       char *argv[],
ctl_t * ctl);
00680
00681
00683 void read_met(
       ctl_t * ctl,
char *filename,
met_t * met);
00684
00685
00686
00687
00689 void read_met_extrapolate(
00690
       met_t * met);
00691
00693 void read_met_help(
00694
        int ncid.
00695
        char *varname,
        char *varname2,
00697
        met_t * met,
00698
        float dest[EX][EY][EP],
00699
        float scl);
00700
00702 void read_met_ml2pl(
       ctl_t * ctl,
met_t * met,
00703
00704
00705
        float var[EX][EY][EP]);
00706
00708 void read_met_periodic(
00709
       met_t * met);
00712 double scan_ctl(
00713
        const char *filename,
00714
        int argc,
00715
       char *argv[],
const char *varname,
00716
```

```
int arridx,
00718
        const char *defvalue,
00719
        char *value);
00720
00722 void time2jsec(
00723
        int year,
int mon,
00724
00725
        int day,
00726
        int hour,
00727
        int min,
00728
        int sec,
00729
        double remain.
00730
        double *jsec);
00731
00733 void timer(
00734
        const char *name,
00735
        int id.
00736
        int mode);
00738 /* Get tropopause pressure... */
00739 double tropopause(
00740
        double t,
00741
        double lat);
00742
00744 void write_atm(
00745 const char *filename,
        ctl_t * ctl,
atm_t * atm,
00746
00747
00748
        double t);
00749
00751 void write_csi(
00752
        const char *filename,
        ctl_t * ctl,
atm_t * atm,
00753
00754
00755
        double t);
00756
00758 void write_ens(
00759 const char *filename,
        ctl_t * ctl,
atm_t * atm,
00760
00761
00762
        double t);
00763
00765 void write_grid(
00766
        const char *filename,
        ctl_t * ctl,
met_t * met0,
00767
00768
        met_t * met1,
atm_t * atm,
00769
00770
00771
        double t);
00772
00774 void write_prof(
00775 const char *filename,
        ctl_t * ctl,
met_t * met0,
met_t * met1,
atm_t * atm,
00776
00777
00778
00779
00780
        double t);
00781
00783 void write_station(
00784
        const char *filename,
        ctl_t * ctl,
atm_t * atm,
00785
00786
00787
        double t);
```

5.15 match.c File Reference

Calculate deviations between two trajectories.

Functions

• int main (int argc, char *argv[])

5.15.1 Detailed Description

Calculate deviations between two trajectories.

Definition in file match.c.

5.15.2 Function Documentation

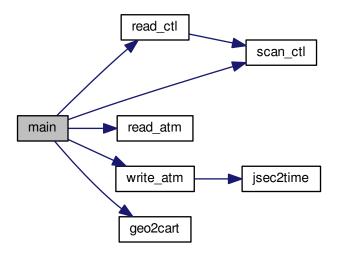
5.15.2.1 int main (int argc, char * argv[])

Definition at line 28 of file match.c.

```
00030
00031
00032
        ctl_t ctl;
00033
00034
        atm t *atm1, *atm2, *atm3;
00035
00036
        FILE *out;
00037
00038
        char filename[LEN];
00039
        double filter_dt, x1[3], x2[3], dh, dq[NQ], dv, lh = 0, lt = 0, lv = 0;
00040
00041
00042
        int filter, ip1, ip2, iq, n;
00043
00044
         /* Allocate... */
00045
        ALLOC(atm1, atm_t, 1);
00046
        ALLOC(atm2, atm_t, 1);
00047
        ALLOC(atm3, atm t, 1);
00048
00049
         /* Check arguments... */
00050
        if (argc < 5)</pre>
00051
          ERRMSG("Give parameters: <ctl> <atm_test> <atm_ref> <outfile>");
00052
00053
        /* Read control parameters... */
        read_ctl(argv[1], argc, argv, &ctl);
filter = (int) scan_ctl(argv[1], argc, argv, "FILTER", -1, "0", NULL);
00054
00055
00056
        filter_dt = scan_ctl(argv[1], argc, argv, "FILTER_DT", -1, "0", NULL);
00057
00058
         /* Read atmospheric data... */
00059
        read_atm(argv[2], &ctl, atml);
00060
        read_atm(argv[3], &ctl, atm2);
00061
00062
00063
        printf("Write transport deviations: %s\n", argv[4]);
00064
00065
        /* Create output file... */
        if (!(out = fopen(argv[4], "w")))
00066
          ERRMSG("Cannot create file!");
00067
00068
00069
        /* Write header... */
        00070
00071
00072
                 "# $2 = altitude [km] \n"
                 "# \$3 = longitude [deg] \n" "# <math>\$4 = latitude [deg] \n");
00073
        for (iq = 0; iq < ctl.nq; iq++)
fprintf(out, "# $%i = %s [%s]\n", iq + 5, ctl.qnt_name[iq],
00074
00075
00076
                   ctl.qnt_unit[iq]);
        fprintf(out,
    "# $%d = trajectory time [s]\n"
    "# $%d = vertical length of trajectory [km]\n"
    "# $%d = vertical length of trajectory [km]\n"
00077
00078
00079
00080
                 "# \$d = horizontal length of trajectory [km]\n"
00081
                 "# \$%d = vertical deviation [km]\n"
                 "# \$%d = horizontal deviation [km]\n",
00082
00083
                 5 + ctl.nq, 6 + ctl.nq, 7 + ctl.nq, 8 + ctl.nq, 9 + ctl.nq);
        for (iq = 0; iq < ctl.nq; iq+)
fprintf(out, "# $%d = %s deviation [%s]\n", ctl.nq + iq + 10,
00084
00085
        ctl.qnt_name[iq], ctl.qnt_unit[iq]);
fprintf(out, "\n");
00086
00087
00088
00089
         /\star Filtering of reference time series... \star/
        if (filter) {
00090
00091
00092
           /* Copy data... */
00093
          memcpy(atm3, atm2, sizeof(atm_t));
00094
00095
           /* Loop over data points... */
00096
           for (ip1 = 0; ip1 < atm2->np; ip1++) {
00097
            n = 0;
00098
             atm2->p[ip1] = 0;
00099
             for (iq = 0; iq < ctl.nq; iq++)</pre>
00100
               atm2->q[iq][ip1] = 0;
             for (ip2 = 0; ip2 < atm2->np; ip2++)
00101
               if (fabs(atm2->time[ip1] - atm2->time[ip2]) < filter_dt) {</pre>
00102
                 atm2->p[ip1] += atm3->p[ip2];
00103
00104
                 for (iq = 0; iq < ctl.nq; iq++)</pre>
00105
                   atm2->q[iq][ip1] += atm3->q[iq][ip2];
```

```
00106
                 n++;
00107
00108
             atm2->p[ip1] /= n;
             for (iq = 0; iq < ctl.nq; iq++)</pre>
00109
00110
               atm2->q[iq][ip1] /= n;
00111
00112
00113
           /\star Write filtered data... \star/
00114
           sprintf(filename, "%s.filt", argv[3]);
00115
           write_atm(filename, &ctl, atm2, 0);
00116
00117
00118
         /* Loop over air parcels (reference data)... */
00119
         for (ip2 = 0; ip2 < atm2->np; ip2++) {
00120
00121
           /* Get trajectory length... */
00122
           if (ip2 > 0) {
             geoCart(0, atm2->lon[ip2 - 1], atm2->lat[ip2 - 1], x1);
geo2cart(0, atm2->lon[ip2], atm2->lat[ip2], x2);
00123
00125
              lh += DIST(x1, x2);
             lv += fabs(Z(atm2->p[ip2 - 1]) - Z(atm2->p[ip2]));
lt = fabs(atm2->time[ip2] - atm2->time[0]);
00126
00127
00128
           }
00129
00130
           /* Init... */
00131
           n = 0;
00132
           dh = 0;
00133
           dv = 0;
           for (iq = 0; iq < ctl.nq; iq++)</pre>
00134
            dq[iq] = 0;
00135
00136
           geo2cart(0, atm2->lon[ip2], atm2->lat[ip2], x2);
00137
00138
           /\star Find corresponding time step (test data)... \star/
00139
           for (ip1 = 0; ip1 < atm1->np; ip1++)
             00140
00141
00142
               /* Calculate deviations... */
00144
                geo2cart(0, atm1->lon[ip1], atm1->lat[ip1], x1);
00145
                dh += DIST(x1, x2);
00146
                \label{eq:dv += Z(atm1->p[ip1]) - Z(atm2->p[ip2]);} dv += Z(atm1->p[ip1]);
               for (iq = 0; iq < ctl.nq; iq++)
  dq[iq] += atml->q[iq][ip1] - atm2->q[iq][ip2];
00147
00148
00149
               n++;
00150
00151
00152
           /* Write output... */
00153
           if (n > 0) {
             fprintf(out, "%.2f %.4f %.4f %.4f",
00154
                     atm2->time[ip2], Z(atm2->p[ip2]), atm2->lon[ip2], atm2->lat[ip2]);
00155
00156
             for (iq = 0; iq < ctl.nq; iq++) {
  fprintf(out, " ");</pre>
00157
00158
00159
                fprintf(out, ctl.qnt_format[iq], atm2->q[iq][ip2]);
00160
             fprintf(out, " %.2f %g %g %g %g", lt, lv, lh, dv / n, dh / n);
00161
             for (iq = 0; iq < ctl.nq; iq++) {
  fprintf(out, " ");</pre>
00163
00164
                fprintf(out, ctl.qnt_format[iq], dq[iq] / n);
00165
00166
             fprintf(out, "\n");
00167
00168
00169
00170
        /* Close file... */
00171
        fclose(out);
00172
00173
        /* Free... */
00174
        free(atm1);
        free(atm2);
00176
        free(atm3);
00177
00178
        return EXIT_SUCCESS;
00179 }
```

Here is the call graph for this function:



5.16 match.c

```
00001 /*
00002
         This file is part of MPTRAC.
00003
00004
         MPTRAC is free software: you can redistribute it and/or modify it under the terms of the GNU General Public License as published by
00005
00006
         the Free Software Foundation, either version 3 of the License, or
00007
         (at your option) any later version.
80000
         MPTRAC is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of
00009
00010
00011
         MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
00012
         GNU General Public License for more details.
00013
         You should have received a copy of the GNU General Public License along with MPTRAC. If not, see <a href="http://www.gnu.org/licenses/">http://www.gnu.org/licenses/</a>>.
00014
00015
00016
         Copright (C) 2013-2015 Forschungszentrum Juelich GmbH
00017
00018 */
00019
00025 #include "libtrac.h"
00026 #include <gsl/gsl_sort.h>
00027
00028 int main(
00029
        int argc,
00030
         char *argv[]) {
00031
00032
         ctl_t ctl;
00033
00034
         atm_t *atm1, *atm2, *atm3;
00035
00036
         FILE *out;
00037
00038
         char filename[LEN];
00039
         double filter_dt, x1[3], x2[3], dh, dq[NQ], dv, 1h = 0, 1t = 0, 1v = 0;
00040
00041
00042
         int filter, ip1, ip2, iq, n;
00043
00044
          /* Allocate... */
00045
00046
         ALLOC(atm1, atm_t, 1);
         ALLOC(atm2, atm_t, 1);
ALLOC(atm3, atm_t, 1);
00047
00048
         /* Check arguments... */
```

5.16 match.c 137

```
if (argc < 5)</pre>
00051
           ERRMSG("Give parameters: <ctl> <atm_test> <atm_ref> <outfile>");
00052
00053
        /\star Read control parameters... \star/
        read_ctl(argv[1], argc, argv, &ctl);
filter = (int) scan_ctl(argv[1], argc, argv, "FILTER", -1, "0", NULL);
00054
00055
        filter_dt = scan_ctl(argv[1], argc, argv, "FILTER_DT", -1, "0", NULL);
00057
00058
         /* Read atmospheric data... */
00059
        read_atm(argv[2], &ctl, atm1);
00060
        read_atm(argv[3], &ctl, atm2);
00061
00062
        /* Write info... */
00063
        printf("Write transport deviations: %s\n", argv[4]);
00064
        /* Create output file... */
if (!(out = fopen(argv[4], "w")))
00065
00066
          ERRMSG("Cannot create file!");
00067
00068
00069
        /* Write header... */
00070
        fprintf(out,
00071
                  "# $1 = time [s] \n"
                  "# $2 = altitude [km]\n"
"# $3 = longitude [deg]\n" "# $4 = latitude [deg]\n");
00072
00073
        for (iq = 0; iq < ctl.nq; iq++)
    fprintf(out, "# $%i = %s [%s]\n", iq + 5, ctl.qnt_name[iq],</pre>
00074
00075
00076
                    ctl.qnt_unit[iq]);
        fprintf(out,
00077
                  "# \$%d = trajectory time [s]\n"
00078
                  "# $%d = vertical length of trajectory [km]\n"
00079
                  "# $%d = horizontal length of trajectory [km]\n'
08000
00081
                  "# \$%d = vertical deviation [km]\n"
00082
                  "# \$%d = horizontal deviation [km]\n",
00083
                  5 + ctl.nq, 6 + ctl.nq, 7 + ctl.nq, 8 + ctl.nq, 9 + ctl.nq);
        00084
00085
00086
00088
00089
         /\star Filtering of reference time series... \star/
00090
         if (filter) {
00091
00092
          /* Copy data... */
00093
           memcpy(atm3, atm2, sizeof(atm_t));
00094
00095
           /* Loop over data points... */
00096
           for (ip1 = 0; ip1 < atm2->np; ip1++) {
00097
            n = 0;
             atm2->p[ip1] = 0;
00098
             for (iq = 0; iq < ctl.nq; iq++)
atm2->q[iq][ip1] = 0;
00099
00100
00101
              for (ip2 = 0; ip2 < atm2->np; ip2++)
00102
               if (fabs(atm2->time[ip1] - atm2->time[ip2]) < filter_dt) {</pre>
                 atm2->p[ip1] += atm3->p[ip2];

for (iq = 0; iq < ctl.nq; iq++)

atm2->q[iq][ip1] += atm3->q[iq][ip2];
00103
00104
00105
00107
00108
              atm2->p[ip1] /= n;
             for (iq = 0; iq < ctl.nq; iq++)</pre>
00109
00110
               atm2->q[iq][ip1] /= n;
00111
00112
           /\star Write filtered data... \star/
00113
00114
           sprintf(filename, "%s.filt", argv[3]);
00115
          write_atm(filename, &ctl, atm2, 0);
00116
00117
00118
         /* Loop over air parcels (reference data)... */
         for (ip2 = 0; ip2 < atm2->np; ip2++) {
00119
00120
00121
           /* Get trajectory length... */
00122
           if (ip2 > 0) {
             geo2cart(0, atm2->lon[ip2 - 1], atm2->lat[ip2 - 1], x1);
geo2cart(0, atm2->lon[ip2], atm2->lat[ip2], x2);
00123
00124
00125
              lh += DIST(x1, x2);
             lv += fabs(Z(atm2->p[ip2 - 1]) - Z(atm2->p[ip2]));
lt = fabs(atm2->time[ip2] - atm2->time[0]);
00126
00127
00128
00129
           /* Init... */
00130
00131
           n = 0;
00132
           dh = 0;
00133
           dv = 0;
           for (iq = 0; iq < ctl.nq; iq++)
  dq[iq] = 0;</pre>
00134
00135
00136
           geo2cart(0, atm2->lon[ip2], atm2->lat[ip2], x2);
```

```
00138
           /* Find corresponding time step (test data)... */
           for (ip1 = 0; ip1 < atm1->np; ip1++)
   if (fabs(atm1->time[ip1] - atm2->time[ip2])
00139
00140
00141
                  < (filter ? filter_dt : 0.1)) {
00142
00143
               /* Calculate deviations... */
00144
               geo2cart(0, atm1->lon[ip1], atm1->lat[ip1], x1);
00145
                dh += DIST(x1, x2);
                dv += Z(atm1->p[ip1]) - Z(atm2->p[ip2]);
00146
               for (iq = 0; iq < ctl.nq; iq++)
    dq[iq] += atml->q[iq][ip1] - atm2->q[iq][ip2];
00147
00148
00149
               n++;
00150
00151
00152
           /* Write output... */
           if (n > 0) {
00153
             fprintf(out, "%.2f %.4f %.4f %.4f",
00154
                      atm2->time[ip2], Z(atm2->p[ip2]),
00155
                      atm2->lon[ip2], atm2->lat[ip2]);
00156
             for (iq = 0; iq < ctl.nq; iq++) {
  fprintf(out, " ");</pre>
00157
00158
               fprintf(out, ctl.qnt_format[iq], atm2->q[iq][ip2]);
00159
00160
00161
             fprintf(out, " %.2f %g %g %g %g", lt, lv, lh, dv / n, dh / n);
00162
             for (iq = 0; iq < ctl.nq; iq++) {
   fprintf(out, " ");</pre>
00163
00164
               fprintf(out, ctl.qnt_format[iq], dq[iq] / n);
00165
00166
              fprintf(out, "\n");
00167
00168
        }
00169
00170
        /* Close file... */
00171
        fclose(out);
00172
00173
         /* Free... */
00174
        free(atm1);
00175
         free(atm2);
00176
        free(atm3);
00177
00178
        return EXIT_SUCCESS;
00179 }
```

5.17 met_map.c File Reference

Extract global map from meteorological data.

Functions

• int main (int argc, char *argv[])

5.17.1 Detailed Description

Extract global map from meteorological data.

Definition in file met_map.c.

5.17.2 Function Documentation

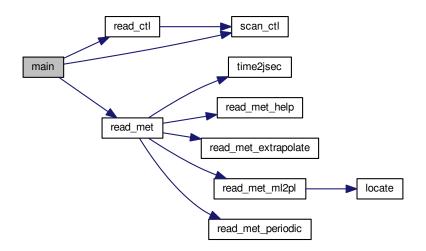
5.17.2.1 int main (int argc, char * argv[])

Definition at line 27 of file met_map.c.

```
00029
00030
00031
        ctl_t ctl;
00032
00033
        met t *met;
00034
        FILE *in, *out;
00036
00037
        static double dz, dzmin = 1e10, z, timem[EX][EY], psm[EX][EY], tm[EX][EY],
00038
          um[EX][EY], vm[EX][EY], wm[EX][EY], h2om[EX][EY], o3m[EX][EY];
00039
00040
        static int i, ip, ip2, ix, iy, np[EX][EY];
00041
00042
         /* Allocate... */
00043
        ALLOC(met, met_t, 1);
00044
00045
         /* Check arguments... */
00046
        if (argc < 4)
00047
           ERRMSG("Give parameters: <ctl> <map.tab> <met0> [ <met1> ... ]");
00048
00049
         /* Read control parameters... */
00050
        read_ctl(argv[1], argc, argv, &ctl);
        z = scan_ctl(argv[1], argc, argv, "Z", -1, "", NULL);
00051
00052
00053
         /* Loop over files... */
        for (i = 3; i < argc; i++) {
00054
00055
           /* Read meteorological data... */
00056
00057
           if (!(in = fopen(argv[i], "r")))
00058
            continue:
00059
           else
00060
            fclose(in);
00061
           read_met(&ctl, argv[i], met);
00062
00063
           /\star Find nearest pressure level... \star/
           for (ip2 = 0; ip2 < met->np; ip2++) {
00064
             dz = fabs(Z(met->p[ip2]) - z);
00065
             if (dz < dzmin) {
00066
               dzmin = dz;
00067
00068
               ip = ip2;
00069
             }
00070
          }
00071
00072
           /* Average data... */
00073
           for (ix = 0; ix < met->nx; ix++)
00074
             for (iy = 0; iy < met->ny; iy++) {
00075
               timem[ix][iy] += met->time;
               tm[ix][iy] += met->t[ix][iy][ip];
um[ix][iy] += met->u[ix][iy][ip];
00076
00077
00078
               vm[ix][iy] += met->v[ix][iy][ip];
               wm[ix][iy] += met->w[ix][iy][ip];
00080
               h2om[ix][iy] += met->h2o[ix][iy][ip];
               o3m[ix][iy] += met->o3[ix][iy][ip];
psm[ix][iy] += met->ps[ix][iy];
00081
00082
00083
               np[ix][iy]++;
00084
             }
00085
00086
00087
         /\star Create output file... \star/
        printf("Write meteorological data file: %s\n", argv[2]);
if (!(out = fopen(argv[2], "w")))
00088
00089
           ERRMSG("Cannot create file!");
00090
00091
00092
         /* Write header... */
00093
        fprintf(out,
00094
                 "# $1 = time [s] \n"
                  "# $2 = altitude [km]\n"
00095
00096
                 "# $3 = longitude [deg]\n"
                 "# $4 = latitude [deg]\n"
00097
                 "# $5 = pressure [hPa]\n"
00098
00099
                 "# $6 = temperature [K] \n"
                 "# $7 = zonal wind [m/s] n"
00100
                 "# $8 = meridional wind [m/s]\n"
00101
                 "# $9 = vertical wind [hPa/s]\n"
00102
                 "# $10 = H20 volume mixing ratio [1]\n"
00103
                 "# $11 = 03 volume mixing ratio [1]\n
00104
00105
                 "# $12 = surface pressure [hPa]\n");
00106
00107
         /* Write data... */
        for (iy = 0; iy < met->ny; iy++) {
  fprintf(out, "\n");
  for (ix = 0; ix < met->nx; ix++)
00108
00109
00110
             00111
00112
                        timem[ix][iy] / np[ix][iy], Z(met->p[ip]),
met->lon[ix] - 360.0, met->lat[iy], met->p[ip],
tm[ix][iy] / np[ix][iy], um[ix][iy] / np[ix][iy],
00113
00114
00115
```

```
00116
                                                                                                                                    vm[ix][iy] / np[ix][iy], wm[ix][iy] / np[ix][iy],
h2om[ix][iy] / np[ix][iy], o3m[ix][iy] / np[ix][iy],
psm[ix][iy] / np[ix][iy]);
 00117
 00118
                                                             for (ix = 0; ix < met\rightarrownx; ix++)
 00119
                                                                      00120
 00121
 00122
 00123
                                                                                                                                    hete value (x), hete valu
 00124
 00125
 00126
 00127
 00128
 00129
 00130
                                                  /* Close file... */
 00131
                                                fclose(out);
 00132
 00133
                                                  /* Free... */
 00134
                                                free (met);
 00135
 00136
                                                return EXIT_SUCCESS;
00137 }
```

Here is the call graph for this function:



5.18 met_map.c

```
00001 /*
00002
           This file is part of MPTRAC.
00003
00004
           \ensuremath{\mathsf{MPTRAC}} is free software: you can redistribute it and/or modify
           it under the terms of the GNU General Public License as published by
the Free Software Foundation, either version 3 of the License, or
00005
00006
00007
           (at your option) any later version.
00008
00009
           MPTRAC is distributed in the hope that it will be useful,
          but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
00010
00011
00012
           GNU General Public License for more details.
00013
          You should have received a copy of the GNU General Public License along with MPTRAC. If not, see <a href="http://www.gnu.org/licenses/">http://www.gnu.org/licenses/</a>>.
00014
00015
00016
00017
          Copright (C) 2013-2015 Forschungszentrum Juelich GmbH
00018 */
00019
00025 #include "libtrac.h"
```

5.18 met map.c 141

```
00027 int main(
00028
        int argc,
00029
        char *argv[]) {
00030
00031
        ctl t ctl;
00032
        met_t *met;
00034
00035
        FILE *in, *out;
00036
        static double dz, dzmin = 1e10, z, timem[EX][EY], psm[EX][EY], tm[EX][EY],
um[EX][EY], vm[EX][EY], wm[EX][EY], h2om[EX][EY], o3m[EX][EY];
00037
00038
00039
00040
        static int i, ip, ip2, ix, iy, np[EX][EY];
00041
         /* Allocate... */
00042
00043
        ALLOC(met, met_t, 1);
00044
00045
         /* Check arguments... */
00046
        if (argc < 4)
00047
           ERRMSG("Give parameters: <ctl> <map.tab> <met0> [ <met1> ... ]");
00048
00049
        /* Read control parameters... */
        read_ctl(argv[1], argc, argv, &ctl);
z = scan_ctl(argv[1], argc, argv, "Z", -1, "", NULL);
00050
00051
00052
         /* Loop over files... */
00053
00054
         for (i = 3; i < argc; i++) {</pre>
00055
00056
           /* Read meteorological data... */
           if (!(in = fopen(argv[i], "r")))
00057
00058
             continue;
00059
00060
             fclose(in);
00061
           read_met(&ctl, argv[i], met);
00062
00063
           /* Find nearest pressure level... */
           for (ip2 = 0; ip2 < met->np; ip2++) {
    dz = fabs(Z(met->p[ip2]) - z);
00064
00065
00066
             if (dz < dzmin) {
00067
                dzmin = dz;
00068
               ip = ip2;
00069
             }
00070
           }
00071
00072
           /* Average data... */
00073
           for (ix = 0; ix < met->nx; ix++)
             for (iy = 0; iy < met->ny; iy++) {
  timem[ix][iy] += met->time;
00074
00075
                tm[ix][iy] += met->t[ix][iy][ip];
00076
               um[ix][iy] += met->u[ix][iy][ip];
00078
                vm[ix][iy] += met->v[ix][iy][ip];
00079
                wm[ix][iy] += met->w[ix][iy][ip];
                h2om[ix][iy] += met->h2o[ix][iy][ip];
00080
               o3m[ix][iy] += met->o3[ix][iy][ip];

psm[ix][iy] += met->ps[ix][iy];

np[ix][iy]++;
00081
00082
00083
00084
00085
00086
00087
        /* Create output file... */
        printf("Write meteorological data file: %s\n", argv[2]);
if (!(out = fopen(argv[2], "w")))
00088
00089
00090
           ERRMSG("Cannot create file!");
00091
00092
         /* Write header... */
00093
        fprintf(out, "# $1
00094
                         = time [s]\n"
                  "# $2 = altitude [km] \n"
00095
                         = longitude [deg]\n"
00096
00097
                  "# $4 = latitude [deg]\n"
                  "# $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
00103
                  "# $10 = H20 volume mixing ratio [1]\n"
                  "# $11 = 03 volume mixing ratio [1]\n'
"# $12 = surface pressure [hPa]\n");
00104
00105
00106
00107
         /* Write data... */
        for (iy = 0; iy < met->ny; iy++) {
  fprintf(out, "\n");
00108
00109
00110
           for (ix = 0; ix < met->nx; ix++)
             00111
00112
00113
```

```
met->lon[ix] - 360.0, met->lat[iy], met->p[ip],
                                 met=>lon(ix) = 360.0, imet=>lat([iy], imet=>p[ip],
tm[ix][iy] / np[ix][iy], um[ix][iy] / np[ix][iy],
vm[ix][iy] / np[ix][iy], wm[ix][iy] / np[ix][iy],
h2om[ix][iy] / np[ix][iy], o3m[ix][iy] / np[ix][iy],
psm[ix][iy] / np[ix][iy]);
00115
00116
00117
00118
               for (ix = 0; ix < met->nx; ix++)
00119
                00120
00121
                                timem[ix][iy] / np[ix][iy], Z (met->p[ip]),
met->lon[ix], met->lat[iy], met->p[ip],
00122
00123
                                 tm[ix][iy] / np[ix][iy], um[ix][iy] / np[ix][iy],
vm[ix][iy] / np[ix][iy], wm[ix][iy] / np[ix][iy],
h2om[ix][iy] / np[ix][iy], o3m[ix][iy] / np[ix][iy],
00124
00125
00126
00127
                                psm[ix][iy] / np[ix][iy]);
00128
00129
           /* Close file... */
00130
00131
           fclose(out);
00132
00133
            /* Free... */
00134
           free(met);
00135
00136
           return EXIT_SUCCESS;
00137 }
```

5.19 met_prof.c File Reference

Extract vertical profile from meteorological data.

Functions

• int main (int argc, char *argv[])

5.19.1 Detailed Description

Extract vertical profile from meteorological data.

Definition in file met_prof.c.

5.19.2 Function Documentation

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

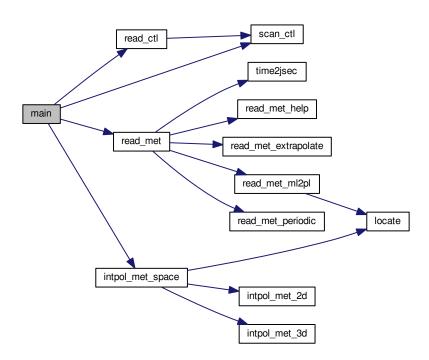
Definition at line 38 of file met prof.c.

```
00041
00042
         ctl_t ctl;
00043
00044
        met t *met;
00045
00046
        FILE *in, *out;
00047
        static double timem[NZ], z, z0, z1, dz, lon, lon0, lon1, dlon, lonm[NZ], lat, lat0, lat1, dlat, latm[NZ], t, tm[NZ], u, um[NZ], v, vm[NZ],
00048
00049
          w, wm[NZ], h2o, h2om[NZ], o3, o3m[NZ], ps, psm[NZ];
00050
00051
00052
        static int i, iz, np[NZ];
00053
00054
         /* Allocate... */
00055
        ALLOC(met, met_t, 1);
00056
00057
         /* Check arguments... */
00058
        if (argc < 4)
00059
           ERRMSG("Give parameters: <ctl>   <met0> [ <met1> ... ]");
```

```
00060
00061
            /* Read control parameters... */
           /* Read control parameters... */
read_ctl(argv[1], argc, argv, &ctl);
z0 = scan_ctl(argv[1], argc, argv, "Z0", -1, "0", NULL);
z1 = scan_ctl(argv[1], argc, argv, "Z1", -1, "60", NULL);
dz = scan_ctl(argv[1], argc, argv, "DZ", -1, "1", NULL);
lon0 = scan_ctl(argv[1], argc, argv, "LON0", -1, "0", NULL);
dlon1 = scan_ctl(argv[1], argc, argv, "LON1", -1, "0", NULL);
dlon2 = scan_ctl(argv[1], argc, argv, "DLON", -1, "1", NULL);
lat0 = scan_ctl(argv[1], argc, argv, "LAT0", -1, "0", NULL);
lat1 = scan_ctl(argv[1], argc, argv, "LAT1", -1, "0", NULL);
dlat = scan_ctl(argv[1], argc, argv, "DLAT", -1, "1", NULL);
00062
00063
00064
00065
00067
00068
00069
00070
00071
00072
00073
            /* Loop over input files... */
00074
            for (i = 3; i < argc; i++) {</pre>
00075
               /* Read meteorological data... */
if (!(in = fopen(argv[i], "r")))
00076
00077
                 continue;
00079
               else
08000
                 fclose(in);
00081
               read_met(&ctl, argv[i], met);
00082
00083
               /* Average... */
for (z = z0; z <= z1; z += dz) {
00084
                 iz = (int) ((z - z0) / dz);
00086
                  if (iz < 0 || iz > NZ)
00087
                     ERRMSG("Too many altitudes!");
00088
                  for (lon = lon0; lon <= lon1; lon += dlon)</pre>
                    00089
00090
00091
00092
00093
                               && gsl_finite(v) && gsl_finite(w)) {
                           timem[iz] += met->time;
lonm[iz] += lon;
latm[iz] += lat;
00094
00095
00096
                           tm[iz] += t;
00098
                           um[iz] += u;
00099
                           vm[iz] += v;
                           wm[iz] += w;
00100
                           h2om[iz] += h2o;
o3m[iz] += o3;
psm[iz] += ps;
00101
00102
00103
                           np[iz]++;
00105
                        }
00106
                    }
          }
00107
00108
00109
00110
            /* Normalize... */
00111
            for (z = z0; z \le z1; z += dz) {
             iz = (int) ((z - z0) / dz);
00112
             if (np[iz] > 0) {
  timem[iz] /= np[iz];
  lonm[iz] /= np[iz];
  latm[iz] /= np[iz];
00113
00114
00115
00117
                  tm[iz] /= np[iz];
                  um[iz] /= np[iz];
00118
                  vm[iz] /= np[iz];
wm[iz] /= np[iz];
00119
00120
                 h2om[iz] /= np[iz];
o3m[iz] /= np[iz];
psm[iz] /= np[iz];
00121
00122
00123
00124
              } else {
                 timem[iz] = GSL_NAN;
lonm[iz] = GSL_NAN;
latm[iz] = GSL_NAN;
00125
00126
00127
                 tm[iz] = GSL_NAN;
um[iz] = GSL_NAN;
00128
00130
                  vm[iz] = GSL_NAN;
                  wm[iz] = GSL_NAN;
00131
                 h2om[iz] = GSL_NAN;
o3m[iz] = GSL_NAN;
00132
00133
                  psm[iz] = GSL_NAN;
00134
00135
00136
00137
00138
            /* Create output file... */
            printf("Write meteorological data file: %s\n", argv[2]);
00139
            if (!(out = fopen(argv[2], "w")))
00140
               ERRMSG("Cannot create file!");
00141
00142
00143
            /* Write header... */
00144
            fprintf(out,
                         "# $1 = time [s] \n"
00145
00146
                         "# $2 = altitude [km]\n"
```

```
"# $3 = longitude [deg] \n"
00148
                "# $4 = latitude [deg]\n"
                "# $5 = pressure [hPa]\n"
00149
                "# $6 = temperature [K]\n"
00150
                "# $7 = zonal wind [m/s]\n"
"# $8 = meridional wind [m/s]\n"
00151
00152
00153
                "# $9 = vertical wind [hPa/s]\n"
00154
                "# $10 = H20 volume mixing ratio [1]\n"
00155
                "# $11 = 03 volume mixing ratio [1] n"
                "# $12 = surface pressure [hPa]\n\n");
00156
00157
        /* Write data... */
for (z = z0; z <= z1; z += dz) {
  iz = (int) ((z - z0) / dz);
00158
00159
00160
         00161
00162
00163
00164
00165
00166
        /* Close file... */
00167
        fclose(out);
00168
       /* Free... */
00169
00170
       free (met);
00171
00172
       return EXIT_SUCCESS;
00173 }
```

Here is the call graph for this function:



5.20 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.
```

5.20 met prof.c 145

```
MPTRAC is distributed in the hope that it will be useful,
          but WITHOUT ANY WARRANTY; without even the implied warranty of
00010
00011
          MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
00012
          GNU General Public License for more details.
00013
          You should have received a copy of the GNU General Public License along with MPTRAC. If not, see <a href="http://www.gnu.org/licenses/">http://www.gnu.org/licenses/</a>>.
00014
00016
00017
          Copright (C) 2013-2015 Forschungszentrum Juelich GmbH
00018 */
00019
00025 #include "libtrac.h"
00026
00027 /*
00028
           Dimensions...
00029
00030
00031 /* Maximum number of altitudes. */
00032 #define NZ 1000
00034 /*
00035
           Main...
00036
00037
00038 int main(
00039
          int argc,
          char *argv[]) {
00040
00041
00042
          ctl_t ctl;
00043
00044
          met t *met:
00045
00046
          FILE *in, *out;
00047
          static double timem[NZ], z, z0, z1, dz, lon, lon0, lon1, dlon, lonm[NZ], lat, lat0, lat1, dlat, latm[NZ], t, tm[NZ], u, um[NZ], v, vm[NZ],
00048
00049
             w, wm[NZ], h2o, h2om[NZ], o3, o3m[NZ], ps, psm[NZ];
00050
00051
00052
          static int i, iz, np[NZ];
00053
           /* Allocate... */
00054
00055
          ALLOC(met, met_t, 1);
00056
00057
           /* Check arguments... */
00058
          if (argc < 4)</pre>
00059
             ERRMSG("Give parameters: <ctl> <prof.tab> <met0> [ <met1> ... ]");
00060
          /* Read control parameters... */
read_ctl(argv[1], argc, argv, &ctl);
00061
00062
          read_ctl(argv[1], argc, argv, &ctl);
z0 = scan_ctl(argv[1], argc, argv, "Z0", -1, "0", NULL);
z1 = scan_ctl(argv[1], argc, argv, "Z1", -1, "60", NULL);
dz = scan_ctl(argv[1], argc, argv, "DZ", -1, "1", NULL);
lon0 = scan_ctl(argv[1], argc, argv, "LONO", -1, "0", NULL);
lon1 = scan_ctl(argv[1], argc, argv, "LON1", -1, "0", NULL);
dlon = scan_ctl(argv[1], argc, argv, "DLON", -1, "1", NULL);
lat0 = scan_ctl(argv[1], argc, argv, "LAT0", -1, "0", NULL);
lat1 = scan_ctl(argv[1], argc, argv, "LAT1", -1, "0", NULL);
00063
00064
00065
00066
00067
00068
00069
00070
          dlat = scan_ctl(argv[1], argc, argv, "DLAT", -1, "1", NULL);
00071
00072
00073
           /* Loop over input files...
00074
          for (i = 3; i < argc; i++) {</pre>
00075
00076
              /* Read meteorological data...
00077
             if (!(in = fopen(argv[i], "r")))
00078
                continue;
00079
             else
00080
               fclose(in);
00081
             read_met(&ctl, argv[i], met);
00082
00083
              /* Average... */
00084
             for (z = z0; z \le z1; z += dz) {
00085
                iz = (int) ((z - z0) / dz);
00086
                if (iz < 0 || iz > NZ)
                   ERRMSG("Too many altitudes!");
00087
00088
                for (lon = lon0; lon <= lon1; lon += dlon)</pre>
                  for (lat = lat0; lat <= lat1; lat += dlat) {</pre>
00089
00090
                     intpol_met_space(met, P(z), lon, lat, &ps,
                     &t, &u, &v, &w, &h2o, &o3); if (gsl_finite(t) && gsl_finite(u)
00091
00092
                           && gsl_finite(v) && gsl_finite(w)) {
00093
                        timem[iz] += met->time;
00094
                        lonm[iz] += lon;
latm[iz] += lat;
00095
00096
00097
                        tm[iz] += t;
00098
                        um[iz] += u;
00099
                        vm[iz] += v;
00100
                        wm[iz] += w;
```

```
h2om[iz] += h2o;
                     o3m[iz] += o3;
psm[iz] += ps;
00102
00103
00104
                     np[iz]++;
00105
                }
00106
00107
           }
00108
00109
00110
         /* Normalize... */
         for (z = z0; z <= z1; z += dz) {
  iz = (int) ((z - z0) / dz);
00111
00112
           if (np[iz] > 0) {
00113
00114
              timem[iz] /= np[iz];
             lonm[iz] /= np[iz];
lonm[iz] /= np[iz];
latm[iz] /= np[iz];
tm[iz] /= np[iz];
vm[iz] /= np[iz];
00115
00116
00117
00118
00119
00120
              wm[iz] /= np[iz];
             h2om[iz] /= np[iz];
o3m[iz] /= np[iz];
psm[iz] /= np[iz];
00121
00122
00123
00124
           } else {
00125
              timem[iz] = GSL_NAN;
              lonm[iz] = GSL_NAN;
latm[iz] = GSL_NAN;
00126
00127
             tm[iz] = GSL_NAN;
um[iz] = GSL_NAN;
00128
00129
              vm[iz] = GSL_NAN;
00130
              wm[iz] = GSL_NAN;
00131
              h2om[iz] = GSL_NAN;
o3m[iz] = GSL_NAN;
00132
00133
00134
              psm[iz] = GSL_NAN;
00135
00136
00137
00138
         /* Create output file... */
00139
         printf("Write meteorological data file: %s\n", argv[2]);
00140
         if (!(out = fopen(argv[2], "w")))
00141
           ERRMSG("Cannot create file!");
00142
         /* Write header... */
00143
00144
         fprintf(out,
                   "# $1
                          = time [s]\n"
                   "# $2 = altitude [km]\n"
00146
                   "# $3 = longitude [deg]\n"
"# $4 = latitude [deg]\n"
00147
00148
                   "# $5 = pressure [hPa]\n"
00149
                   "# $6 = temperature [K]\n"
00150
                   "# $7 = zonal wind [m/s]\n"
00151
00152
                   "# $8 = meridional wind [m/s]\n"
00153
                   "# $9 = vertical wind [hPa/s] n"
                   "# $10 = H2O volume mixing ratio [1]\n"
"# $11 = O3 volume mixing ratio [1]\n"
"# $12 = surface pressure [hPa]\n\n");
00154
00155
00156
        00158
00159
00160
00161
00162
00163
00164
00165
00166
         /* Close file... */
00167
         fclose(out);
00168
00169
         /* Free... */
         free(met);
00171
00172
         return EXIT_SUCCESS;
00173 }
```

5.21 met sample.c File Reference

Sample meteorological data at given geolocations.

Functions

• int main (int argc, char *argv[])

5.21.1 Detailed Description

Sample meteorological data at given geolocations.

Definition in file met sample.c.

5.21.2 Function Documentation

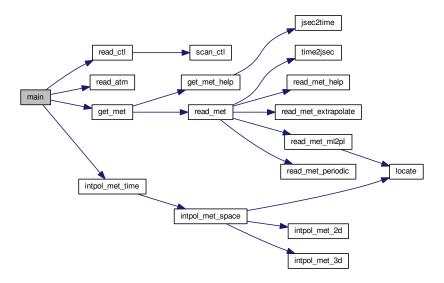
5.21.2.1 int main (int argc, char * argv[])

Definition at line 31 of file met_sample.c.

```
00033
00035
        ctl_t ctl;
00036
00037
        atm_t *atm;
00038
00039
       met t *met0, *met1;
00040
00041
       FILE *out;
00042
00043
       double t, u, v, w, h2o, o3;
00044
00045
        int ip;
00046
00047
        /* Check arguments... */
00048
00049
          ERRMSG("Give parameters: <ctl> <metbase> <atm_in> <sample.tab>");
00050
        /* Allocate... */
00051
00052
        ALLOC(atm, atm_t, 1);
       ALLOC(met0, met_t, 1);
00053
00054
        ALLOC(met1, met_t, 1);
00055
00056
       /* Read control parameters... */
00057
       read_ctl(argv[1], argc, argv, &ctl);
00058
00059
        /* Read atmospheric data... */
00060
        read_atm(argv[3], &ctl, atm);
00061
       /* Create output file... */
printf("Write meteorological data file: %s\n", argv[4]);
if (!(out = fopen(argv[4], "w")))
00062
00063
00064
          ERRMSG("Cannot create file!");
00065
00066
00067
        /* Write header... */
       fprintf(out,
00068
                "# $1 = time [s]\n"
"# $2 = altitude [km]\n"
00069
00070
00071
                "# $3 = longitude [deg] \n"
00072
                "# $4 = latitude [deg]\n"
00073
                "# $5 = pressure [hPa] \n"
                "# $6 = temperature [K]\n"
00074
                "# $7 = zonal wind [m/s]\n"
00075
00076
                "# $8 = meridional wind [m/s]\n"
                "# $9 = vertical wind [hPa/s]\n"
00077
                "# $10 = H20 volume mixing ratio [1]\n"
                "# $11 = 03 volume mixing ratio [1] \n\n");
00079
08000
       /* Loop over air parcels... */
for (ip = 0; ip < atm->np; ip++) {
00081
00082
00083
00084
          /* Get meteorological data... */
00085
          get_met(&ctl, argv[2], atm->time[ip], met0, met1);
00086
00087
          /\star Interpolate meteorological data... \star/
          intpol_met_time(met0, met1, atm->time[ip], atm->p[ip], atm->
00088
     lon[ip],
00089
                           atm->lat[ip], NULL, &t, &u, &v, &w, &h2o, &o3);
00090
         00091
00092
                  atm->time[ip], Z(atm->p[ip]), atm->lon[ip], atm->lat[ip],
00093
00094
                  atm->p[ip], t, u, v, w, h2o, o3);
00095
        }
00096
```

```
00097
        /* Close file... */
00098
        fclose(out);
00099
00100
        /* Free... */
00101
        free(atm);
00102
        free (met 0):
00103
        free (met1);
00104
00105
        return EXIT_SUCCESS;
00106 }
```

Here is the call graph for this function:



5.22 met_sample.c

```
00001 /*
00002
          This file is part of MPTRAC.
00003
00004
          \ensuremath{\mathsf{MPTRAC}} is free software: you can redistribute it and/or modify
          it under the terms of the GNU General Public License as published by the Free Software Foundation, either version 3 of the License, or
00005
00006
00007
          (at your option) any later version.
00008
00009
          MPTRAC is distributed in the hope that it will be useful,
          but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
00010
00011
00012
          GNU General Public License for more details.
00013
          You should have received a copy of the GNU General Public License along with MPTRAC. If not, see <a href="http://www.gnu.org/licenses/">http://www.gnu.org/licenses/</a>>.
00014
00015
00016
00017
          Copright (C) 2013-2015 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 t, u, v, w, h2o, o3;
00044
        int ip;
00046
00047
        /* Check arguments... */
00048
        if (argc < 4)</pre>
          ERRMSG("Give parameters: <ctl> <metbase> <atm_in> <sample.tab>");
00049
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... */
read_ctl(argv[1], argc, argv, &ctl);
00057
00058
00059
        /* Read atmospheric data... */
00060
        read_atm(argv[3], &ctl, atm);
00061
00062
        /* Create output file... */
00063
        printf("Write meteorological data file: %s\n", argv[4]);
00064
        if (!(out = fopen(argv[4], "w")))
00065
          ERRMSG("Cannot create file!");
00066
00067
        /* Write header... */
00068
        fprintf(out,
                       = time [s]\n"
00069
                 "# $1
00070
                 "# $2 = altitude [km] \n"
00071
                "# $3 = longitude [deg] \n"
00072
                "# $4 = latitude [deg]\n"
                 "# $5 = pressure [hPa] \n"
00073
                "# $6 = temperature [K]\n"
"# $7 = zonal wind [m/s]\n"
00074
00075
                 "# $8 = meridional wind [m/s]\n"
00077
                "# $9 = vertical wind [hPa/s]\n"
                "# $10 = H2O volume mixing ratio [1]\n"
"# $11 = O3 volume mixing ratio [1]\n";
00078
00079
08000
       /* Loop over air parcels... */
for (ip = 0; ip < atm->np; ip++) {
00081
00082
00083
00084
           /* Get meteorological data... */
00085
          get_met(&ctl, argv[2], atm->time[ip], met0, met1);
00086
00087
          /* Interpolate meteorological data... */
          intpol_met_time(met0, met1, atm->time[ip], atm->p[ip], atm->
00088
      lon[ip],
00089
                           atm->lat[ip], NULL, &t, &u, &v, &w, &h2o, &o3);
00090
          00091
00092
00093
00094
                   atm->p[ip], t, u, v, w, h2o, o3);
00095
00096
00097
        /* Close file... */
00098
        fclose(out);
00099
00100
        /* Free... */
00101
        free(atm);
00102
        free (met0);
00103
       free(met1);
00104
        return EXIT SUCCESS:
00105
00106 }
```

5.23 met_zm.c File Reference

Extract zonal mean from meteorological data.

Functions

• int main (int argc, char *argv[])

5.23.1 Detailed Description

Extract zonal mean from meteorological data.

Definition in file met zm.c.

5.23.2 Function Documentation

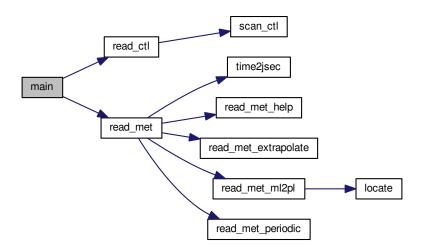
5.23.2.1 int main (int argc, char * argv[])

Definition at line 27 of file met zm.c.

```
00029
00031
         ctl_t ctl;
00032
00033
        met_t *met;
00034
00035
        FILE *in, *out;
00036
00037
         static double timem[EP][EY], psm[EP][EY], tm[EP][EY], um[EP][EY],
           vm[EP][EY], vhm[EP][EY], wm[EP][EY], h2om[EP][EY], o3m[EP][EY],
psm2[EP][EY], tm2[EP][EY], um2[EP][EY], vm2[EP][EY], vhm2[EP][EY],
wm2[EP][EY], h2om2[EP][EY], o3m2[EP][EY];
00038
00039
00040
00041
00042
         static int i, ip, ix, iv, np[EP][EY];
00043
00044
         /* Allocate... */
00045
         ALLOC(met, met_t, 1);
00046
00047
         /* Check arguments... */
00048
         if (argc < 4)
           ERRMSG("Give parameters: <ctl> <zm.tab> <met0> [ <met1> ... ]");
00049
00050
00051
         /\star Read control parameters... \star/
00052
         read_ctl(argv[1], argc, argv, &ctl);
00053
00054
         /* Loop over files... */
00055
         for (i = 3; i < argc; i++) {
00056
00057
            /* Read meteorological data... */
00058
           if (!(in = fopen(argv[i], "r")))
00059
             continue;
00060
           else
00061
             fclose(in);
00062
           read_met(&ctl, argv[i], met);
00063
00064
           /* Average data... */
           for (ix = 0; ix < met->nx; ix++)
  for (iy = 0; iy < met->ny; iy++)
    for (ip = 0; ip < met->np; ip++) {
00065
00066
00067
00068
                  timem[ip][iy] += met->time;
                  tm[ip][iy] += met->t[ix][iy][ip];
um[ip][iy] += met->u[ix][iy][ip];
00069
00070
                  vm[ip][iy] += met->v[ix][iy][ip];
00071
00072
                  \label{limits} \mbox{\ensuremath{$v$hm[ip][iy]$ += sqrt(gsl_pow_2(met->u[ix][iy][ip])$}} \label{limits}
00073
                                         + gsl_pow_2 (met->v[ix][iy][ip]));
00074
                  wm[ip][iy] += met->w[ix][iy][ip];
00075
                  h2om[ip][iy] += met->h2o[ix][iy][ip];
00076
                  o3m[ip][iy] += met->o3[ix][iy][ip];
                  psm[ip][iy] += met->ps[ix][iy];
00077
00078
                  tm2[ip][iy] += gsl_pow_2(met->t[ix][iy][ip]);
                  um2[ip][iy] += gsl_pow_2(met->u[ix][iy][ip]);
00079
                  vm2[ip][iy] += gsl_pow_2(met->v[ix][iy][ip]);
00080
00081
                  vhm2[ip][iy] += gsl_pow_2(met->u[ix][iy][ip])
00082
                    + gsl_pow_2 (met->v[ix][iy][ip]);
00083
                  wm2[ip][iy] += gsl_pow_2(met->w[ix][iy][ip]);
                  00084
00085
00086
00087
                  np[ip][iy]++;
00088
00089
        }
00090
00091
         /* Create output file... */
00092
        printf("Write meteorological data file: %s\n", argv[2]);
00093
         if (!(out = fopen(argv[2], "w")))
```

```
00094
          ERRMSG("Cannot create file!");
00095
00096
        /* Write header... */
00097
       fprintf(out,
                "# $1
00098
                      = time [s]\n"
               "# $2 = altitude [km]\n"
"# $3 = latitude [deg]\n"
00099
00101
               "# $4 = temperature mean [K]\n"
00102
               "# $5 = temperature standard deviation [K]\n"
                "# $6 = zonal wind mean [m/s]\n"
00103
               "# $7 = zonal wind standard deviation [m/s]\n"
00104
               "# $8 = meridional wind mean [m/s]\n"
00105
                      = meridional wind standard deviation [m/s]\n"
00106
               "# $9
00107
               "# $10 = horizontal wind mean [m/s]\n"
00108
               "# $11 = horizontal wind standard deviation [m/s]\n"
               "# $12 = vertical wind mean [hPa/s]\n" "# $13 = vertical wind standard deviation [hPa/s]\n"
00109
00110
               "# $14 = H20 vmr mean [1]\n"
"# $15 = H20 vmr standard deviation [1]\n"
00111
00112
               "# $16 = 03 vmr mean [1]\n"
00113
00114
               "# $17 = 03 vmr standard deviation [1]\n"
                "# $18 = surface pressure mean [hPa] \n"
00115
               "# $19 = surface pressure standard deviation [hPa] \n");
00116
00117
00118
       /* Write data... */
       for (iy = 0; iy < met->ny; iy++) {
  fprintf(out, "\n");
00119
00120
         00121
00122
00123
00124
00125
00126
                        gsl_pow_2(tm[ip][iy] / np[ip][iy])),
00127
                   um[ip][iy] / np[ip][iy],
00128
                   00129
00130
00131
00132
00133
00134
00135
00136
00137
00138
00139
                        gsl_pow_2(wm[ip][iy] / np[ip][iy])),
                   00140
00141
00142
00143
00144
00145
00146
                   sqrt(psm2[ip][iy] / np[ip][iy] -
00147
                        gsl_pow_2(psm[ip][iy] / np[ip][iy])));
00148
00149
        /* Close file... */
00151
00152
       fclose(out);
00153
00154
       /* Free... */
00155
       free (met);
00156
       return EXIT_SUCCESS;
00158 }
```

Here is the call graph for this function:



5.24 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 along with MPTRAC. If not, see <a href="http://www.gnu.org/licenses/">http://www.gnu.org/licenses/</a>>.
00015
00016
00017
         Copright (C) 2013-2015 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 *in, *out;
00036
         static double timem[EP][EY], psm[EP][EY], tm[EP][EY], um[EP][EY],
00037
           vm[EP][EY], vhm[EP][EY], wm[EP][EY], h2om[EP][EY], o3m[EP][EY],
psm2[EP][EY], tm2[EP][EY], um2[EP][EY], vm2[EP][EY], vhm2[EP][EY],
wm2[EP][EY], h2om2[EP][EY], o3m2[EP][EY];
00038
00039
00040
00041
00042
         static int i, ip, ix, iy, np[EP][EY];
00043
00044
         /* Allocate... */
00045
         ALLOC(met, met_t, 1);
00046
00047
         /* Check arguments... */
00048
         if (argc < 4)
00049
           ERRMSG("Give parameters: <ctl> <zm.tab> <met0> [ <met1> ... ]");
00050
00051
         /* Read control parameters... */
00052
         read_ctl(argv[1], argc, argv, &ctl);
```

5.24 met zm.c 153

```
00053
00054
              /* Loop over files... */
00055
              for (i = 3; i < argc; i++) {
00056
00057
                  /* Read meteorological data...
                  if (!(in = fopen(argv[i], "r")))
00058
00059
                     continue;
00060
                  else
00061
                     fclose(in);
00062
                  read_met(&ctl, argv[i], met);
00063
00064
                 /* Average data... */
for (ix = 0; ix < met->nx; ix++)
00065
                      for (iy = 0; iy < met->ny; iy++)
00066
00067
                         for (ip = 0; ip < met->np; ip++) {
00068
                             timem[ip][iy] += met->time;
                             tm[ip][iy] += met->t[ix][iy][ip];
um[ip][iy] += met->u[ix][iy][ip];
vm[ip][iy] += met->v[ix][iy][ip];
00069
00070
00071
00072
                             vhm[ip][iy] += sqrt(gsl_pow_2(met->u[ix][iy][ip])
00073
                                                                  + gsl_pow_2 (met->v[ix][iy][ip]));
00074
                             wm[ip][iy] += met->w[ix][iy][ip];
                             h2om[ip][iy] += met->h2o[ix][iy][ip];
00075
00076
                             o3m[ip][iy] += met->o3[ix][iy][ip];
                             OSM[tp][ty] += met->ps[ix][ty][tp],
psm[ip][iy] += met->ps[ix][iy];
tm2[ip][iy] += gsl_pow_2(met->t[ix][iy][ip]);
00077
00078
00079
                             um2[ip][iy] += gsl_pow_2(met->u[ix][iy][ip]);
00080
                             vm2[ip][iy] += gsl_pow_2(met->v[ix][iy][ip]);
                             vhm2[ip][iy] += gsl_pow_2(met->u[ix][iy][ip])
00081
                             + gsl_pow_2 (met->v[ix][iy][ip]);
wm2[ip][iy] += gsl_pow_2 (met->w[ix][iy][ip]);
00082
00083
                             Mind if it is a state of the state of t
00084
00085
00086
                             psm2[ip][iy] += gsl_pow_2(met->ps[ix][iy]);
00087
                             np[ip][iy]++;
00088
00089
              }
00091
               /* Create output file... */
00092
              printf("Write meteorological data file: %s\n", argv[2]);
00093
               if (!(out = fopen(argv[2], "w")))
                 ERRMSG("Cannot create file!");
00094
00095
00096
              /* Write header... */
00097
              fprintf(out,
00098
                             "# $1
                                         = time [s]\n"
                             "# $2 = altitude [km]\n"
"# $3 = latitude [deg]\n"
00099
00100
                             "# $4 = temperature mean [K]\n"
00101
                             "# $5 = temperature standard deviation [K]\n"
00102
00103
                             "# $6 = zonal wind mean [m/s]\n"
00104
                             "# \$7 = zonal wind standard deviation [m/s]\n"
00105
                             "# $8 = meridional wind mean [m/s]\n"
00106
                             "# $9 = meridional wind standard deviation [m/s]\n"
                             "# $10 = horizontal wind mean [m/s]\n"
00107
                             "# $11 = horizontal wind standard deviation [m/s]\n"
00108
                             "# $12 = vertical wind mean [hPa/s]\n"
00110
                             "# $13 = vertical wind standard deviation [hPa/s]\n"
00111
                             "# $14 = H20 vmr mean [1]\n"
                             "# $15 = H20 vmr standard deviation [1]\n"
00112
                             "# $16 = 03 vmr mean [1] n"
00113
                             "# $17 = 03 vmr standard deviation [1]\n"
00114
00115
                             "# $18 = surface pressure mean [hPa]\n'
                             "# $19 = surface pressure standard deviation [hPa]\n");
00116
00117
              /* Write data... */
00118
              for (iy = 0; iy < met->ny; iy++) {
  fprintf(out, "\n");
00119
00120
                 00121
00122
00123
00124
                                    tm[ip][iy] / np[ip][iy],
sqrt(tm2[ip][iy] / np[ip][iy] -
00125
00126
                                    gsl_pow_2(tm[ip][iy] / np[ip][iy])),
um[ip][iy] / np[ip][iy],
00127
00128
                                    00129
00130
                                    00131
00132
00133
00134
00135
00136
                                             gsl_pow_2(vhm[ip][iy] / np[ip][iy])),
                                    00137
00138
00139
```

```
h2om[ip][iy] / np[ip][iy],
                     00142
                     o3m[ip][iy] / np[ip][iy],
sqrt(o3m2[ip][iy] / np[ip][iy] -
00143
00144
                     gsl_pow_2(o3m[ip][iy] / np[ip][iy])),
psm[ip][iy] / np[ip][iy],
sqrt(psm2[ip][iy] / np[ip][iy] -
00145
00146
00147
                          gsl_pow_2(psm[ip][iy] / np[ip][iy]));
00148
00149
00150
        /* Close file... */
00151
00152
        fclose(out);
00153
00154
        /* Free... */
00155
        free (met);
00156
        return EXIT_SUCCESS;
00157
00158 }
```

5.25 smago.c File Reference

Estimate horizontal diffusivity based on Smagorinsky theory.

Functions

• int main (int argc, char *argv[])

5.25.1 Detailed Description

Estimate horizontal diffusivity based on Smagorinsky theory.

Definition in file smago.c.

5.25.2 Function Documentation

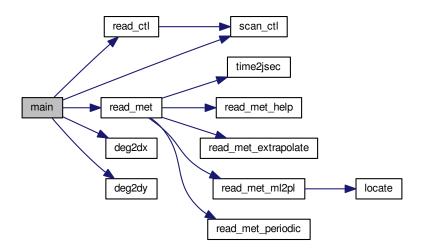
5.25.2.1 int main (int argc, char * argv[])

Definition at line 8 of file smago.c.

```
00010
00011
00012
        ctl_t ctl;
00013
00014
        met t *met;
00015
00016
00017
        static double dz, dzmin = 1e10, z, t, s, 1s2, k[EX][EY], c = 0.15;
00018
00019
00020
        static int ip, ip2, ix, iy;
00021
00022
         /* Allocate... */
00023
        ALLOC(met, met_t, 1);
00024
        /* Check arguments... */
if (argc < 4)</pre>
00025
00026
00027
          ERRMSG("Give parameters: <ctl> <map.tab> <met>");
00028
00029
        /* Read control parameters... */
        read_ctl(argv[1], argc, argv, &ctl);
z = scan_ctl(argv[1], argc, argv, "Z", -1, "", NULL);
00030
00031
00032
00033
        /* Read meteorological data... */
00034
        read_met(&ctl, argv[3], met);
```

```
00035
00036
         /* Find nearest pressure level... */
        for (ip2 = 0; ip2 < met->np; ip2++) {
  dz = fabs(Z(met->p[ip2]) - z);
  if (dz < dzmin) {</pre>
00037
00038
00039
            dzmin = dz;
00040
00041
             ip = ip2;
00042
00043
00044
        /* Write info... */
printf("Analyze %g hPa...\n", met->p[ip]);
00045
00046
00047
00048
         /* Calculate horizontal diffusion coefficients... */
        for (ix = 1; ix < met->nx - 1; ix++)
for (iy = 1; iy < met->ny - 1; iy++) {
00049
00050
             t = 0.5 * ((met->u[ix + 1][iy][ip] - met->u[ix - 1][iy][ip])
00051
                        / (1000. *
00052
00053
                            deg2dx (met->lon[ix + 1] - met->lon[ix - 1], met->
      lat[iy]))
00054
                         - (met->v[ix][iy + 1][ip] - met->v[ix][iy - 1][ip])
00055
                         / (1000. * deg2dy(met->lat[iy + 1] - met->lat[iy - 1])));
             00056
00057
00058
00059
                         / (1000. *
                            deg2dx(met->lon[ix + 1] - met->lon[ix - 1],
00060
00061
                                   met->lat[iy])));
             1s2 = gsl_pow_2(c * 500. * deg2dy(met->lat[iy + 1] - met->lat[iy - 1]));
00062
00063
             if (fabs(met->lat[iy]) > 80)
               ls2 *= (90. - fabs(met->lat[iy])) / 10.;
00064
00065
             k[ix][iy] = 1s2 * sqrt(2.0 * (gsl_pow_2(t) + gsl_pow_2(s)));
00066
00067
        /* Create output file... */
printf("Write data file: %s\n", argv[2]);
if (!(out = fopen(argv[2], "w")))
00068
00069
00070
00071
           ERRMSG("Cannot create file!");
00072
00073
         /* Write header... */
        00074
00075
                 "# $2 = latitude [deg]\n"
00076
                 "# $3 = zonal wind [m/s]\n"
00077
00078
                 "# $4 = meridional wind [m/s]\n"
00079
                 "# $5 = horizontal diffusivity [m^2/s]\n");
08000
00081
        /\star Write data... \star/
        for (iy = 0; iy < met->ny; iy++) {
  fprintf(out, "\n");
  for (ix = 0; ix < met->nx; ix++)
00082
00083
00084
00085
            if (met->lon[ix] >= 180)
               00086
00087
00088
          for (ix = 0; ix < met->nx; ix++)
if (met->lon[ix] <= 180)</pre>
00089
00090
00091
               fprintf(out, "%g %g %g %g %g\n",
00092
                       met->lon[ix], met->lat[iy],
00093
                        met \rightarrow u[ix][iy][ip], met \rightarrow v[ix][iy][ip], k[ix][iy]);
00094
00095
00096
         /* Close file... */
00097
        fclose(out);
00098
         /* Free... */
00099
00100
        free (met);
00101
00102
        return EXIT_SUCCESS;
00103 }
```

Here is the call graph for this function:



5.26 smago.c

```
00001
00006 #include "libtrac.h"
00007
00008 int main(
00009
        int argc,
         char *argv[]) {
00010
00011
00012
         ctl t ctl:
00013
00014
         met_t *met;
00015
00016
         FILE *out;
00017
00018
         static double dz, dzmin = 1e10, z, t, s, 1s2, k[EX][EY], c = 0.15;
00019
00020
         static int ip, ip2, ix, iy;
00021
00022
         /* Allocate... */
00023
         ALLOC(met, met_t, 1);
00024
00025
         /* Check arguments... */
00026
         if (argc < 4)
00027
           ERRMSG("Give parameters: <ctl> <map.tab> <met>");
00028
         /* Read control parameters... */
read_ctl(argv[1], argc, argv, &ctl);
z = scan_ctl(argv[1], argc, argv, "Z", -1, "", NULL);
00029
00030
00031
00032
00033
          /* Read meteorological data... */
00034
         read_met(&ctl, argv[3], met);
00035
00036
         /* Find nearest pressure level... */
         for (ip2 = 0; ip2 < met->np; ip2++) {
  dz = fabs(Z(met->p[ip2]) - z);
00037
00038
00039
           if (dz < dzmin) {
00040
              dzmin = dz;
00041
              ip = ip2;
00042
           }
00043
00044
00045
          /* Write info... */
00046
         printf("Analyze %g hPa...\n", met->p[ip]);
00047
         /* Calculate horizontal diffusion coefficients... */
for (ix = 1; ix < met->nx - 1; ix++)
  for (iy = 1; iy < met->ny - 1; iy++) {
00048
00049
00050
00051
              t = 0.5 * ((met -> u[ix + 1][iy][ip] - met -> u[ix - 1][iy][ip])
```

```
00052
                         / (1000. *
                             deg2dx(met->lon[ix + 1] - met->lon[ix - 1], met->
      lat[iy]))
00054
                         - (met->v[ix][iy + 1][ip] - met->v[ix][iy - 1][ip])
             / (1000. * deg2dy(met->lat[iy + 1] - met->lat[iy - 1])));

s = 0.5 * ((met->u[ix][iy + 1][ip] - met->u[ix][iy - 1][ip])

/ (1000. * deg2dy(met->lat[iy + 1] - met->lat[iy - 1]))
00055
00056
00058
                          + (met -> v[ix + 1][iy][ip] - met -> v[ix - 1][iy][ip])
                          / (1000. *
00059
00060
                             deg2dx(met->lon[ix + 1] - met->lon[ix - 1],
00061
                                    met->lat[iy])));
             ls2 = gsl_pow_2(c * 500. * deg2dy(met->lat[iy + 1] - met->lat[iy - 1]));
00062
            if (fabs(met->lat[iy]) > 80)
ls2 *= (90. - fabs(met->lat[iy])) / 10.;
00063
00064
00065
             k[ix][iy] = 1s2 * sqrt(2.0 * (gsl_pow_2(t) + gsl_pow_2(s)));
00066
00067
        /* Create output file... */
printf("Write data file: %s\n", argv[2]);
00068
00069
00070
        if (!(out = fopen(argv[2], "w")))
00071
          ERRMSG("Cannot create file!");
00072
00073
        /* Write header... */
00074
        00075
00076
                  "# $2 = latitude [deg]\n"
00077
                  "# $3 = zonal wind [m/s] \n"
00078
                  "# $4 = meridional wind [m/s]\n"
                  "# $5 = horizontal diffusivity [m^2/s]\n");
00079
00080
00081
        /* Write data... */
for (iy = 0; iy < met->ny; iy++) {
  fprintf(out, "\n");
00082
00083
00084
           for (ix = 0; ix < met->nx; ix++)
            00085
00086
00087
                        met->u[ix][iy][ip], met->v[ix][iy][ip], k[ix][iy]);
88000
00089
          for (ix = 0; ix < met->nx; ix++)
00090
           if (met->lon[ix] <= 180)</pre>
00091
               fprintf(out, "%g %g %g %g %g\n",
                        met->lon[ix], met->lat[iy],
00092
                        \label{eq:met-v} \text{met->} u \texttt{[ix][iy][ip], met->} v \texttt{[ix][iy][ip], k[ix][iy]);}
00093
00094
00095
00096
         /* Close file... */
00097
        fclose(out);
00098
00099
        /* Free... */
00100
        free (met);
00101
00102
        return EXIT_SUCCESS;
00103 }
```

5.27 split.c File Reference

Split air parcels into a larger number of parcels.

Functions

• int main (int argc, char *argv[])

5.27.1 Detailed Description

Split air parcels into a larger number of parcels.

Definition in file split.c.

5.27.2 Function Documentation

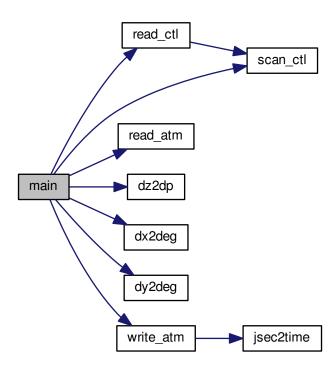
5.27.2.1 int main (int argc, char * argv[])

Definition at line 27 of file split.c.

```
00029
00030
00031
          atm_t *atm, *atm2;
00032
00033
          ctl t ctl;
00034
          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
              (argc < 4)
00048
            ERRMSG("Give parameters: <ctl> <atm_in> <atm_out>");
00049
00050
          /* Read control parameters... */
         read_ctl(argv[1], argc, argv, &ctl);
n = (int) scan_ctl(argv[1], argc, argv, "SPLIT_N", -1, "", NULL);
m = scan_ctl(argv[1], argc, argv, "SPLIT_M", -1, "-999", NULL);
dt = scan_ctl(argv[1], argc, argv, "SPLIT_DT", -1, "0", NULL);
00051
00052
00053
          to = scan_ctl(argv[1], argc, argv, "SPLIT_TO", -1, "0", NULL);
t1 = scan_ctl(argv[1], argc, argv, "SPLIT_T1", -1, "0", NULL);
00055
00056
          dz = scan_ctl(argv[1], argc, argv, "SPLIT_DZ", -1, "0", NULL);
z0 = scan_ctl(argv[1], argc, argv, "SPLIT_Z0", -1, "0", NULL);
z1 = scan_ctl(argv[1], argc, argv, "SPLIT_Z1", -1, "0", NULL);
00057
00058
00059
          dx = scan_ctl(argv[1], argc, argv, "SPLIT_DX", -1, "0", NULL);
00060
         lon0 = scan_ctl(argv[1], argc, argv, "SPLIT_LON0", -1, "0", NULL);
lon1 = scan_ctl(argv[1], argc, argv, "SPLIT_LON1", -1, "0", NULL);
lat0 = scan_ctl(argv[1], argc, argv, "SPLIT_LAT0", -1, "0", NULL);
lat1 = scan_ctl(argv[1], argc, argv, "SPLIT_LAT1", -1, "0", NULL);
00061
00062
00063
00064
00065
00066
          /* Init random number generator... */
          gsl_rng_env_setup();
00067
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++) {
               mtot += atm->q[ctl.qnt_m][ip];
00076
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) * qsl_rnq_uniform_pos(rnq);
00096
             else
00097
              atm2->time[atm2->np] = atm->time[ip]
00098
                 + gsl_ran_gaussian_ziggurat(rng, dt / 2.3548);
00099
00100
             /* Set vertical position... */
             if (z1 > z0)
00101
00102
               atm2 \rightarrow p[atm2 \rightarrow np] = P(z0 + (z1 - z0) * gsl_rng_uniform_pos(rng));
00103
00104
               atm2->p[atm2->np] = atm->p[ip]
```

```
+ dz2dp(gsl_ran_gaussian_ziggurat(rng, dz / 2.3548), atm->p[ip]);
00106
00107
            /\star Set horizontal position... \star/
           if (lon1 > lon0 && lat1 > lat0) {
00108
             atm2->lon(atm2->np) = lon0 + (lon1 - lon0) * gsl_rng_uniform_pos(rng);
atm2->lat(atm2->np) = lat0 + (lat1 - lat0) * gsl_rng_uniform_pos(rng);
00109
00110
00111
00112
            atm2 \rightarrow lon[atm2 \rightarrow np] = atm \rightarrow lon[ip]
00113
                + gsl_ran_gaussian_ziggurat(rng, dx2deg(dx, atm->lat[ip]) / 2.3548);
00114
             atm2->lat[atm2->np] = atm->lat[ip]
                + gsl_ran_gaussian_ziggurat(rng, dy2deg(dx) / 2.3548);
00115
00116
00117
00118
            /* Copy quantities... */
00119
           for (iq = 0; iq < ctl.nq; iq++)
            atm2->q[iq][atm2->np] = atm->q[iq][ip];
00120
00121
           /* Adjust mass... */
if (ctl.qnt_m >= 0)
00122
00123
00124
             atm2->q[ct1.qnt_m][atm2->np] = mtot / n;
00125
          /* Increment particle counter... */
if ((++atm2->np) >= NP)
00126
00127
             ERRMSG("Too many air parcels!");
00128
00129
00130
00131
         /\star Save data and close file... \star/
00132
         write_atm(argv[3], &ctl, atm2, atm->time[0]);
00133
         /* Free... */
00134
00135
         free (atm);
00136
         free(atm2);
00137
00138
         return EXIT_SUCCESS;
00139 }
```

Here is the call graph for this function:



5.28 split.c

```
00001 /*
          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
          the Free Software Foundation, either version 3 of the License, or
00006
00007
          (at your option) any later version.
80000
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
          You should have received a copy of the GNU General Public License along with MPTRAC. If not, see <a href="http://www.gnu.org/licenses/">http://www.gnu.org/licenses/</a>>.
00014
00015
00016
00017
          Copright (C) 2013-2015 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
          double m, mtot = 0, dt, dx, dz, mmax = 0,
   t0, t1, z0, z1, lon0, lon1, lat0, lat1;
00037
00038
00039
00040
          int i, ip, iq, n;
00041
           /* Allocate... */
00042
          ALLOC(atm, atm_t, 1);
ALLOC(atm2, atm_t, 1);
00043
00044
00045
00046
          /* Check arguments... */
00047
          if (argc < 4)
00048
             ERRMSG("Give parameters: <ctl> <atm_in> <atm_out>");
00049
00050
          /* Read control parameters... */
          /* Read control parameters... */
read_ctl(argv[1], argc, argv, &ctl);
n = (int) scan_ctl(argv[1], argc, argv, "SPLIT_N", -1, "", NULL);
m = scan_ctl(argv[1], argc, argv, "SPLIT_M", -1, "-999", NULL);
dt = scan_ctl(argv[1], argc, argv, "SPLIT_DT", -1, "0", NULL);
t0 = scan_ctl(argv[1], argc, argv, "SPLIT_TO", -1, "0", NULL);
t1 = scan_ctl(argv[1], argc, argv, "SPLIT_TI", -1, "0", NULL);
dz = scan_ctl(argv[1], argc, argv, "SPLIT_DZ", -1, "0", NULL);
00051
00052
00053
00054
00055
00056
          dz = scan_ctl(argv[1], argc, argv, "SPLIT_DZ", -1, "0", NULL);
00057
          z0 = scan_ctl(argv[1], argc, argv, "SPLIT_Z0", -1, "0", NULL);
z1 = scan_ctl(argv[1], argc, argv, "SPLIT_Z1", -1, "0", NULL);
00058
00059
          dx = scan_ctl(argv[1], argc, argv, "SPLIT_DX", -1, "0", NULL);
00060
          lon0 = scan_ctl(argv[1], argc, argv, "SPLIT_LON0", -1, "0", NULL);
lon1 = scan_ctl(argv[1], argc, argv, "SPLIT_LON1", -1, "0", NULL);
lat0 = scan_ctl(argv[1], argc, argv, "SPLIT_LAT0", -1, "0", NULL);
lat1 = scan_ctl(argv[1], argc, argv, "SPLIT_LAT1", -1, "0", NULL);
00061
00062
00063
00064
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)
            for (ip = 0; ip < atm->np; ip++) {
00075
               mtot += atm->q[ctl.qnt_m][ip];
00076
00077
                mmax = GSL_MAX(mmax, atm->q[ctl.qnt_m][ip]);
00078
          if (m > 0)
00079
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
           /\star Set time... \star/
00093
00094
           if (t1 > t0)
             atm2->time[atm2->np] = t0 + (t1 - t0) * gsl_rng_uniform_pos(rng);
00095
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
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... */
if (lon1 > lon0 && lat1 > lat0) {
00108
            atm2->latm2->np] = lon0 + (lon1 - lon0) * gsl_rng_uniform_pos(rng);
atm2->lat[atm2->np] = lat0 + (lat1 - lat0) * gsl_rng_uniform_pos(rng);
00109
00110
00111
00112
            atm2 \rightarrow lon[atm2 \rightarrow np] = atm \rightarrow lon[ip]
             + gsl_ran_gaussian_ziggurat(rng, dx2deg(dx, atm->lat[ip]) / 2.3548);
atm2->lat[atm2->np] = atm->lat[ip]
00113
00114
00115
               + gsl_ran_gaussian_ziggurat(rng, dy2deg(dx) / 2.3548);
00116
00117
00118
           /* Copy quantities... */
00119
           for (iq = 0; iq < ctl.nq; iq++)</pre>
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
          /* Increment particle counter... */
if ((++atm2->np) >= NP)
00126
00128
             ERRMSG("Too many air parcels!");
00129
00130
         /* Save data and close file... */
00131
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 }
```

5.29 time2jsec.c File Reference

Convert date to Julian seconds.

Functions

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

5.29.1 Detailed Description

Convert date to Julian seconds.

Definition in file time2jsec.c.

5.29.2 Function Documentation

5.29.2.1 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
          ERRMSG("Give parameters: <year> <mon> <day> <hour> <min> <sec> <remain>");
00037
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]);
sec = atoi(argv[6]);
00045
00046
        remain = atof(argv[7]);
00047
00048
        time2jsec(year, mon, day, hour, min, sec, remain, &jsec);
printf("%.2f\n", jsec);
00049
00050
00051
00052
        return EXIT_SUCCESS;
00053 }
```

Here is the call graph for this function:



5.30 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.
80000
00009
        MPTRAC is distributed in the hope that it will be useful,
        but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
00010
00011
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 <a href="http://www.gnu.org/licenses/">http://www.gnu.org/licenses/>.
00016
00017
        Copright (C) 2013-2015 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... */
       year = atoi(arqv[1]);
00040
00041
        mon = atoi(argv[2]);
00042
        day = atoi(argv[3]);
00043
       hour = atoi(argv[4]);
00044
       min = atoi(argv[5]);
       sec = atoi(argv[6]);
00045
00046
        remain = atof(argv[7]);
00047
00048
       /* Convert... */
       time2jsec(year, mon, day, hour, min, sec, remain, &jsec);
printf("%.2f\n", jsec);
00049
00050
00051
00052
       return EXIT_SUCCESS;
00053 }
```

5.31 trac.c File Reference

Lagrangian particle dispersion model.

Functions

void init_simtime (ctl_t *ctl, atm_t *atm)

Set simulation time interval.

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.

double module_meteo_hno3 (double t, double lat, double p)

Auxiliary function for meteo module.

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[])

5.31.1 Detailed Description

Lagrangian particle dispersion model.

Definition in file trac.c.

5.31.2 Function Documentation

5.31.2.1 void init_simtime (ctl_t * ctl, atm_t * atm)

Set simulation time interval.

Definition at line 405 of file trac.c.

```
00407
00408
         /\star Set inital and final time... \star/
00410
         if (ctl->direction == 1)
00411
          if (ctl->t_start < -1e99)
00412
             ctl->t_start = gsl_stats_min(atm->time, 1, (size_t) atm->np);
        if (ctl->t_stop < -le99)
   ctl->t_stop = gsl_stats_max(atm->time, 1, (size_t) atm->np);
} else if (ctl->direction == -1) {
00413
00414
00415
          if (ctl->t_stop < -1e99)</pre>
00417
             ctl->t_stop = gsl_stats_min(atm->time, 1, (size_t) atm->np);
00418
           if (ctl->t_start < -1e99)
             ctl->t_start = gsl_stats_max(atm->time, 1, (size_t) atm->np);
00419
00420
00421
         /* Check time... */
00423
         if (ctl->direction * (ctl->t_stop - ctl->t_start) <= 0)</pre>
00424
           ERRMSG("Nothing to do!");
00425 }
```

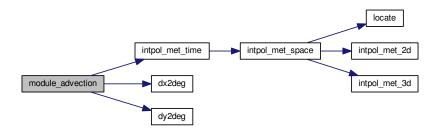
5.31.2.2 void module_advection (met_t * met0, met_t * met1, atm_t * atm, int ip, double dt)

Calculate advection of air parcels.

Definition at line 429 of file trac.c.

```
00434
00435
00436
           double v[3], xm[3];
00437
00438
            /* Interpolate meteorological data... */
           intpol_met_time(met0, met1, atm->time[ip], atm->p[ip],
00439
00440
                                   atm->lon[ip], atm->lat[ip], NULL, NULL,
00441
                                    &v[0], &v[1], &v[2], NULL, NULL);
00442
           /* Get position of the mid point... */ xm[0] = atm->lon[ip] + dx2deg(0.5 * dt * v[0] / 1000., atm->lat[ip]); <math>xm[1] = atm->lat[ip] + dy2deg(0.5 * dt * v[1] / 1000.);
00443
00444
00445
00446
           xm[2] = atm - p[ip] + 0.5 * dt * v[2];
00447
00448
            /\star Interpolate meteorological data for mid point... \star/
            \begin{array}{c} intpol\_met\_time \, (met0, \, met1, \, atm->time \, [ip] \, + \, 0.5 \, * \, dt, \\ xm[2], \, xm[0], \, xm[1], \, NULL, \, NULL, \\ & vv[0], \, & vv[1], \, & vv[2], \, NULL, \, NULL); \end{array} 
00449
00450
00451
00452
00453
            /* Save new position... */
00454
           atm->time[ip] += dt;
           atm->lan[ip] += dx2deg(dt * v[0] / 1000., xm[1]);
atm->lat[ip] += dy2deg(dt * v[1] / 1000.);
00455
00456
           atm->p[ip] += dt * v[2];
00457
00458 }
```

Here is the call graph for this function:



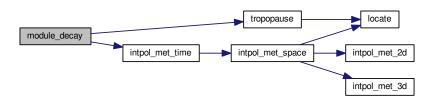
5.31.2.3 void module_decay ($ctl_t * ctl$, $met_t * met0$, $met_t * met1$, $atm_t * atm$, it ip, double dt)

Calculate exponential decay of particle mass.

Definition at line 462 of file trac.c.

```
00468
00469
00470
        double ps, pt, tdec;
00471
00472
        /* Check lifetime values... */
00473
         if ((ctl->tdec_trop <= 0 && ctl->tdec_strat <= 0) || ctl->
      qnt_m < 0)
00474
          return;
00475
00476
        /* Set constant lifetime... */
00477
        if (ctl->tdec_trop == ctl->tdec_strat)
00478
          tdec = ctl->tdec_trop;
00479
00480
        /\star Set altitude-dependent lifetime... \star/
00481
        else {
00482
00483
           /* Get surface pressure... */
00484
           intpol_met_time(met0, met1, atm->time[ip], atm->p[ip],
00485
                            atm->lon[ip], atm->lat[ip], &ps, NULL,
00486
                            NULL, NULL, NULL, NULL, NULL);
00487
00488
          /* Get tropopause pressure... */
00489
          pt = tropopause(atm->time[ip], atm->lat[ip]);
00490
00491
           /\star Set lifetime... \star/
00492
          if (atm->p[ip] \le pt)
00493
            tdec = ctl->tdec_strat;
00494
          else
00495
            tdec = LIN(ps, ctl->tdec_trop, pt, ctl->tdec_strat, atm->
     p[ip]);
00496
00497
        /* Calculate exponential decay... */
atm->q[ctl->qnt_m][ip] *= exp(-dt / tdec);
00498
00499
00500 }
```

Here is the call graph for this function:



5.31.2.4 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 504 of file trac.c.

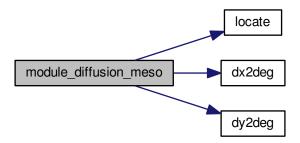
```
00512
00513
         double r, rs, u[16], v[16], w[16], usig, vsig, wsig;
00514
00515
         int ix, iv, iz;
00516
00517
          /* Calculate mesoscale velocity fluctuations... */
00518
          if (ctl->turb_meso > 0) {
00519
00520
            /* Get indices... */
00521
           ix = locate(met0->lon, met0->nx, atm->lon[ip]);
00522
            iy = locate(met0->lat, met0->ny, atm->lat[ip]);
00523
            iz = locate(met0->p, met0->np, atm->p[ip]);
00524
00525
            /* Collect local wind data... */
           u[0] = met0->u[ix][iy][iz];
u[1] = met0->u[ix + 1][iy][iz];
00526
00527
           u[2] = met0 >u[ix | 1][iy][12],
u[2] = met0 >u[ix][iy + 1][iz];
u[3] = met0 >u[ix + 1][iy + 1][iz];
00528
            u[4] = met0 -> u[ix][iy][iz + 1];
00530
00531
            u[5] = met0 -> u[ix + 1][iy][iz + 1];
00532
            u[6] = met0 -> u[ix][iy + 1][iz + 1];
            u[7] = met0 -> u[ix + 1][iy + 1][iz + 1];
00533
00534
00535
            v[0] = met0 -> v[ix][iy][iz];
            v[1] = met0 -> v[ix + 1][iy][iz];
00536
00537
            v[2] = met0 -> v[ix][iy + 1][iz];
            v[3] = met0->v[ix + 1][iy + 1][iz];
v[4] = met0->v[ix][iy][iz + 1];
00538
00539
            v[5] = met0 - v[ix + 1][iy][iz + 1];

v[6] = met0 - v[ix][iy + 1][iz + 1];
00540
00541
00542
            v[7] = met0 -> v[ix + 1][iy + 1][iz + 1];
00543
00544
            w[0] = met0->w[ix][iy][iz];
00545
            w[1] = met0->w[ix + 1][iy][iz];
            w[2] = met0 -> w[ix][iy + 1][iz];
00546
            w[3] = met0->w[ix + 1][iy + 1][iz];
w[4] = met0->w[ix][iy][iz + 1];
00547
00549
            w[5] = met0 -> w[ix + 1][iy][iz + 1];
00550
            w[6] = met0 -> w[ix][iy + 1][iz + 1];
00551
            w[7] = met0 -> w[ix + 1][iy + 1][iz + 1];
00552
            /* Get indices... */
00553
            ix = locate(met1->lon, met1->nx, atm->lon[ip]);
00554
            iy = locate(met1->lat, met1->ny, atm->lat[ip]);
00555
00556
            iz = locate(met1->p, met1->np, atm->p[ip]);
00557
00558
            /* Collect local wind data... */
           u[8] = met1->u[ix][iy][iz];
u[9] = met1->u[ix + 1][iy][iz];
00559
00560
00561
            u[10] = met1->u[ix][iy + 1][iz];
            u[11] = met1->u[ix + 1][iy + 1][iz];
u[12] = met1->u[ix][iy][iz + 1];
00562
00563
           u[13] = met1->u[ix + 1][iy][iz + 1];

u[14] = met1->u[ix][iy + 1][iz + 1];
00564
00565
00566
            u[15] = met1->u[ix + 1][iy + 1][iz + 1];
00568
            v[8] = met1->v[ix][iy][iz];
00569
            v[9] = met1 -> v[ix + 1][iy][iz];
00570
            v[10] = met1->v[ix][iy + 1][iz];
            v[13] = met1 > v[ix][iy + 1][iz];
v[11] = met1 - > v[ix + 1][iy + 1][iz];
v[12] = met1 - > v[ix][iy][iz + 1];
00571
00572
            v[13] = met1->v[ix + 1][iy][iz + 1];
v[14] = met1->v[ix][iy + 1][iz + 1];
00573
00574
00575
            v[15] = met1 - v[ix + 1][iy + 1][iz + 1];
00576
00577
            w[8] = met1->w[ix][iy][iz];
00578
            w[9] = met1->w[ix + 1][iy][iz];
            w(10) = met1->w(ix) [iy + 1] [iz];
w(11) = met1->w(ix) [iy + 1] [iz];
w(12) = met1->w(ix) [iy] [iz + 1];
00579
00581
00582
            w[13] = met1->w[ix + 1][iy][iz + 1];
            w[14] = met1->w[ix][iy + 1][iz + 1];
w[15] = met1->w[ix + 1][iy + 1][iz + 1];
00583
00584
00585
00586
            /* Get standard deviations of local wind data... */
00587
            usig = gsl_stats_sd(u, 1, 16);
00588
            vsig = gsl_stats_sd(v, 1, 16);
00589
            wsig = gsl_stats_sd(w, 1, 16);
00590
00591
            /\star Set temporal correlations for mesoscale fluctuations... \star/
            r = 1 - 2 * fabs(dt) / ctl->dt_met;
00593
            rs = sqrt(1 - r * r);
00594
00595
            /\star Calculate mesoscale wind fluctuations... \star/
00596
            atm->up[ip]
00597
              r * atm->up[ip] + rs * gsl ran gaussian ziggurat(rng.
```

```
ctl->turb_meso * usig);
00599
            atm->vp[ip] =
00600
             r * atm->vp[ip] + rs * gsl_ran_gaussian_ziggurat(rng,
00601
                                                                            ctl->turb_meso * vsig);
00602
            atm->wp[ip] =
00603
              r * atm->wp[ip] + rs * gsl_ran_gaussian_ziggurat(rng,
                                                                            ctl->turb_meso * wsig);
00604
00605
            /* Calculate air parcel displacement... */
atm->lon[ip] += dx2deg(atm->up[ip] * dt / 1000., atm->lat[ip]);
atm->lat[ip] += dy2deg(atm->vp[ip] * dt / 1000.);
00606
00607
00608
00609
            atm->p[ip] += atm->wp[ip] * dt;
00610
00611 }
```

Here is the call graph for this function:



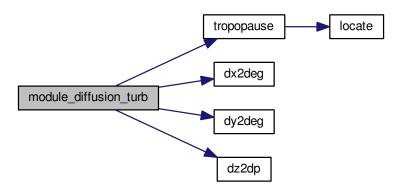
5.31.2.5 void module diffusion turb (ctl t * ctl, atm t * atm, int ip, double dt, gsl rng * rng)

Calculate turbulent diffusion.

Definition at line 615 of file trac.c.

```
00620
00621
00622
        double dx, dz, pt, p0, p1, w;
00623
00624
        /* Get tropopause pressure... */
00625
        pt = tropopause(atm->time[ip], atm->lat[ip]);
00626
00627
        /* Get weighting factor... */
        p1 = pt * 0.866877899;
p0 = pt / 0.866877899;
00628
00629
00630
        if (atm->p[ip] > p0)
00631
        else if (atm->p[ip] < p1)</pre>
00632
          w = 0;
00633
00634
        else
          w = LIN(p0, 1.0, p1, 0.0, atm->p[ip]);
00635
00636
         /* Set diffusivitiy... */
        dx = w * ctl->turb_dx_trop + (1 - w) * ctl->turb_dx_strat;
dz = w * ctl->turb_dz_trop + (1 - w) * ctl->turb_dz_strat;
00638
00639
00640
00641
        /* Horizontal turbulent diffusion... */
00642
        if (dx > 0) {
00643
         atm->lon[ip]
00644
             += dx2deg(gsl_ran_gaussian_ziggurat(rng, sqrt(2.0 * dx * fabs(dt)))
00645
                         / 1000., atm->lat[ip]);
          atm->lat[ip]
00646
00647
             += dy2deg(gsl_ran_gaussian_ziggurat(rng, sqrt(2.0 * dx * fabs(dt)))
00648
                        / 1000.);
00649
```

Here is the call graph for this function:



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

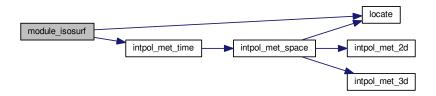
Force air parcels to stay on isosurface.

Definition at line 660 of file trac.c.

```
00665
                  {
00666
         static double *iso, *ps, t, *ts;
00668
        static int idx, ip2, n, nb = 100000;
00669
00670
00671
        FILE *in;
00672
00673
         char line[LEN];
00674
         /* Check control parameter... */ if (ctl->isosurf < 1 || ctl->isosurf > 4)
00675
00676
00677
           return:
00678
00679
         /* Initialize... */
00680
         if (ip < 0) {</pre>
00681
00682
           /* Allocate... */
00683
           ALLOC(iso, double,
                  NP);
00684
           ALLOC(ps, double, nb);
00685
00686
00687
           ALLOC(ts, double,
00688
                  nb);
00689
00690
           /* Save pressure... */
if (ctl->isosurf == 1)
00691
00692
             for (ip2 = 0; ip2 < atm->np; ip2++)
00693
                iso[ip2] = atm->p[ip2];
00694
00695
           /* Save density... */
else if (ctl->isosurf == 2)
00696
00697
             for (ip2 = 0; ip2 < atm->np; ip2++) {
00698
                intpol_met_time(met0, met1, atm->time[ip2], atm->p[ip2],
```

```
00699
                                   atm->lon[ip2], atm->lat[ip2], NULL, &t, NULL, NULL,
00700
                                   NULL, NULL, NULL);
00701
                iso[ip2] = atm->p[ip2] / t;
00702
              }
00703
00704
           /\star Save potential temperature... \star/
00705
           else if (ctl->isosurf == 3)
00706
              for (ip2 = 0; ip2 < atm->np; ip2++) {
00707
                intpol_met_time(met0, met1, atm->time[ip2], atm->p[ip2],
                atm->lon[ip2], atm->lat[ip2], NULL, &t, NULL, NULL, NULL, NULL, NULL); iso[ip2] = t * pow(P0 / atm->p[ip2], 0.286);
00708
00709
00710
00711
00712
00713
            /* Read balloon pressure data... */
00714
           else if (ctl->isosurf == 4) {
00715
00716
             /* Write info... */
printf("Read balloon pressure data: %s\n", ctl->balloon);
00718
00719
              /* Open file... */
00720
              if (!(in = fopen(ctl->balloon, "r")))
               ERRMSG("Cannot open file!");
00721
00722
00723
              /* Read pressure time series... */
             while (fgets(line, LEN, in))
if (sscanf(line, "%lg %lg", &ts[n], &ps[n]) == 2)
00724
00725
                  if ((++n) > 100000)
    ERRMSG("Too many data points!");
00726
00727
00728
00729
              /* Check number of points... */
00730
              <u>if</u> (n < 1)
00731
                ERRMSG("Could not read any data!");
00732
00733
              /* Close file... */
00734
              fclose(in);
00735
           }
00736
00737
           /* Leave initialization... */
00738
           return;
00739
00740
         /* Restore pressure... */
if (ctl->isosurf == 1)
00741
00742
00743
           atm \rightarrow p[ip] = iso[ip];
00744
         /* Restore density... */
else if (ctl->isosurf == 2) {
00745
00746
00747
           intpol_met_time(met0, met1, atm->time[ip], atm->p[ip], atm->
      lon[ip].
00748
                              atm->lat[ip], NULL, &t, NULL, NULL, NULL, NULL, NULL);
00749
           atm \rightarrow p[ip] = iso[ip] * t;
00750
00751
        /* Restore potential temperature... */
else if (ctl->isosurf == 3) {
00752
00753
           intpol_met_time(met0, met1, atm->time[ip], atm->p[ip], atm->
      lon[ip],
           atm->lat[ip], NULL, &t, NULL, NULL, NULL, NULL, NULL); \\ atm->p[ip] = P0 * pow(iso[ip] / t, -1. / 0.286); \\
00755
00756
00757
00758
00759
         /* Interpolate pressure... */
00760
         else if (ctl->isosurf == 4)
00761
         if (atm->time[ip] <= ts[0])</pre>
00762
             atm->p[ip] = ps[0];
00763
           else if (atm->time[ip] >= ts[n-1])
00764
             atm->p[ip] = ps[n - 1];
00765
           else {
             idx = locate(ts, n, atm->time[ip]);
00766
              atm->p[ip] = LIN(ts[idx], ps[idx],
ts[idx + 1], ps[idx + 1], atm->time[ip]);
00767
00768
00769
00770 }
00771 }
```

Here is the call graph for this function:



```
5.31.2.7 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 775 of file trac.c.

```
00780
                 {
00781
00782
        static FILE *in;
00784
        static char filename[LEN], line[LEN];
00785
        static double lon[GX], lat[GY], var[GX][GY],
rdum, rlat, rlat_old = -999, rlon, rvar;
00786
00787
00788
00789
        static int year_old, mon_old, day_old, nlon, nlat;
00790
00791
        double a, b, c, ps, p1, p_hno3, p_h2o, t, t1, u, u1, v, v1, w,
00792
          x1, x2, h2o, o3, grad, vort, var0, var1;
00793
00794
        int day, mon, year, idum, ilat, ilon;
00795
00796
         /* Interpolate meteorological data... */
00797
        intpol_met_time(met0, met1, atm->time[ip], atm->p[ip], atm->
      lon[ip],
00798
                          atm->lat[ip], &ps, &t, &u, &v, &w, &h2o, &o3);
00799
00800
        /* Set surface pressure... */
        if (ctl->qnt_ps >= 0)
00801
00802
          atm->q[ctl->qnt_ps][ip] = ps;
00803
00804
        /* Set pressure... */
if (ctl->qnt_p >= 0)
00805
00806
          atm->q[ctl->qnt_p][ip] = atm->p[ip];
00807
00808
        /* Set temperature... */
        if (ctl->qnt_t >= 0)
00809
00810
          atm->q[ctl->qnt_t][ip] = t;
00811
00812
        /* Set zonal wind... */
00813
        if (ctl->qnt_u >= 0)
00814
          atm \rightarrow q[ctl \rightarrow qnt_u][ip] = u;
00815
00816
         /\star Set meridional wind... \star/
        if (ctl->qnt_v >= 0)
00817
          atm->q[ctl->qnt_v][ip] = v;
00818
00819
00820
        /\star Set vertical velocity... \star/
00821
        if (ctl->qnt_w >= 0)
00822
           atm->q[ctl->qnt_w][ip] = w;
00823
00824
        /\star Set water vapor vmr... \star/
00825
        if (ct1->qnt_h2o>=0)
00826
          atm->q[ctl->qnt_h2o][ip] = h2o;
00827
00828
         /* Set ozone vmr... */
        if (ctl->qnt o3 >= 0)
00829
          atm->q[ctl->qnt_o3][ip] = o3;
00830
00831
00832
        /* Calculate potential temperature... */
```

```
if (ctl->qnt_theta >= 0)
          atm \rightarrow q[ctl \rightarrow qnt\_theta][ip] = t * pow(P0 / atm \rightarrow p[ip], 0.286);
00834
00835
00836
         /* Calculate potential vorticity... */
00837
         if (ctl->qnt_pv >= 0) {
00838
            /* Absolute vorticity... */
00840
           vort = 2 * 7.2921e-5 * sin(atm->lat[ip] * M_PI / 180.);
00841
           if (fabs(atm->lat[ip]) < 89.) {
00842
              intpol_met_time(met0, met1, atm->time[ip], atm->p[ip],
                                (atm->lon[ip] >=
00843
00844
                                 0 ? atm->lon[ip] - 1. : atm->lon[ip] + 1.),
00845
                                atm->lat[ip], NULL, NULL, NULL, &v1, NULL, NULL, NULL);
00846
              vort += (v1 - v) / 1000.
00847
               / ((atm->lon[ip] >= 0 ? -1 : 1) * deg2dx(1., atm->lat[ip]));
00848
00849
           intpol_met_time(met0, met1, atm->time[ip], atm->p[ip], atm->
      lon[ip],
00850
                              (atm->lat[ip] >=
00851
                               0 ? atm->lat[ip] - 1. : atm->lat[ip] + 1.), NULL, NULL,
           &u1, NULL, NULL, NULL);

vort += (u1 - u) / 1000. / ((atm->lat[ip] >= 0 ? -1 : 1) * deg2dy(1.));
00852
00853
00854
00855
           /* Potential temperature gradient... */
00856
           p1 = 0.85 * atm->p[ip];
           intpol_met_time(met0, met1, atm->time[ip], p1, atm->lon[ip],
00858
                             atm->lat[ip], NULL, &t1, NULL, NULL, NULL, NULL, NULL);
00859
           grad = (t1 * pow(P0 / p1, 0.286) - t * pow(P0 / atm->p[ip], 0.286))
             / (100. * (p1 - atm->p[ip]));
00860
00861
00862
           /* Calculate PV... */
00863
           atm \rightarrow q[ctl \rightarrow qnt_pv][ip] = -1e6 * G0 * vort * grad;
00864
00865
         /* Calculate T_ice (Marti and Mauersberger, 1993)... */
if (ctl->qnt_tice >= 0 || ctl->qnt_tsts >= 0)
00866
00867
          atm->q[ctl->qnt_tice][ip] =
00868
             -2663.5 /
00870
              (log10((ct1->psc_h2o > 0 ? ct1->psc_h2o : h2o) * atm->p[ip] * 100.) -
00871
00872
00873
         /* Calculate T NAT (Hanson and Mauersberger, 1988)... */
         if (ctl->qnt_tnat >= 0 || ctl->qnt_tsts >= 0) {
   if (ctl->psc_hno3 > 0)
00874
00875
00876
             p_hno3 = ctl->psc_hno3 * atm->p[ip] / 1.333224;
00877
00878
             p_hno3 = module_meteo_hno3(atm->time[ip], atm->lat[ip], atm->
      p[ip])
00879
           * le-9 * atm->p[ip] / 1.333224;

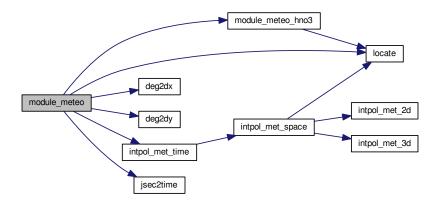
p_h2o = (ctl->psc_h2o > 0 ? ctl->psc_h2o : h2o) * atm->p[ip] / 1.333224;

a = 0.009179 - 0.00088 * log10(p_h2o);
00880
           b = (38.9855 - log10(p_hno3) - 2.7836 * log10(p_h2o)) / a;
00882
           c = -11397.0 / a;
00883
           x1 = (-b + sqrt(b * b - 4. * c)) / 2.;

x2 = (-b - sqrt(b * b - 4. * c)) / 2.;
00884
00885
00886
           if (x1 > 0)
             atm->q[ctl->qnt_tnat][ip] = x1;
00888
           if (x2 > 0)
00889
             atm->q[ctl->qnt_tnat][ip] = x2;
00890
00891
00892
         /* Calculate T_STS (mean of T_ice and T_NAT)... */
00893
         if (ctl->qnt_tsts >= 0) {
          if (ctl->qnt_tice < 0 || ctl->qnt_tnat < 0)</pre>
00894
00895
             ERRMSG("Need T_ice and T_NAT to calculate T_STS!");
00896
           atm -> q[ctl -> qnt\_tsts][ip] = 0.5 * (atm -> q[ctl -> qnt\_tice][ip]
00897
                                                    + atm->q[ctl->qnt_tnat][ip]);
00898
00899
         /* Read variance data for current day... */
00901
         if (ip == 0 && ctl->qnt_gw_var >= 0) {
           jsec2time(atm->time[ip], &year, &mon, &day, &idum, &idum, &idum, &rdum);
00902
           if (year != year_old || mon != mon_old || day != day_old) {
  year_old = year;
00903
00904
             mon_old = mon;
day_old = day;
00905
00906
00907
             nlon = nlat = -1;
00908
             sprintf(filename, "%s_%d_%02d_%02d.tab",
             ctl->gw_basename, year, mon, day);
if ((in = fopen(filename, "r"))) {
00909
00910
               printf("Read gravity wave data: %s\n", filename);
00911
                while (fgets(line, LEN, in)) {
  if (sscanf(line, "%lg %lg %lg", &rlon, &rlat, &rvar) != 3)
00912
00913
00914
                     continue;
                  if (rlat != rlat_old) {
  rlat_old = rlat;
00915
00916
00917
                    if ((++nlat) > GY)
```

```
ERRMSG("Too many latitudes!");
00919
                 nlon = -1;
00920
00921
               if ((++nlon) > GX)
                ERRMSG("Too many longitudes!");
00922
               lon[nlon] = rlon;
lat[nlat] = rlat;
00923
00924
00925
               var[nlon][nlat] = GSL_MAX(0, rvar);
00926
00927
             fclose(in);
00928
             nlat++;
00929
             nlon++;
00930
           } else
00931
             printf("Missing gravity wave data: %s\n", filename);
00932
00933
00934
00935
       /\star Interpolate variance data... \star/
       if (ctl->qnt_gw_var >= 0) {
00936
00937
         if (nlat >= 2 && nlon >= 2) {
00938
           ilat = locate(lat, nlat, atm->lat[ip]);
           ilon = locate(lon, nlon, atm->lon[ip]);
00939
           00940
00941
00942
00943
00944
           atm->q[ctl->qnt_gw_var][ip]
00945
             = LIN(lon[ilon], var0, lon[ilon + 1], var1, atm->lon[ip]);
         } else
00946
00947
           atm->q[ctl->qnt_gw_var][ip] = GSL_NAN;
00948
00949 }
```

Here is the call graph for this function:



5.31.2.8 double module_meteo_hno3 (double t, double lat, double p)

Auxiliary function for meteo module.

Definition at line 953 of file trac.c.

```
00956
00957
        static double secs[12] = { 1209600.00, 3888000.00, 6393600.00,
00958
00959
          9072000.00, 11664000.00, 14342400.00,
00960
          16934400.00, 19612800.00, 22291200.00,
00961
         24883200.00, 27561600.00, 30153600.00
00962
00963
00964
        static double lats[18] = { -85, -75, -65, -55, -45, -35, -25, -15, -5,
00965
         5, 15, 25, 35, 45, 55, 65, 75, 85
```

```
00966
00967
00968
          static double ps[10] = { 4.64159, 6.81292, 10, 14.678, 21.5443,
00969
            31.6228, 46.4159, 68.1292, 100, 146.78
00970
00971
          static double hno3[12][18][10] = {
            {{0.782, 1.65, 2.9, 4.59, 6.71, 8.25, 7.16, 5.75, 2.9, 1.74},
00973
00974
              {0.529, 1.64, 2.76, 4.55, 6.58, 8, 6.99, 5.55, 2.68, 1.57},
00975
              \{0.723, 1.55, 2.73, 4.48, 6.32, 7.58, 7.05, 5.16, 2.49, 1.54\},
00976
              {0.801, 1.56, 2.74, 4.52, 6.23, 7.35, 6.68, 4.4, 1.97, 1.23},
00977
              \{0.818, 1.62, 2.77, 4.38, 5.98, 6.84, 5.83, 3.05, 1.15, 0.709\}
              {0.901, 1.73, 2.78, 4.21, 5.63, 6.16, 4.68, 1.87, 0.617, 0.371, {0.997, 1.8, 2.79, 4.09, 4.88, 4.96, 3.12, 1.22, 0.311, 0.244},
00978
00979
00980
              {1, 1.71, 2.51, 3.4, 3.74, 3.39, 2.25, 0.845, 0.204, 0.222},
              {0.997, 1.7, 2.36, 2.88, 3.01, 2.25, 1.77, 0.608, 0.163, 0.181}, {0.991, 1.79, 2.57, 3.06, 3.08, 2.15, 1.81, 0.59, 0.168, 0.104}, {0.974, 1.86, 2.84, 3.8, 3.93, 3.79, 2.91, 1.02, 0.152, 0.0985}, {0.85, 1.86, 3.3, 5.24, 6.55, 6.86, 5.12, 1.93, 0.378, 0.185},
00981
00982
00983
00985
              \{0.783, 1.89, 3.85, 6.6, 8.56, 8.66, 6.95, 3.95, 1.47, 0.745\},
              {0.883, 2.05, 4.34, 7.54, 9.68, 9.77, 8.19, 5.72, 3.15, 1.77},
00986
00987
              {1.4, 2.44, 4.72, 8.07, 10.5, 10.9, 9.28, 6.95, 4.47, 2.49},
              {1.7, 2.43, 4.24, 7.43, 10.4, 11.2, 9.72, 8.15, 5.7, 2.97}, {2.06, 2.27, 3.68, 6.77, 10.3, 10.3, 9.05, 9.1, 6.73, 3.14}, {2.33, 2.39, 3.51, 6.45, 10.3, 9.88, 8.57, 9.42, 7.22, 3.19}},
00988
00989
00990
             {{0.947, 2.21, 3.81, 5.69, 7.55, 8.63, 7.53, 5.98, 3.03, 1.64},
00992
              {0.642, 2, 3.4, 5.49, 7.5, 8.52, 7.53, 5.83, 2.74, 1.42},
              {0.756, 1.83, 3.18, 5.11, 7.24, 8.63, 7.66, 5.5, 2.45, 1.33}, {0.837, 1.75, 3.06, 5, 6.79, 8.08, 7.05, 4.42, 1.81, 1.05},
00003
00994
              {0.86, 1.73, 2.96, 4.68, 6.38, 7.38, 6.09, 2.92, 1.06, 0.661},
00995
00996
              {0.926, 1.78, 2.89, 4.37, 5.74, 6.14, 4.59, 1.78, 0.561, 0.332},
              {0.988, 1.78, 2.75, 3.95, 4.64, 4.49, 2.85, 1.13, 0.271, 0.184},
              {0.999, 1.7, 2.44, 3.27, 3.57, 3.03, 2.06, 0.736, 0.181, 0.189},
00998
00999
              {0.971, 1.67, 2.23, 2.63, 2.83, 2.15, 1.74, 0.554, 0.157, 0.167}
              {0.985, 1.72, 2.34, 2.69, 2.81, 2.11, 1.78, 0.592, 0.152, 0.101}, {0.95, 1.72, 2.57, 3.44, 3.84, 3.89, 2.91, 0.976, 0.135, 0.114},
01000
01001
              {0.819, 1.64, 2.93, 4.75, 6.02, 6.93, 5.2, 1.83, 0.347, 0.191}, {0.731, 1.58, 3.3, 5.95, 7.81, 8.32, 6.93, 3.83, 1.47, 0.875},
01002
01004
              \{0.77, 1.75, 3.74, 6.67, 8.76, 9.41, 8.19, 5.78, 3.32, 2.11\},
              {1.08, 2.17, 4.24, 7.13, 9.2, 10.3, 9.03, 6.87, 4.65, 3.01},
01005
              {1.43, 2.49, 4.31, 7, 9.14, 10.6, 9.34, 7.6, 5.86, 3.64}, {1.5, 2.68, 4.32, 6.75, 8.78, 10.6, 9.05, 7.65, 6.27, 4.07},
01006
01007
            {1.73, 2.91, 4.33, 6.67, 8.73, 10.6, 8.5, 7.54, 6.63, 4.17}}, {{1.43, 3.07, 5.22, 7.54, 9.78, 10.4, 10.1, 7.26, 3.61, 1.69},
01008
              \{0.989, 2.69, 4.76, 7.19, 9.44, 9.94, 9.5, 6.74, 3.24, 1.52\},
01011
              {0.908, 2.23, 4.11, 6.48, 8.74, 9.41, 8.58, 5.8, 2.66, 1.3},
              {0.923, 1.99, 3.61, 5.83, 7.84, 8.6, 7.55, 4.57, 1.87, 0.98}
{0.933, 1.9, 3.31, 5.28, 7.1, 7.84, 6.44, 3.18, 1.1, 0.642},
01012
01013
              \{0.982, 1.88, 3.1, 4.76, 6.16, 6.57, 5.16, 2.04, 0.598, 0.33\},
01014
              {1.02, 1.82, 2.88, 4.12, 4.71, 4.54, 3.03, 1.22, 0.268, 0.174},
01015
              \{0.992, 1.7, 2.51, 3.33, 3.62, 2.87, 2.05, 0.705, 0.161, 0.169\},
              {0.969, 1.69, 2.2, 2.62, 2.84, 2.13, 1.78, 0.529, 0.146, 0.186},
01017
01018
              {0.945, 1.69, 2.27, 2.64, 2.83, 2.2, 1.83, 0.561, 0.139, 0.121},
01019
              \{0.922, 1.65, 2.48, 3.33, 3.83, 4.09, 2.92, 0.973, 0.117, 0.135\},
              {0.886, 1.59, 2.66, 4.26, 5.51, 6.57, 5.09, 1.79, 0.342, 0.194}, {0.786, 1.5, 2.78, 5.01, 6.8, 7.83, 6.65, 3.62, 1.45, 1},
01020
01021
              {0.745, 1.55, 3.05, 5.49, 7.44, 8.6, 7.8, 5.28, 2.95, 2.12},
{0.938, 1.76, 3.4, 5.82, 7.8, 9.04, 8.43, 6.15, 3.85, 2.82},
01023
              {0.999, 2, 3.66, 5.95, 7.94, 9.27, 8.8, 6.93, 4.87, 3.54},
01024
01025
              {1.13, 2.23, 3.86, 5.82, 7.65, 9, 8.82, 7.17, 5.72, 4.08}
01026
              \{1.23, 2.33, 3.94, 5.74, 7.48, 8.9, 8.84, 7.35, 6.3, 4.42\}\},
             {{1.55, 3.2, 6.25, 10, 12.9, 12.9, 11.9, 7.96, 3.96, 1.75},
01027
              {1.32, 3.27, 6.32, 9.99, 12.7, 12.4, 11.3, 7.51, 3.66, 1.58},
              {1.25, 3.08, 5.77, 8.71, 11.2, 11.2, 9.84, 6.52, 3.23, 1.5},
01030
              {1.18, 2.59, 4.76, 7.46, 9.61, 9.66, 8.42, 5.06, 2.25, 1.09}
01031
              {1.09, 2.24, 3.99, 6.4, 8.33, 8.54, 7.08, 3.69, 1.36, 0.727}
01032
              {1.06, 2.07, 3.52, 5.52, 7.06, 7.26, 5.83, 2.46, 0.732, 0.409}, {1.07, 1.91, 3.09, 4.63, 5.21, 4.9, 3.68, 1.43, 0.326, 0.198},
01033
              {1.03, 1.74, 2.63, 3.54, 3.78, 2.89, 2.09, 0.743, 0.175, 0.12}
01034
              \{0.959, 1.71, 2.32, 2.77, 2.99, 2.24, 1.76, 0.519, 0.149, 0.172\},
              {0.931, 1.68, 2.32, 2.74, 2.99, 2.46, 1.88, 0.578, 0.156, 0.157},
01036
01037
              {0.933, 1.66, 2.49, 3.42, 3.99, 4.12, 2.93, 1.02, 0.181, 0.138},
              {0.952, 1.64, 2.6, 4, 5.15, 6.07, 4.84, 1.78, 0.407, 0.286}, {0.84, 1.54, 2.68, 4.47, 5.97, 7.13, 6.23, 3.25, 1.38, 1.02},
01038
01039
01040
              \{0.714, 1.44, 2.73, 4.68, 6.28, 7.68, 7.21, 4.82, 2.55, 1.96\}
              {0.838, 1.57, 2.96, 4.93, 6.55, 8.08, 7.74, 5.77, 3.32, 2.52},
01041
              {0.823, 1.65, 3.11, 5.09, 6.89, 8.36, 8.31, 6.59, 4.1, 3.04},
01042
01043
              {0.886, 1.83, 3.42, 5.33, 6.92, 8.36, 8.63, 7.21, 4.82, 3.46}
              {1.07, 2.12, 3.74, 5.54, 6.98, 8.41, 8.75, 7.41, 5.16, 3.62}},
01044
             {{1.13, 2.59, 7.49, 13.5, 15.4, 12.9, 11.3, 8.62, 4.18, 1.63},
01045
              {0.973, 2.79, 7.23, 12.8, 15.2, 13.3, 11.6, 8.42, 4.06, 1.57}, {1.46, 3.44, 6.78, 10.4, 12.7, 12.1, 10.5, 7.04, 3.59, 1.63},
01046
              {1.52, 3.38, 6.04, 9.08, 11, 10.3, 8.9, 5.7, 2.77, 1.37},
01048
01049
              {1.32, 2.65, 4.75, 7.49, 9.32, 8.89, 7.42, 4.27, 1.7, 0.88}
01050
              {1.19, 2.2, 3.88, 6.36, 8.03, 7.81, 6.19, 2.94, 0.948, 0.527},
              {1.14, 1.96, 3.28, 5.26, 6.12, 5.8, 4.47, 1.66, 0.388, 0.229}, {1.07, 1.82, 2.82, 3.92, 4.03, 3.15, 2.31, 0.871, 0.183, 0.0972},
01051
01052
```

```
\{0.978, 1.77, 2.53, 3.04, 3.1, 2.36, 1.76, 0.575, 0.16, 0.126\},\
              \{0.962, 1.72, 2.49, 3.01, 3.22, 2.72, 2, 0.716, 0.162, 0.183\},
01054
01055
              {0.968, 1.7, 2.6, 3.57, 4.28, 4.35, 3.09, 1.2, 0.262, 0.18},
              {0.977, 1.68, 2.71, 4.03, 5.17, 6.01, 4.81, 1.81, 0.473, 0.343},
01056
              {0.819, 1.58, 2.75, 4.37, 5.8, 6.9, 5.96, 2.95, 1.19, 0.964},
01057
              {0.672, 1.44, 2.69, 4.42, 5.92, 7.26, 6.79, 4.32, 2.22, 1.83},
01058
              {0.783, 1.42, 2.65, 4.45, 6.04, 7.57, 7.39, 5.4, 2.94, 2.25}, {0.757, 1.43, 2.7, 4.54, 6.14, 7.65, 7.51, 5.95, 3.42, 2.39},
01060
01061
              {0.758, 1.57, 3.04, 4.88, 6.24, 7.85, 7.58, 6.35, 3.81, 2.52},
            {0.835, 1.72, 3.35, 5.24, 6.5, 8.1, 7.67, 6.51, 4, 2.6}}, {1.5, 2.12, 7.64, 10.5, 5.59, 2.14, 2.2, 3.5, 4.71, 3.26},
01062
01063
              \{1.32, 2.14, 7.23, 12, 9.3, 5.3, 5.11, 5.37, 5.12, 3.05\},\
01064
              {1.53, 2.92, 6.9, 11.9, 13.5, 11.3, 9.91, 7.18, 4.75, 2.65},
01065
              {1.66, 3.48, 6.25, 9.53, 11.3, 10.3, 9.01, 5.76, 2.99, 1.67},
01066
01067
              {1.54, 3.03, 5.21, 8.03, 9.66, 8.98, 7.5, 4.64, 2.11, 1.13},
              {1.32, 2.39, 4.03, 6.74, 8.52, 8.05, 6.4, 3.48, 1.2, 0.639}, {1.17, 2.08, 3.35, 5.52, 6.86, 6.54, 5.08, 1.97, 0.462, 0.217},
01068
01069
01070
              {1.07, 1.92, 3.01, 4.24, 4.47, 3.77, 2.77, 1.07, 0.213, 0.0694},
              {0.992, 1.88, 2.76, 3.39, 3.32, 2.52, 1.8, 0.713, 0.192, 0.136},
              \{0.992, 1.8, 2.63, 3.34, 3.46, 2.95, 2.09, 0.9, 0.242, 0.194\},
01072
              {0.987, 1.77, 2.67, 3.64, 4.37, 4.36, 3, 1.27, 0.354, 0.229},
01073
              {0.979, 1.74, 2.77, 3.99, 5.12, 5.75, 4.53, 1.75, 0.555, 0.302},
01074
              \{0.832, 1.6, 2.78, 4.32, 5.53, 6.67, 5.69, 2.59, 0.982, 0.66\},
01075
01076
              {0.696, 1.41, 2.64, 4.31, 5.65, 7.14, 6.56, 3.8, 1.75, 1.41}, {0.788, 1.36, 2.59, 4.3, 5.73, 7.35, 7.04, 4.82, 2.41, 1.8},
              {0.761, 1.43, 2.61, 4.28, 5.64, 7.37, 7.11, 5.37, 2.68, 1.9}
              {0.701, 1.44, 2.82, 4.64, 5.76, 7.63, 7.07, 5.74, 2.98, 1.88},
01079
              {0.763, 1.5, 2.95, 4.97, 6.08, 7.88, 7.12, 5.98, 3.21, 1.91}}
01080
01081
             \{\{3.58,\ 2.59,\ 6.49,\ 5.84,\ 1.63,\ 0.282,\ 0.647,\ 0.371,\ 1.36,\ 2.33\},
01082
              {3.09, 2.38, 6.37, 7.66, 4.06, 1.23, 1.8, 1.65, 2.32, 2.78},
              {2.31, 2.84, 5.58, 9.63, 11, 9.02, 8.2, 6.23, 4.17, 3.08},
01083
              {1.61, 3.16, 5.72, 9.13, 11.4, 10.4, 9.15, 6.18, 3.52, 2.3},
              {1.32, 2.8, 4.79, 7.44, 9.43, 8.83, 7.41, 4.9, 2.38, 1.38},
01085
01086
              {1.14, 2.36, 3.94, 6.41, 8.38, 8.17, 6.53, 3.76, 1.31, 0.656},
              {1.05, 2.1, 3.36, 5.45, 7.07, 6.98, 5.44, 2.22, 0.52, 0.176}, {1.02, 2, 3.05, 4.33, 4.74, 4.21, 3.2, 1.26, 0.277, 0.0705},
01087
01088
              {1.01, 1.96, 2.9, 3.53, 3.46, 2.69, 1.89, 0.859, 0.254, 0.12}, {1.01, 1.86, 2.7, 3.46, 3.59, 3.03, 2.14, 1, 0.34, 0.199},
01089
01091
              {1.02, 1.81, 2.67, 3.68, 4.39, 4.3, 2.93, 1.35, 0.477, 0.25}
              \{0.991, 1.79, 2.82, 4.05, 5.08, 5.5, 4.21, 1.74, 0.605, 0.259\},
01092
01093
              {0.844, 1.73, 2.87, 4.38, 5.49, 6.47, 5.5, 2.44, 0.85, 0.422},
              {0.729, 1.57, 2.76, 4.43, 5.73, 7.13, 6.43, 3.52, 1.38, 0.913},
01094
              {0.819, 1.46, 2.69, 4.45, 5.92, 7.47, 7.05, 4.52, 2, 1.4},
01095
              {0.783, 1.47, 2.71, 4.48, 5.92, 7.46, 7.16, 5.08, 2.35, 1.56},
              \{0.735, 1.51, 2.96, 4.84, 5.92, 7.77, 7.2, 5.54, 2.56, 1.61\},
01098
              {0.8, 1.61, 3.14, 5.2, 6.26, 8.08, 7.27, 5.72, 2.75, 1.62}},
            {5, 4.43, 5.53, 5.35, 2.33, 0.384, 0.663, 0.164, 0.692, 1.4}, {3.62, 3.79, 4.77, 5.94, 4.12, 1.36, 1.3, 0.973, 1.37, 1.73}, {2.11, 2.7, 4.12, 7.14, 9.03, 7.74, 7.12, 5.44, 3.73, 2.6}, {1.13, 2.32, 4.12, 6.97, 9.86, 9.69, 8.85, 6.22, 3.59, 2.14},
01099
01100
01101
01102
              (0.957, 2.28, 4.11, 6.47, 8.66, 8.78, 7.33, 4.94, 2.44, 1.38), {0.881, 2.1, 3.65, 5.94, 7.98, 8.29, 6.69, 3.95, 1.36, 0.672},
01104
01105
              {0.867, 1.96, 3.26, 5.23, 6.94, 7.2, 5.63, 2.41, 0.578, 0.19}
              {0.953, 1.94, 2.98, 4.23, 4.83, 4.52, 3.38, 1.34, 0.293, 0.181}, {1.01, 1.91, 2.77, 3.35, 3.3, 2.62, 1.99, 0.905, 0.245, 0.107},
01106
01107
01108
              {1.03, 1.81, 2.57, 3.29, 3.43, 2.87, 2.13, 0.988, 0.306, 0.185},
              {1.02, 1.78, 2.58, 3.59, 4.19, 4, 2.72, 1.29, 0.389, 0.224},
              {1.01, 1.84, 2.84, 4.06, 4.9, 5.08, 3.71, 1.64, 0.529, 0.232}
01110
              {0.902, 1.84, 2.98, 4.43, 5.5, 6.28, 5.18, 2.35, 0.734, 0.341},
01111
01112
              \{0.785, 1.68, 2.93, 4.67, 5.95, 7.3, 6.52, 3.48, 1.24, 0.754\},
01113
              \{0.847, 1.62, 2.94, 4.86, 6.38, 7.99, 7.5, 4.64, 1.93, 1.23\},
              {0.8, 1.6, 2.94, 4.95, 6.62, 8.16, 7.91, 5.43, 2.43, 1.45}, {0.82, 1.76, 3.37, 5.47, 6.82, 8.24, 7.73, 5.79, 2.69, 1.5},
01114
              \{0.988, 2.05, 3.87, 6.01, 7.18, 8.41, 7.7, 5.93, 2.89, 1.55\}
01116
01117
             {{1.52, 2.7, 3.79, 4.95, 3.8, 1.51, 1.11, 0.784, 1.1, 1.56},
01118
              {1.19, 2.16, 3.34, 4.76, 4.61, 2.93, 2.07, 1.65, 1.63, 1.74},
01119
              {0.804, 1.65, 2.79, 4.63, 6.64, 6.95, 6.68, 5.11, 3.3, 2.09}, {0.86, 1.8, 3.25, 5.3, 7.91, 8.76, 8.28, 6.01, 3.39, 1.83},
01120
              (0.859, 1.95, 3.54, 5.64, 7.88, 8.55, 7.3, 4.88, 2.3, 1.22), (0.809, 1.88, 3.38, 5.45, 7.47, 8.02, 6.69, 3.98, 1.35, 0.646),
01121
              {0.822, 1.81, 3.11, 4.9, 6.62, 6.96, 5.63, 2.47, 0.614, 0.169}, {0.92, 1.83, 2.8, 3.93, 4.56, 4.4, 3.25, 1.31, 0.295, 0.0587},
01123
01124
01125
              {0.986, 1.83, 2.6, 3.13, 3.08, 2.53, 1.94, 0.886, 0.244, 0.0815},
              {0.997, 1.74, 2.5, 3.16, 3.24, 2.67, 2.05, 0.939, 0.281, 0.147},
01126
              {1.01, 1.75, 2.57, 3.55, 4.1, 3.81, 2.53, 1.21, 0.354, 0.197},
{1.04, 1.88, 2.9, 4.16, 4.95, 4.96, 3.48, 1.63, 0.502, 0.163},
01127
              \{0.967, 1.95, 3.17, 4.72, 5.85, 6.5, 5.34, 2.53, 0.748, 0.303\},
01129
              {0.846, 1.83, 3.23, 5.15, 6.62, 7.82, 6.85, 3.79, 1.36, 0.714}, {0.91, 1.81, 3.35, 5.55, 7.32, 8.55, 7.88, 5.03, 2.13, 1.1}, {0.87, 1.94, 3.6, 5.97, 7.98, 9.14, 8.71, 6.04, 2.73, 1.41},
01130
01131
01132
              {1.04, 2.36, 4.22, 6.57, 8.5, 9.53, 9.22, 6.71, 3.2, 1.56}, {1.36, 2.84, 4.72, 6.94, 8.81, 9.87, 9.59, 7.1, 3.43, 1.65}},
01133
             {{0.704, 1.4, 2.03, 3.08, 4.64, 4.24, 2.55, 1.57, 1.99, 1.91},
01135
01136
              {0.484, 1.38, 2.08, 3.54, 5.11, 4.98, 3.73, 2.57, 2.29, 1.84},
01137
              {0.749, 1.57, 2.63, 4.17, 6.15, 6.97, 6.64, 5.11, 3.35, 1.97},
              {0.864, 1.69, 3.16, 4.87, 7.13, 8.33, 7.87, 5.9, 3.17, 1.56}, {0.861, 1.79, 3.28, 5.2, 7.29, 8.32, 7.38, 4.9, 2.23, 1.11},
01138
01139
```

```
{0.835, 1.79, 3.19, 4.99, 6.72, 7.58, 6.45, 3.68, 1.25, 0.616},
                \{0.847, 1.8, 3.07, 4.66, 6.12, 6.6, 5.21, 2.18, 0.554, 0.21\},
01141
01142
                {0.941, 1.78, 2.68, 3.68, 4.28, 4.18, 2.97, 1.15, 0.238, 0.0968},
                {0.98, 1.78, 2.48, 2.99, 2.96, 2.35, 1.88, 0.747, 0.207, 0.105},
01143
                {0.978, 1.74, 2.51, 3.07, 3.12, 2.36, 1.95, 0.777, 0.216, 0.146}, {1.01, 1.79, 2.63, 3.53, 3.95, 3.47, 2.38, 1.08, 0.265, 0.178},
01144
01145
                {1.06, 1.94, 3.02, 4.43, 5.19, 5.01, 3.68, 1.71, 0.429, 0.14},
01146
                {0.99, 2.02, 3.38, 5.22, 6.56, 6.91, 5.56, 2.75, 0.816, 0.353},
01147
01148
                {0.923, 2.05, 3.66, 5.98, 7.78, 8.5, 7.23, 4.26, 1.67, 0.802},
                {1.08, 2.27, 4.17, 6.8, 8.89, 9.55, 8.59, 5.64, 2.58, 1.2}, {1.12, 2.5, 4.52, 7.22, 9.76, 10.3, 9.72, 6.79, 3.32, 1.52},
01149
01150
                {1.2, 2.64, 4.81, 7.64, 10.5, 11.4, 10.6, 7.65, 3.87, 1.73},
01151
                {1.4, 2.91, 5.01, 7.75, 10.7, 11.6, 11.1, 8.02, 4.04, 1.8}},
01152
              {{0.75, 1.49, 2.39, 3.39, 4.93, 5.94, 5.03, 2.75, 2.27, 1.78},
01153
01154
                {0.508, 1.52, 2.38, 3.82, 5.34, 6.13, 5.6, 3.31, 2.42, 1.73},
01155
                \{0.715, 1.56, 2.7, 4.39, 6.18, 6.96, 7.1, 5.04, 3.01, 1.75\},\
                {0.813, 1.62, 2.94, 4.65, 6.53, 7.65, 7.52, 5.49, 2.75, 1.41},
01156
                \{0.802, 1.68, 2.97, 4.64, 6.37, 7.53, 7.01, 4.56, 1.9, 0.955\},
01157
                {0.816, 1.75, 3.01, 4.59, 6.15, 7.06, 6.15, 3.38, 1.11, 0.61},
                {0.867, 1.78, 2.92, 4.35, 5.69, 6.05, 4.73, 1.91, 0.519, 0.269},
                {0.932, 1.7, 2.55, 3.44, 4.03, 3.98, 2.74, 1.08, 0.247, 0.132},
01160
01161
                {0.937, 1.74, 2.51, 3.09, 3.11, 2.34, 1.84, 0.67, 0.189, 0.121},
                {0.942, 1.75, 2.63, 3.3, 3.27, 2.21, 1.87, 0.663, 0.171, 0.147}, {0.959, 1.8, 2.82, 3.78, 4.03, 3.37, 2.53, 1.04, 0.199, 0.146}, {1.01, 1.9, 3.13, 4.76, 5.63, 5.6, 4.31, 1.83, 0.367, 0.172}, {0.989, 2.04, 3.64, 6, 7.62, 7.6, 6, 3.35, 1.05, 0.448}, {1.02, 2.28, 4.32, 7.19, 9.21, 9.16, 7.64, 4.97, 2.2, 0.948},
01162
01163
01164
01165
01166
01167
                {1.26, 2.77, 5.2, 8.31, 10.5, 10.4, 9.01, 6.37, 3.46, 1.56},
                {1.31, 2.76, 5.23, 8.49, 11.2, 11.3, 10.1, 7.27, 3.98, 1.76}, {1.26, 2.5, 5.14, 8.85, 12.3, 12.3, 11.2, 8.13, 4.45, 1.97}, {1.35, 2.49, 5.26, 9.16, 13, 12.8, 11.8, 8.57, 4.72, 2.05}},
01168
01169
01170
              {0.759, 1.54, 2.54, 4.22, 6.26, 7.44, 7.14, 4.99, 2.84, 1.89}, {0.508, 1.55, 2.5, 4.29, 6.29, 7.29, 7.07, 5.03, 2.77, 1.74},
01171
01172
               {0.699, 1.55, 2.5, 4.29, 6.29, 7.29, 7.07, 5.03, 2.77, 1.74}, {0.699, 1.56, 2.62, 4.17, 6.08, 7.38, 7.04, 5.17, 2.81, 1.65}, {0.778, 1.5, 2.65, 4.35, 6.07, 7.28, 6.84, 4.8, 2.28, 1.28}, {0.772, 1.55, 2.71, 4.3, 5.76, 6.91, 6.2, 3.69, 1.45, 0.837}, {0.836, 1.67, 2.78, 4.21, 5.56, 6.41, 5.33, 2.47, 0.807, 0.488}, {0.937, 1.79, 2.78, 4.12, 5.17, 5.38, 3.89, 1.47, 0.392, 0.256}, {0.97, 1.75, 2.52, 3.39, 3.83, 3.63, 2.48, 0.968, 0.212, 0.198},
01173
01174
01175
01176
                {0.968, 1.74, 2.5, 3.11, 3.2, 2.34, 1.79, 0.629, 0.169, 0.173}, {0.98, 1.8, 2.69, 3.42, 3.4, 2.18, 1.81, 0.606, 0.164, 0.138}, {0.975, 1.84, 2.96, 4.08, 4.12, 3.5, 2.79, 1.02, 0.145, 0.133}, {0.96, 1.94, 3.27, 5.17, 6.26, 6.35, 4.88, 1.91, 0.329, 0.189}, {0.954, 2.06, 3.8, 6.53, 8.46, 8.32, 6.53, 3.83, 1.32, 0.6},
01179
01180
01181
01182
01183
                {1, 2.34, 4.58, 7.71, 9.68, 9.75, 7.96, 5.45, 2.84, 1.39},
01184
01185
                    24, 2.65, 5.14, 8.51, 10.7, 10.6, 8.96, 6.51, 3.83, 1.85},
01186
                {1.34, 2.44, 4.99, 8.63, 11.6, 11.4, 10.1, 7.84, 4.77, 2.24},
                {1.33, 2.1, 4.76, 8.78, 12.2, 11.7, 10.8, 8.68, 5.15, 2.35}, {1.42, 2.04, 4.68, 8.92, 12.7, 12, 11.2, 8.99, 5.32, 2.33}}
01187
01188
01189
01190
01191
           double aux00, aux01, aux10, aux11, sec;
01192
01193
           int ilat, ip, isec;
01194
01195
           /* Get seconds since begin of year... */
           sec = fmod(t, 365.25 * 86400.);
01196
01197
01198
            /* Get indices...
01199
           ilat = locate(lats, 18, lat);
01200
           ip = locate(ps, 10, p);
01201
           isec = locate(secs, 12, sec);
01202
01203
           /* Interpolate...
01204
           aux00 = LIN(ps[ip], hno3[isec][ilat][ip],
01205
                            ps[ip + 1], hno3[isec][ilat][ip + 1], p);
01206
           aux01 = LIN(ps[ip], hno3[isec][ilat + 1][ip],
                            ps[ip + 1], hno3[isec][ilat + 1][ip + 1], p);
01207
           aux10 = LIN(ps[ip], hno3[isec + 1][ilat][ip],
01208
                            ps[ip + 1], hno3[isec + 1][ilat][ip + 1], p);
           aux11 = LIN(ps[ip], hno3[isec + 1][ilat + 1][ip],
01210
01211
                             ps[ip + 1], hno3[isec + 1][ilat + 1][ip + 1], p);
           aux00 = LIN(lats[ilat], aux00, lats[ilat + 1], aux01, lat);
aux11 = LIN(lats[ilat], aux10, lats[ilat + 1], aux11, lat);
01212
01213
01214
           return LIN(secs[isec], aux00, secs[isec + 1], aux11, sec);
01215 }
```

Here is the call graph for this function:



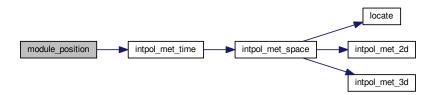
5.31.2.9 void module_position (met_t * met0, met_t * met1, atm_t * atm, int ip)

Check position of air parcels.

Definition at line 1219 of file trac.c.

```
01223
01224
01225
          double ps;
01226
          /* Calculate modulo... */
          atm->lon[ip] = fmod(atm->lon[ip], 360);
atm->lat[ip] = fmod(atm->lat[ip], 360);
01228
01229
01230
          /* Check latitude... */
while (atm->lat[ip] < -90 || atm->lat[ip] > 90) {
01231
01232
           if (atm->lat[ip] > 90) {
  atm->lat[ip] = 180 - atm->lat[ip];
  atm->lon[ip] += 180;
01233
01234
01235
01236
            if (atm->lat[ip] < -90) {
  atm->lat[ip] = -180 - atm->lat[ip];
  atm->lon[ip] += 180;
01237
01238
01240
01241
01242
         /* Check longitude... */
while (atm->lon[ip] < -180)
atm->lon[ip] += 360;
01243
01244
01245
01246
          while (atm->lon[ip] >= 180)
01247
            atm->lon[ip] -= 360;
01248
          01249
01250
01251
01252
                               NULL, NULL, NULL, NULL, NULL);
01253
01254
          /* Check pressure... */
          if (atm->p[ip] > ps)
01255
          atm->p[ip] = ps;
else if (atm->p[ip] < met0->p[met0->np - 1])
atm->p[ip] = met0->p[met0->np - 1];
01256
01257
01258
01259 }
```

Here is the call graph for this function:



5.31 trac.c File Reference 177

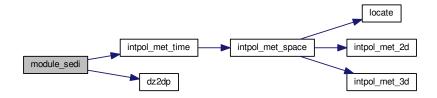
5.31.2.10 void module_sedi (ctl_t * ctl, met_t * met0, met_t * met1, atm_t * atm, int ip, double dt)

Calculate sedimentation of air parcels.

Definition at line 1263 of file trac.c.

```
01269
                     {
01270
         /\star Coefficients for Cunningham slip-flow correction (Kasten, 1968): \star/
01272
         const double A = 1.249, B = 0.42, C = 0.87;
01273
        /* Specific gas constant for dry air [J/(kg K)]: \star/ const double R = 287.058;
01274
01275
01276
01277
         /* Average mass of an air molecule [kg/molec]: */
01278
         const double m = 4.8096e-26;
01279
01280
         double G, K, eta, lambda, p, r_p, rho, rho_p, T, v, v_p;
01281
01282
         /\star Check if parameters are available... \star/
01283
         if (ctl->qnt_r < 0 || ctl->qnt_rho < 0)</pre>
01284
          return;
01285
01286
         /* Convert units... */
01287
         p = 100 * atm->p[ip];
         r_p = 1e-6 * atm->q[ctl->qnt_r][ip];
01288
01289
        rho_p = atm->q[ctl->qnt_rho][ip];
01290
01291
         /* Get temperature... */
         intpol_met_time(met0, met1, atm->time[ip], atm->p[ip], atm->
01292
      lon[ip],
01293
                          atm->lat[ip], NULL, &T, NULL, NULL, NULL, NULL, NULL);
01294
01295
        /* Density of dry air... */
rho = p / (R * T);
01296
01297
01298
        /* Dynamic viscosity of air... */
        eta = 1.8325e-5 * (416.16 / (T + 120.)) * pow(T / 296.16, 1.5);
01299
01300
        /* Thermal velocity of an air molecule... */ v = sqrt(8 * GSL_CONST_MKSA_BOLTZMANN * T / (M_PI * m));
01301
01302
01303
01304
         /\star Mean free path of an air molecule... \star/
01305
        lambda = 2 * eta / (rho * v);
01306
01307
         /* Knudsen number for air... */
01308
        K = lambda / r_p;
01309
01310
         /* Cunningham slip-flow correction... */
01311
         G = 1 + K * (A + B * exp(-C / K));
01312
01313
         /* Sedimentation (fall) velocity... */
01314
01315
           2. * gsl_pow_2(r_p) * (rho_p
01316
                                    rho) * GSL_CONST_MKSA_GRAV_ACCEL / (9. * eta) * G;
01317
        /* Calculate pressure change... */
atm->p[ip] += dz2dp(v_p * dt / 1000., atm->p[ip]);
01318
01319
01320 }
```

Here is the call graph for this function:



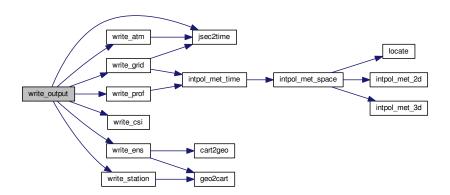
5.31.2.11 void write_output (const char * dirname, ctl_t * ctl, met_t * met0, met_t * met1, atm_t * atm, double t)

Write simulation output.

Definition at line 1324 of file trac.c.

```
01330
                    {
01331
01332
        char filename[LEN];
01333
01334
        double r;
01335
01336
        int year, mon, day, hour, min, sec;
01337
01338
         /* Get time... */
01339
         jsec2time(t, &year, &mon, &day, &hour, &min, &sec, &r);
01340
        /* Write atmospheric data... */
if (ctl->atm_basename[0] != '-' && fmod(t, ctl->atm_dt_out) == 0) {
01341
01342
         sprintf(filename, "%s/%s_%04d_%02d_%02d_%02d_%02d.tab",
01343
01344
                   dirname, ctl->atm_basename, year, mon, day, hour, min);
01345
           write_atm(filename, ctl, atm, t);
01346
01347
01348
        /* Write CST data... */
        if (ctl->csi_basename[0] != '-') {
01349
          sprintf(filename, "%s/%s.tab", dirname, ctl->csi_basename);
01350
01351
           write_csi(filename, ctl, atm, t);
01352
01353
        /* Write ensemble data... */
if (ctl->ens_basename[0] != '-') {
01354
01355
         sprintf(filename, "%s/%s.tab", dirname, ctl->ens_basename);
01356
01357
          write_ens(filename, ctl, atm, t);
01358
01359
        /* Write gridded data... */
if (ctl->grid_basename[0] != '-' && fmod(t, ctl->grid_dt_out) == 0) {
01360
01361
01362
         sprintf(filename, "%s/%s_%04d_%02d_%02d_%02d_%02d.tab",
01363
                    dirname, ctl->grid_basename, year, mon, day, hour, min);
01364
           write_grid(filename, ctl, met0, met1, atm, t);
01365
01366
        /* Write profile data... */
if (ctl->prof_basename[0] != '-') {
   sprintf(filename, "%s/%s.tab", dirname, ctl->prof_basename);
   write_prof(filename, ctl, met0, met1, atm, t);
01367
01368
01370
01371
01372
        /* Write station data...
01373
        if (ctl->stat_basename[0] != '-') {
01374
01375
         sprintf(filename, "%s/%s.tab", dirname, ctl->stat_basename);
01376
           write_station(filename, ctl, atm, t);
01377
01378 }
```

Here is the call graph for this function:



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

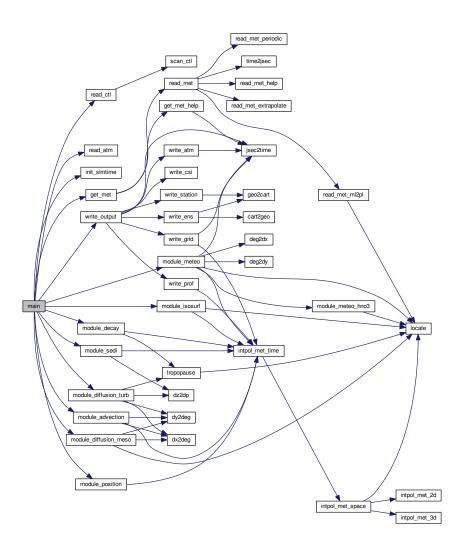
Definition at line 166 of file trac.c.

```
00168
00169
00170
        ctl t ctl:
00171
00172
        atm_t *atm;
00173
00174
        met_t *met0, *met1;
00175
00176
        gsl_rng *rng[NTHREADS];
00177
00178
        FILE *dirlist;
00179
00180
        char dirname[LEN], filename[LEN];
00181
00182
        double *dt. t. t0:
00183
00184
        int i, ip, ntask = 0, rank = 0, size = 1;
00185
00186 #ifdef MPI
00187
        /* Initialize MPI... */
        MPI_Init(&argc, &argv);
00188
        MPI_Comm_rank (MPI_COMM_WORLD, &rank);
00189
00190
        MPI_Comm_size(MPI_COMM_WORLD, &size);
00191 #endif
00192
00193
         /* Check arguments... */
        if (argc < 5)
00194
          ERRMSG("Give parameters: <dirlist> <ctl> <atm_in> <metbase>");
00195
00196
00197
        /* Open directory list... */
00198
        if (!(dirlist = fopen(argv[1], "r")))
00199
          ERRMSG("Cannot open directory list!");
00200
        /* Loop over directories... */
while (fscanf(dirlist, "%s", dirname) != EOF) {
00201
00202
00203
00204
           /* MPI parallelization... */
00205
          if ((++ntask) % size != rank)
             continue;
00206
00207
00208
00209
             Initialize model run...
00210
00211
00212
           /* Set timers... */
          START_TIMER(TIMER_TOTAL);
00213
00214
          START_TIMER(TIMER_INIT);
00215
00216
           /* Allocate... */
00217
           ALLOC(atm, atm_t, 1);
00218
           ALLOC(met0, met_t, 1);
00219
          ALLOC(met1, met_t, 1);
          ALLOC(dt, double, NP);
00220
00221
00222
          /* Read control parameters... */
sprintf(filename, "%s/%s", dirname, argv[2]);
00223
00224
00225
          read_ctl(filename, argc, argv, &ctl);
00226
00227
           /* Initialize random number generators... */
00228
          gsl_rng_env_setup();
00229
                  = 0; i < NTHREADS; i++)
00230
            rng[i] = gsl_rng_alloc(gsl_rng_default);
00231
          /* Read atmospheric data... */
sprintf(filename, "%s/%s", dirname, argv[3]);
read_atm(filename, &ctl, atm);
00232
00233
00234
00235
00236
           /\star Get simulation time interval... \star/
00237
           init_simtime(&ctl, atm);
00238
00239
           /* Get rounded start time... */
00240
           if (ctl.direction == 1)
00241
            t0 = floor(ctl.t_start / ctl.dt_mod) * ctl.dt_mod;
00242
00243
            t0 = ceil(ctl.t_start / ctl.dt_mod) * ctl.dt_mod;
00244
00245
           /* Set timers... */
00246
           STOP_TIMER(TIMER_INIT);
00247
```

```
00248
00249
            Loop over timesteps...
00250
00251
00252
          /* Loop over timesteps... */
for (t = t0; ctl.direction * (t - ctl.t_stop) < ctl.dt_mod;</pre>
00253
               t += ctl.direction * ctl.dt_mod) {
00255
            /* Adjust length of final time step... */ if (ctl.direction * (t - ctl.t_stop) > 0)
00256
00257
00258
              t = ctl.t_stop;
00259
00260
            /* Set time steps for air parcels... */
00261
            for (ip = 0; ip < atm->np; ip++)
00262
              if ((ctl.direction * (atm->time[ip] - ctl.t_start) >= 0
                   00263
00264
00265
                dt[ip] = t - atm->time[ip];
00266
              else
00267
                dt[ip] = GSL_NAN;
00268
00269
            /* Get meteorological data... */
            START_TIMER(TIMER_INPUT);
00270
            get_met(&ctl, argv[4], t, met0, met1);
00271
00272
            STOP_TIMER(TIMER_INPUT);
00273
00274
            /* Initialize isosurface... */
00275
            START_TIMER(TIMER_ISOSURF);
00276
            if (t == t0)
              module_isosurf(&ctl, met0, met1, atm, -1);
00277
00278
            STOP TIMER (TIMER ISOSURF);
00279
00280
            /* Advection... */
00281
            START_TIMER(TIMER_ADVECT);
00282 #pragma omp parallel for default(shared) private(ip)
00283
            for (ip = 0; ip < atm->np; ip++)
            if (gsl_finite(dt[ip]))
   module_advection(met0, met1, atm, ip, dt[ip]);
00284
00286
            STOP_TIMER(TIMER_ADVECT);
00287
00288
            /* Turbulent diffusion... */
            START_TIMER(TIMER_DIFFTURB);
00289
00290 \#pragma omp parallel for default(shared) private(ip)
            for (ip = 0; ip < atm->np; ip++)
00291
             if (gsl_finite(dt[ip]))
00292
00293
                module_diffusion_turb(&ctl, atm, ip, dt[ip],
00294
                                       rng[omp_get_thread_num()]);
00295
            STOP TIMER (TIMER DIFFTURB);
00296
00297
            /* Mesoscale diffusion...
00298
            START_TIMER(TIMER_DIFFMESO);
00299 #pragma omp parallel for default(shared) private(ip)
00300
            for (ip = 0; ip < atm\rightarrownp; ip++)
00301
             if (gsl_finite(dt[ip]))
00302
                module_diffusion_meso(&ctl, met0, met1, atm, ip, dt[ip],
00303
                                       rng[omp_get_thread_num()]);
            STOP_TIMER(TIMER_DIFFMESO);
00305
00306
            /* Sedimentation...
00307
            START_TIMER(TIMER_SEDI);
00308 #pragma omp parallel for default(shared) private(ip)
            for (ip = 0; ip < atm->np; ip++)
00309
00310
             if (gsl_finite(dt[ip]))
00311
                module_sedi(&ctl, met0, met1, atm, ip, dt[ip]);
00312
            STOP_TIMER(TIMER_SEDI);
00313
00314
            /* Tsosurface... */
            START_TIMER(TIMER_ISOSURF);
00315
00316 #pragma omp parallel for default(shared) private(ip)
            for (ip = 0; ip < atm->np; ip++)
00318
              module_isosurf(&ctl, met0, met1, atm, ip);
00319
            STOP_TIMER(TIMER_ISOSURF);
00320
00321
            /* Position... */
            START_TIMER(TIMER_POSITION);
00322
00323 #pragma omp parallel for default(shared) private(ip)
           for (ip = 0; ip < atm->np; ip++)
00324
00325
              module_position(met0, met1, atm, ip);
00326
            STOP_TIMER(TIMER_POSITION);
00327
00328
            /* Meteorological data... */
00329
            START_TIMER(TIMER_METEO);
            module_meteo(&ctl, met0, met1, atm, 0);
00330
00331 #pragma omp parallel for default(shared) private(ip)
00332
           for (ip = 1; ip < atm->np; ip++)
              module_meteo(&ctl, met0, met1, atm, ip);
00333
00334
            STOP_TIMER(TIMER_METEO);
```

```
00336
            /* Decay... */
00337
            START_TIMER (TIMER_DECAY);
00338 \#pragma omp parallel for default(shared) private(ip)
00339
           for (ip = 0; ip < atm->np; ip++)
             if (gsl_finite(dt[ip]))
00340
               module_decay(&ctl, met0, met1, atm, ip, dt[ip]);
00342
            STOP_TIMER(TIMER_DECAY);
00343
            /* Write output... */
START_TIMER(TIMER_OUTPUT);
00344
00345
00346
            write_output(dirname, &ctl, met0, met1, atm, t);
00347
            STOP_TIMER(TIMER_OUTPUT);
00348
00349
00350
00351
            Finalize model run...
00352
00353
00354
          /* Report timers...
00355
          STOP_TIMER(TIMER_TOTAL);
00356
          PRINT_TIMER(TIMER_TOTAL);
          PRINT_TIMER(TIMER_INIT);
00357
          PRINT_TIMER(TIMER_INPUT);
PRINT_TIMER(TIMER_OUTPUT);
PRINT_TIMER(TIMER_ADVECT);
00358
00359
00360
00361
          PRINT_TIMER(TIMER_DECAY);
00362
          PRINT_TIMER(TIMER_DIFFMESO);
00363
          PRINT_TIMER(TIMER_DIFFTURB);
          PRINT_TIMER(TIMER_ISOSURF);
PRINT_TIMER(TIMER_METEO);
00364
00365
00366
          PRINT_TIMER (TIMER_POSITION);
00367
          PRINT_TIMER(TIMER_SEDI);
00368
          00369
00370
00371
00373
          00374
00375
00376
00377
00378
          /* Report problem size... */
printf("SIZE_NP = %d\n", atm->np);
00379
00380
          printf("SIZE_TASKS = %d\n", size);
00381
          printf("SIZE_THREADS = %d\n", omp_get_max_threads());
00382
00383
00384
          /* Free random number generators... */
          for (i = 0; i < NTHREADS; i++)</pre>
00385
00386
            gsl_rng_free(rng[i]);
00387
00388
          /* Free... */
         free(atm);
00389
00390
          free (met0);
         free (met1);
00392
         free(dt);
00393
00394
00395 #ifdef MPI
00396 /* Finalize MPI... */
00397
       MPI_Finalize();
00398 #endif
00399
00400
       return EXIT_SUCCESS;
00401 }
```

Here is the call graph for this function:



```
00001 /*
           This file is part of MPTRAC.
00002
00003
           MPTRAC is free software: you can redistribute it and/or modify it under the terms of the GNU General Public License as published by
00004
00005
00006
           the Free Software Foundation, either version 3 of the License, or
00007
           (at your option) any later version.
00008
           MPTRAC is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
00009
00010
00011
00012
           GNU General Public License for more details.
00013
           You should have received a copy of the GNU General Public License along with MPTRAC. If not, see <a href="http://www.gnu.org/licenses/">http://www.gnu.org/licenses/</a>>.
00014
00015
00016
00017
           Copright (C) 2013-2015 Forschungszentrum Juelich GmbH
00018 */
00019
00025 #include "libtrac.h"
00026
00027 #ifdef MPI
00028 #include "mpi.h"
00029 #endif
00030
```

```
00032
        Defines...
00033
00034
00036 #define TIMER_TOTAL 0
00037
00039 #define TIMER_INIT 1
00040
00042 #define TIMER_INPUT 2
00043
00045 #define TIMER_OUTPUT 3
00046
00048 #define TIMER_ADVECT 4
00049
00051 #define TIMER_DECAY 5
00052
00054 #define TIMER DIFFMESO 6
00055
00057 #define TIMER_DIFFTURB 7
00058
00060 #define TIMER_ISOSURF 8
00061
00063 #define TIMER_METEO 9
00064
00066 #define TIMER_POSITION 10
00069 #define TIMER_SEDI 11
00070
00071 /* -----
        Functions...
00072
00073
00074
00076 void init_simtime(
00077 ctl_t * ctl,
       atm_t * atm);
00078
00079
00081 void module_advection(
00082 met_t * met0,
00083
        met_t * met1,
00084
        atm_t * atm,
00085
        int ip,
00086
       double dt);
00087
00089 void module_decay(
00090
       ctl_t * ctl,
00091
        met_t * met0,
        met_t * met1,
atm_t * atm,
00092
00093
00094
        int ip,
00095
        double dt);
00096
00098 void module_diffusion_meso(
00099
        ctl_t * ctl,
        met_t * met0,
00100
        met_t * met1,
atm_t * atm,
00101
00102
00103
        int ip,
00104
        double dt,
00105
        gsl_rng * rng);
00106
00108 void module diffusion turb(
       ctl_t * ctl,
atm_t * atm,
00109
00110
00111
        int ip,
00112
        double dt,
00113
        gsl_rng * rng);
00114
00116 void module isosurf(
00117
       ctl_t * ctl,
00118
        met_t * met0,
        met_t * met1,
atm_t * atm,
00119
00120
00121
        int ip);
00122
00124 void module_meteo(
00125
       ctl_t * ctl,
00126
        met_t * met0,
        met_t * met1,
atm_t * atm,
00127
00128
00129
        int ip);
00130
00132 double module_meteo_hno3(
00133
        double t,
00134
        double lat,
00135
        double p);
00136
00138 void module_position(
```

```
00139
        met_t * met0,
        met_t * met1,
atm_t * atm,
00140
00141
00142
        int ip);
00143
00145 void module_sedi(
00146
        ctl_t * ctl,
00147
        met_t * met0,
        met_t * met1,
atm_t * atm,
00148
00149
00150
        int ip,
00151
        double dt);
00152
00154 void write_output(
00155
        const char *dirname,
        ctl_t * ctl,
met_t * met0,
00156
00157
        met_t * met1,
atm_t * atm,
00158
00159
00160
        double t);
00161
00162 /* -----
        Main...
00163
00164
00165
00166 int main(
00167
00168
       char *argv[]) {
00169
00170
        ctl_t ctl;
00171
00172
        atm_t *atm;
00173
00174
        met_t *met0, *met1;
00175
        gsl_rng *rng[NTHREADS];
00176
00177
00178
        FILE *dirlist;
00179
00180
        char dirname[LEN], filename[LEN];
00181
00182
        double *dt, t, t0;
00183
00184
        int i, ip, ntask = 0, rank = 0, size = 1;
00185
00186 #ifdef MPI
00187
        /* Initialize MPI... */
        MPI_Init(&argc, &argv);
MPI_Comm_rank(MPI_COMM_WORLD, &rank);
MPI_Comm_size(MPI_COMM_WORLD, &size);
00188
00189
00190
00191 #endif
00192
00193
         /* Check arguments... */
00194
        if (argc < 5)
          ERRMSG("Give parameters: <dirlist> <ctl> <atm_in> <metbase>");
00195
00196
00197
        /* Open directory list... */
00198
        if (!(dirlist = fopen(argv[1], "r")))
00199
          ERRMSG("Cannot open directory list!");
00200
        /* Loop over directories... */
while (fscanf(dirlist, "%s", dirname) != EOF) {
00201
00202
00203
00204
           /* MPI parallelization... */
00205
          if ((++ntask) % size != rank)
00206
            continue;
00207
00208
00209
            Initialize model run...
00210
00211
00212
           /* Set timers... */
          START_TIMER(TIMER_TOTAL);
00213
00214
          START_TIMER(TIMER_INIT);
00215
           /* Allocate... */
00216
00217
           ALLOC(atm, atm_t, 1);
00218
           ALLOC(met0, met_t, 1);
00219
           ALLOC(met1, met_t, 1);
          ALLOC (dt, double, NP);
00220
00221
00222
00223
           /* Read control parameters... */
00224
           sprintf(filename, "%s/%s", dirname, argv[2]);
          read_ctl(filename, argc, argv, &ctl);
00225
00226
00227
           /* Initialize random number generators... */
```

```
gsl_rng_env_setup();
          for (i = 0; i < NTHREADS; i++)</pre>
00229
00230
            rng[i] = gsl_rng_alloc(gsl_rng_default);
00231
          /* Read atmospheric data... */
sprintf(filename, "%s/%s", dirname, argv[3]);
read_atm(filename, &ctl, atm);
00232
00233
00234
00235
00236
           /* Get simulation time interval... */
00237
          init_simtime(&ctl, atm);
00238
00239
          /* Get rounded start time... */
00240
          if (ctl.direction == 1)
00241
            t0 = floor(ctl.t_start / ctl.dt_mod) * ctl.dt_mod;
00242
00243
            t0 = ceil(ctl.t_start / ctl.dt_mod) * ctl.dt_mod;
00244
00245
           /* Set timers... */
          STOP_TIMER(TIMER_INIT);
00246
00247
00248
00249
            Loop over timesteps...
00250
00251
00252
          /* Loop over timesteps... */
          for (t = t0; ctl.direction * (t - ctl.t_stop) < ctl.dt_mod;</pre>
00253
00254
                t += ctl.direction * ctl.dt_mod) {
00255
            /* Adjust length of final time step... */ if (ctl.direction * (t - ctl.t_stop) > 0)
00256
00257
00258
              t = ctl.t stop;
00259
00260
             /* Set time steps for air parcels... */
00261
            for (ip = 0; ip < atm\rightarrownp; ip++)
00262
              if ((ctl.direction * (atm->time[ip] - ctl.t_start) >= 0
                   00263
00264
                dt[ip] = t - atm->time[ip];
00265
00266
              else
00267
                dt[ip] = GSL_NAN;
00268
00269
            /* Get meteorological data... */
00270
            START_TIMER(TIMER_INPUT);
00271
            get_met(&ctl, argv[4], t, met0, met1);
00272
            STOP_TIMER(TIMER_INPUT);
00273
00274
            /* Initialize isosurface... */
00275
            START_TIMER(TIMER_ISOSURF);
00276
            if (t == t0)
  module_isosurf(&ctl, met0, met1, atm, -1);
00277
00278
            STOP_TIMER(TIMER_ISOSURF);
00279
00280
            /* Advection... */
00281
            START_TIMER (TIMER_ADVECT);
00282 #pragma omp parallel for default(shared) private(ip)
            for (ip = 0; ip < atm->np; ip++)
00283
             if (gsl_finite(dt[ip]))
00285
                module_advection(met0, met1, atm, ip, dt[ip]);
00286
            STOP_TIMER(TIMER_ADVECT);
00287
            /* Turbulent diffusion... */
00288
            START_TIMER(TIMER_DIFFTURB);
00289
00290 #pragma omp parallel for default(shared) private(ip)
00291
            for (ip = 0; ip < atm->np; ip++)
00292
                  (gsl_finite(dt[ip]))
00293
                module_diffusion_turb(&ctl, atm, ip, dt[ip],
00294
                                        rng[omp_get_thread_num()]);
            STOP_TIMER(TIMER_DIFFTURB);
00295
00296
00297
             /* Mesoscale diffusion...
00298
            START_TIMER(TIMER_DIFFMESO);
00299 #pragma omp parallel for default(shared) private(ip)
00300
            for (ip = 0; ip < atm->np; ip++)
              if (gsl_finite(dt[ip]))
00301
                module_diffusion_meso(&ctl, met0, met1, atm, ip, dt[ip],
00302
                                        rng[omp_get_thread_num()]);
00303
00304
            STOP_TIMER(TIMER_DIFFMESO);
00305
             /* Sedimentation...
00306
            START_TIMER(TIMER_SEDI);
00307
00308 #pragma omp parallel for default(shared) private(ip)
            for (ip = 0; ip < atm->np; ip++)
00309
00310
             if (gsl_finite(dt[ip]))
00311
                module_sedi(&ctl, met0, met1, atm, ip, dt[ip]);
00312
            STOP_TIMER(TIMER_SEDI);
00313
00314
            /* Isosurface... */
```

```
START_TIMER(TIMER_ISOSURF);
00316 #pragma omp parallel for default(shared) private(ip)
          for (ip = 0; ip < atm->np; ip++)
  module_isosurf(&ctl, met0, met1, atm, ip);
00317
00318
00319
             STOP_TIMER(TIMER_ISOSURF);
00320
              /* Position...
00322
             START_TIMER(TIMER_POSITION);
00323 #pragma omp parallel for default(shared) private(ip)
            for (ip = 0; ip < atm->np; ip++)
  module_position(met0, met1, atm, ip);
00324
00325
00326
             STOP_TIMER(TIMER_POSITION);
00327
00328
              /* Meteorological data... */
00329
             START_TIMER(TIMER_METEO);
00330
             module_meteo(&ctl, met0, met1, atm, 0);
00331 #pragma omp parallel for default(shared) private(ip)
            for (ip = 1; ip < atm->np; ip++)
module_meteo(&ctl, met0, met1, atm, ip);
00332
00334
             STOP_TIMER(TIMER_METEO);
00335
             /* Decay... */
00336
             START_TIMER(TIMER_DECAY);
00337
00338 \#pragma omp parallel for default(shared) private(ip)
00339
             for (ip = 0; ip < atm->np; ip++)
              if (gsl_finite(dt[ip]))
00340
00341
                 module_decay(&ctl, met0, met1, atm, ip, dt[ip]);
00342
             STOP_TIMER(TIMER_DECAY);
00343
             /* Write output... */
00344
             START_TIMER (TIMER_OUTPUT);
00345
00346
             write_output(dirname, &ctl, met0, met1, atm, t);
00347
             STOP_TIMER(TIMER_OUTPUT);
00348
00349
00350
00351
              Finalize model run...
00352
00353
00354
           /* Report timers...
00355
           STOP_TIMER(TIMER_TOTAL);
           PRINT_TIMER (TIMER_TOTAL);
00356
           PRINT_TIMER(TIMER_INIT);
00357
00358
           PRINT_TIMER (TIMER_INPUT);
           PRINT_TIMER (TIMER_OUTPUT);
00359
00360
           PRINT_TIMER (TIMER_ADVECT);
00361
           PRINT_TIMER (TIMER_DECAY);
00362
           PRINT_TIMER (TIMER_DIFFMESO);
           PRINT_TIMER(TIMER_DIFFTURB);
PRINT_TIMER(TIMER_ISOSURF);
00363
00364
           PRINT_TIMER (TIMER_METEO);
00365
00366
           PRINT_TIMER (TIMER_POSITION);
00367
           PRINT_TIMER(TIMER_SEDI);
00368
           /* Report memory usage... */
printf("MEMORY_ATM = %g MByte\n", 2. * sizeof(atm_t) / 1024. / 1024.);
printf("MEMORY_METEO = %g MByte\n", 2. * sizeof(met_t) / 1024. / 1024.);
printf("MEMORY_DYNAMIC = %g MByte\n",
00369
00370
00371
00372
           00373
00374
00375
00376
00377
00378
           /* Report problem size... */
00379
00380
           printf("SIZE_NP = d\n", atm->np);
           printf("SIZE_TASKS = %d\n", size);
printf("SIZE_THREADS = %d\n", omp_get_max_threads());
00381
00382
00383
00384
           /* Free random number generators... */
00385
           for (i = 0; i < NTHREADS; i++)</pre>
00386
             gsl_rng_free(rng[i]);
00387
00388
           /* Free... */
00389
           free (atm);
00390
           free (met0);
00391
           free (met1);
00392
           free(dt);
00393
00394
00395 #ifdef MPI
         /* Finalize MPI... */
00397
        MPI_Finalize();
00398 #endif
00399
00400
        return EXIT_SUCCESS;
00401 }
```

```
00404
00405 void init_simtime(
00406
       ctl_t * ctl,
       atm_t * atm) {
00407
00409
       /* Set inital and final time... */
       if (ctl->direction == 1) {
   if (ctl->t_start < -1e99)</pre>
00410
00411
          ctl->t_start = gsl_stats_min(atm->time, 1, (size_t) atm->np);
00412
         if (ctl->t\_stop < -1e99)
00413
          ctl->t_stop = gsl_stats_max(atm->time, 1, (size_t) atm->np);
00414
00415
       } else if (ctl->direction == -1) {
00416
         if (ctl->t_stop < -1e99)
00417
           ctl->t_stop = gsl_stats_min(atm->time, 1, (size_t) atm->np);
         if (ctl->t_start < -1e99)
  ctl->t_start = gsl_stats_max(atm->time, 1, (size_t) atm->np);
00418
00419
00420
00421
00422
       /* Check time... */
00423
       if (ctl->direction * (ctl->t_stop - ctl->t_start) <= 0)</pre>
00424
        ERRMSG("Nothing to do!");
00425 }
00426
00428
00429 void module_advection(
00430
       met_t * met0,
00431
       met t * met1.
       atm_t * atm,
00432
00433
       int ip,
00434
       double dt) {
00435
00436
       double v[3], xm[3];
00437
00438
       /\star Interpolate meteorological data... \star/
       intpol_met_time(met0, met1, atm->time[ip], atm->p[ip],
00439
00440
                      atm->lon[ip], atm->lat[ip], NULL, NULL,
00441
                      &v[0], &v[1], &v[2], NULL, NULL);
00442
00443
       /* Get position of the mid point... */
       xm[0] = atm->lon[ip] + dx2deg(0.5 * dt * v[0] / 1000., atm->lat[ip]);
xm[1] = atm->lat[ip] + dy2deg(0.5 * dt * v[1] / 1000.);
00444
00445
       xm[2] = atm - p[ip] + 0.5 * dt * v[2];
00446
00447
00448
       /* Interpolate meteorological data for mid point... */
       00449
00450
00451
00452
00453
       /* Save new position... */
00454
       atm->time[ip] += dt;
       00455
00456
       atm->p[ip] += dt * v[2];
00457
00459
00461
00462 void module decay(
       ctl_t * ctl,
met_t * met0,
00463
00464
       met_t * met1,
00465
00466
       atm_t * atm,
00467
       int ip,
00468
       double dt) {
00469
00470
       double ps, pt, tdec;
00472
       /\star Check lifetime values... \star/
00473
       if ((ctl->tdec_trop <= 0 && ctl->tdec_strat <= 0) || ctl->
     qnt_m < 0
00474
         return:
00475
00476
       /* Set constant lifetime... */
00477
       if (ctl->tdec_trop == ctl->tdec_strat)
00478
        tdec = ctl->tdec_trop;
00479
00480
       /* Set altitude-dependent lifetime... */
00481
       else {
00482
00483
         /* Get surface pressure... */
00484
         intpol_met_time(met0, met1, atm->time[ip], atm->p[ip],
00485
                        atm->lon[ip], atm->lat[ip], &ps, NULL,
00486
                        NULL, NULL, NULL, NULL, NULL);
00487
```

```
/\star Get tropopause pressure... \star/
00489
           pt = tropopause(atm->time[ip], atm->lat[ip]);
00490
           /* Set lifetime... */
00491
00492
           if (atm->p[ip] <= pt)
00493
             tdec = ctl->tdec_strat;
           else
00495
             tdec = LIN(ps, ctl->tdec_trop, pt, ctl->tdec_strat, atm->
      p[ip]);
00496
00497
00498
         /* Calculate exponential decay... */
00499
        atm->q[ctl->qnt_m][ip] *= exp(-dt / tdec);
00500 }
00501
00503
00504 void module diffusion meso(
        ctl_t * ctl,
met_t * met0,
00506
00507
         met_t * met1,
00508
         atm_t * atm,
00509
         int ip,
00510
        double dt.
00511
        qsl_rnq * rnq) {
00512
00513
        double r, rs, u[16], v[16], w[16], usig, vsig, wsig;
00514
00515
        int ix, iy, iz;
00516
00517
         /* Calculate mesoscale velocity fluctuations... */
00518
         if (ctl->turb_meso > 0) {
00519
00520
           /* Get indices... */
00521
           ix = locate(met0->lon, met0->nx, atm->lon[ip]);
           iy = locate(met0->lat, met0->ny, atm->lat[ip]);
00522
00523
           iz = locate(met0->p, met0->np, atm->p[ip]);
00525
           /* Collect local wind data... */
00526
           u[0] = met0->u[ix][iy][iz];
00527
           u[1] = met0 -> u[ix + 1][iy][iz];
           u[2] = met0->u[ix][iy + 1][iz];

u[3] = met0->u[ix + 1][iy + 1][iz];

u[4] = met0->u[ix][iy][iz + 1];
00528
00529
00530
           u[5] = met0 -> u[ix + 1][iy][iz + 1];
00531
00532
           u[6] = met0 -> u[ix][iy + 1][iz + 1];
00533
           u[7] = met0 -> u[ix + 1][iy + 1][iz + 1];
00534
           v[0] = met0 -> v[ix][iy][iz];
00535
           v[1] = met0->v[ix + 1][iy][iz];
00536
           v[2] = met0 -> v[ix][iy + 1][iz];
           v[3] = met0->v[ix + 1][iy + 1][iz];
v[4] = met0->v[ix][iy][iz + 1];
00538
00539
           v[5] = met0->v[ix + 1][iy][iz + 1];
v[6] = met0->v[ix][iy + 1][iz + 1];
00540
00541
00542
           v[7] = met0 -> v[ix + 1][iy + 1][iz + 1];
00544
           w[0] = met0->w[ix][iy][iz];
00545
           w[1] = met0->w[ix + 1][iy][iz];
00546
           w[2] = met0 -> w[ix][iy + 1][iz];
           w(z) = met0->w(ix)(iy + 1)(iz);
w(3) = met0->w(ix + 1)(iy + 1)(iz);
w(4) = met0->w(ix)(iy)(iz + 1);
w(5) = met0->w(ix + 1)(iy)(iz + 1);
w(6) = met0->w(ix)(iy + 1)(iz + 1);
00547
00548
00549
00550
00551
           w[7] = met0 -> w[ix + 1][iy + 1][iz + 1];
00552
00553
           /* Get indices... */
           ix = locate(met1->lon, met1->nx, atm->lon[ip]);
00554
00555
           iy = locate(met1->lat, met1->ny, atm->lat[ip]);
00556
           iz = locate(met1->p, met1->np, atm->p[ip]);
00557
00558
           /* Collect local wind data... */
           u[8] = met1->u[ix][iy][iz];
u[9] = met1->u[ix + 1][iy][iz];
00559
00560
           u[10] = met1->u[ix][iy + 1][iz];
u[11] = met1->u[ix + 1][iy + 1][iz];
00561
00562
00563
           u[12] = met1->u[ix][iy][iz + 1];
00564
           u[13] = met1->u[ix + 1][iy][iz + 1];
00565
           u[14] = met1->u[ix][iy + 1][iz + 1];
           u[15] = met1 -> u[ix + 1][iy + 1][iz + 1];
00566
00567
           v[8] = met1->v[ix][iy][iz];
00568
00569
           v[9] = met1 -> v[ix + 1][iy][iz];
00570
           v[10] = met1->v[ix][iy + 1][iz];
           v[11] = metl->v[ix + 1][iy + 1][iz];
v[12] = metl->v[ix][iy][iz + 1];
v[13] = metl->v[ix][iy][iz + 1];
00571
00572
00573
```

```
v[14] = met1->v[ix][iy + 1][iz + 1];
00575
          v[15] = met1 -> v[ix + 1][iy + 1][iz + 1];
00576
00577
          w[8] = met1->w[ix][iy][iz];
          w[9] = met1->w[ix + 1][iy][iz];
00578
          w[10] = met1->w[ix][iy + 1][iz];
00579
          w[11] = met1->w[ix + 1][iy + 1][iz];
00581
          w[12] = met1->w[ix][iy][iz + 1];
00582
          w[13] = met1->w[ix + 1][iy][iz + 1];
00583
          w[14] = met1->w[ix][iy + 1][iz + 1];
          w[15] = met1->w[ix + 1][iy + 1][iz + 1];
00584
00585
00586
          /\star Get standard deviations of local wind data... \star/
00587
          usig = gsl_stats_sd(u, 1, 16);
00588
          vsig = gsl_stats_sd(v, 1, 16);
00589
          wsig = gsl_stats_sd(w, 1, 16);
00590
00591
          /\star Set temporal correlations for mesoscale fluctuations... \star/
          r = 1 - 2 * fabs(dt) / ctl->dt_met;
00592
          rs = sqrt(1 - r * r);
00593
00594
00595
          /\star Calculate mesoscale wind fluctuations... \star/
00596
          atm->up[ip] =
           r * atm->up[ip] + rs * gsl_ran_gaussian_ziggurat(rng,
00597
00598
                                                               ctl->turb_meso * usig);
00599
          atm->vp[ip] =
00600
           r * atm->vp[ip] + rs * gsl_ran_gaussian_ziggurat(rng,
00601
                                                               ctl->turb_meso * vsig);
00602
          atm->wp[ip] =
00603
           r * atm->wp[ip] + rs * gsl_ran_gaussian_ziggurat(rng,
00604
                                                              ctl->turb meso * wsig);
00605
          /* Calculate air parcel displacement... */
atm->lon[ip] += dx2deg(atm->up[ip] * dt / 1000., atm->lat[ip]);
atm->lat[ip] += dy2deg(atm->vp[ip] * dt / 1000.);
00606
00607
00608
00609
          atm \rightarrow p[ip] += atm \rightarrow wp[ip] * dt;
00610
00611 }
00612
00614
00615 void module_diffusion_turb(
       ctl_t * ctl,
atm_t * atm,
00616
00617
       int ip,
00618
00619
        double dt,
00620
       gsl_rng * rng) {
00621
00622
       double dx, dz, pt, p0, p1, w;
00623
00624
        /* Get tropopause pressure... */
00625
       pt = tropopause(atm->time[ip], atm->lat[ip]);
00626
       /* Get weighting factor... */
p1 = pt * 0.866877899;
p0 = pt / 0.866877899;
00627
00628
00629
00630
        if (atm->p[ip] > p0)
00631
          w = 1;
00632
        else if (atm->p[ip] < p1)
00633
         w = 0;
00634
       else
00635
         w = LIN(p0, 1.0, p1, 0.0, atm->p[ip]);
00636
00637
        /* Set diffusivitiy... */
00638
       dx = w * ctl->turb_dx_trop + (1 - w) * ctl->turb_dx_strat;
        dz = w * ctl->turb_dz_trop + (1 - w) * ctl->turb_dz_strat;
00639
00640
00641
        /* Horizontal turbulent diffusion... */
00642
        if (dx > 0) {
00643
         atm->lon[ip]
00644
           += dx2deg(gsl_ran_gaussian_ziggurat(rng, sqrt(2.0 * dx * fabs(dt)))
00645
                      / 1000., atm->lat[ip]);
00646
          atm->lat[ip]
00647
           += dy2deg(gsl_ran_gaussian_ziggurat(rng, sqrt(2.0 * dx * fabs(dt)))
00648
                      / 1000.);
00649
00650
00651
        /* Vertical turbulent diffusion... */
00652
        if (dz > 0)
         atm->p[ip]
00653
00654
            += dz2dp(gsl_ran_gaussian_ziggurat(rng, sqrt(2.0 * dz * fabs(dt)))
00655
                     / 1000., atm->p[ip]);
00656 }
00657
00659
00660 void module isosurf(
```

```
00661
        ctl_t * ctl,
        met_t * met0,
met_t * met1,
00662
00663
        atm_t * atm,
00664
00665
        int ip) {
00666
00667
        static double *iso, *ps, t, *ts;
00668
00669
        static int idx, ip2, n, nb = 100000;
00670
00671
        FILE *in;
00672
00673
        char line[LEN];
00674
00675
        /\star Check control parameter... \star/
00676
        if (ctl->isosurf < 1 || ctl->isosurf > 4)
00677
          return:
00678
00679
        /* Initialize... */
00680
        if (ip < 0) {</pre>
00681
00682
          /* Allocate... */
00683
          ALLOC(iso, double,
00684
                 NP);
00685
          ALLOC (ps, double,
00686
                 nb);
00687
          ALLOC(ts, double,
00688
                nb);
00689
00690
          /* Save pressure... */
00691
          if (ctl->isosurf == 1)
00692
            for (ip2 = 0; ip2 < atm->np; ip2++)
00693
               iso[ip2] = atm->p[ip2];
00694
00695
           /* Save density... */
          else if (ctl->isosurf == 2)
00696
            for (ip2 = 0; ip2 < atm->np; ip2++) {
00697
              intpol_met_time(met0, met1, atm->time[ip2], atm->p[ip2],
00698
00699
                                atm->lon[ip2], atm->lat[ip2], NULL, &t, NULL, NULL,
00700
                                NULL, NULL, NULL);
00701
               iso[ip2] = atm->p[ip2] / t;
00702
00703
00704
          /* Save potential temperature... */
00705
          else if (ctl->isosurf == 3)
00706
             for (ip2 = 0; ip2 < atm->np; ip2++) {
00707
               intpol_met_time(met0, met1, atm->time[ip2], atm->p[ip2],
00708
                                atm->lon[ip2], atm->lat[ip2], NULL, &t, NULL, NULL,
                                NULL, NULL, NULL);
00709
               iso[ip2] = t * pow(P0 / atm->p[ip2], 0.286);
00710
00711
00712
00713
          /\star Read balloon pressure data... \star/
00714
          else if (ctl->isosurf == 4) {
00715
00716
            /* Write info... */
printf("Read balloon pressure data: %s\n", ctl->balloon);
00717
00718
00719
             /* Open file... */
00720
            if (!(in = fopen(ctl->balloon, "r")))
              ERRMSG("Cannot open file!");
00721
00722
00723
             /* Read pressure time series... */
            while (fgets(line, LEN, in))
  if (sscanf(line, "%lg %lg", &ts[n], &ps[n]) == 2)
00724
00725
                 if ((++n) > 100000)

ERRMSG("Too many data points!");
00726
00727
00728
00729
             /* Check number of points... */
                (n < 1)
00730
00731
               ERRMSG("Could not read any data!");
00732
00733
             /* Close file... */
00734
            fclose(in);
00735
00736
00737
          /* Leave initialization... */
00738
00739
00740
00741
        /* Restore pressure... */
00742
        if (ctl->isosurf == 1)
00743
          atm->p[ip] = iso[ip];
00744
        /* Restore density... */
else if (ctl->isosurf == 2) {
00745
00746
00747
          intpol_met_time(met0, met1, atm->time[ip], atm->p[ip], atm->
```

```
lon[ip],
00748
                          atm->lat[ip], NULL, &t, NULL, NULL, NULL, NULL, NULL);
00749
          atm->p[ip] = iso[ip] * t;
00750
00751
       /* Restore potential temperature... */
else if (ctl->isosurf == 3) {
00752
00753
00754
         intpol_met_time(met0, met1, atm->time[ip], atm->p[ip], atm->
     lon[ip],
00755
                          atm->lat[ip], NULL, &t, NULL, NULL, NULL, NULL, NULL);
         atm->p[ip] = P0 * pow(iso[ip] / t, -1. / 0.286);
00756
00757
00758
00759
        /* Interpolate pressure... */
        else if (ctl->isosurf == 4) {
00760
00761
        if (atm->time[ip] <= ts[0])</pre>
         atm->p[ip] = ps[0];
else if (atm->time[ip] >= ts[n - 1])
00762
00763
           atm->p[ip] = ps[n-1];
00764
00765
         else {
00766
           idx = locate(ts, n, atm->time[ip]);
            atm->p[ip] = LIN(ts[idx], ps[idx],
ts[idx + 1], ps[idx + 1], atm->time[ip]);
00767
00768
00769
00770
       }
00771 }
00772
00774
00775 void module_meteo(
00776
       ctl_t * ctl,
00777
        met_t * met0,
00778
        met_t * met1,
        atm_t * atm,
00779
00780
       int ip) {
00781
00782
       static FILE *in;
00783
00784
       static char filename[LEN], line[LEN];
00785
00786
       static double lon[GX], lat[GY], var[GX][GY],
00787
         rdum, rlat, rlat_old = -999, rlon, rvar;
00788
00789
       static int year_old, mon_old, day_old, nlon, nlat;
00790
00791
       double a, b, c, ps, p1, p_hno3, p_h2o, t, t1, u, u1, v, v1, w,
00792
         x1, x2, h2o, o3, grad, vort, var0, var1;
00793
00794
       int day, mon, year, idum, ilat, ilon;
00795
00796
        /* Interpolate meteorological data... */
00797
        intpol_met_time(met0, met1, atm->time[ip], atm->p[ip], atm->
     lon[ip],
00798
                        atm->lat[ip], &ps, &t, &u, &v, &w, &h2o, &o3);
00799
00800
        /* Set surface pressure... */
       if (ctl->qnt_ps >= 0)
00801
00802
         atm->q[ctl->qnt_ps][ip] = ps;
00803
00804
       /* Set pressure... */
       if (ctl->qnt_p >= 0)
00805
00806
         atm->q[ctl->qnt_p][ip] = atm->p[ip];
00807
00808
        /* Set temperature... */
00809
        if (ctl->qnt_t >= 0)
00810
         atm->q[ctl->qnt_t][ip] = t;
00811
00812
        /* Set zonal wind... */
00813
       if (ctl->qnt_u >= 0)
00814
         atm->q[ctl->qnt_u][ip] = u;
00815
00816
        /* Set meridional wind... */
        if (ctl->qnt_v >= 0)
00817
00818
         atm->q[ctl->qnt_v][ip] = v;
00819
00820
        /* Set vertical velocity... */
00821
        if (ctl->qnt_w >= 0)
00822
         atm->q[ctl->qnt_w][ip] = w;
00823
00824
        /* Set water vapor vmr... */
        if (ct1->qnt_h2o>=0)
00825
00826
         atm->q[ctl->qnt_h2o][ip] = h2o;
00827
00828
        /* Set ozone vmr...
00829
        if (ctl->qnt_o3 >= 0)
00830
          atm \rightarrow q[ctl \rightarrow qnt_o3][ip] = o3;
00831
```

```
/* Calculate potential temperature... */
         if (ctl->qnt_theta >= 0)
00833
00834
           atm \rightarrow q[ctl \rightarrow qnt\_theta][ip] = t * pow(P0 / atm \rightarrow p[ip], 0.286);
00835
00836
         /* Calculate potential vorticity... */
00837
         if (ctl->ant pv >= 0) {
00839
            /* Absolute vorticity... */
           vort = 2 * 7.2921e-5 * sin(atm->lat[ip] * M_PI / 180.);
if (fabs(atm->lat[ip]) < 89.) {</pre>
00840
00841
00842
             intpol_met_time(met0, met1, atm->time[ip], atm->p[ip],
                                (atm->lon[ip] >=
00843
00844
                                 0 ? atm->lon[ip] - 1. : atm->lon[ip] + 1.),
00845
                                atm->lat[ip], NULL, NULL, NULL, &v1, NULL, NULL, NULL);
00846
              vort += (v1 - v) / 1000.
00847
               / ((atm->lon[ip] >= 0 ? -1 : 1) * deg2dx(1., atm->lat[ip]));
00848
00849
            intpol_met_time(met0, met1, atm->time[ip], atm->p[ip], atm->
      lon[ip],
00850
                              (atm->lat[ip] >=
                             0 ? atm->lat[ip] - 1. : atm->lat[ip] + 1.), NULL, NULL, &ul, NULL, NULL, NULL, NULL);
00851
00852
           vort += (u1 - u) / 1000. / ((atm->lat[ip] >= 0 ? -1 : 1) * deg2dy(1.));
00853
00854
00855
           /* Potential temperature gradient... */
00856
           p1 = 0.85 * atm->p[ip];
00857
           intpol_met_time(met0, met1, atm->time[ip], p1, atm->lon[ip],
           atm->lat[ip], NULL, &t1, NULL, NULL, NULL, NULL, NULL, NULL); grad = (t1 * pow(P0 / p1, 0.286) - t * pow(P0 / atm->p[ip], 0.286))
00858
00859
             / (100. * (p1 - atm - p[ip]));
00860
00861
00862
            /* Calculate PV... *
00863
           atm->q[ctl->qnt_pv][ip] = -1e6 * G0 * vort * grad;
00864
00865
         /* Calculate T_ice (Marti and Mauersberger, 1993)... \star/
00866
00867
         if (ctl->qnt_tice >= 0 || ctl->qnt_tsts >= 0)
           atm->q[ctl->qnt_tice][ip] =
00869
              -2663.5 /
00870
              (\log 10((ct1->psc_h2o > 0 ? ct1->psc_h2o : h2o) * atm->p[ip] * 100.) -
00871
               12.537);
00872
00873
         /* Calculate T NAT (Hanson and Mauersberger, 1988)... */
00874
         if (ctl->qnt_tnat >= 0 || ctl->qnt_tsts >= 0) {
00875
           if (ctl->psc_hno3 > 0)
00876
             p_hno3 = ctl->psc_hno3 * atm->p[ip] / 1.333224;
00877
00878
             p_hno3 = module_meteo_hno3(atm->time[ip], atm->lat[ip], atm->
      p[ip])
                * 1e-9 * atm->p[ip] / 1.333224;
00879
           p_h2o = (ctl->psc_h2o > 0 ? ctl->psc_h2o : h2o) * atm->p[ip] / 1.333224;
00880
           a = 0.009179 - 0.00088 * log10(p_h2o);
b = (38.9855 - log10(p_hno3) - 2.7836 * log10(p_h2o)) / a;
00881
00882
00883
           c = -11397.0 / a;
           x1 = (-b + \text{sqrt}(b * b - 4. * c)) / 2.;

x2 = (-b - \text{sqrt}(b * b - 4. * c)) / 2.;
00884
00885
           if (x1 > 0)
00887
             atm->q[ctl->qnt_tnat][ip] = x1;
00888
           if (x2 > 0)
00889
             atm->q[ctl->qnt\_tnat][ip] = x2;
00890
00891
00892
         /* Calculate T_STS (mean of T_ice and T_NAT)... */
00893
         if (ctl->qnt_tsts >= 0) {
00894
           if (ctl->qnt_tice < 0 || ctl->qnt_tnat < 0)</pre>
00895
             ERRMSG("Need T_ice and T_NAT to calculate T_STS!");
00896
           \label{eq:atm-prop} $$atm->q[ctl->qnt\_tsts][ip] = 0.5 * (atm->q[ctl->qnt\_tice][ip]$
                                                    + atm->q[ctl->qnt_tnat][ip]);
00897
00898
00899
00900
         /* Read variance data for current day... */
00901
         if (ip == 0 \&\& ctl->qnt_gw_var >= 0) {
           jsec2time(atm->time[ip], &year, &mon, &day, &idum, &idum, &idum, &rdum);
00902
           if (year != year_old || mon != mon_old || day != day_old) {
  year_old = year;
00903
00904
00905
              mon_old = mon;
00906
              day_old = day;
             nlon = nlat = -1;
sprintf(filename, "%s_%d_%02d_%02d.tab",
00907
00908
             ctl->gw_basename, year, mon, day);
if ((in = fopen(filename, "r"))) {
00909
00910
00911
               printf("Read gravity wave data: %s\n", filename);
                while (fgets(line, LEN, in)) {
  if (sscanf(line, "%lg %lg %lg", &rlon, &rlat, &rvar) != 3)
00912
00913
                 continue;
if (rlat != rlat_old) {
00914
00915
                    rlat_old = rlat;
00916
```

```
if ((++nlat) > GY)
00918
                        ERRMSG("Too many latitudes!");
00919
                     nlon = -1;
00920
                   if ((++nlon) > GX)
00921
00922
                     ERRMSG("Too many longitudes!");
                   lon[nlon] = rlon;
00924
                   lat[nlat] = rlat;
00925
                   var[nlon][nlat] = GSL_MAX(0, rvar);
00926
                fclose(in);
00927
00928
                nlat++;
00929
                nlon++;
00930
00931
                printf("Missing gravity wave data: %s\n", filename);
00932
00933
00934
         /* Interpolate variance data... */
         if (ctl->qnt_gw_var >= 0) {
00937
           if (nlat >= 2 && nlon >= 2) {
00938
              ilat = locate(lat, nlat, atm->lat[ip]);
              ilon = locate(lon, nlon, atm->lon[ip]);
00939
              00940
00941
              00942
00943
00944
              atm->q[ctl->qnt_gw_var][ip]
00945
                = LIN(lon[ilon], var0, lon[ilon + 1], var1, atm->lon[ip]);
            } else
00946
00947
              atm->q[ctl->qnt_gw_var][ip] = GSL NAN;
00948
         }
00949 }
00950
00952
00953 double module meteo hno3(
        double t,
00955
         double lat.
00956
         double p) {
00957
         static double secs[12] = { 1209600.00, 3888000.00, 6393600.00,
00958
          9072000.00, 11664000.00, 14342400.00, 16934400.00, 19612800.00, 22291200.00,
00959
00960
00961
            24883200.00, 27561600.00, 30153600.00
00962
00963
         static double lats[18] = { -85, -75, -65, -55, -45, -35, -25, -15, -5,
00964
           5, 15, 25, 35, 45, 55, 65, 75, 85
00965
00966
00967
00968
         static double ps[10] = { 4.64159, 6.81292, 10, 14.678, 21.5443,
00969
           31.6228, 46.4159, 68.1292, 100, 146.78
00970
00971
00972
         static double hno3[12][18][10] = { \{0.782, 1.65, 2.9, 4.59, 6.71, 8.25, 7.16, 5.75, 2.9, 1.74\},
00974
             \{0.529, 1.64, 2.76, 4.55, 6.58, 8, 6.99, 5.55, 2.68, 1.57\},
00975
             {0.723, 1.55, 2.73, 4.48, 6.32, 7.58, 7.05, 5.16, 2.49, 1.54},
00976
             {0.801, 1.56, 2.74, 4.52, 6.23, 7.35, 6.68, 4.4, 1.97, 1.23},
             {0.818, 1.62, 2.77, 4.38, 5.98, 6.84, 5.83, 3.05, 1.15, 0.709},
00977
             {0.901, 1.73, 2.78, 4.21, 5.63, 6.16, 4.68, 1.87, 0.617, 0.37}, {0.997, 1.8, 2.79, 4.09, 4.88, 4.96, 3.12, 1.22, 0.311, 0.244}, {1, 1.71, 2.51, 3.4, 3.74, 3.39, 2.25, 0.845, 0.204, 0.222},
00978
00980
00981
             {0.997, 1.7, 2.36, 2.88, 3.01, 2.25, 1.77, 0.608, 0.163, 0.181},
00982
             {0.991, 1.79, 2.57, 3.06, 3.08, 2.15, 1.81, 0.59, 0.168, 0.104},
             {0.974, 1.86, 2.84, 3.8, 3.93, 3.79, 2.91, 1.02, 0.152, 0.0985}, {0.85, 1.86, 3.3, 5.24, 6.55, 6.86, 5.12, 1.93, 0.378, 0.185},
00983
00984
             {0.783, 1.89, 3.85, 6.6, 8.56, 8.66, 6.95, 3.95, 1.47, 0.745},
00985
             {0.883, 2.05, 4.34, 7.54, 9.68, 9.77, 8.19, 5.72, 3.15, 1.77},
00987
             {1.4, 2.44, 4.72, 8.07, 10.5, 10.9, 9.28, 6.95, 4.47, 2.49},
00988
             {1.7, 2.43, 4.24, 7.43, 10.4, 11.2, 9.72, 8.15, 5.7, 2.97},
             {2.06, 2.27, 3.68, 6.77, 10.3, 10.3, 9.05, 9.1, 6.73, 3.14}, {2.33, 2.39, 3.51, 6.45, 10.3, 9.88, 8.57, 9.42, 7.22, 3.19}},
00989
00990
00991
            {{0.947, 2.21, 3.81, 5.69, 7.55, 8.63, 7.53, 5.98, 3.03,
             {0.642, 2, 3.4, 5.49, 7.5, 8.52, 7.53, 5.83, 2.74, 1.42}, {0.756, 1.83, 3.18, 5.11, 7.24, 8.63, 7.66, 5.5, 2.45, 1.33}, {0.837, 1.75, 3.06, 5, 6.79, 8.08, 7.05, 4.42, 1.81, 1.05},
00992
00993
00994
             {0.86, 1.73, 2.96, 4.68, 6.38, 7.38, 6.09, 2.92, 1.06, 0.661}, {0.926, 1.78, 2.89, 4.37, 5.74, 6.14, 4.59, 1.78, 0.561, 0.332}, {0.988, 1.78, 2.75, 3.95, 4.64, 4.49, 2.85, 1.13, 0.271, 0.184}, {0.999, 1.7, 2.44, 3.27, 3.57, 3.03, 2.06, 0.736, 0.181, 0.189},
00995
00996
00997
             {0.971, 1.67, 2.23, 2.63, 2.83, 2.15, 1.74, 0.554, 0.157, 0.167), {0.985, 1.72, 2.34, 2.69, 2.81, 2.11, 1.78, 0.592, 0.152, 0.101},
00999
01000
01001
             {0.95, 1.72, 2.57, 3.44, 3.84, 3.89, 2.91, 0.976, 0.135, 0.114},
             {0.819, 1.64, 2.93, 4.75, 6.02, 6.93, 5.2, 1.83, 0.347, 0.191}, {0.731, 1.58, 3.3, 5.95, 7.81, 8.32, 6.93, 3.83, 1.47, 0.875},
01002
01003
```

```
{0.77, 1.75, 3.74, 6.67, 8.76, 9.41, 8.19, 5.78, 3.32, 2.11},
               {1.08, 2.17, 4.24, 7.13, 9.2, 10.3, 9.03, 6.87, 4.65, 3.01}, {1.43, 2.49, 4.31, 7, 9.14, 10.6, 9.34, 7.6, 5.86, 3.64},
01005
01006
                {1.5, 2.68, 4.32, 6.75, 8.78, 10.6, 9.05, 7.65, 6.27, 4.07},
01007
01008
                \{1.73, 2.91, 4.33, 6.67, 8.73, 10.6, 8.5, 7.54, 6.63, 4.17\}\},
              {{1.43, 3.07, 5.22, 7.54, 9.78, 10.4, 10.1, 7.26, 3.61, 1.69},
01009
               \{0.989, 2.69, 4.76, 7.19, 9.44, 9.94, 9.5, 6.74, 3.24, 1.52\},
                {0.908, 2.23, 4.11, 6.48, 8.74, 9.41, 8.58, 5.8, 2.66, 1.3},
01011
               {0.923, 1.99, 3.61, 5.83, 7.84, 8.6, 7.55, 4.57, 1.87, 0.98}, {0.933, 1.9, 3.31, 5.28, 7.1, 7.84, 6.44, 3.18, 1.1, 0.642}, {0.982, 1.88, 3.1, 4.76, 6.16, 6.57, 5.16, 2.04, 0.598, 0.33},
01012
01013
01014
01015
               {1.02, 1.82, 2.88, 4.12, 4.71, 4.54, 3.03, 1.22, 0.268, 0.174},
               {0.992, 1.7, 2.51, 3.33, 3.62, 2.87, 2.05, 0.705, 0.161, 0.169},
                {0.969, 1.69, 2.2, 2.62, 2.84, 2.13, 1.78, 0.529, 0.146, 0.186},
01017
01018
                \{0.945, 1.69, 2.27, 2.64, 2.83, 2.2, 1.83, 0.561, 0.139, 0.121\},
               {0.922, 1.65, 2.48, 3.33, 3.83, 4.09, 2.92, 0.973, 0.117, 0.135}, {0.886, 1.59, 2.66, 4.26, 5.51, 6.57, 5.09, 1.79, 0.342, 0.194}, {0.786, 1.5, 2.78, 5.01, 6.8, 7.83, 6.65, 3.62, 1.45, 1}, {0.745, 1.55, 3.05, 5.49, 7.44, 8.6, 7.8, 5.28, 2.95, 2.12}, {0.938, 1.76, 3.4, 5.82, 7.8, 9.04, 8.43, 6.15, 3.85, 2.82},
01019
01020
01021
01023
               {0.999, 2, 3.66, 5.95, 7.94, 9.27, 8.8, 6.93, 4.87, 3.54}, {1.13, 2.23, 3.86, 5.82, 7.65, 9, 8.82, 7.17, 5.72, 4.08},
01024
01025
              {1.23, 2.33, 3.94, 5.74, 7.48, 8.9, 8.84, 7.35, 6.3, 4.42}}, {{1.55, 3.2, 6.25, 10, 12.9, 12.9, 11.9, 7.96, 3.96, 1.75}, {1.32, 3.27, 6.32, 9.99, 12.7, 12.4, 11.3, 7.51, 3.66, 1.58},
01026
01027
01028
               {1.25, 3.08, 5.77, 8.71, 11.2, 11.2, 9.84, 6.52, 3.23, 1.5},
                {1.18, 2.59, 4.76, 7.46, 9.61, 9.66, 8.42, 5.06, 2.25, 1.09}
01030
01031
                {1.09, 2.24, 3.99, 6.4, 8.33, 8.54, 7.08, 3.69, 1.36, 0.727},
               {1.06, 2.07, 3.52, 5.52, 7.06, 7.26, 5.83, 2.46, 0.732, 0.409}, {1.07, 1.91, 3.09, 4.63, 5.21, 4.9, 3.68, 1.43, 0.326, 0.198}, {1.03, 1.74, 2.63, 3.54, 3.78, 2.89, 2.09, 0.743, 0.175, 0.12},
01032
01033
01034
               \{0.959, 1.71, 2.32, 2.77, 2.99, 2.24, 1.76, 0.519, 0.149, 0.172\},
                {0.931, 1.68, 2.32, 2.74, 2.99, 2.46, 1.88, 0.578, 0.156, 0.157},
01036
01037
                {0.933, 1.66, 2.49, 3.42, 3.99, 4.12, 2.93, 1.02, 0.181, 0.138},
               {0.952, 1.64, 2.6, 4, 5.15, 6.07, 4.84, 1.78, 0.407, 0.286}, {0.84, 1.54, 2.68, 4.47, 5.97, 7.13, 6.23, 3.25, 1.38, 1.02},
01038
01039
01040
               {0.714, 1.44, 2.73, 4.68, 6.28, 7.68, 7.21, 4.82, 2.55, 1.96},
               {0.838, 1.57, 2.96, 4.93, 6.55, 8.08, 7.74, 5.77, 3.32, 2.52},
01042
                {0.823, 1.65, 3.11, 5.09, 6.89, 8.36, 8.31, 6.59, 4.1, 3.04},
                {0.886, 1.83, 3.42, 5.33, 6.92, 8.36, 8.63, 7.21, 4.82, 3.46},
01043
01044
                {1.07, 2.12, 3.74, 5.54, 6.98, 8.41, 8.75, 7.41, 5.16, 3.62}},
              \{\{1.13,\ 2.59,\ 7.49,\ 13.5,\ 15.4,\ 12.9,\ 11.3,\ 8.62,\ 4.18,\ 1.63\},
01045
               {0.973, 2.79, 7.23, 12.8, 15.2, 13.3, 11.6, 8.42, 4.06, 1.57}, {1.46, 3.44, 6.78, 10.4, 12.7, 12.1, 10.5, 7.04, 3.59, 1.63},
01046
               {1.52, 3.38, 6.04, 9.08, 11, 10.3, 8.9, 5.7, 2.77, 1.37},
01048
01049
                {1.32, 2.65, 4.75, 7.49, 9.32, 8.89, 7.42, 4.27, 1.7, 0.88}
01050
               {1.19, 2.2, 3.88, 6.36, 8.03, 7.81, 6.19, 2.94, 0.948, 0.527},
01051
                {1.14, 1.96, 3.28, 5.26, 6.12, 5.8, 4.47, 1.66, 0.388, 0.229},
               {1.07, 1.82, 2.82, 3.92, 4.03, 3.15, 2.31, 0.871, 0.183, 0.0972},
01052
               {0.978, 1.77, 2.53, 3.04, 3.1, 2.36, 1.76, 0.575, 0.16, 0.126},
{0.962, 1.72, 2.49, 3.01, 3.22, 2.72, 2, 0.716, 0.162, 0.183},
01053
                {0.968, 1.7, 2.6, 3.57, 4.28, 4.35, 3.09, 1.2, 0.262, 0.18},
01055
01056
                {0.977, 1.68, 2.71, 4.03, 5.17, 6.01, 4.81, 1.81, 0.473, 0.343},
               {0.819, 1.58, 2.75, 4.37, 5.8, 6.9, 5.96, 2.95, 1.19, 0.964}, {0.672, 1.44, 2.69, 4.42, 5.92, 7.26, 6.79, 4.32, 2.22, 1.83}, {0.783, 1.42, 2.65, 4.45, 6.04, 7.57, 7.39, 5.4, 2.94, 2.25}, {0.757, 1.43, 2.7, 4.54, 6.14, 7.65, 7.51, 5.95, 3.42, 2.39},
01057
01058
01059
              {0.758, 1.57, 3.04, 4.88, 6.24, 7.85, 7.58, 6.35, 3.81, 2.52}, {0.835, 1.72, 3.35, 5.24, 6.5, 8.1, 7.67, 6.51, 4, 2.6}}, {1.5, 2.12, 7.64, 10.5, 5.59, 2.14, 2.2, 3.5, 4.71, 3.26}, {1.32, 2.14, 7.23, 12, 9.3, 5.3, 5.11, 5.37, 5.12, 3.05},
01061
01062
01063
01064
               {1.53, 2.92, 6.9, 11.9, 13.5, 11.3, 9.91, 7.18, 4.75, 2.65},
01065
               {1.66, 3.48, 6.25, 9.53, 11.3, 10.3, 9.01, 5.76, 2.99, 1.67},
               {1.54, 3.03, 5.21, 8.03, 9.66, 8.98, 7.5, 4.64, 2.11, 1.13},
01067
01068
                {1.32, 2.39, 4.03, 6.74, 8.52, 8.05, 6.4, 3.48, 1.2, 0.639}
01069
               {1.17, 2.08, 3.35, 5.52, 6.86, 6.54, 5.08, 1.97, 0.462, 0.217},
01070
               {1.07, 1.92, 3.01, 4.24, 4.47, 3.77, 2.77, 1.07, 0.213, 0.0694}, {0.992, 1.88, 2.76, 3.39, 3.32, 2.52, 1.8, 0.713, 0.192, 0.136},
01071
               \{0.992, 1.8, 2.63, 3.34, 3.46, 2.95, 2.09, 0.9, 0.242, 0.194\},
01072
                {0.987, 1.77, 2.67, 3.64, 4.37, 4.36, 3, 1.27, 0.354,
                {0.979, 1.74, 2.77, 3.99, 5.12, 5.75, 4.53, 1.75, 0.555, 0.302},
01074
01075
                {0.832, 1.6, 2.78, 4.32, 5.53, 6.67, 5.69, 2.59, 0.982, 0.66},
               {0.696, 1.41, 2.64, 4.31, 5.65, 7.14, 6.56, 3.8, 1.75, 1.41}, {0.788, 1.36, 2.59, 4.3, 5.73, 7.35, 7.04, 4.82, 2.41, 1.8},
01076
01077
01078
               \{0.761, 1.43, 2.61, 4.28, 5.64, 7.37, 7.11, 5.37, 2.68, 1.9\},
                {0.701, 1.44, 2.82, 4.64, 5.76, 7.63, 7.07, 5.74, 2.98, 1.88},
01079
                {0.763, 1.5, 2.95, 4.97, 6.08, 7.88, 7.12, 5.98, 3.21, 1.91}},
01080
              {{3.58, 2.59, 6.49, 5.84, 1.63, 0.282, 0.647, 0.371, 1.36, 2.33}, {3.09, 2.38, 6.37, 7.66, 4.06, 1.23, 1.8, 1.65, 2.32, 2.78},
01081
01082
               {2.31, 2.84, 5.58, 9.63, 11, 9.02, 8.2, 6.23, 4.17, 3.08},
01083
               {1.61, 3.16, 5.72, 9.13, 11.4, 10.4, 9.15, 6.18, 3.52, 2.3}, {1.32, 2.8, 4.79, 7.44, 9.43, 8.83, 7.41, 4.9, 2.38, 1.38},
01084
               {1.14, 2.36, 3.94, 6.41, 8.38, 8.17, 6.53, 3.76, 1.31, 0.656}, {1.05, 2.1, 3.36, 5.45, 7.07, 6.98, 5.44, 2.22, 0.52, 0.176},
01086
01087
01088
               {1.02, 2, 3.05, 4.33, 4.74, 4.21, 3.2, 1.26, 0.277, 0.0705},
               {1.01, 1.96, 2.9, 3.53, 3.46, 2.69, 1.89, 0.859, 0.254, 0.12}, {1.01, 1.86, 2.7, 3.46, 3.59, 3.03, 2.14, 1, 0.34, 0.199},
01089
01090
```

```
{1.02, 1.81, 2.67, 3.68, 4.39, 4.3, 2.93, 1.35, 0.477, 0.25},
                (0.991, 1.79, 2.82, 4.05, 5.08, 5.5, 4.21, 1.74, 0.605, 0.259), (0.844, 1.73, 2.87, 4.38, 5.49, 6.47, 5.5, 2.44, 0.85, 0.422),
01092
01093
01094
                 {0.729, 1.57, 2.76, 4.43, 5.73, 7.13, 6.43, 3.52, 1.38, 0.913},
                {0.819, 1.46, 2.69, 4.45, 5.92, 7.47, 7.05, 4.52, 2, 1.4}, {0.783, 1.47, 2.71, 4.48, 5.92, 7.46, 7.16, 5.08, 2.35, 1.56},
01095
01096
                 \{0.735, 1.51, 2.96, 4.84, 5.92, 7.77, 7.2, 5.54, 2.56, 1.61\},
                 {0.8, 1.61, 3.14, 5.2, 6.26, 8.08, 7.27, 5.72, 2.75, 1.62}},
01098
               {{5, 4.43, 5.53, 5.35, 2.33, 0.384, 0.663, 0.164, 0.692, 1.4}, {3.62, 3.79, 4.77, 5.94, 4.12, 1.36, 1.3, 0.973, 1.37, 1.73}, {2.11, 2.7, 4.12, 7.14, 9.03, 7.74, 7.12, 5.44, 3.73, 2.6},
01099
01100
01101
                {1.13, 2.32, 4.12, 6.97, 9.86, 9.69, 8.85, 6.22, 3.59, 2.14}, {0.957, 2.28, 4.11, 6.47, 8.66, 8.78, 7.33, 4.94, 2.44, 1.38}, {0.881, 2.1, 3.65, 5.94, 7.98, 8.29, 6.69, 3.95, 1.36, 0.672},
01102
01103
01104
01105
                 {0.867, 1.96, 3.26, 5.23, 6.94, 7.2, 5.63, 2.41, 0.578, 0.19}
                {0.953, 1.94, 2.98, 4.23, 4.83, 4.52, 3.38, 1.34, 0.293, 0.181}, {1.01, 1.91, 2.77, 3.35, 3.3, 2.62, 1.99, 0.905, 0.245, 0.107},
01106
01107
                {1.03, 1.81, 2.57, 3.29, 3.43, 2.87, 2.13, 0.988, 0.306, 0.185},
01108
                {1.02, 1.78, 2.58, 3.59, 4.19, 4, 2.72, 1.29, 0.389, 0.224},
01110
                {1.01, 1.84, 2.84, 4.06, 4.9, 5.08, 3.71, 1.64, 0.529, 0.232},
                 {0.902, 1.84, 2.98, 4.43, 5.5, 6.28, 5.18, 2.35, 0.734, 0.341},
01111
01112
                 {0.785, 1.68, 2.93, 4.67, 5.95, 7.3, 6.52, 3.48, 1.24, 0.754},
01113
                \{0.847, 1.62, 2.94, 4.86, 6.38, 7.99, 7.5, 4.64, 1.93, 1.23\},
                {0.8, 1.6, 2.94, 4.95, 6.62, 8.16, 7.91, 5.43, 2.43, 1.45}, {0.82, 1.76, 3.37, 5.47, 6.82, 8.24, 7.73, 5.79, 2.69, 1.5},
01114
01115
                 {0.988, 2.05, 3.87, 6.01, 7.18, 8.41, 7.7, 5.93, 2.89, 1.55}},
01116
               {{1.52, 2.7, 3.79, 4.95, 3.8, 1.51, 1.11, 0.784, 1.1, 1.56},
01117
01118
                 {1.19, 2.16, 3.34, 4.76, 4.61, 2.93, 2.07, 1.65, 1.63, 1.74}
01119
                {0.804, 1.65, 2.79, 4.63, 6.64, 6.95, 6.68, 5.11, 3.3, 2.09},
                {0.86, 1.8, 3.25, 5.3, 7.91, 8.76, 8.28, 6.01, 3.39, 1.83}, {0.859, 1.95, 3.54, 5.64, 7.88, 8.55, 7.3, 4.88, 2.3, 1.22}, {0.809, 1.88, 3.38, 5.45, 7.47, 8.02, 6.69, 3.98, 1.35, 0.646},
01120
01121
01122
                {0.822, 1.81, 3.11, 4.9, 6.62, 6.96, 5.63, 2.47, 0.614, 0.169), {0.92, 1.83, 2.8, 3.93, 4.56, 4.4, 3.25, 1.31, 0.295, 0.0587},
01123
01124
01125
                 {0.986, 1.83, 2.6, 3.13, 3.08, 2.53, 1.94, 0.886, 0.244, 0.0815},
                 {0.997, 1.74, 2.5, 3.16, 3.24, 2.67, 2.05, 0.939, 0.281, 0.147},
01126
                {1.01, 1.75, 2.57, 3.55, 4.1, 3.81, 2.53, 1.21, 0.354, 0.197},
{1.04, 1.88, 2.9, 4.16, 4.95, 4.96, 3.48, 1.63, 0.502, 0.163},
01127
01129
                 \{0.967, 1.95, 3.17, 4.72, 5.85, 6.5, 5.34, 2.53, 0.748, 0.303\},
                {0.846, 1.83, 3.23, 5.15, 6.62, 7.82, 6.85, 3.79, 1.36, 0.714}, {0.91, 1.81, 3.35, 5.55, 7.32, 8.55, 7.88, 5.03, 2.13, 1.1}, {0.87, 1.94, 3.6, 5.97, 7.98, 9.14, 8.71, 6.04, 2.73, 1.41},
01130
01131
01132
                {1.04, 2.36, 4.22, 6.57, 8.5, 9.53, 9.22, 6.71, 3.2, 1.56}, {1.36, 2.84, 4.72, 6.94, 8.81, 9.87, 9.59, 7.1, 3.43, 1.65}},
01133
01134
               {{0.704, 1.4, 2.03, 3.08, 4.64, 4.24, 2.55, 1.57, 1.99, 1.91},
01135
01136
                 {0.484, 1.38, 2.08, 3.54, 5.11, 4.98, 3.73, 2.57, 2.29, 1.84},
01137
                 {0.749, 1.57, 2.63, 4.17, 6.15, 6.97, 6.64, 5.11, 3.35, 1.97},
                {0.864, 1.69, 3.16, 4.87, 7.13, 8.33, 7.87, 5.9, 3.17, 1.56}, {0.861, 1.79, 3.28, 5.2, 7.29, 8.32, 7.38, 4.9, 2.23, 1.11},
01138
01139
                {0.835, 1.79, 3.19, 4.99, 6.72, 7.58, 6.45, 3.68, 1.25, 0.616}, {0.847, 1.8, 3.07, 4.66, 6.12, 6.6, 5.21, 2.18, 0.554, 0.21},
01140
01141
                 {0.941, 1.78, 2.68, 3.68, 4.28, 4.18, 2.97, 1.15, 0.238, 0.0968},
01142
01143
                 {0.98, 1.78, 2.48, 2.99, 2.96, 2.35, 1.88, 0.747, 0.207, 0.105},
                {0.978, 1.74, 2.51, 3.07, 3.12, 2.36, 1.95, 0.777, 0.216, 0.146}, {1.01, 1.79, 2.63, 3.53, 3.95, 3.47, 2.38, 1.08, 0.265, 0.178},
01144
01145
                 {1.06, 1.94, 3.02, 4.43, 5.19, 5.01, 3.68, 1.71, 0.429, 0.14},
01146
                {0.99, 2.02, 3.38, 5.22, 6.56, 6.91, 5.56, 2.75, 0.816, 0.353},
                \{0.923, 2.05, 3.66, 5.98, 7.78, 8.5, 7.23, 4.26, 1.67, 0.802\},
01148
                {1.08, 2.27, 4.17, 6.8, 8.89, 9.55, 8.59, 5.64, 2.58, 1.2}, {1.12, 2.5, 4.52, 7.22, 9.76, 10.3, 9.72, 6.79, 3.32, 1.52}, {1.2, 2.64, 4.81, 7.64, 10.5, 11.4, 10.6, 7.65, 3.87, 1.73}, {1.4, 2.91, 5.01, 7.75, 10.7, 11.6, 11.1, 8.02, 4.04, 1.8}},
01149
01150
01151
01152
               {{0.75, 1.49, 2.39, 3.39, 4.93, 5.94, 5.03, 2.75, 2.27, 1.78},
                {0.508, 1.52, 2.38, 3.82, 5.34, 6.13, 5.6, 3.31, 2.42, 1.73}, {0.715, 1.56, 2.7, 4.39, 6.18, 6.96, 7.1, 5.04, 3.01, 1.75},
01155
01156
                 {0.813, 1.62, 2.94, 4.65, 6.53, 7.65, 7.52, 5.49, 2.75, 1.41},
01157
                 \{0.802, 1.68, 2.97, 4.64, 6.37, 7.53, 7.01, 4.56, 1.9, 0.955\},
                {0.816, 1.75, 3.01, 4.59, 6.15, 7.06, 6.15, 3.38, 1.11, 0.61},
01158
                {0.867, 1.78, 2.92, 4.35, 5.69, 6.05, 4.73, 1.91, 0.519, 0.269},
{0.932, 1.7, 2.55, 3.44, 4.03, 3.98, 2.74, 1.08, 0.247, 0.132},
01159
                 {0.937, 1.74, 2.51, 3.09, 3.11, 2.34, 1.84, 0.67, 0.189, 0.121},
01161
01162
                 {0.942, 1.75, 2.63, 3.3, 3.27, 2.21, 1.87, 0.663, 0.171, 0.147},
                {0.959, 1.8, 2.82, 3.78, 4.03, 3.37, 2.53, 1.04, 0.199, 0.146}, {1.01, 1.9, 3.13, 4.76, 5.63, 5.6, 4.31, 1.83, 0.367, 0.172}, {0.989, 2.04, 3.64, 6, 7.62, 7.6, 6, 3.35, 1.05, 0.448}, {1.02, 2.28, 4.32, 7.19, 9.21, 9.16, 7.64, 4.97, 2.2, 0.948},
01163
01164
01165
                {1.26, 2.77, 5.2, 8.31, 10.5, 10.4, 9.01, 6.37, 3.46, 1.56},
01167
01168
                 {1.31, 2.76, 5.23, 8.49, 11.2, 11.3, 10.1, 7.27, 3.98, 1.76},
               {1.26, 2.5, 5.14, 8.85, 12.3, 11.2, 11.3, 10.1, 1.2, 3.38, 1.70}, {1.35, 2.49, 5.26, 9.16, 13, 12.8, 11.8, 8.57, 4.72, 2.05}}, {0.759, 1.54, 2.54, 4.22, 6.26, 7.44, 7.14, 4.99, 2.84, 1.89}, {0.508, 1.55, 2.5, 4.29, 6.29, 7.29, 7.07, 5.03, 2.77, 1.74},
01169
01170
01171
                {0.699, 1.56, 2.62, 4.17, 6.08, 7.38, 7.04, 5.17, 2.81, 1.65}, {0.778, 1.5, 2.65, 4.35, 6.07, 7.28, 6.84, 4.8, 2.28, 1.28},
01173
01174
01175
                 {0.772, 1.55, 2.71, 4.3, 5.76, 6.91, 6.2, 3.69, 1.45, 0.837}
                {0.836, 1.67, 2.78, 4.21, 5.56, 6.41, 5.33, 2.47, 0.807, 0.488}, {0.937, 1.79, 2.78, 4.12, 5.17, 5.38, 3.89, 1.47, 0.392, 0.256},
01176
```

```
\{0.97, 1.75, 2.52, 3.39, 3.83, 3.63, 2.48, 0.968, 0.212, 0.198\},\
            {0.968, 1.74, 2.5, 3.11, 3.2, 2.34, 1.79, 0.629, 0.169, 0.173}, {0.98, 1.8, 2.69, 3.42, 3.4, 2.18, 1.81, 0.606, 0.164, 0.138}, {0.975, 1.84, 2.96, 4.08, 4.12, 3.5, 2.79, 1.02, 0.145, 0.133}, {0.96, 1.94, 3.27, 5.17, 6.26, 6.35, 4.88, 1.91, 0.329, 0.189}, {0.954, 2.06, 3.8, 6.53, 8.46, 8.32, 6.53, 3.83, 1.32, 0.6},
01179
01180
01181
01182
01183
             {1, 2.34, 4.58, 7.71, 9.68, 9.75, 7.96, 5.45, 2.84, 1.39},
01184
01185
             {1.24, 2.65, 5.14, 8.51, 10.7, 10.6, 8.96, 6.51, 3.83, 1.85},
01186
             {1.34, 2.44, 4.99, 8.63, 11.6, 11.4, 10.1, 7.84, 4.77, 2.24},
            {1.33, 2.1, 4.76, 8.78, 12.2, 11.7, 10.8, 8.68, 5.15, 2.35}, {1.42, 2.04, 4.68, 8.92, 12.7, 12, 11.2, 8.99, 5.32, 2.33}}
01187
01188
01189
01190
01191
         double aux00, aux01, aux10, aux11, sec;
01192
01193
         int ilat, ip, isec;
01194
01195
         /* Get seconds since begin of year... */
         sec = fmod(t, 365.25 * 86400.);
01196
01197
01198
         /* Get indices... */
01199
         ilat = locate(lats, 18, lat);
01200
        ip = locate(ps, 10, p);
01201
         isec = locate(secs, 12, sec);
01202
01203
         /* Interpolate... */
01204
         aux00 = LIN(ps[ip], hno3[isec][ilat][ip],
01205
                       ps[ip + 1], hno3[isec][ilat][ip + 1], p);
01206
         aux01 = LIN(ps[ip], hno3[isec][ilat + 1][ip],
                       ps[ip + 1], hno3[isec][ilat + 1][ip + 1], p);
01207
         aux10 = LIN(ps[ip], hno3[isec + 1][ilat][ip],
01208
01209
                       ps[ip + 1], hno3[isec + 1][ilat][ip + 1], p);
01210
         aux11 = LIN(ps[ip], hno3[isec + 1][ilat + 1][ip],
01211
                       ps[ip + 1], hno3[isec + 1][ilat + 1][ip + 1], p);
         aux00 = LIN(lats[ilat], aux00, lats[ilat + 1], aux01, lat);
aux11 = LIN(lats[ilat], aux10, lats[ilat + 1], aux11, lat);
01212
01213
         return LIN(secs[isec], aux00, secs[isec + 1], aux11, sec);
01214
01215 }
01216
01218
01219 void module position(
        met_t * met0,
met_t * met1,
01220
01221
         atm_t * atm,
01222
01223
         int ip) {
01224
01225
         double ps;
01226
01227
        /* Calculate modulo... */
01228
         atm->lon[ip] = fmod(atm->lon[ip], 360);
01229
         atm->lat[ip] = fmod(atm->lat[ip], 360);
01230
         /* Check latitude... */
while (atm->lat[ip] < -90 || atm->lat[ip] > 90) {
01231
01232
          if (atm->lat[ip] > 90) {
   atm->lat[ip] = 180 - atm->lat[ip];
01233
01235
             atm->lon[ip] += 180;
01236
           if (atm->lat[ip] < -90) {</pre>
01237
             atm->lat[ip] = -180 - atm->lat[ip];
atm->lon[ip] += 180;
01238
01239
01240
           }
01241
01242
01243
         /* Check longitude... */
         while (atm->ion[ip] < -180)
01244
01245
          atm->lon[ip] += 360;
        while (atm->lon[ip] >= 180)
atm->lon[ip] -= 360;
01246
01247
01248
01249
         /* Get surface pressure... */
        intpol_met_time(met0, met1, atm->time[ip], atm->p[ip],
        atm->lon[ip], atm->lat[ip], &ps, NULL,
01250
01251
                           NULL, NULL, NULL, NULL, NULL);
01252
01253
01254
         /* Check pressure... */
01255
        if (atm->p[ip] > ps)
01256
          atm->p[ip] = ps;
         else if (atm->p[ip] < met0->p[met0->np - 1])
01257
          atm - p[ip] = met0 - p[met0 - np - 1];
01258
01259 }
01260
01262
01263 void module sedi(
01264
        ctl t * ctl.
```

```
01265
        met_t * met0,
        met_t * met1,
atm_t * atm,
01266
01267
01268
        int ip,
01269
        double dt) {
01270
01271
         /\star Coefficients for Cunningham slip-flow correction (Kasten, 1968): \star/
01272
        const double A = 1.249, B = 0.42, C = 0.87;
01273
01274
        /\star Specific gas constant for dry air [J/(kg K)]: \star/
01275
        const double R = 287.058;
01276
01277
        /* Average mass of an air molecule [kg/molec]: */
01278
        const double m = 4.8096e-26;
01279
01280
        double G, K, eta, lambda, p, r_p, rho, rho_p, T, v, v_p;
01281
01282
        /* Check if parameters are available... */
        if (ctl->qnt_r < 0 || ctl->qnt_rho < 0)</pre>
01283
01284
          return;
01285
01286
        /* Convert units...
01287
        p = 100 * atm->p[ip];
        r_p = 1e-6 * atm->q[ctl->qnt_r][ip];
01288
01289
        rho_p = atm->q[ctl->qnt_rho][ip];
01290
01291
         /* Get temperature... */
01292
        intpol_met_time(met0, met1, atm->time[ip], atm->p[ip], atm->
      lon[ip],
01293
                         atm->lat[ip], NULL, &T, NULL, NULL, NULL, NULL, NULL);
01294
        /* Density of dry air... */ rho = p / (R * T);
01295
01296
01297
        /* Dynamic viscosity of air... */
eta = 1.8325e-5 * (416.16 / (T + 120.)) * pow(T / 296.16, 1.5);
01298
01299
01300
01301
        /* Thermal velocity of an air molecule... */
01302
        v = sqrt(8 * GSL_CONST_MKSA_BOLTZMANN * T / (M_PI * m));
01303
01304
        /\star Mean free path of an air molecule... \star/
01305
        lambda = 2 * eta / (rho * v);
01306
01307
         /* Knudsen number for air... */
01308
        K = lambda / r_p;
01309
01310
         /* Cunningham slip-flow correction... */
01311
        G = 1 + K * (A + B * exp(-C / K));
01312
01313
         /* Sedimentation (fall) velocity... */
01314
01315
          2. * gsl_pow_2(r_p) * (rho_p -
01316
                                   rho) * GSL_CONST_MKSA_GRAV_ACCEL / (9. * eta) * G;
01317
        /* Calculate pressure change... */ atm->p[ip] += dz2dp(v_p * dt / 1000., atm->p[ip]);
01318
01319
01320 }
01321
01323
01324 void write output (
01325
        const char *dirname,
        ctl_t * ctl,
met_t * met0,
01326
01327
01328
        met_t * met1,
        atm_t * atm,
01329
01330
        double t) {
01331
01332
        char filename[LEN]:
01333
01334
        double r;
01335
01336
        int year, mon, day, hour, min, sec;
01337
01338
        /* Get time... */
01339
        jsec2time(t, &year, &mon, &day, &hour, &min, &sec, &r);
01340
        /* Write atmospheric data... */
if (ctl->atm_basename[0] != '-' && fmod(t, ctl->atm_dt_out) == 0) {
01341
01342
          sprintf(filename, "%s/%s_%04d_%02d_%02d_%02d_%02d.tab",
01343
                  dirname, ctl->atm_basename, year, mon, day, hour, min);
01344
01345
          write_atm(filename, ctl, atm, t);
01346
01347
01348
         /* Write CSI data... */
        if (ctl->csi_basename[0] != '-') {
   sprintf(filename, "%s/%s.tab", dirname, ctl->csi_basename);
01349
01350
```

```
01351
              write_csi(filename, ctl, atm, t);
01352
01353
           /* Write ensemble data... */
if (ctl->ens_basename[0] != '-') {
   sprintf(filename, "%s/%s.tab", dirname, ctl->ens_basename);
   write_ens(filename, ctl, atm, t);
01354
01355
01356
01357
01358
01359
           /* Write gridded data... */
if (ctl->grid_basename[0] != '-' && fmod(t, ctl->grid_dt_out) == 0) {
01360
01361
            sprintf(filename, "%s/%s_%04d_%02d_%02d_%02d_%02d.tab", dirname, ctl->grid_basename, year, mon, day, hour, min); write_grid(filename, ctl, met0, met1, atm, t);
01362
01363
01364
01365
01366
           /* Write profile data... */
if (ctl->prof_basename[0] != '-') {
01367
01368
            sprintf(filename, "%s/%s.tab", dirname, ctl->prof_basename);
01369
01370
              write_prof(filename, ctl, met0, met1, atm, t);
01371
01372
           /* Write station data... */
if (ctl->stat_basename[0] != '-') {
    sprintf(filename, "%s/%s.tab", dirname, ctl->stat_basename);
01373
01374
01375
01376
              write_station(filename, ctl, atm, t);
01377
01378 }
```

5.33 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[])

5.33.1 Detailed Description

Create meteorological data files with synthetic wind fields.

Definition in file wind.c.

5.33.2 Function Documentation

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

Definition at line 173 of file wind.c.

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

Definition at line 41 of file wind.c.

```
00043
00044
00045
               ctl t ctl:
00046
               static char filename[LEN];
00047
00048
00049
               static double r, t0, z0, z1, dataLon[EX], dataLat[EY], dataZ[EP],
00050
                   u0, u1, alpha;
00051
               static float dataT[EP * EY * EX], dataU[EP * EY * EX], dataV[EP * EY * EX],
00052
                   dataW[EP * EY * EX];
00054
00055
               static int ncid, dims[4], timid, levid, latid, lonid, tid, uid, vid, wid,
00056
                   idx, ix, iy, iz, nx, ny, nz, year, mon, day, hour, min, sec;
00057
00058
               /* Check arguments... */
00059
               if (argc < 3)
00060
                   ERRMSG("Give parameters: <ctl> <metbase>");
00061
00062
               /* Read control parameters... */
               read_ctl(argv[1], argc, argv, &ctl);
t0 = scan_ctl(argv[1], argc, argv, "WIND_TO", -1, "0", NULL);
00063
00064
              t0 = scan_ctl(argv[1], argc, argv, "WIND_TO", -1, "0", NULL);

nx = (int) scan_ctl(argv[1], argc, argv, "WIND_NX", -1, "360", NULL);

ny = (int) scan_ctl(argv[1], argc, argv, "WIND_NY", -1, "181", NULL);

nz = (int) scan_ctl(argv[1], argc, argv, "WIND_NZ", -1, "61", NULL);

z0 = scan_ctl(argv[1], argc, argv, "WIND_ZO", -1, "0", NULL);

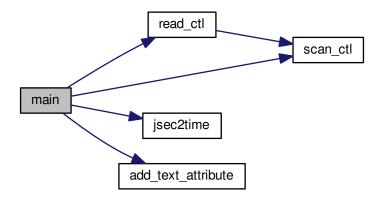
z1 = scan_ctl(argv[1], argc, argv, "WIND_Z1", -1, "60", NULL);

u0 = scan_ctl(argv[1], argc, argv, "WIND_UO", -1, "38.587660177302", NULL);

u1 = scan_ctl(argv[1], argc, argv, "WIND_UO", -1, "38.587660177302", NULL);
00065
00066
00067
00068
00069
00070
00071
               alpha = scan_ctl(argv[1], argc, argv, "WIND_ALPHA", -1, "0.0", NULL);
00073
00074
               /* Check dimensions... */
00075
               if (nx < 1 || nx > EX)
00076
                  ERRMSG("Set 1 \leq NX \leq MAX!"):
               if (ny < 1 || ny > EY)
ERRMSG("Set 1 <= NY <= MAX!");
00077
00078
               if (nz < 1 || nz > EP)
00079
00080
                   ERRMSG("Set 1 <= NZ <= MAX!");</pre>
00081
00082
               /* Get time... */
               jsec2time(t0, &year, &mon, &day, &hour, &min, &sec, &r);
t0 = year * 10000. + mon * 100. + day + hour / 24.;
00083
00084
00085
               /* Set filename... */
sprintf(filename, "%s_%d_%02d_%02d_%02d.nc", argv[2], year, mon, day, hour);
00086
00087
00088
00089
                /* Create netCDF file... */
00090
               NC(nc_create(filename, NC_CLOBBER, &ncid));
00091
               /* Create dimensions... */
NC(nc_def_dim(ncid, "time", 1, &dims[0]));
NC(nc_def_dim(ncid, "lev", (size_t) nz, &dims[1]));
NC(nc_def_dim(ncid, "lat", (size_t) ny, &dims[2]));
NC(nc_def_dim(ncid, "lon", (size_t) nx, &dims[3]));
00092
00093
00094
00095
00096
00097
00098
                /* Create variables...
               /* Create variables... */
NC(nc_def_var(ncid, "time", NC_DOUBLE, 1, &dims[0], &timid));
NC(nc_def_var(ncid, "lev", NC_DOUBLE, 1, &dims[1], &levid));
NC(nc_def_var(ncid, "lat", NC_DOUBLE, 1, &dims[2], &latid));
NC(nc_def_var(ncid, "lon", NC_DOUBLE, 1, &dims[3], &lonid));
00099
00100
00101
00102
               NC(nc_def_var(ncid, "T", NC_FLOAT, 4, &dims[0], &id));
NC(nc_def_var(ncid, "U", NC_FLOAT, 4, &dims[0], &uid));
NC(nc_def_var(ncid, "V", NC_FLOAT, 4, &dims[0], &vid));
00103
00104
00105
               NC(nc_def_var(ncid, "W", NC_FLOAT, 4, &dims[0], &wid));
00106
00107
              /* Set attributes... */
add_text_attribute(ncid, "time", "long_name", "time");
add_text_attribute(ncid, "time", "units", "day as %Y$m%d.%f");
add_text_attribute(ncid, "lon", "long_name", "longitude");
add_text_attribute(ncid, "lon", "units", "degrees_east");
add_text_attribute(ncid, "lat", "long_name", "latitude");
add_text_attribute(ncid, "lat", "units", "degrees_north");
add_text_attribute(ncid, "lev", "long_name", "air_pressure");
add_text_attribute(ncid, "lev", "units", "Pa");
add_text_attribute(ncid, "T", "long_name", "Temperature");
add_text_attribute(ncid, "T", "units", "K");
add_text_attribute(ncid, "U", "long_name", "U velocity");
add_text_attribute(ncid, "V", "units", "m s**-1");
add_text_attribute(ncid, "V", "units", "m s**-1");
add_text_attribute(ncid, "V", "units", "m s**-1");
00108
                /* Set attributes... */
00109
00110
00111
00112
00113
00114
00115
00116
00117
00118
00119
00120
00121
               add_text_attribute(ncid, "V", "units", "m s**-1");
```

```
add_text_attribute(ncid, "W", "long_name", "Vertical velocity");
add_text_attribute(ncid, "W", "units", "Pa s**-1");
00124
00125
00126
          /* End definition... */
00127
         NC(nc_enddef(ncid));
00128
00129
          /* Set coordinates... */
00130
         for (ix = 0; ix < nx; ix++)
00131
           dataLon[ix] = 360.0 / nx * (double) ix;
         dataLat[ix] = 300.0 / nx * (double) ix,
for (iy = 0; iy < ny; iy++)
  dataLat[iy] = 180.0 / (ny - 1) * (double) iy - 90;
for (iz = 0; iz < nz; iz++)
  dataZ[iz] = 100. * P(LIN(0.0, z0, nz - 1.0, z1, iz));</pre>
00132
00133
00134
00135
00136
00137
          /* Write coordinates...
00138
         NC(nc_put_var_double(ncid, timid, &t0));
00139
         NC(nc_put_var_double(ncid, levid, dataZ));
         NC(nc_put_var_double(ncid, lonid, dataLon));
NC(nc_put_var_double(ncid, latid, dataLat));
00140
00141
00142
00143
          /* Create wind fields (Williamson et al., 1992)... \star/
00144
          for (ix = 0; ix < nx; ix++)
           for (iy = 0; iy < ny; iy++)</pre>
00145
              for (iz = 0; iz < nz; iz++) {
  idx = (iz * ny + iy) * nx + ix;</pre>
00146
00147
00148
                 dataU[idx] = (float) (LIN(0.0, u0, nz - 1.0, u1, iz)
00149
                                             * (cos(dataLat[iy] * M_PI / 180.0)
00150
                                                * cos(alpha * M_PI / 180.0)
                                                + sin(dataLat[iy] * M_PI / 180.0)
* cos(dataLon[ix] * M_PI / 180.0)
00151
00152
                00153
00154
00155
00156
                                            * sin(alpha * M_PI / 180.0));
00157
00158
00159
          /* Write wind data... */
         NC(nc_put_var_float(ncid, tid, dataT));
00160
00161
         NC(nc_put_var_float(ncid, uid, dataU));
00162
         NC(nc_put_var_float(ncid, vid, dataV));
00163
         NC(nc_put_var_float(ncid, wid, dataW));
00164
00165
          /* Close file...
00166
         NC(nc_close(ncid));
00168
         return EXIT_SUCCESS;
00169 }
```

Here is the call graph for this function:



5.34 wind.c

00001 /*

5.34 wind.c 201

```
This file is part of MPTRAC.
00003
00004
         MPTRAC is free software: you can redistribute it and/or modify
         it under the terms of the GNU General Public License as published by
00005
         the Free Software Foundation, either version 3 of the License, or
00006
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
         You should have received a copy of the GNU General Public License along with MPTRAC. If not, see <a href="http://www.gnu.org/licenses/">http://www.gnu.org/licenses/</a>>.
00014
00015
00016
00017
         Copright (C) 2013-2015 Forschungszentrum Juelich GmbH
00018 */
00019
00025 #include "libtrac.h"
00027 /*
00028
          Functions...
00029
00030
00031 void add_text_attribute(
        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[EP * EY * EX], dataU[EP * EY * EX], dataV[EP * EY * EX],
00053
           dataW[EP * EY * EX];
00054
00055
         static int ncid, dims[4], timid, levid, latid, lonid, tid, uid, wid, wid,
00056
           idx, ix, iy, iz, nx, ny, nz, year, mon, day, hour, min, sec;
00057
00058
         /* Check arguments... */
00059
         if (argc < 3)</pre>
00060
           ERRMSG("Give parameters: <ctl> <metbase>");
00061
00062
         /* Read control parameters... */
         read_ctl(argv[1], argc, argv, &ctl);
00063
         read_ctl(argv[1], argc, argv, &ctl);
t0 = scan_ctl(argv[1], argc, argv, "WIND_T0", -1, "0", NULL);
nx = (int) scan_ctl(argv[1], argc, argv, "WIND_NX", -1, "360", NULL);
ny = (int) scan_ctl(argv[1], argc, argv, "WIND_NY", -1, "181", NULL);
nz = (int) scan_ctl(argv[1], argc, argv, "WIND_NZ", -1, "61", NULL);
z0 = scan_ctl(argv[1], argc, argv, "WIND_Z0", -1, "0", NULL);
z1 = scan_ctl(argv[1], argc, argv, "WIND_Z1", -1, "60", NULL);
00064
00065
00066
00067
00068
00069
         u0 = scan_ctl(argy[1], argc, argv, "WIND_U0", -1, "38.587660177302", NULL);
u1 = scan_ctl(argv[1], argc, argv, "WIND_U1", -1, "38.587660177302", NULL);
00070
00071
         alpha = scan_ctl(argv[1], argc, argv, "WIND_ALPHA", -1, "0.0", NULL);
00072
00073
00074
         /* Check dimensions... */
00075
         if (nx < 1 || nx > EX)
           ERRMSG("Set 1 <= NX <= MAX!");</pre>
           f (ny < 1 || ny > EY)
ERRMSG("Set 1 <= NY <= MAX!");
00077
00078
         if (nz < 1 || nz > EP)
   ERRMSG("Set 1 <= NZ <= MAX!");</pre>
00079
08000
00081
         /* Get time... */
00082
00083
          jsec2time(t0, &year, &mon, &day, &hour, &min, &sec, &r);
00084
         t0 = year * 10000. + mon * 100. + day + hour / 24.;
00085
         00086
00087
00088
          /* Create netCDF file...
00089
00090
         NC(nc_create(filename, NC_CLOBBER, &ncid));
00091
         /* Create dimensions... */
NC(nc_def_dim(ncid, "time", 1, &dims[0]));
00092
00093
```

```
NC(nc_def_dim(ncid, "lev", (size_t) nz, &dims[1]));
NC(nc_def_dim(ncid, "lat", (size_t) ny, &dims[2]));
NC(nc_def_dim(ncid, "lon", (size_t) nx, &dims[3]));
00095
00096
00097
           /* Create variables... */
NC(nc_def_var(ncid, "time", NC_DOUBLE, 1, &dims[0], &timid));
NC(nc_def_var(ncid, "lev", NC_DOUBLE, 1, &dims[1], &levid));
NC(nc_def_var(ncid, "lat", NC_DOUBLE, 1, &dims[2], &latid));
00098
00099
00101
           NC(nc_def_var(ncid, "lon", NC_DOUBLE, 1, &dims[3], &lonid));
00102
           NC(nc_def_var(ncid, "T", NC_FLOAT, 4, &dims[0], &tid));
NC(nc_def_var(ncid, "U", NC_FLOAT, 4, &dims[0], &uid));
NC(nc_def_var(ncid, "V", NC_FLOAT, 4, &dims[0], &vid));
00103
00104
00105
           NC(nc_def_var(ncid, "W", NC_FLOAT, 4, &dims[0], &wid));
00106
00107
00108
            /* Set attributes... */
           /* Set attributes... */
add_text_attribute(ncid, "time", "long_name", "time");
add_text_attribute(ncid, "time", "units", "day as %Y%m%d.%f");
add_text_attribute(ncid, "lon", "long_name", "longitude");
add_text_attribute(ncid, "lon", "units", "degrees_east");
add_text_attribute(ncid, "lat", "long_name", "latitude");
add_text_attribute(ncid, "lat", "units", "degrees_north");
add_text_attribute(ncid, "lev", "long_name", "air_pressure");
add_text_attribute(ncid, "lev", "units", "Pa");
add_text_attribute(ncid, "T", "units", "Fa");
add_text_attribute(ncid, "T", "units", "K");
add_text_attribute(ncid, "T", "units", "K");
add_text_attribute(ncid, "T", "units", "R");
add_text_attribute(ncid, "T", "units", "R");
add_text_attribute(ncid, "T", "units", "R");
add_text_attribute(ncid, "T", "units", "R");
00109
00110
00111
00112
00113
00114
00115
00116
00117
00118
           add_text_attribute(ncid, "U", "long_name", "U velocity");
add_text_attribute(ncid, "U", "units", "m s**-1");
00119
00120
            add_text_attribute(ncid, "V", "long_name", "V velocity");
00121
           add_text_attribute(ncid, "V", "units", "m s**-1");
add_text_attribute(ncid, "W", "long_name", "Vertical velocity");
add_text_attribute(ncid, "W", "units", "Pa s**-1");
00122
00123
00124
00125
00126
            /* End definition... */
00127
           NC(nc_enddef(ncid));
00128
00129
            /* Set coordinates... */
00130
           for (ix = 0; ix < nx; ix++)
              dataLon[ix] = 360.0 / nx * (double) ix;
00132
            for (iy = 0; iy < ny; iy++)
00133
              dataLat[iy] = 180.0 / (ny - 1) * (double) iy - 90;
00134
            for (iz = 0; iz < nz; iz++)
              dataZ[iz] = 100. * P(LIN(0.0, z0, nz - 1.0, z1, iz));
00135
00136
00137
            /* Write coordinates... */
           NC(nc_put_var_double(ncid, timid, &t0));
00138
           NC(nc_put_var_double(ncid, levid, dataZ));
00139
00140
           NC(nc_put_var_double(ncid, lonid, dataLon));
00141
           NC(nc_put_var_double(ncid, latid, dataLat));
00142
00143
            /* Create wind fields (Williamson et al., 1992)... */
00144
           for (ix = 0; ix < nx; ix++)
00145
              for (iy = 0; iy < ny; iy++)</pre>
00146
                  for (iz = 0; iz < nz; iz++) {
                     idx = (iz * ny + iy) * nx + ix;
00147
                     dataU[idx] = (float) (LIN(0.0, u0, nz - 1.0, u1, iz)
00148
                                                      * (cos(dataLat[iy] * M_PI / 180.0)

* cos(alpha * M_PI / 180.0)
00149
00151
                                                           + sin(dataLat[iy] * M_PI / 180.0)
00152
                                                           * cos(dataLon[ix] * M_PI / 180.0)
                                                           * sin(alpha * M_PI / 180.0)));
00153
                    00154
00155
00156
                                                      * sin(alpha * M_PI / 180.0));
00157
00158
00159
            /* Write wind data... */
00160
           NC(nc_put_var_float(ncid, tid, dataT));
00161
           NC(nc_put_var_float(ncid, uid, dataU));
00162
           NC(nc_put_var_float(ncid, vid, dataV));
00163
           NC(nc_put_var_float(ncid, wid, dataW));
00164
00165
           /* Close file... */
00166
           NC(nc_close(ncid));
00167
00168
           return EXIT SUCCESS;
00170
00172
00173 void add text attribute(
00174 int ncid,
           char *varname,
           char *attrname,
00176
00177
           char *text) {
00178
00179
           int varid;
00180
```

5.34 wind.c 203

```
00181    NC(nc_ing_varid(ncid, varname, &varid));
00182    NC(nc_put_att_text(ncid, varid, attrname, strlen(text), text));
00183 }
```

Index

index	
add_text_attribute	ctl_t, 15
wind.c, 198	ctl_t, 5
atm basename	atm_basename, 14
ctl t, 14	atm_dt_out, 14
atm_dt_out	atm_filter, 14
ctl t, 14	atm_gpfile, 14
atm filter	balloon, 13
ctl_t, 14	csi_basename, 14
atm_gpfile	csi_dt_out, 14
ctl_t, 14	csi_lat0, 16
atm_t, 3	csi_lat1, 16
lat, 4	csi_lon0, 15
lon, 4	csi_lon1, 15
np, 4	csi_modmin, 15
p, 4	csi_nx, 15
q, 4	csi_ny, 15
time, 4	csi_nz, 15
up, 4	csi_obsfile, 14
vp, 4	csi_obsmin, 15
wp, 5	csi_z0, 15
	csi_z1, 15
balloon	direction, 12
ctl_t, 13	dt_met, 12
cart2geo	dt_mod, 12
libtrac.c, 42	ens_basename, 18
libtrac.h, 97	grid_basename, 16
center.c, 22	grid_dt_out, 16
main, 23	grid_gpfile, 16
csi basename	grid_lat0, 17
ctl_t, 14	grid_lat1, 17
csi dt out	grid_lon0, 17
ctl_t, 14	grid_lon1, 17
csi lat0	grid_nx, 17
ctl_t, 16	grid_ny, 17
csi lat1	grid_nz, 16
ctl_t, 16	grid_sparse, 16
csi_lon0	grid_z0, 16
ctl_t, 15	grid_z1, 16
csi_lon1	gw_basename, 14
ctl_t, 15	isosurf, 12
csi_modmin	met_np, 12
ctl_t, 15	met_p, 12
csi_nx	nq, 9
ctl_t, 15	prof_basename, 17
csi_ny	prof_lat0, 18
ctl_t, 15	prof_lat1, 18
csi_nz	prof_lon0, 18
ctl_t, 15	prof_lon1, 18
csi_obsfile	prof_nx, 18
ctl_t, 14	prof_ny, 18
csi_obsmin	prof_nz, 17
ctl_t, 15	prof_obsfile, 17
csi_z0	prof_z0, 18
ctl_t, 15	prof_z1, 18
csi_z1	psc_h2o, 13

psc_hno3, 14	libtrac.h, 97
qnt_ens, 9	dy2deg
qnt_format, 9	libtrac.c, 43
qnt_gw_sso, 11	libtrac.h, 98
qnt_gw_u750, 11	dz2dp
qnt_gw_v750, 11	libtrac.c, 43
qnt_gw_var, 12	libtrac.h, 98
qnt_h2o, 10	motracin, oc
qnt_m, 9	ens_basename
qnt_name, 9	ctl_t, 18
qnt_name, 3 qnt_o3, 10	extract.c, 33
qnt_p, 10	main, 33
qnt_ps, 10	main, oo
• —	geo2cart
qnt_pv, 11	libtrac.c, 43
qnt_r, 10	libtrac.h, 98
qnt_rho, 9	get_met
qnt_stat, 11	libtrac.c, 44
qnt_t, 10	
qnt_theta, 11	libtrac.h, 98
qnt_tice, 11	get_met_help
qnt_tnat, 11	libtrac.c, 45
qnt_tsts, 11	libtrac.h, 99
qnt_u, 10	grid_basename
qnt_unit, 9	ctl_t, 16
qnt_v, 10	grid_dt_out
qnt_w, 10	ctl_t, 16
stat_basename, 19	grid_gpfile
stat_lat, 19	ctl_t, 16
stat_lon, 19	grid_lat0
stat_r, 19	ctl_t, 17
t_start, 12	grid_lat1
t stop, 12	ctl_t, 17
tdec_strat, 13	grid lon0
tdec_trop, 13	ctl_t, 17
turb_dx_strat, 13	grid lon1
turb_dx_trop, 13	ctl t, 17
turb_dz_strat, 13	grid_nx
turb_dz_trop, 13	ctl_t, 17
turb_meso, 13	grid_ny
turb_meso, 15	ctl_t, 17
deg2dx	grid nz
libtrac.c, 42	ctl_t, 16
libtrac.h, 97	grid_sparse
deg2dy	ctl t, 16
libtrac.c, 42	grid z0
libtrac.h, 97	• –
direction	ctl_t, 16
ctl t, 12	grid_z1
dist.c, 26	ctl_t, 16
	gw_basename
main, 27	ctl_t, 14
dp2dz	l- 0 -
libtrac.c, 43	h2o
libtrac.h, 97	met_t, 22
dt_met	inte a OF
ctl_t, 12	init.c, 35
dt_mod	main, 36
ctl_t, 12	init_simtime
dx2deg	trac.c, 164
libtrac.c, 43	intpol_met_2d

libtrac.c, 45	deg2dx, 97
libtrac.h, 100	deg2dy, 97
intpol_met_3d	dp2dz, 97
libtrac.c, 46	dx2deg, 97
libtrac.h, 100	dy2deg, 98
intpol_met_space	dz2dp, 98
libtrac.c, 46	geo2cart, 98
libtrac.h, 101	get_met, 98
intpol_met_time	get_met_help, 99
libtrac.c, 47	intpol_met_2d, 100
libtrac.h, 102	intpol_met_3d, 100
isosurf	intpol_met_space, 101
ctl_t, 12	intpol_met_time, 102
<u>-</u> -,	jsec2time, 103
jsec2time	locate, 103
libtrac.c, 48	read_atm, 104
libtrac.h, 103	read_ctl, 104
jsec2time.c, 39	read_met, 108
main, 39	read met extrapolate, 110
,	read met help, 110
lat	read_met_ml2pl, 111
atm_t, 4	read met periodic, 111
met_t, 21	scan_ctl, 112
libtrac.c, 40	time2jsec, 113
cart2geo, 42	-
deg2dx, 42	timer, 113
deg2dy, 42	tropopause, 114
dp2dz, 43	write_atm, 116
dx2deg, 43	write_csi, 117
dy2deg, 43	write_ens, 119
· · · · ·	write_grid, 121
dz2dp, 43	write_prof, 123
dz2dp, 43 geo2cart, 43	write_prof, 123 write_station, 125
dz2dp, 43 geo2cart, 43 get_met, 44	write_prof, 123 write_station, 125 locate
dz2dp, 43 geo2cart, 43 get_met, 44 get_met_help, 45	write_prof, 123 write_station, 125 locate libtrac.c, 48
dz2dp, 43 geo2cart, 43 get_met, 44 get_met_help, 45 intpol_met_2d, 45	write_prof, 123 write_station, 125 locate libtrac.c, 48 libtrac.h, 103
dz2dp, 43 geo2cart, 43 get_met, 44 get_met_help, 45 intpol_met_2d, 45 intpol_met_3d, 46	write_prof, 123 write_station, 125 locate libtrac.c, 48 libtrac.h, 103
dz2dp, 43 geo2cart, 43 get_met, 44 get_met_help, 45 intpol_met_2d, 45 intpol_met_3d, 46 intpol_met_space, 46	write_prof, 123 write_station, 125 locate libtrac.c, 48 libtrac.h, 103
dz2dp, 43 geo2cart, 43 get_met, 44 get_met_help, 45 intpol_met_2d, 45 intpol_met_3d, 46 intpol_met_space, 46 intpol_met_time, 47	write_prof, 123 write_station, 125 locate libtrac.c, 48 libtrac.h, 103
dz2dp, 43 geo2cart, 43 get_met, 44 get_met_help, 45 intpol_met_2d, 45 intpol_met_3d, 46 intpol_met_space, 46 intpol_met_time, 47 jsec2time, 48	write_prof, 123 write_station, 125 locate libtrac.c, 48 libtrac.h, 103 lon atm_t, 4 met_t, 21
dz2dp, 43 geo2cart, 43 get_met, 44 get_met_help, 45 intpol_met_2d, 45 intpol_met_3d, 46 intpol_met_space, 46 intpol_met_time, 47 jsec2time, 48 locate, 48	write_prof, 123 write_station, 125 locate libtrac.c, 48 libtrac.h, 103 lon atm_t, 4 met_t, 21 main
dz2dp, 43 geo2cart, 43 get_met, 44 get_met_help, 45 intpol_met_2d, 45 intpol_met_3d, 46 intpol_met_space, 46 intpol_met_time, 47 jsec2time, 48 locate, 48 read_atm, 49	write_prof, 123 write_station, 125 locate libtrac.c, 48 libtrac.h, 103 lon atm_t, 4 met_t, 21 main center.c, 23
dz2dp, 43 geo2cart, 43 get_met, 44 get_met_help, 45 intpol_met_2d, 45 intpol_met_3d, 46 intpol_met_space, 46 intpol_met_time, 47 jsec2time, 48 locate, 48 read_atm, 49 read_ctl, 49	write_prof, 123 write_station, 125 locate libtrac.c, 48 libtrac.h, 103 lon atm_t, 4 met_t, 21 main center.c, 23 dist.c, 27
dz2dp, 43 geo2cart, 43 get_met, 44 get_met_help, 45 intpol_met_2d, 45 intpol_met_3d, 46 intpol_met_space, 46 intpol_met_time, 47 jsec2time, 48 locate, 48 read_atm, 49 read_ctl, 49 read_met, 53	write_prof, 123 write_station, 125 locate libtrac.c, 48 libtrac.h, 103 lon atm_t, 4 met_t, 21 main center.c, 23 dist.c, 27 extract.c, 33
dz2dp, 43 geo2cart, 43 get_met, 44 get_met_help, 45 intpol_met_2d, 45 intpol_met_3d, 46 intpol_met_space, 46 intpol_met_time, 47 jsec2time, 48 locate, 48 read_atm, 49 read_met, 53 read_met_extrapolate, 55	write_prof, 123 write_station, 125 locate libtrac.c, 48 libtrac.h, 103 lon atm_t, 4 met_t, 21 main center.c, 23 dist.c, 27 extract.c, 33 init.c, 36
dz2dp, 43 geo2cart, 43 get_met, 44 get_met_help, 45 intpol_met_2d, 45 intpol_met_3d, 46 intpol_met_space, 46 intpol_met_time, 47 jsec2time, 48 locate, 48 read_atm, 49 read_ctl, 49 read_met, 53 read_met_extrapolate, 55 read_met_help, 55	write_prof, 123 write_station, 125 locate libtrac.c, 48 libtrac.h, 103 lon atm_t, 4 met_t, 21 main center.c, 23 dist.c, 27 extract.c, 33 init.c, 36 jsec2time.c, 39
dz2dp, 43 geo2cart, 43 get_met, 44 get_met_help, 45 intpol_met_2d, 45 intpol_met_3d, 46 intpol_met_space, 46 intpol_met_time, 47 jsec2time, 48 locate, 48 read_atm, 49 read_ctl, 49 read_met, 53 read_met_extrapolate, 55 read_met_help, 55 read_met_ml2pl, 56	write_prof, 123 write_station, 125 locate libtrac.c, 48 libtrac.h, 103 lon atm_t, 4 met_t, 21 main center.c, 23 dist.c, 27 extract.c, 33 init.c, 36 jsec2time.c, 39 match.c, 134
dz2dp, 43 geo2cart, 43 get_met, 44 get_met_help, 45 intpol_met_2d, 45 intpol_met_3d, 46 intpol_met_space, 46 intpol_met_time, 47 jsec2time, 48 locate, 48 read_atm, 49 read_ctl, 49 read_met, 53 read_met_extrapolate, 55 read_met_help, 55 read_met_periodic, 56	write_prof, 123 write_station, 125 locate libtrac.c, 48 libtrac.h, 103 lon atm_t, 4 met_t, 21 main center.c, 23 dist.c, 27 extract.c, 33 init.c, 36 jsec2time.c, 39 match.c, 134 met_map.c, 138
dz2dp, 43 geo2cart, 43 get_met, 44 get_met_help, 45 intpol_met_2d, 45 intpol_met_3d, 46 intpol_met_space, 46 intpol_met_time, 47 jsec2time, 48 locate, 48 read_atm, 49 read_ctl, 49 read_met, 53 read_met_extrapolate, 55 read_met_help, 55 read_met_ml2pl, 56	write_prof, 123 write_station, 125 locate libtrac.c, 48 libtrac.h, 103 lon atm_t, 4 met_t, 21 main center.c, 23 dist.c, 27 extract.c, 33 init.c, 36 jsec2time.c, 39 match.c, 134
dz2dp, 43 geo2cart, 43 get_met, 44 get_met_help, 45 intpol_met_2d, 45 intpol_met_3d, 46 intpol_met_space, 46 intpol_met_time, 47 jsec2time, 48 locate, 48 read_atm, 49 read_ctl, 49 read_met, 53 read_met_extrapolate, 55 read_met_help, 55 read_met_periodic, 56	write_prof, 123 write_station, 125 locate libtrac.c, 48 libtrac.h, 103 lon atm_t, 4 met_t, 21 main center.c, 23 dist.c, 27 extract.c, 33 init.c, 36 jsec2time.c, 39 match.c, 134 met_map.c, 138
dz2dp, 43 geo2cart, 43 get_met, 44 get_met_help, 45 intpol_met_2d, 45 intpol_met_3d, 46 intpol_met_time, 47 jsec2time, 48 locate, 48 read_atm, 49 read_ctl, 49 read_met, 53 read_met_extrapolate, 55 read_met_help, 55 read_met_periodic, 56 scan_ctl, 57	write_prof, 123 write_station, 125 locate libtrac.c, 48 libtrac.h, 103 lon atm_t, 4 met_t, 21 main center.c, 23 dist.c, 27 extract.c, 33 init.c, 36 jsec2time.c, 39 match.c, 134 met_map.c, 138 met_prof.c, 142
dz2dp, 43 geo2cart, 43 get_met, 44 get_met_help, 45 intpol_met_2d, 45 intpol_met_3d, 46 intpol_met_space, 46 intpol_met_time, 47 jsec2time, 48 locate, 48 read_atm, 49 read_ctl, 49 read_met, 53 read_met_extrapolate, 55 read_met_help, 55 read_met_ml2pl, 56 read_met_periodic, 56 scan_ctl, 57 time2jsec, 58	write_prof, 123 write_station, 125 locate libtrac.c, 48 libtrac.h, 103 lon atm_t, 4 met_t, 21 main center.c, 23 dist.c, 27 extract.c, 33 init.c, 36 jsec2time.c, 39 match.c, 134 met_map.c, 138 met_prof.c, 142 met_sample.c, 147 met_zm.c, 150 smago.c, 154
dz2dp, 43 geo2cart, 43 get_met, 44 get_met_help, 45 intpol_met_2d, 45 intpol_met_3d, 46 intpol_met_space, 46 intpol_met_time, 47 jsec2time, 48 locate, 48 read_atm, 49 read_ctl, 49 read_met, 53 read_met_extrapolate, 55 read_met_help, 55 read_met_ml2pl, 56 read_met_periodic, 56 scan_ctl, 57 time2jsec, 58 timer, 58	write_prof, 123 write_station, 125 locate libtrac.c, 48 libtrac.h, 103 lon atm_t, 4 met_t, 21 main center.c, 23 dist.c, 27 extract.c, 33 init.c, 36 jsec2time.c, 39 match.c, 134 met_map.c, 138 met_prof.c, 142 met_sample.c, 147 met_zm.c, 150
dz2dp, 43 geo2cart, 43 get_met, 44 get_met_help, 45 intpol_met_2d, 45 intpol_met_3d, 46 intpol_met_time, 47 jsec2time, 48 locate, 48 read_atm, 49 read_ctl, 49 read_met, 53 read_met_extrapolate, 55 read_met_help, 55 read_met_ml2pl, 56 read_met_periodic, 56 scan_ctl, 57 time2jsec, 58 timer, 58 tropopause, 59	write_prof, 123 write_station, 125 locate libtrac.c, 48 libtrac.h, 103 lon atm_t, 4 met_t, 21 main center.c, 23 dist.c, 27 extract.c, 33 init.c, 36 jsec2time.c, 39 match.c, 134 met_map.c, 138 met_prof.c, 142 met_sample.c, 147 met_zm.c, 150 smago.c, 154
dz2dp, 43 geo2cart, 43 get_met, 44 get_met_help, 45 intpol_met_2d, 45 intpol_met_3d, 46 intpol_met_space, 46 intpol_met_time, 47 jsec2time, 48 locate, 48 read_atm, 49 read_ctl, 49 read_met, 53 read_met_extrapolate, 55 read_met_help, 55 read_met_ml2pl, 56 read_met_periodic, 56 scan_ctl, 57 time2jsec, 58 timer, 58 tropopause, 59 write_atm, 61	write_prof, 123 write_station, 125 locate libtrac.c, 48 libtrac.h, 103 lon atm_t, 4 met_t, 21 main center.c, 23 dist.c, 27 extract.c, 33 init.c, 36 jsec2time.c, 39 match.c, 134 met_map.c, 138 met_prof.c, 142 met_sample.c, 147 met_zm.c, 150 smago.c, 154 split.c, 158
dz2dp, 43 geo2cart, 43 get_met, 44 get_met_help, 45 intpol_met_2d, 45 intpol_met_3d, 46 intpol_met_time, 47 jsec2time, 48 locate, 48 read_atm, 49 read_ctl, 49 read_met, 53 read_met_extrapolate, 55 read_met_help, 55 read_met_ml2pl, 56 read_met_periodic, 56 scan_ctl, 57 time2jsec, 58 tropopause, 59 write_atm, 61 write_csi, 62	write_prof, 123 write_station, 125 locate libtrac.c, 48 libtrac.h, 103 lon atm_t, 4 met_t, 21 main center.c, 23 dist.c, 27 extract.c, 33 init.c, 36 jsec2time.c, 39 match.c, 134 met_map.c, 138 met_prof.c, 142 met_sample.c, 147 met_zm.c, 150 smago.c, 154 split.c, 158 time2jsec.c, 162
dz2dp, 43 geo2cart, 43 get_met, 44 get_met_help, 45 intpol_met_2d, 45 intpol_met_3d, 46 intpol_met_time, 47 jsec2time, 48 locate, 48 read_atm, 49 read_met, 53 read_met_extrapolate, 55 read_met_help, 55 read_met_ml2pl, 56 read_met_periodic, 56 scan_ctl, 57 time2jsec, 58 timer, 58 tropopause, 59 write_atm, 61 write_csi, 62 write_ens, 64	write_prof, 123 write_station, 125 locate libtrac.c, 48 libtrac.h, 103 lon atm_t, 4 met_t, 21 main center.c, 23 dist.c, 27 extract.c, 33 init.c, 36 jsec2time.c, 39 match.c, 134 met_map.c, 138 met_prof.c, 142 met_sample.c, 147 met_zm.c, 150 smago.c, 154 split.c, 158 time2jsec.c, 162 trac.c, 178
dz2dp, 43 geo2cart, 43 get_met, 44 get_met_help, 45 intpol_met_2d, 45 intpol_met_3d, 46 intpol_met_space, 46 intpol_met_time, 47 jsec2time, 48 locate, 48 read_atm, 49 read_ctl, 49 read_met, 53 read_met_extrapolate, 55 read_met_help, 55 read_met_ml2pl, 56 read_met_periodic, 56 scan_ctl, 57 time2jsec, 58 timer, 58 tropopause, 59 write_atm, 61 write_csi, 62 write_ens, 64 write_grid, 66	write_prof, 123 write_station, 125 locate libtrac.c, 48 libtrac.h, 103 lon atm_t, 4 met_t, 21 main center.c, 23 dist.c, 27 extract.c, 33 init.c, 36 jsec2time.c, 39 match.c, 134 met_map.c, 138 met_prof.c, 142 met_sample.c, 147 met_zm.c, 150 smago.c, 154 split.c, 158 time2jsec.c, 162 trac.c, 178 wind.c, 198
dz2dp, 43 geo2cart, 43 get_met, 44 get_met_help, 45 intpol_met_2d, 45 intpol_met_3d, 46 intpol_met_space, 46 intpol_met_time, 47 jsec2time, 48 locate, 48 read_atm, 49 read_ctl, 49 read_met_extrapolate, 55 read_met_help, 55 read_met_ml2pl, 56 read_met_periodic, 56 scan_ctl, 57 time2jsec, 58 timer, 58 tropopause, 59 write_atm, 61 write_csi, 62 write_ens, 64 write_prof, 68	write_prof, 123 write_station, 125 locate libtrac.c, 48 libtrac.h, 103 lon atm_t, 4 met_t, 21 main center.c, 23 dist.c, 27 extract.c, 33 init.c, 36 jsec2time.c, 39 match.c, 134 met_map.c, 138 met_prof.c, 142 met_sample.c, 147 met_zm.c, 150 smago.c, 154 split.c, 158 time2jsec.c, 162 trac.c, 178 wind.c, 198 match.c, 133
dz2dp, 43 geo2cart, 43 get_met, 44 get_met_help, 45 intpol_met_2d, 45 intpol_met_3d, 46 intpol_met_space, 46 intpol_met_time, 47 jsec2time, 48 locate, 48 read_atm, 49 read_ctl, 49 read_met_extrapolate, 55 read_met_help, 55 read_met_ml2pl, 56 read_met_periodic, 56 scan_ctl, 57 time2jsec, 58 timer, 58 tropopause, 59 write_atm, 61 write_csi, 62 write_prof, 68 write_station, 70	write_prof, 123 write_station, 125 locate libtrac.c, 48 libtrac.h, 103 lon atm_t, 4 met_t, 21 main center.c, 23 dist.c, 27 extract.c, 33 init.c, 36 jsec2time.c, 39 match.c, 134 met_map.c, 138 met_prof.c, 142 met_sample.c, 147 met_zm.c, 150 smago.c, 154 split.c, 158 time2jsec.c, 162 trac.c, 178 wind.c, 198 match.c, 133 main, 134

met_np		atm_t, 4
ctl_t, 12		met_t, 21
met_p	pl	
ctl_t, 12		met_t, 21
met_prof.c, 142	pro	of_basename
main, 142		ctl_t, 17
met_sample.c, 146	pro	of_lat0
main, 147		ctl_t, 18
met_t, 19	pro	of_lat1
h2o, <mark>22</mark>		ctl_t, 18
lat, 21	pro	of_lon0
lon, 21		ctl_t, 18
np, <mark>21</mark>	pro	of_lon1
nx, 20		ctl_t, 18
ny, <mark>21</mark>	pro	of_nx
o3, <mark>22</mark>		ctl_t, 18
p, <mark>21</mark>	pro	of_ny
pl, <mark>21</mark>		ctl_t, 18
ps, 21	pro	of_nz
t, 21		ctl_t, 17
time, 20	pro	of_obsfile
u, <mark>21</mark>		ctl_t, 17
v, <mark>22</mark>	pro	of_z0
w, 22		ctl_t, 18
met_zm.c, 149	pro	of_z1
main, 150		ctl_t, 18
module_advection	ps	
trac.c, 164		met_t, 21
module_decay	ps	c_h2o
trac.c, 164		ctl_t, 13
module_diffusion_m	ieso ps	c_hno3
trac.c, 165		ctl_t, 14
module_diffusion_tu		
trac.c, 167	q	
module_isosurf		atm_t, 4
trac.c, 168	qn	t_ens
module_meteo		ctl_t, 9
trac.c, 170	qn	t_format
module_meteo_hno	3	ctl_t, 9
trac.c, 172	qn	t_gw_sso
module_position		ctl_t, 11
trac.c, 176	qn	t_gw_u750
module_sedi	an a	ctl_t, 11
trac.c, 176	qn	t_gw_v750 ctl_t, 11
	an	t_gw_var
np	qii	ctl_t, 12
atm_t, 4	an	t_h2o
met_t, 21	qii	ctl_t, 10
nq	an	t m
ctl_t, 9	4''	ctl_t, 9
nx	an	t_name
met_t, 20	4	ctl_t, 9
ny mot t 21	an	t_o3
met_t, 21	1	ctl_t, 10
o3	an	t_p
met_t, 22	7	ctl_t, 10
,	qn	t_ps
р	·	 ctl_t, 10

qnt_pv	ctl_t, 19
ctl_t, 11	stat_lon
qnt_r	ctl_t, 19
ctl_t, 10	stat_r
qnt_rho	ctl_t, 19
ctl_t, 9	
qnt_stat	t
ctl_t, 11	met_t, 21
qnt_t ctl_t, 10	t_start
qnt theta	ctl_t, 12
ctl_t, 11	t_stop
qnt_tice	ctl_t, 12
ctl_t, 11	tdec_strat
qnt_tnat	ctl_t, 13
ctl_t, 11	tdec_trop
ant tsts	ctl_t, 13 time
ctl_t, 11	atm t, 4
gnt u	met_t, 20
ctl_t, 10	time2jsec
qnt_unit	libtrac.c, 58
ctl_t, 9	libtrac.h, 113
qnt_v	time2jsec.c, 161
ctl_t, 10	main, 162
qnt_w	timer
ctl_t, 10	libtrac.c, 58
	libtrac.h, 113
read_atm	trac.c, 163
libtrac.c, 49	init_simtime, 164
libtrac.h, 104	main, 178
read_ctl	module_advection, 164
libtrac.c, 49	module decay, 164
libtrac.h, 104	module diffusion meso, 165
read_met	module diffusion turb, 167
libtrac.c, 53	module isosurf, 168
libtrac.h, 108	module_meteo, 170
read_met_extrapolate libtrac.c, 55	module_meteo_hno3, 172
libtrac.h, 110	module_position, 176
read_met_help	module_sedi, 176
libtrac.c, 55	write_output, 177
libtrac.h, 110	tropopause
read met ml2pl	libtrac.c, 59
libtrac.c, 56	libtrac.h, 114
libtrac.h, 111	turb_dx_strat
read met periodic	ctl_t, 13
libtrac.c, 56	turb_dx_trop
libtrac.h, 111	ctl_t, 13
	turb_dz_strat
scan_ctl	ctl_t, 13
libtrac.c, 57	turb_dz_trop
libtrac.h, 112	ctl_t, 13
smago.c, 154	turb_meso
main, 154	ctl_t, 13
split.c, 157	
main, 158	U mot t 01
stat_basename	met_t, 21
ctl_t, 19	up
stat_lat	atm_t, 4

```
٧
     met_t, 22
vp
     atm_t, 4
W
     met_t, 22
wind.c, 198
     add_text_attribute, 198
     main, 198
wp
     atm_t, 5
write_atm
     libtrac.c, 61
     libtrac.h, 116
write_csi
     libtrac.c, 62
     libtrac.h, 117
write_ens
     libtrac.c, 64
     libtrac.h, 119
write_grid
     libtrac.c, 66
     libtrac.h, 121
write_output
     trac.c, 177
write_prof
     libtrac.c, 68
     libtrac.h, 123
write_station
     libtrac.c, 70
     libtrac.h, 125
```