pyrad library reference for users

Release 0.0.1

meteoswiss-mdr

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PROCESSING FLOW CONTROL (`PYRAD.FLOW`)

Functions to control the Pyrad data processing flow

main(cfgfile[, starttime, endtime, . . .])	Main flow control.
main_rt(cfgfile_list[, starttime, endtime, . . .])	main flow control.

`pyrad.flow.`**main**(*cfgfile, starttime=None, endtime=None, trajfile='', trajtype='plane', flashnr=0, infostr='', MULTIPROCESSING_DSET=False, MULTIPROCESSING_PROD=False, PROFILE_MULTIPROCESSING=False*)

    Main flow control. Processes radar data off-line over a period of time given either by the user, a trajectory file, or determined by the last volume processed and the current time. Multiple radars can be processed simultaneously

    Parameters

        cfgfile [str] path of the main config file

        starttime, endtime [datetime object] start and end time of the data to be processed

        trajfile [str] path to file describing the trajectory

        trajtype [str] type of trajectory file. Can be either 'plane' or 'lightning'

        flashnr [int] If larger than 0 will select a flash in a lightning trajectory file. If 0 the data corresponding to the trajectory of all flashes will be plotted

        infostr [str] Information string about the actual data processing (e.g. 'RUN57'). This string is added to product files.

        MULTIPROCESSING_DSET [Bool] If true the generation of datasets at the same processing level will be parallelized

        MULTIPROCESSING_PROD [Bool] If true the generation of products from each dataset will be parallelized

`pyrad.flow.`**main_rt**(*cfgfile_list, starttime=None, endtime=None, infostr_list=None, proc_period=60, proc_finish=None*)

    main flow control. Processes radar data in real time. The start and end processing times can be determined by the user. This function is inteded for a single radar

    Parameters

        cfgfile_list [list of str] path of the main config files

        starttime, endtime [datetime object] start and end time of the data to be processed

        infostr_list [list of str] Information string about the actual data processing (e.g. 'RUN57'). This string is added to product files.

        proc_period [int] period of time before starting a new processing round (seconds)

cronjob_controlled [Boolean] If True means that the program is started periodically from a cronjob and therefore finishes execution after processing

proc_finish [int or None] if set to a value the program will be forced to shut down after the value (in seconds) from start time has been exceeded

Returns

end_proc [Boolean] If true the program has ended successfully

DATASET PROCESSING (`PYRAD.PROC`)

Initiate the dataset processing.

2.1 Auxiliary functions

get_process_func(dataset_type, dsname)	Maps the dataset type into its processing function and data set format associated.
process_raw(procstatus, dscfg[, radar_list])	Dummy function that returns the initial input data set
process_save_radar(procstatus, dscfg[, . . .])	Dummy function that allows to save the entire radar object
process_roi(procstatus, dscfg[, radar_list])	Obtains the radar data at a region of interest.
process_grid(procstatus, dscfg[, radar_list])	Puts the radar data in a regular grid
process_azimuthal_average(procstatus, dscfg)	Averages radar data in azimuth obtaining and RHI as a result

2.2 Echo classification and filtering

process_echo_id(procstatus, dscfg[, radar_list])	identifies echoes as 0: No data, 1: Noise, 2: Clutter, 3: Precipitation
process_birds_id(procstatus, dscfg[, radar_list])	identifies echoes as 0: No data, 1: Noise, 2: Clutter, 3: Birds
process_clt_to_echo_id(procstatus, dscfg[, . . .])	Converts clutter exit code from rad4alp into pyrad echo ID
process_echo_filter(procstatus, dscfg[, . . .])	Masks all echo types that are not of the class specified in keyword echo_type
process_cdf(procstatus, dscfg[, radar_list])	Collects the fields necessary to compute the Cumulative Distribution Function
process_filter_snr(procstatus, dscfg[, . . .])	filters out low SNR echoes
process_filter_visibility(procstatus, dscfg)	filters out rays gates with low visibility and corrects the reflectivity
process_outlier_filter(procstatus, dscfg[, . . .])	filters out gates which are outliers respect to the surrounding
process_hydroclass(procstatus, dscfg[, . . .])	Classifies precipitation echoes
process_melting_layer(procstatus, dscfg[, . . .])	Detects the melting layer

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process_filter_vel_diff(procstatus, dscfg[, ...])	filters out range gates that could not be used for Doppler velocity estimation
process_zdr_column(procstatus, dscfg[, ...])	Detects ZDR columns

2.3 Phase processing and attenuation correction

process_correct_phidp0(procstatus, dscfg[, ...])	corrects phidp of the system phase
process_smooth_phidp_single_window(...[, ...])	corrects phidp of the system phase and smoothes it using one window
process_smooth_phidp_double_window(...[, ...])	corrects phidp of the system phase and smoothes it using one window
process_kdp_leastsquare_single_window(...[, ...])	Computes specific differential phase using a piecewise least square method
process_kdp_leastsquare_double_window(...[, ...])	Computes specific differential phase using a piecewise least square method
process_phidp_kdp_Vulpiani(procstatus, dscfg)	Computes specific differential phase and differential phase using the method developed by Vulpiani et al.
process_phidp_kdp_Kalman(procstatus, dscfg)	Computes specific differential phase and differential phase using the Kalman filter as proposed by Schneebeli et al.
process_phidp_kdp_Maesaka(procstatus, dscfg)	Estimates PhiDP and KDP using the method by Maesaka.
process_phidp_kdp_lp(procstatus, dscfg[, ...])	Estimates PhiDP and KDP using a linear programming algorithm.
process_attenuation(procstatus, dscfg[, ...])	Computes specific attenuation and specific differential attenuation using the Z-Phi method and corrects reflectivity and differential reflectivity

2.4 Monitoring, calibration and noise correction

process_correct_bias(procstatus, dscfg[, ...])	Corrects a bias on the data
process_correct_noise_rhohv(procstatus, dscfg)	identifies echoes as 0: No data, 1: Noise, 2: Clutter, 3: Precipitation
process_rhohv_rain(procstatus, dscfg[, ...])	Keeps only suitable data to evaluate the 80 percentile of RhoHV in rain
process_zdr_precip(procstatus, dscfg[, ...])	Keeps only suitable data to evaluate the differential reflectivity in moderate rain or precipitation (for vertical scans)
process_zdr_snow(procstatus, dscfg[, radar_list])	Keeps only suitable data to evaluate the differential reflectivity in snow
process_estimate_phidp0(procstatus, dscfg[, ...])	estimates the system differential phase offset at each ray
process_sun_hits(procstatus, dscfg[, radar_list])	monitoring of the radar using sun hits
process_selfconsistency_kdp_phidp(...[, ...])	Computes specific differential phase and differential phase in rain using the selfconsistency between Zdr, Zh and KDP

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process_selfconsistency_bias(procstatus, dscfg)	Estimates the reflectivity bias by means of the selfconsistency algorithm by Gourley
process_occurrence(procstatus, dscfg[, …])	computes the frequency of occurrence of data.
process_occurrence_period(procstatus, dscfg)	computes the frequency of occurrence over a long period of time by adding together shorter periods
process_monitoring(procstatus, dscfg[, …])	computes monitoring statistics
process_gc_monitoring(procstatus, dscfg[, …])	computes ground clutter monitoring statistics
process_time_avg(procstatus, dscfg[, radar_list])	computes the temporal mean of a field
process_weighted_time_avg(procstatus, dscfg)	computes the temporal mean of a field weighted by the reflectivity
process_time_avg_flag(procstatus, dscfg[, …])	computes a flag field describing the conditions of the data used while averaging
process_colocated_gates(procstatus, dscfg[, …])	Find colocated gates within two radars
process_intercomp(procstatus, dscfg[, …])	intercomparison between two radars
process_intercomp_time_avg(procstatus, dscfg)	intercomparison between the average reflectivity of two radars

2.5 Retrievals

process_signal_power(procstatus, dscfg[, …])	Computes the signal power in dBm
process_rcs(procstatus, dscfg[, radar_list])	Computes the radar cross-section (assuming a point target) from radar reflectivity.
process_rcs_pr(procstatus, dscfg[, radar_list])	Computes the radar cross-section (assuming a point target) from radar reflectivity by first computing the received power and then the RCS from it.
process_snr(procstatus, dscfg[, radar_list])	Computes SNR
process_l(procstatus, dscfg[, radar_list])	Computes L parameter
process_cdr(procstatus, dscfg[, radar_list])	Computes Circular Depolarization Ratio
process_rainrate(procstatus, dscfg[, radar_list])	Estimates rainfall rate from polarimetric moments
process_vol_refl(procstatus, dscfg[, radar_list])	Computes the volumetric reflectivity in $10\log10(cm^2\ km^{-3})$
process_bird_density(procstatus, dscfg[, …])	Computes the bird density from the volumetric reflectivity

2.6 Doppler processing

process_dealias_fourdd(procstatus, dscfg[, …])	Dealiases the Doppler velocity field using the 4DD technique from Curtis and Houze, 2001
process_dealias_region_based(procstatus, dscfg)	Dealiases the Doppler velocity field using a region based algorithm
process_dealias_unwrap_phase(procstatus, dscfg)	Dealiases the Doppler velocity field using multi-dimensional phase unwrapping
process_wind_vel(procstatus, dscfg[, radar_list])	Estimates the horizontal or vertical component of the wind from the radial velocity
process_windshear(procstatus, dscfg[, …])	Estimates the wind shear from the wind velocity

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process_vad(procstatus, dscfg[, radar_list])	Estimates vertical wind profile using the VAD (velocity Azimuth Display) technique

2.7 Time series functions

process_point_measurement(procstatus, dscfg)	Obtains the radar data at a point location.
process_qvp(procstatus, dscfg[, radar_list])	Computes quasi vertical profiles, by averaging over height levels PPI data.
process_rqvp(procstatus, dscfg[, radar_list])	Computes range defined quasi vertical profiles, by averaging over height levels PPI data.
process_svp(procstatus, dscfg[, radar_list])	Computes slanted vertical profiles, by averaging over height levels PPI data.
process_evp(procstatus, dscfg[, radar_list])	Computes enhanced vertical profiles, by averaging over height levels PPI data.
process_time_height(procstatus, dscfg[, . . .])	Produces time height radar objects at a point of interest defined by latitude and longitude.

2.8 Trajectory functions

process_trajectory(procstatus, dscfg[, . . .])	Return trajectory
process_traj_atplane(procstatus, dscfg[, . . .])	Return time series according to trajectory
process_traj_antenna_pattern(procstatus, dscfg)	Process a new array of data volumes considering a plane trajectory.
process_traj_lightning(procstatus, dscfg[, . . .])	Return time series according to lightning trajectory
process_traj_trt(procstatus, dscfg[, . . .])	Processes data according to TRT trajectory

2.9 COSMO data

process_cosmo(procstatus, dscfg[, radar_list])	Gets COSMO data and put it in radar coordinates
process_cosmo_lookup_table(procstatus, dscfg)	Gets COSMO data and put it in radar coordinates using look up tables computed or loaded when initializing
process_cosmo_coord(procstatus, dscfg[, . . .])	Gets the COSMO indices corresponding to each cosmo coordinates
process_hzt(procstatus, dscfg[, radar_list])	Gets iso0 degree data in HZT format and put it in radar coordinates
process_hzt_lookup_table(procstatus, dscfg)	Gets HZT data and put it in radar coordinates using look up tables computed or loaded when initializing
process_hzt_coord(procstatus, dscfg[, . . .])	Gets the HZT indices corresponding to each HZT coordinates

pyrad.proc.**get_process_func**(*dataset_type*, *dsname*)

Maps the dataset type into its processing function and data set format associated.

> **Parameters**

> **dataset_type** [str] data set type, i.e. 'RAW', 'SAN', etc.
>
> **dsname** [str] Name of dataset
>
> **Returns**
>
> > **func_name** [str or processing function] pyrad function used to process the data set type
> >
> > **dsformat** [str] data set format, i.e.: 'VOL', etc.

pyrad.proc.**process_attenuation**(*procstatus*, *dscfg*, *radar_list=None*)

> Computes specific attenuation and specific differential attenuation using the Z-Phi method and corrects reflectivity and differential reflectivity
>
> **Parameters**
>
> > **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing
> >
> > **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:
> >
> > > **datatype** [list of string. Dataset keyword] The input data types
> > >
> > > **ATT_METHOD** [float. Dataset keyword] The attenuation estimation method used. One of the following: ZPhi, Philin
> > >
> > > **fzl** [float. Dataset keyword] The default freezing level height. It will be used if no temperature field name is specified or the temperature field is not in the radar object. Default 2000.
> >
> > **radar_list** [list of Radar objects] Optional. list of radar objects
>
> **Returns**
>
> > **new_dataset** [dict] dictionary containing the output
> >
> > **ind_rad** [int] radar index

pyrad.proc.**process_azimuthal_average**(*procstatus*, *dscfg*, *radar_list=None*)

> Averages radar data in azimuth obtaining and RHI as a result
>
> **Parameters**
>
> > **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing
> >
> > **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:
> >
> > > **datatype** [string. Dataset keyword] The data type where we want to extract the point measurement
> > >
> > > **gridconfig** [dictionary. Dataset keyword] Dictionary containing some or all of this keywords: xmin, xmax, ymin, ymax, zmin, zmax : floats
> > >
> > > > minimum and maximum horizontal distance from grid origin [km] and minimum and maximum vertical distance from grid origin [m] Defaults -40, 40, -40, 40, 0., 10000.
> > > >
> > > > **hres, vres** [floats] horizontal and vertical grid resolution [m] Defaults 1000., 500.
> > > >
> > > > **latorig, lonorig, altorig** [floats] latitude and longitude of grid origin [deg] and altitude of grid origin [m MSL] Defaults the latitude, longitude and altitude of the radar
> > >
> > > **wfunc** [str] the weighting function used to combine the radar gates close to a grid point. Possible values BARNES, CRESSMAN, NEAREST_NEIGHBOUR Default NEAREST_NEIGHBOUR

>> **roif_func** [str] the function used to compute the region of interest. Possible values: dist_beam, constant

>> **roi** [float] the (minimum) radius of the region of interest in m. Default half the largest resolution

> **radar_list** [list of Radar objects] Optional. list of radar objects

> **Returns**

>> **new_dataset** [dict] dictionary containing the gridded data

>> **ind_rad** [int] radar index

pyrad.proc.**process_bird_density**(*procstatus*, *dscfg*, *radar_list=None*)

> Computes the bird density from the volumetric reflectivity

> **Parameters**

>> **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

>> **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

>>> **datatype** [list of string. Dataset keyword] The input data types

>>> **sigma_bird** [float. Dataset keyword] The bird radar cross section

>> **radar_list** [list of Radar objects] Optional. list of radar objects

> **Returns**

>> **new_dataset** [dict] dictionary containing the output

>> **ind_rad** [int] radar index

pyrad.proc.**process_birds_id**(*procstatus*, *dscfg*, *radar_list=None*)

> identifies echoes as 0: No data, 1: Noise, 2: Clutter, 3: Birds

> **Parameters**

>> **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

>> **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

>>> **datatype** [list of string. Dataset keyword] The input data types

>> **radar_list** [list of Radar objects] Optional. list of radar objects

> **Returns**

>> **new_dataset** [dict] dictionary containing the output

>> **ind_rad** [int] radar index

pyrad.proc.**process_cdf**(*procstatus*, *dscfg*, *radar_list=None*)

> Collects the fields necessary to compute the Cumulative Distribution Function

> **Parameters**

>> **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

>> **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

>>> **datatype** [list of string. Dataset keyword] The input data types

>> **radar_list** [list of Radar objects] Optional. list of radar objects

> **Returns**

>> **new_dataset** [dict] dictionary containing the output

> > > **ind_rad** [int] radar index

pyrad.proc.**process_cdr**(*procstatus*, *dscfg*, *radar_list=None*)
> Computes Circular Depolarization Ratio

> > **Parameters**

> > > **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

> > > **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

> > > > **datatype** [string. Dataset keyword] The input data type

> > > **radar_list** [list of Radar objects] Optional. list of radar objects

> > **Returns**

> > > **new_dataset** [dict] dictionary containing the output

> > > **ind_rad** [int] radar index

pyrad.proc.**process_clt_to_echo_id**(*procstatus*, *dscfg*, *radar_list=None*)
> Converts clutter exit code from rad4alp into pyrad echo ID

> > **Parameters**

> > > **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

> > > **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

> > > > **datatype** [list of string. Dataset keyword] The input data types

> > > **radar_list** [list of Radar objects] Optional. list of radar objects

> > **Returns**

> > > **new_dataset** [dict] dictionary containing the output

> > > **ind_rad** [int] radar index

pyrad.proc.**process_colocated_gates**(*procstatus*, *dscfg*, *radar_list=None*)
> Find colocated gates within two radars

> > **Parameters**

> > > **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

> > > **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

> > > > **datatype** [list of string. Dataset keyword] The input data types

> > > > **h_tol** [float. Dataset keyword] Tolerance in altitude difference between radar gates [m]. Default 100.

> > > > **latlon_tol** [float. Dataset keyword] Tolerance in latitude and longitude position between radar gates [deg]. Default 0.0005

> > > > **vol_d_tol** [float. Dataset keyword] Tolerance in pulse volume diameter [m]. Default 100.

> > > > **vismin** [float. Dataset keyword] Minimum visibility [percent]. Default None.

> > > > **hmin** [float. Dataset keyword] Minimum altitude [m MSL]. Default None.

> > > > **hmax** [float. Dataset keyword] Maximum altitude [m MSL]. Default None.

> > > > **rmin** [float. Dataset keyword] Minimum range [m]. Default None.

> > > > **rmax** [float. Dataset keyword] Maximum range [m]. Default None.

> > > > **elmin** [float. Dataset keyword] Minimum elevation angle [deg]. Default None.

> **elmax** [float. Dataset keyword] Maximum elevation angle [deg]. Default None.
>
> **azrad1min** [float. Dataset keyword] Minimum azimuth angle [deg] for radar 1. Default None.
>
> **azrad1max** [float. Dataset keyword] Maximum azimuth angle [deg] for radar 1. Default None.
>
> **azrad2min** [float. Dataset keyword] Minimum azimuth angle [deg] for radar 2. Default None.
>
> **azrad2max** [float. Dataset keyword] Maximum azimuth angle [deg] for radar 2. Default None.

> **radar_list** [list of Radar objects] Optional. list of radar objects

Returns

> **new_dataset** [radar object] radar object containing the flag field
>
> **ind_rad** [int] radar index

pyrad.proc.**process_correct_bias**(*procstatus*, *dscfg*, *radar_list=None*)
    Corrects a bias on the data

Parameters

> **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing
>
> **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:
>
> > **datatype** [string. Dataset keyword] The data type to correct for bias
> >
> > **bias** [float. Dataset keyword] The bias to be corrected [dB]. Default 0
>
> **radar_list** [list of Radar objects] Optional. list of radar objects

Returns

> **new_dataset** [dict] dictionary containing the output
>
> **ind_rad** [int] radar index

pyrad.proc.**process_correct_noise_rhohv**(*procstatus*, *dscfg*, *radar_list=None*)
    identifies echoes as 0: No data, 1: Noise, 2: Clutter, 3: Precipitation

Parameters

> **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing
>
> **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:
>
> > **datatype** [list of string. Dataset keyword] The data types used in the correction
>
> **radar_list** [list of Radar objects] Optional. list of radar objects

Returns

> **new_dataset** [dict] dictionary containing the output
>
> **ind_rad** [int] radar index

pyrad.proc.**process_correct_phidp0**(*procstatus*, *dscfg*, *radar_list=None*)
    corrects phidp of the system phase

Parameters

> **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

dscfg [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

datatype [list of string. Dataset keyword] The input data types

rmin [float. Dataset keyword] The minimum range where to look for valid data [m]

rmax [float. Dataset keyword] The maximum range where to look for valid data [m]

rcell [float. Dataset keyword] The length of a continuous cell to consider it valid precip [m]

Zmin [float. Dataset keyword] The minimum reflectivity [dBZ]

Zmax [float. Dataset keyword] The maximum reflectivity [dBZ]

radar_list [list of Radar objects] Optional. list of radar objects

Returns

new_dataset [dict] dictionary containing the output

ind_rad [int] radar index

pyrad.proc.**process_cosmo**(*procstatus*, *dscfg*, *radar_list=None*)
Gets COSMO data and put it in radar coordinates

Parameters

procstatus [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

dscfg [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

datatype [string. Dataset keyword] arbitrary data type

keep_in_memory [int. Dataset keyword] if set keeps the COSMO data dict, the COSMO coordinates dict and the COSMO field in radar coordinates in memory

regular_grid [int. Dataset keyword] if set it is assume that the radar has a grid constant in time and there is no need to compute a new COSMO field if the COSMO data has not changed

cosmo_type [str. Dataset keyword] name of the COSMO field to process. Default TEMP

cosmo_variables [list of strings. Dataset keyword] Py-art name of the COSMO fields. Default temperature

radar_list [list of Radar objects] Optional. list of radar objects

Returns

new_dataset [dict] dictionary containing the output

ind_rad [int] radar index

pyrad.proc.**process_cosmo_coord**(*procstatus*, *dscfg*, *radar_list=None*)
Gets the COSMO indices corresponding to each cosmo coordinates

Parameters

procstatus [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

dscfg [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

datatype [string. Dataset keyword] arbitrary data type

cosmopath [string. General keyword] path where to store the look up table

radar_list [list of Radar objects] Optional. list of radar objects

Returns

> > > **new_dataset** [dict] dictionary containing the output
> > >
> > > **ind_rad** [int] radar index

pyrad.proc.**process_cosmo_lookup_table**(*procstatus*, *dscfg*, *radar_list=None*)

> Gets COSMO data and put it in radar coordinates using look up tables computed or loaded when initializing

> > **Parameters**
> >
> > > **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing
> > >
> > > **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:
> > >
> > > > **datatype** [string. Dataset keyword] arbitrary data type
> > > >
> > > > **lookup_table** [int. Dataset keyword] if set a pre-computed look up table for the COSMO coordinates is loaded. Otherwise the look up table is computed taking the first radar object as reference
> > > >
> > > > **regular_grid** [int. Dataset keyword] if set it is assume that the radar has a grid constant in time and therefore there is no need to interpolate the COSMO field in memory to the current radar grid
> > > >
> > > > **cosmo_type** [str. Dataset keyword] name of the COSMO field to process. Default TEMP
> > > >
> > > > **cosmo_variables** [list of strings. Dataset keyword] Py-art name of the COSMO fields. Default temperature
> > >
> > > **radar_list** [list of Radar objects] Optional. list of radar objects
> >
> > **Returns**
> >
> > > **new_dataset** [dict] dictionary containing the output
> > >
> > > **ind_rad** [int] radar index

pyrad.proc.**process_dealias_fourdd**(*procstatus*, *dscfg*, *radar_list=None*)

> Dealiases the Doppler velocity field using the 4DD technique from Curtis and Houze, 2001

> > **Parameters**
> >
> > > **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing
> > >
> > > **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:
> > >
> > > > **datatype** [string. Dataset keyword] The input data type
> > > >
> > > > **filt** [int. Dataset keyword] Flag controlling Bergen and Albers filter, 1 = yes, 0 = no.
> > > >
> > > > **sign** [int. Dataset keyword] Sign convention which the radial velocities in the volume created from the sounding data will will. This should match the convention used in the radar data. A value of 1 represents when positive values velocities are towards the radar, -1 represents when negative velocities are towards the radar.
> > >
> > > **radar_list** [list of Radar objects] Optional. list of radar objects
> >
> > **Returns**
> >
> > > **new_dataset** [dict] dictionary containing the output
> > >
> > > **ind_rad** [int] radar index

pyrad.proc.**process_dealias_region_based**(*procstatus*, *dscfg*, *radar_list=None*)

> Dealiases the Doppler velocity field using a region based algorithm

> > **Parameters**
> >
> > > **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

---

dscfg [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

datatype [string. Dataset keyword] The input data type

interval_splits [int, optional] Number of segments to split the nyquist interval into when finding regions of similar velocity. More splits creates a larger number of initial regions which takes longer to process but may result in better dealiasing. The default value of 3 seems to be a good compromise between performance and artifact free dealiasing. This value is not used if the interval_limits parameter is not None.

skip_between_rays, skip_along_ray [int, optional] Maximum number of filtered gates to skip over when joining regions, gaps between region larger than this will not be connected. Parameters specify the maximum number of filtered gates between and along a ray. Set these parameters to 0 to disable unfolding across filtered gates.

centered [bool, optional] True to apply centering to each sweep after the dealiasing algorithm so that the average number of unfolding is near 0. False does not apply centering which may results in individual sweeps under or over folded by the nyquist interval.

radar_list [list of Radar objects] Optional. list of radar objects

Returns

new_dataset [dict] dictionary containing the output

ind_rad [int] radar index

pyrad.proc.**process_dealias_unwrap_phase**(*procstatus*, *dscfg*, *radar_list=None*)
Dealiases the Doppler velocity field using multi-dimensional phase unwrapping

Parameters

procstatus [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

dscfg [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

datatype [string. Dataset keyword] The input data type

unwrap_unit [{'ray', 'sweep', 'volume'}, optional] Unit to unwrap independently. 'ray' will unwrap each ray individually, 'sweep' each sweep, and 'volume' will unwrap the entire volume in a single pass. 'sweep', the default, often gives superior results when the lower sweeps of the radar volume are contaminated by clutter. 'ray' does not use the gatefilter parameter and rays where gates ared masked will result in poor dealiasing for that ray.

radar_list [list of Radar objects] Optional. list of radar objects

Returns

new_dataset [dict] dictionary containing the output

ind_rad [int] radar index

pyrad.proc.**process_echo_filter**(*procstatus*, *dscfg*, *radar_list=None*)
Masks all echo types that are not of the class specified in keyword echo_type

Parameters

procstatus [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

dscfg [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

datatype [list of string. Dataset keyword] The input data types

echo_type [int] The type of echo to keep: 1 noise, 2 clutter, 3 precipitation. Default 3

> > **radar_list** [list of Radar objects] Optional. list of radar objects
>
> > **Returns**
>
> > **new_dataset** [dict] dictionary containing the output
>
> > **ind_rad** [int] radar index

pyrad.proc.**process_echo_id**(*procstatus*, *dscfg*, *radar_list=None*)
> identifies echoes as 0: No data, 1: Noise, 2: Clutter, 3: Precipitation

> > **Parameters**
>
> > **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing
>
> > **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:
>
> > > **datatype** [list of string. Dataset keyword] The input data types
>
> > **radar_list** [list of Radar objects] Optional. list of radar objects
>
> > **Returns**
>
> > **new_dataset** [dict] dictionary containing the output
>
> > **ind_rad** [int] radar index

pyrad.proc.**process_estimate_phidp0**(*procstatus*, *dscfg*, *radar_list=None*)
> estimates the system differential phase offset at each ray

> > **Parameters**
>
> > **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing
>
> > **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:
>
> > > **datatype** [list of string. Dataset keyword] The input data types
> >
> > > **rmin** [float. Dataset keyword] The minimum range where to look for valid data [m]
> >
> > > **rmax** [float. Dataset keyword] The maximum range where to look for valid data [m]
> >
> > > **rcell** [float. Dataset keyword] The length of a continuous cell to consider it valid precip [m]
> >
> > > **Zmin** [float. Dataset keyword] The minimum reflectivity [dBZ]
> >
> > > **Zmax** [float. Dataset keyword] The maximum reflectivity [dBZ]
>
> > **radar_list** [list of Radar objects] Optional. list of radar objects
>
> > **Returns**
>
> > **new_dataset** [dict] dictionary containing the output
>
> > **ind_rad** [int] radar index

pyrad.proc.**process_evp**(*procstatus*, *dscfg*, *radar_list=None*)
> Computes enhanced vertical profiles, by averaging over height levels PPI data.

> > **Parameters**
>
> > **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing
>
> > **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:
>
> > > **datatype** [string. Dataset keyword] The data type where we want to extract the point measurement
> >
> > > **lat, lon** [float] latitude and longitude of the point of interest [deg]

latlon_tol [float] tolerance in latitude and longitude in deg. Default 0.0005

delta_rng, delta_azi [float] maximum range distance [m] and azimuth distance [degree] from the central point of the evp containing data to average. Default 5000. and 10.

hmax [float] The maximum height to plot [m]. Default 10000.

hres [float] The height resolution [m]. Default 250.

avg_type [str] The type of averaging to perform. Can be either "mean" or "median" Default "mean"

nvalid_min [int] Minimum number of valid points to consider the data valid when performing the averaging. Default 1

interp_kind [str] type of interpolation when projecting to vertical grid: 'none', or 'nearest', etc. Default 'none'. 'none' will select from all data points within the regular grid height bin the closest to the center of the bin. 'nearest' will select the closest data point to the center of the height bin regardless if it is within the height bin or not. Data points can be masked values If another type of interpolation is selected masked values will be eliminated from the data points before the interpolation

radar_list [list of Radar objects] Optional. list of radar objects

Returns

new_dataset [dict] dictionary containing the EVP and a keyboard stating whether the processing has finished or not.

ind_rad [int] radar index

pyrad.proc.**process_filter_snr**(*procstatus*, *dscfg*, *radar_list=None*)
filters out low SNR echoes

Parameters

procstatus [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

dscfg [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

datatype [list of string. Dataset keyword] The input data types

SNRmin [float. Dataset keyword] The minimum SNR to keep the data.

radar_list [list of Radar objects] Optional. list of radar objects

Returns

new_dataset [dict] dictionary containing the output

ind_rad [int] radar index

pyrad.proc.**process_filter_vel_diff**(*procstatus*, *dscfg*, *radar_list=None*)
filters out range gates that could not be used for Doppler velocity estimation

Parameters

procstatus [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

dscfg [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

datatype [list of string. Dataset keyword] The input data types

SNRmin [float. Dataset keyword] The minimum SNR to keep the data.

radar_list [list of Radar objects] Optional. list of radar objects

Returns

> **new_dataset** [dict] dictionary containing the output
>
> **ind_rad** [int] radar index

pyrad.proc.**process_filter_visibility**(*procstatus*, *dscfg*, *radar_list=None*)
> filters out rays gates with low visibility and corrects the reflectivity

> **Parameters**
>
> > **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing
> >
> > **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:
> >
> > > **datatype** [list of string. Dataset keyword] The input data types
> > >
> > > **VISmin** [float. Dataset keyword] The minimum visibility to keep the data.
> >
> > **radar_list** [list of Radar objects] Optional. list of radar objects
>
> **Returns**
>
> > **new_dataset** [dict] dictionary containing the output
> >
> > **ind_rad** [int] radar index

pyrad.proc.**process_gc_monitoring**(*procstatus*, *dscfg*, *radar_list=None*)
> computes ground clutter monitoring statistics

> **Parameters**
>
> > **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing
> >
> > **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:
> >
> > > **excessgatespath** [str. Config keyword] The path to the gates in excess of quantile location
> > >
> > > **excessgates_fname** [str. Dataset keyword] The name of the gates in excess of quantile file
> > >
> > > **datatype** [list of string. Dataset keyword] The input data types
> > >
> > > **step** [float. Dataset keyword] The width of the histogram bin. Default is None. In that case the default step in function get_histogram_bins is used
> > >
> > > **regular_grid** [Boolean. Dataset keyword] Whether the radar has a Boolean grid or not. Default False
> > >
> > > **val_min** [Float. Dataset keyword] Minimum value to consider that the gate has signal. Default None
> > >
> > > **filter_prec** [str. Dataset keyword] Give which type of volume should be filtered. None, no filtering; keep_wet, keep wet volumes; keep_dry, keep dry volumes.
> > >
> > > **rmax_prec** [float. Dataset keyword] Maximum range to consider when looking for wet gates [m]
> > >
> > > **percent_prec_max** [float. Dataset keyword] Maxim percentage of wet gates to consider the volume dry
> >
> > **radar_list** [list of Radar objects] Optional. list of radar objects
>
> **Returns**
>
> > **new_dataset** [Radar] radar object containing histogram data
> >
> > **ind_rad** [int] radar index

pyrad.proc.**process_grid**(*procstatus*, *dscfg*, *radar_list=None*)
> Puts the radar data in a regular grid

Parameters

> **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing
>
> **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:
>
> > **datatype** [string. Dataset keyword] The data type where we want to extract the point measurement
> >
> > **gridconfig** [dictionary. Dataset keyword] Dictionary containing some or all of this keywords: xmin, xmax, ymin, ymax, zmin, zmax : floats
> >
> > > minimum and maximum horizontal distance from grid origin [km] and minimum and maximum vertical distance from grid origin [m] Defaults -40, 40, -40, 40, 0., 10000.
> > >
> > > **hres, vres** [floats] horizontal and vertical grid resolution [m] Defaults 1000., 500.
> > >
> > > **latorig, lonorig, altorig** [floats] latitude and longitude of grid origin [deg] and altitude of grid origin [m MSL] Defaults the latitude, longitude and altitude of the radar
> >
> > **wfunc** [str] the weighting function used to combine the radar gates close to a grid point. Possible values BARNES, CRESSMAN, NEAREST_NEIGHBOUR Default NEAREST_NEIGHBOUR
> >
> > **roif_func** [str] the function used to compute the region of interest. Possible values: dist_beam, constant
> >
> > **roi** [float] the (minimum) radius of the region of interest in m. Default half the largest resolution
>
> **radar_list** [list of Radar objects] Optional. list of radar objects

Returns

> **new_dataset** [dict] dictionary containing the gridded data
>
> **ind_rad** [int] radar index

pyrad.proc.**process_hydroclass**(*procstatus*, *dscfg*, *radar_list=None*)

> Classifies precipitation echoes

Parameters

> **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing
>
> **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:
>
> > **datatype** [list of string. Dataset keyword] The input data types
> >
> > **HYDRO_METHOD** [string. Dataset keyword] The hydrometeor classification method. One of the following: SEMISUPERVISED
> >
> > **RADARCENTROIDS** [string. Datset keyword] Used with HYDRO_METHOD SEMISUPERVISED. The name of the radar of which the derived centroids will be used. One of the following: A Albis, L Lema, P Plaine Morte, DX50
>
> **radar_list** [list of Radar objects] Optional. list of radar objects

Returns

> **new_dataset** [dict] dictionary containing the output
>
> **ind_rad** [int] radar index

pyrad.proc.**process_hzt**(*procstatus*, *dscfg*, *radar_list=None*)

    Gets iso0 degree data in HZT format and put it in radar coordinates

        Parameters

            procstatus [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

            dscfg [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

                datatype [string. Dataset keyword] arbitrary data type

                keep_in_memory [int. Dataset keyword] if set keeps the COSMO data dict, the COSMO coordinates dict and the COSMO field in radar coordinates in memory

                regular_grid [int. Dataset keyword] if set it is assume that the radar has a grid constant in time and there is no need to compute a new COSMO field if the COSMO data has not changed

                cosmo_type [str. Dataset keyword] name of the COSMO field to process. Default TEMP

                cosmo_variables [list of strings. Dataset keyword] Py-art name of the COSMO fields. Default temperature

            radar_list [list of Radar objects] Optional. list of radar objects

        Returns

            new_dataset [dict] dictionary containing the output

            ind_rad [int] radar index

pyrad.proc.**process_hzt_coord**(*procstatus*, *dscfg*, *radar_list=None*)

    Gets the HZT indices corresponding to each HZT coordinates

        Parameters

            procstatus [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

            dscfg [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

                datatype [string. Dataset keyword] arbitrary data type

                cosmopath [string. General keyword] path where to store the look up table

            radar_list [list of Radar objects] Optional. list of radar objects

        Returns

            new_dataset [dict] dictionary containing the output

            ind_rad [int] radar index

pyrad.proc.**process_hzt_lookup_table**(*procstatus*, *dscfg*, *radar_list=None*)

    Gets HZT data and put it in radar coordinates using look up tables computed or loaded when initializing

        Parameters

             procstatus [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

            dscfg [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

                datatype [string. Dataset keyword] arbitrary data type

                lookup_table [int. Dataset keyword] if set a pre-computed look up table for the COSMO coordinates is loaded. Otherwise the look up table is computed taking the first radar object as reference

> **regular_grid** [int. Dataset keyword] if set it is assume that the radar has a grid constant in time and therefore there is no need to interpolate the COSMO field in memory to the current radar grid

> **radar_list** [list of Radar objects] Optional. list of radar objects

Returns

> **new_dataset** [dict] dictionary containing the output

> **ind_rad** [int] radar index

pyrad.proc.**process_intercomp**(*procstatus*, *dscfg*, *radar_list=None*)

> intercomparison between two radars

Parameters

> **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

> **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

> > **datatype** [list of string. Dataset keyword] The input data types

> > **coloc_data_dir** [string. Dataset keyword] name of the directory containing the csv file with colocated data

> > **coloc_radars_name** [string. Dataset keyword] string identifying the radar names

> > **azi_tol** [float. Dataset keyword] azimuth tolerance between the two radars. Default 0.5 deg

> > **ele_tol** [float. Dataset keyword] elevation tolerance between the two radars. Default 0.5 deg

> > **rng_tol** [float. Dataset keyword] range tolerance between the two radars. Default 50 m

> **radar_list** [list of Radar objects] Optional. list of radar objects

Returns

> **new_dataset** [dict] dictionary containing a dictionary with intercomparison data and the key "final" which contains a boolean that is true when all volumes have been processed

> **ind_rad** [int] radar index

pyrad.proc.**process_intercomp_time_avg**(*procstatus*, *dscfg*, *radar_list=None*)

> intercomparison between the average reflectivity of two radars

Parameters

> **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

> **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

> > **datatype** [list of string. Dataset keyword] The input data types

> > **coloc_data_dir** [string. Dataset keyword] name of the directory containing the csv file with colocated data

> > **coloc_radars_name** [string. Dataset keyword] string identifying the radar names

> > **azi_tol** [float. Dataset keyword] azimuth tolerance between the two radars. Default 0.5 deg

> > **ele_tol** [float. Dataset keyword] elevation tolerance between the two radars. Default 0.5 deg

> > **rng_tol** [float. Dataset keyword] range tolerance between the two radars. Default 50 m

clt_max [int. Dataset keyword] maximum number of samples that can be clutter contaminated. Default 100 i.e. all

phi_excess_max [int. Dataset keyword] maximum number of samples that can have excess instantaneous PhiDP. Default 100 i.e. all

non_rain_max [int. Dataset keyword] maximum number of samples that can be no rain. Default 100 i.e. all

phi_avg_max [float. Dataset keyword] maximum average PhiDP allowed. Default 600 deg i.e. any

radar_list [list of Radar objects] Optional. list of radar objects

Returns

new_dataset [dict] dictionary containing a dictionary with intercomparison data and the key "final" which contains a boolean that is true when all volumes have been processed

ind_rad [int] radar index

pyrad.proc.**process_kdp_leastsquare_double_window**(*procstatus*, *dscfg*, *radar_list=None*)
    Computes specific differential phase using a piecewise least square method

Parameters

procstatus [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

dscfg [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

datatype [list of string. Dataset keyword] The input data types

rwinds [float. Dataset keyword] The length of the short segment for the least square method [m]

rwindl [float. Dataset keyword] The length of the long segment for the least square method [m]

Zthr [float. Dataset keyword] The threshold defining which estimated data to use [dBZ]

radar_list [list of Radar objects] Optional. list of radar objects

Returns

new_dataset [dict] dictionary containing the output

ind_rad [int] radar index

pyrad.proc.**process_kdp_leastsquare_single_window**(*procstatus*, *dscfg*, *radar_list=None*)
    Computes specific differential phase using a piecewise least square method

Parameters

procstatus [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

dscfg [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

datatype [list of string. Dataset keyword] The input data types

rwind [float. Dataset keyword] The length of the segment for the least square method [m]

radar_list [list of Radar objects] Optional. list of radar objects

Returns

new_dataset [dict] dictionary containing the output

ind_rad [int] radar index

pyrad.proc.**process_l**(*procstatus*, *dscfg*, *radar_list=None*)
> Computes L parameter
>> **Parameters**
>>> **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing
>>>
>>> **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:
>>>> **datatype** [string. Dataset keyword] The input data type
>>>
>>> **radar_list** [list of Radar objects] Optional. list of radar objects
>>
>> **Returns**
>>> **new_dataset** [dict] dictionary containing the output
>>>
>>> **ind_rad** [int] radar index

pyrad.proc.**process_melting_layer**(*procstatus*, *dscfg*, *radar_list=None*)
> Detects the melting layer
>> **Parameters**
>>> **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing
>>>
>>> **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:
>>>> **datatype** [list of string. Dataset keyword] The input data types
>>>
>>> **radar_list** [list of Radar objects] Optional. list of radar objects
>>
>> **Returns**
>>> **new_dataset** [dict] dictionary containing the output
>>>
>>> **ind_rad** [int] radar index

pyrad.proc.**process_monitoring**(*procstatus*, *dscfg*, *radar_list=None*)
> computes monitoring statistics
>> **Parameters**
>>> **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing
>>>
>>> **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:
>>>> **datatype** [list of string. Dataset keyword] The input data types
>>>>
>>>> **step** [float. Dataset keyword] The width of the histogram bin. Default is None. In that case the default step in function get_histogram_bins is used
>>>
>>> **radar_list** [list of Radar objects] Optional. list of radar objects
>>
>> **Returns**
>>> **new_dataset** [Radar] radar object containing histogram data
>>>
>>> **ind_rad** [int] radar index

pyrad.proc.**process_occurrence**(*procstatus*, *dscfg*, *radar_list=None*)
> computes the frequency of occurrence of data. It looks only for gates where data is present.
>> **Parameters**
>>> **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing
>>>
>>> **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:
>>>> **datatype** [list of string. Dataset keyword] The input data types

> **regular_grid** [Boolean. Dataset keyword] Whether the radar has a Boolean grid or not. Default False
>
> **rmin, rmax** [float. Dataset keyword] minimum and maximum ranges where the computation takes place. If -1 the whole range is considered. Default is -1
>
> **val_min** [Float. Dataset keyword] Minimum value to consider that the gate has signal. Default None
>
> **filter_prec** [str. Dataset keyword] Give which type of volume should be filtered. None, no filtering; keep_wet, keep wet volumes; keep_dry, keep dry volumes.
>
> **rmax_prec** [float. Dataset keyword] Maximum range to consider when looking for wet gates [m]
>
> **percent_prec_max** [float. Dataset keyword] Maxim percentage of wet gates to consider the volume dry

> **radar_list** [list of Radar objects] Optional. list of radar objects

> **Returns**

> **new_dataset** [dict] dictionary containing the output

> **ind_rad** [int] radar index

pyrad.proc.**process_occurrence_period**(*procstatus*, *dscfg*, *radar_list=None*)
    computes the frequency of occurrence over a long period of time by adding together shorter periods

> **Parameters**

> **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

> **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

> > **datatype** [list of string. Dataset keyword] The input data types
> >
> > **regular_grid** [Boolean. Dataset keyword] Whether the radar has a Boolean grid or not. Default False
> >
> > **rmin, rmax** [float. Dataset keyword] minimum and maximum ranges where the computation takes place. If -1 the whole range is considered. Default is -1

> **radar_list** [list of Radar objects] Optional. list of radar objects

> **Returns**

> **new_dataset** [dict] dictionary containing the output

> **ind_rad** [int] radar index

pyrad.proc.**process_outlier_filter**(*procstatus*, *dscfg*, *radar_list=None*)
    filters out gates which are outliers respect to the surrounding

> **Parameters**

> **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

> **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

> > **datatype** [list of string. Dataset keyword] The input data types
> >
> > **threshold** [float. Dataset keyword] The distance between the value of the examined range gate and the median of the surrounding gates to consider the gate an outlier
> >
> > **nb** [int. Dataset keyword] The number of neighbours (to one side) to analyse. i.e. 2 would correspond to 24 gates

> **nb_min** [int. Dataset keyword] Minimum number of neighbouring gates to consider the examined gate valid
>
> **percentile_min, percentile_max** [float. Dataset keyword] gates below (above) these percentiles (computed over the sweep) are considered potential outliers and further examined

radar_list [list of Radar objects] Optional. list of radar objects

Returns

> **new_dataset** [dict] dictionary containing the output
>
> **ind_rad** [int] radar index

pyrad.proc.**process_phidp_kdp_Kalman**(*procstatus*, *dscfg*, *radar_list=None*)

Computes specific differential phase and differential phase using the Kalman filter as proposed by Schneebeli et al. The data is assumed to be clutter free and continous

Parameters

> **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing
>
> **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:
>
> > **datatype** [list of string. Dataset keyword] The input data types
> >
> > **parallel** [boolean. Dataset keyword] if set use parallel computing
> >
> > **get_phidp** [boolean. Datset keyword] if set the PhiDP computed by integrating the resultant KDP is added to the radar field
>
> **radar_list** [list of Radar objects] Optional. list of radar objects

Returns

> **new_dataset** [dict] dictionary containing the output
>
> **ind_rad** [int] radar index

pyrad.proc.**process_phidp_kdp_Maesaka**(*procstatus*, *dscfg*, *radar_list=None*)

Estimates PhiDP and KDP using the method by Maesaka. This method only retrieves data in rain (i.e. below the melting layer)

Parameters

> **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing
>
> **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:
>
> > **datatype** [list of string. Dataset keyword] The input data types
> >
> > **rmin** [float. Dataset keyword] The minimum range where to look for valid data [m]
> >
> > **rmax** [float. Dataset keyword] The maximum range where to look for valid data [m]
> >
> > **rcell** [float. Dataset keyword] The length of a continuous cell to consider it valid precip [m]
> >
> > **Zmin** [float. Dataset keyword] The minimum reflectivity [dBZ]
> >
> > **Zmax** [float. Dataset keyword] The maximum reflectivity [dBZ]
> >
> > **fzl** [float. Dataset keyword] The freezing level height [m]. Default 2000.
> >
> > **ml_thickness** [float. Dataset keyword] The melting layer thickness in meters. Default 700.
>
> **radar_list** [list of Radar objects] Optional. list of radar objects

Returns

> > **new_dataset** [dict] dictionary containing the output
> >
> > **ind_rad** [int] radar index

pyrad.proc.**process_phidp_kdp_Vulpiani**(*procstatus*, *dscfg*, *radar_list=None*)
> Computes specific differential phase and differential phase using the method developed by Vulpiani et al. The data is assumed to be clutter free and monotonous

> > **Parameters**

> > > **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

> > > **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

> > > > **datatype** [list of string. Dataset keyword] The input data types

> > > > **rwind** [float. Dataset keyword] The length of the segment [m]

> > > > **n_iter** [int. Dataset keyword] number of iterations

> > > > **interp** [boolean. Dataset keyword] if set non valid values are interpolated using neighbouring valid values

> > > > **parallel** [boolean. Dataset keyword] if set use parallel computing

> > > > **get_phidp** [boolean. Datset keyword] if set the PhiDP computed by integrating the resultant KDP is added to the radar field

> > > **radar_list** [list of Radar objects] Optional. list of radar objects

> > **Returns**

> > > **new_dataset** [dict] dictionary containing the output

> > > **ind_rad** [int] radar index

pyrad.proc.**process_phidp_kdp_lp**(*procstatus*, *dscfg*, *radar_list=None*)
> Estimates PhiDP and KDP using a linear programming algorithm. This method only retrieves data in rain (i.e. below the melting layer)

> > **Parameters**

> > > **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

> > > **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

> > > > **datatype** [list of string. Dataset keyword] The input data types

> > > > **fzl** [float. Dataset keyword] The freezing level height [m]. Default 2000.

> > > > **ml_thickness** [float. Dataset keyword] The melting layer thickness in meters. Default 700.

> > > **radar_list** [list of Radar objects] Optional. list of radar objects

> > **Returns**

> > > **new_dataset** [dict] dictionary containing the output

> > > **ind_rad** [int] radar index

pyrad.proc.**process_point_measurement**(*procstatus*, *dscfg*, *radar_list=None*)
> Obtains the radar data at a point location.

> > **Parameters**

> > > **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

> > > **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

datatype [string. Dataset keyword] The data type where we want to extract the point measurement

latlon [boolean. Dataset keyword] if True position is obtained from latitude, longitude information, otherwise position is obtained from antenna coordinates (range, azimuth, elevation).

truealt [boolean. Dataset keyword] if True the user input altitude is used to determine the point of interest. if False use the altitude at a given radar elevation ele over the point of interest.

lon [float. Dataset keyword] the longitude [deg]. Use when latlon is True.

lat [float. Dataset keyword] the latitude [deg]. Use when latlon is True.

alt [float. Dataset keyword] altitude [m MSL]. Use when latlon is True.

ele [float. Dataset keyword] radar elevation [deg]. Use when latlon is False or when latlon is True and truealt is False

azi [float. Dataset keyword] radar azimuth [deg]. Use when latlon is False

rng [float. Dataset keyword] range from radar [m]. Use when latlon is False

AziTol [float. Dataset keyword] azimuthal tolerance to determine which radar azimuth to use [deg]

EleTol [float. Dataset keyword] elevation tolerance to determine which radar elevation to use [deg]

RngTol [float. Dataset keyword] range tolerance to determine which radar bin to use [m]

radar_list [list of Radar objects] Optional. list of radar objects

Returns

new_dataset [dict] dictionary containing the data and metadata at the point of interest

ind_rad [int] radar index

pyrad.proc.**process_qvp**(*procstatus*, *dscfg*, *radar_list=None*)
    Computes quasi vertical profiles, by averaging over height levels PPI data.

Parameters

procstatus [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

dscfg [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

datatype [string. Dataset keyword] The data type where we want to extract the point measurement

angle [int or float] If the radar object contains a PPI volume, the sweep number to use, if it contains an RHI volume the elevation angle. Default 0.

ang_tol [float] If the radar object contains an RHI volume, the tolerance in the elevation angle for the conversion into PPI

hmax [float] The maximum height to plot [m]. Default 10000.

hres [float] The height resolution [m]. Default 50

avg_type [str] The type of averaging to perform. Can be either "mean" or "median" Default "mean"

nvalid_min [int] Minimum number of valid points to accept average. Default 30.

> **interp_kind** [str] type of interpolation when projecting to vertical grid: 'none', or 'nearest',
> etc. Default 'none' 'none' will select from all data points within the regular grid height
> bin the closest to the center of the bin. 'nearest' will select the closest data point to
> the center of the height bin regardless if it is within the height bin or not. Data points
> can be masked values If another type of interpolation is selected masked values will be
> eliminated from the data points before the interpolation

> **radar_list** [list of Radar objects] Optional. list of radar objects

> **Returns**

> > **new_dataset** [dict] dictionary containing the QVP and a keyboard stating whether the process-
> > ing has finished or not.

> > **ind_rad** [int] radar index

pyrad.proc.**process_rainrate**(*procstatus*, *dscfg*, *radar_list=None*)
> Estimates rainfall rate from polarimetric moments

> > **Parameters**

> > > **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

> > > **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

> > > > **datatype** [string. Dataset keyword] The input data type

> > > > **RR_METHOD** [string. Dataset keyword] The rainfall rate estimation method. One of the
> > > > following: Z, ZPoly, KDP, A, ZKDP, ZA, hydro

> > > **radar_list** [list of Radar objects] Optional. list of radar objects

> > **Returns**

> > > **new_dataset** [dict] dictionary containing the output

> > > **ind_rad** [int] radar index

pyrad.proc.**process_raw**(*procstatus*, *dscfg*, *radar_list=None*)
> Dummy function that returns the initial input data set

> > **Parameters**

> > > **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

> > > **dscfg** [dictionary of dictionaries] data set configuration

> > > **radar_list** [list of Radar objects] Optional. list of radar objects

> > **Returns**

> > > **new_dataset** [dict] dictionary containing the output

> > > **ind_rad** [int] radar index

pyrad.proc.**process_rcs**(*procstatus*, *dscfg*, *radar_list=None*)
> Computes the radar cross-section (assuming a point target) from radar reflectivity.

> > **Parameters**

> > > **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

> > > **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

> > > > **datatype** [list of string. Dataset keyword] The input data types

> > > > **kw2** [float. Dataset keyowrd] The water constant

> **pulse_width** [float. Dataset keyowrd] The pulse width [s]
>
> **beamwidthv** [float. Global keyword] The vertical polarization antenna beamwidth [deg]. Used if input is vertical reflectivity
>
> **beamwidthh** [float. Global keyword] The horizontal polarization antenna beamwidth [deg]. Used if input is horizontal reflectivity

radar_list [list of Radar objects] Optional. list of radar objects

Returns

> **new_dataset** [dict] dictionary containing the output
>
> **ind_rad** [int] radar index

pyrad.proc.**process_rcs_pr**(*procstatus*, *dscfg*, *radar_list=None*)

Computes the radar cross-section (assuming a point target) from radar reflectivity by first computing the received power and then the RCS from it.

Parameters

> **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing
>
> **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:
>
>> **datatype** [list of string. Dataset keyword] The input data types
>>
>> **antenna_gain** [float. Global keyword] The antenna gain [dB]
>>
>> **txpwrv** [float. Global keyword] The transmitted power of the vertical channel [dBm]. Used if input is vertical reflectivity
>>
>> **mflossv** [float. Global keyword] The matching filter losses of the vertical channel. Used if input is vertical reflectivity
>>
>> **radconstv** [float. Global keyword] The vertical channel radar constant. Used if input is vertical reflectivity
>>
>> **lrxv** [float. Global keyword] The receiver losses from the antenna feed to the reference point. [dB] positive value Used if input is vertical reflectivity
>>
>> **ltxv** [float. Global keyword] The transmitter losses from the output of the high power amplifier to the antenna feed. [dB] positive value Used if input is vertical reflectivity
>>
>> **lradomev** [float. Global keyword] The 1-way dry radome losses [dB] positive value. Used if input is vertical reflectivity
>>
>> **txpwrh** [float. Global keyword] The transmitted power of the horizontal channel [dBm]. Used if input is horizontal reflectivity
>>
>> **mflossh** [float. Global keyword] The matching filter losses of the vertical channel. Used if input is horizontal reflectivity
>>
>> **radconsth** [float. Global keyword] The horizontal channel radar constant. Used if input is horizontal reflectivity
>>
>> **lrxh** [float. Global keyword] The receiver losses from the antenna feed to the reference point. [dB] positive value Used if input is horizontal reflectivity
>>
>> **ltxh** [float. Global keyword] The transmitter losses from the output of the high power amplifier to the antenna feed. [dB] positive value Used if input is horizontal reflectivity
>>
>> **lradomeh** [float. Global keyword] The 1-way dry radome losses [dB] positive value. Used if input is horizontal reflectivity

> > **attg** [float. Dataset keyword] The gas attenuation
>
> > **radar_list** [list of Radar objects] Optional. list of radar objects
>
> > **Returns**
>
> > > **new_dataset** [dict] dictionary containing the output
> >
> > > **ind_rad** [int] radar index

pyrad.proc.**process_rhohv_rain**(*procstatus*, *dscfg*, *radar_list=None*)

> Keeps only suitable data to evaluate the 80 percentile of RhoHV in rain

> > **Parameters**
>
> > > **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing
> >
> > > **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:
> > >
> > > > **datatype** [list of string. Dataset keyword] The input data types
> > > >
> > > > **rmin** [float. Dataset keyword] minimum range where to look for rain [m]. Default 1000.
> > > >
> > > > **rmax** [float. Dataset keyword] maximum range where to look for rain [m]. Default 50000.
> > > >
> > > > **Zmin** [float. Dataset keyword] minimum reflectivity to consider the bin as precipitation [dBZ]. Default 20.
> > > >
> > > > **Zmax** [float. Dataset keyword] maximum reflectivity to consider the bin as precipitation [dBZ] Default 40.
> > > >
> > > > **ml_thickness** [float. Dataset keyword] assumed thickness of the melting layer. Default 700.
> > > >
> > > > **fzl** [float. Dataset keyword] The default freezing level height. It will be used if no temperature field name is specified or the temperature field is not in the radar object. Default 2000.
> > >
> > > **radar_list** [list of Radar objects] Optional. list of radar objects
> >
> > > **Returns**
> >
> > > > **new_dataset** [dict] dictionary containing the output
> > > >
> > > > **ind_rad** [int] radar index

pyrad.proc.**process_roi**(*procstatus*, *dscfg*, *radar_list=None*)

> Obtains the radar data at a region of interest.

> > **Parameters**
>
> > > **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing
> >
> > > **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:
> > >
> > > > **datatype** [string. Dataset keyword] The data type where we want to extract the point measurement
> > >
> > > **radar_list** [list of Radar objects] Optional. list of radar objects
> >
> > > **Returns**
> >
> > > > **new_dataset** [dict] dictionary containing the data and metadata at the point of interest
> > > >
> > > > **ind_rad** [int] radar index

pyrad.proc.**process_rqvp**(*procstatus*, *dscfg*, *radar_list=None*)

> Computes range defined quasi vertical profiles, by averaging over height levels PPI data.

Parameters

procstatus [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

dscfg [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

datatype [string. Dataset keyword] The data type where we want to extract the point measurement

anglenr [int] The sweep number to use. It assumes the radar volume consists on PPI scans

hmax [float] The maximum height to plot [m]. Default 10000.

hres [float] The height resolution [m]. Default 2.

avg_type [str] The type of averaging to perform. Can be either "mean" or "median" Default "mean"

nvalid_min [int] Minimum number of valid points to accept average. Default 30.

interp_kind [str] type of interpolation when projecting to vertical grid: 'none', or 'nearest', etc. Default 'nearest' 'none' will select from all data points within the regular grid height bin the closest to the center of the bin. 'nearest' will select the closest data point to the center of the height bin regardless if it is within the height bin or not. Data points can be masked values If another type of interpolation is selected masked values will be eliminated from the data points before the interpolation

rmax [float] ground range up to which the data is intended for use [m]. Default 50000.

weight_power [float] Power p of the weighting function 1/abs(grng-(rmax-1))**p given to the data outside the desired range. -1 will set the weight to 0. Default 2.

radar_list [list of Radar objects] Optional. list of radar objects

Returns

new_dataset [dict] dictionary containing the QVP and a keyboard stating whether the processing has finished or not.

ind_rad [int] radar index

pyrad.proc.**process_save_radar**(*procstatus*, *dscfg*, *radar_list=None*)
Dummy function that allows to save the entire radar object

Parameters

procstatus [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

dscfg [dictionary of dictionaries] data set configuration

radar_list [list of Radar objects] Optional. list of radar objects

Returns

new_dataset [dict] dictionary containing the output

ind_rad [int] radar index

pyrad.proc.**process_selfconsistency_bias**(*procstatus*, *dscfg*, *radar_list=None*)
Estimates the reflectivity bias by means of the selfconsistency algorithm by Gourley

Parameters

procstatus [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

dscfg [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

datatype [list of string. Dataset keyword] The input data types

fzl [float. Dataset keyword] Default freezing level height. Default 2000.

rsmooth [float. Dataset keyword] length of the smoothing window [m]. Default 1000.

min_rhohv [float. Dataset keyword] minimum valid RhoHV. Default 0.92

max_phidp [float. Dataset keyword] maximum valid PhiDP [deg]. Default 20.

ml_thickness [float. Dataset keyword] Melting layer thickness [m]. Default 700.

rcell [float. Dataset keyword] length of continuous precipitation to consider the precipitation cell a valid phidp segment [m]. Default 1000.

dphidp_min [float. Dataset keyword] minimum phase shift [deg]. Default 2.

dphidp_max [float. Dataset keyword] maximum phase shift [deg]. Default 16.

radar_list [list of Radar objects] Optional. list of radar objects

Returns

new_dataset [dict] dictionary containing the output

ind_rad [int] radar index

pyrad.proc.**process_selfconsistency_kdp_phidp**(*procstatus*, *dscfg*, *radar_list=None*)
Computes specific differential phase and differential phase in rain using the selfconsistency between Zdr, Zh and KDP

Parameters

procstatus [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

dscfg [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

datatype [list of strings. Dataset keyword] The input data types

rsmooth [float. Dataset keyword] length of the smoothing window [m]. Default 1000.

min_rhohv [float. Dataset keyword] minimum valid RhoHV. Default 0.92

max_phidp [float. Dataset keyword] maximum valid PhiDP [deg]. Default 20.

ml_thickness [float. Dataset keyword] assumed melting layer thickness [m]. Default 700.

fzl [float. Dataset keyword] The default freezing level height. It will be used if no temperature field name is specified or the temperature field is not in the radar object. Default 2000.

radar_list [list of Radar objects] Optional. list of radar objects

Returns

new_dataset [dict] dictionary containing the output

ind_rad [int] radar index

pyrad.proc.**process_signal_power**(*procstatus*, *dscfg*, *radar_list=None*)
Computes the signal power in dBm

Parameters

procstatus [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

dscfg [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

datatype [list of string. Dataset keyword] The input data types

mflossv [float. Global keyword] The matching filter losses of the vertical channel. Used if input is vertical reflectivity

radconstv [float. Global keyword] The vertical channel radar constant. Used if input is vertical reflectivity

lrxv [float. Global keyword] The receiver losses from the antenna feed to the reference point. [dB] positive value Used if input is vertical reflectivity

lradomev [float. Global keyword] The 1-way dry radome losses [dB] positive value. Used if input is vertical reflectivity

mflossh [float. Global keyword] The matching filter losses of the vertical channel. Used if input is horizontal reflectivity

radconsth [float. Global keyword] The horizontal channel radar constant. Used if input is horizontal reflectivity

lrxh [float. Global keyword] The receiver losses from the antenna feed to the reference point. [dB] positive value Used if input is horizontal reflectivity

lradomeh [float. Global keyword] The 1-way dry radome losses [dB] positive value. Used if input is horizontal reflectivity

attg [float. Dataset keyword] The gas attenuation

radar_list [list of Radar objects] Optional. list of radar objects

Returns

new_dataset [dict] dictionary containing the output

ind_rad [int] radar index

pyrad.proc.**process_smooth_phidp_double_window**(*procstatus*, *dscfg*, *radar_list=None*)
corrects phidp of the system phase and smoothes it using one window

Parameters

procstatus [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

dscfg [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

datatype [list of string. Dataset keyword] The input data types

rmin [float. Dataset keyword] The minimum range where to look for valid data [m]

rmax [float. Dataset keyword] The maximum range where to look for valid data [m]

rcell [float. Dataset keyword] The length of a continuous cell to consider it valid precip [m]

rwinds [float. Dataset keyword] The length of the short smoothing window [m]

rwindl [float. Dataset keyword] The length of the long smoothing window [m]

Zmin [float. Dataset keyword] The minimum reflectivity [dBZ]

Zmax [float. Dataset keyword] The maximum reflectivity [dBZ]

Zthr [float. Dataset keyword] The threshold defining wich smoothed data to used [dBZ]

radar_list [list of Radar objects] Optional. list of radar objects

Returns

new_dataset [dict] dictionary containing the output

ind_rad [int] radar index

pyrad.proc.**process_smooth_phidp_single_window**(*procstatus*, *dscfg*, *radar_list=None*)
> corrects phidp of the system phase and smoothes it using one window

> > **Parameters**

> > > **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

> > > **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

> > > > **datatype** [list of string. Dataset keyword] The input data types

> > > > **rmin** [float. Dataset keyword] The minimum range where to look for valid data [m]

> > > > **rmax** [float. Dataset keyword] The maximum range where to look for valid data [m]

> > > > **rcell** [float. Dataset keyword] The length of a continuous cell to consider it valid precip [m]

> > > > **rwind** [float. Dataset keyword] The length of the smoothing window [m]

> > > > **Zmin** [float. Dataset keyword] The minimum reflectivity [dBZ]

> > > > **Zmax** [float. Dataset keyword] The maximum reflectivity [dBZ]

> > > **radar_list** [list of Radar objects] Optional. list of radar objects

> > **Returns**

> > > **new_dataset** [dict] dictionary containing the output

> > > **ind_rad** [int] radar index

pyrad.proc.**process_snr**(*procstatus*, *dscfg*, *radar_list=None*)
> Computes SNR

> > **Parameters**

> > > **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

> > > **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

> > > > **datatype** [string. Dataset keyword] The input data type

> > > > **output_type** [string. Dataset keyword] The output data type. Either SNRh or SNRv

> > > **radar_list** [list of Radar objects] Optional. list of radar objects

> > **Returns**

> > > **new_dataset** [dict] dictionary containing the output

> > > **ind_rad** [int] radar index

pyrad.proc.**process_sun_hits**(*procstatus*, *dscfg*, *radar_list=None*)
> monitoring of the radar using sun hits

> > **Parameters**

> > > **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

> > > **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

> > > > **datatype** [list of string. Dataset keyword] The input data types

> > > > **rmin** [float. Dataset keyword] minimum range where to look for a sun hit signal [m]. Default 50000.

> > > > **hmin** [float. Dataset keyword] minimum altitude where to look for a sun hit signal [m MSL]. Default 10000. The actual range from which a sun hit signal will be search will be the minimum between rmin and the range from which the altitude is higher than hmin.

delev_max [float. Dataset keyword] maximum elevation distance from nominal radar elevation where to look for a sun hit signal [deg]. Default 1.5

dazim_max [float. Dataset keyword] maximum azimuth distance from nominal radar elevation where to look for a sun hit signal [deg]. Default 1.5

elmin [float. Dataset keyword] minimum radar elevation where to look for sun hits [deg]. Default 1.

nbins_min [int. Dataset keyword.] minimum number of range bins that have to contain signal to consider the ray a potential sun hit. Default 10.

attg [float. Dataset keyword] gaseous attenuation. Default None

max_std_pwr [float. Dataset keyword] maximum standard deviation of the signal power to consider the data a sun hit [dB]. Default 2.

max_std_zdr [float. Dataset keyword] maximum standard deviation of the ZDR to consider the data a sun hit [dB]. Default 2.

az_width_co [float. Dataset keyword] co-polar antenna azimuth width (convoluted with sun width) [deg]. Default None

el_width_co [float. Dataset keyword] co-polar antenna elevation width (convoluted with sun width) [deg]. Default None

az_width_cross [float. Dataset keyword] cross-polar antenna azimuth width (convoluted with sun width) [deg]. Default None

el_width_cross [float. Dataset keyword] cross-polar antenna elevation width (convoluted with sun width) [deg]. Default None

ndays [int. Dataset keyword] number of days used in sun retrieval. Default 1

coeff_band [float. Dataset keyword] multiplicate coefficient to transform pulse width into receiver bandwidth

radar_list [list of Radar objects] Optional. list of radar objects

Returns

sun_hits_dict [dict] dictionary containing a radar object, a sun_hits dict and a sun_retrieval dictionary

ind_rad [int] radar index

pyrad.proc.**process_svp**(*procstatus*, *dscfg*, *radar_list=None*)
    Computes slanted vertical profiles, by averaging over height levels PPI data.

Parameters

procstatus [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

dscfg [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

datatype [string. Dataset keyword] The data type where we want to extract the point measurement

angle [int or float] If the radar object contains a PPI volume, the sweep number to use, if it contains an RHI volume the elevation angle. Default 0.

ang_tol [float] If the radar object contains an RHI volume, the tolerance in the elevation angle for the conversion into PPI

lat, lon [float] latitude and longitude of the point of interest [deg]

latlon_tol [float] tolerance in latitude and longitude in deg. Default 0.0005

delta_rng, delta_azi [float] maximum range distance [m] and azimuth distance [degree] from the central point of the svp containing data to average. Default 5000. and 10.

hmax [float] The maximum height to plot [m]. Default 10000.

hres [float] The height resolution [m]. Default 250.

avg_type [str] The type of averaging to perform. Can be either "mean" or "median" Default "mean"

nvalid_min [int] Minimum number of valid points to consider the data valid when performing the averaging. Default 1

interp_kind [str] type of interpolation when projecting to vertical grid: 'none', or 'nearest', etc. Default 'none' 'none' will select from all data points within the regular grid height bin the closest to the center of the bin. 'nearest' will select the closest data point to the center of the height bin regardless if it is within the height bin or not. Data points can be masked values If another type of interpolation is selected masked values will be eliminated from the data points before the interpolation

radar_list [list of Radar objects] Optional. list of radar objects

Returns

new_dataset [dict] dictionary containing the svp and a keyboard stating whether the processing has finished or not.

ind_rad [int] radar index

pyrad.proc.**process_time_avg**(*procstatus*, *dscfg*, *radar_list=None*)
computes the temporal mean of a field

Parameters

procstatus [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

dscfg [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

datatype [list of string. Dataset keyword] The input data types

period [float. Dataset keyword] the period to average [s]. Default 3600.

start_average [float. Dataset keyword] when to start the average [s from midnight UTC]. Default 0.

lin_trans: int. Dataset keyword If 1 apply linear transformation before averaging

radar_list [list of Radar objects] Optional. list of radar objects

Returns

new_dataset [dict] dictionary containing the output

ind_rad [int] radar index

pyrad.proc.**process_time_avg_flag**(*procstatus*, *dscfg*, *radar_list=None*)
computes a flag field describing the conditions of the data used while averaging

Parameters

procstatus [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

dscfg [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

datatype [list of string. Dataset keyword] The input data types

period [float. Dataset keyword] the period to average [s]. Default 3600.

start_average [float. Dataset keyword] when to start the average [s from midnight UTC]. Default 0.

phidpmax: float. Dataset keyword maximum PhiDP

radar_list [list of Radar objects] Optional. list of radar objects

Returns

new_dataset [Radar] radar object

ind_rad [int] radar index

pyrad.proc.**process_time_height**(*procstatus*, *dscfg*, *radar_list=None*)

Produces time height radar objects at a point of interest defined by latitude and longitude. A time-height contains the evolution of the vertical structure of radar measurements above the location of interest.

Parameters

procstatus [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

dscfg [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

datatype [string. Dataset keyword] The data type where we want to extract the point measurement

lat, lon [float] latitude and longitude of the point of interest [deg]

latlon_tol [float] tolerance in latitude and longitude in deg. Default 0.0005

hmax [float] The maximum height to plot [m]. Default 10000.

hres [float] The height resolution [m]. Default 50

interp_kind [str] type of interpolation when projecting to vertical grid: 'none', or 'nearest', etc. Default 'none' 'none' will select from all data points within the regular grid height bin the closest to the center of the bin. 'nearest' will select the closest data point to the center of the height bin regardless if it is within the height bin or not. Data points can be masked values If another type of interpolation is selected masked values will be eliminated from the data points before the interpolation

radar_list [list of Radar objects] Optional. list of radar objects

Returns

new_dataset [dict] dictionary containing the QVP and a keyboard stating whether the processing has finished or not.

ind_rad [int] radar index

pyrad.proc.**process_traj_antenna_pattern**(*procstatus*, *dscfg*, *radar_list=None*, *trajectory=None*)

Process a new array of data volumes considering a plane trajectory. As result a timeseries with the values transposed for a given antenna pattern is created. The result is created when the LAST flag is set.

Parameters

procstatus [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

dscfg [dictionary of dictionaries]

datatype [list of string. Dataset keyword] The input data types

antennaType [str. Dataset keyword] Type of antenna of the radar we want to get the view from. Can be AZIMUTH, ELEVATION, LOWBEAM, HIGHBEAM

par_azimuth_antenna [dict. Global ekyword] Dictionary containing the parameters of the PAR azimuth antenna, i.e. name of the file with the antenna elevation pattern and fixed antenna angle

par_elevation_antenna [dict. Global keyword] Dictionary containing the parameters of the PAR elevation antenna, i.e. name of the file with the antenna azimuth pattern and fixed antenna angle

asr_lowbeam_antenna [dict. Global keyword] Dictionary containing the parameters of the ASR low beam antenna, i.e. name of the file with the antenna elevation pattern and fixed antenna angle

asr_highbeam_antenna [dict. Global keyword] Dictionary containing the parameters of the ASR high beam antenna, i.e. name of the file with the antenna elevation pattern and fixed antenna angle

target_radar_pos [dict. Global keyword] Dictionary containing the latitude, longitude and altitude of the radar we want to get the view from. If not specifying it will assume the radar is collocated

range_all [Bool. Dataset keyword] If the real radar and the synthetic radar are co-located and this parameter is true the statistics are going to be computed using all the data from range 0 to the position of the plane. Default False

rhi_resolution [Bool. Dataset keyword] Resolution of the synthetic RHI used to compute the data as viewed from the synthetic radar [deg]. Default 0.5

max_altitude [float. Dataset keyword] Max altitude of the data to use when computing the view from the synthetic radar [m MSL]. Default 12000.

latlon_tol [float. Dataset keyword] The tolerance in latitude and longitude to determine which synthetic radar gates are co-located with real radar gates [deg]. Default 0.04

alt_tol [float. Datset keyword] The tolerance in altitude to determine which synthetic radar gates are co-located with real radar gates [m]. Default 1000.

pattern_thres [float. Dataset keyword] The minimum of the sum of the weights given to each value in order to consider the weighted quantile valid. It is related to the number of valid data points

data_is_log [dict. Dataset keyword] Dictionary specifying for each field if it is in log (True) or linear units (False). Default False

use_nans [dict. Dataset keyword] Dictionary specyfing whether the nans have to be used in the computation of the statistics for each field. Default False

nan_value [dict. Dataset keyword] Dictionary with the value to use to substitute the NaN values when computing the statistics of each field. Default 0

radar_list [list of Radar objects] Optional. list of radar objects

trajectory [Trajectory object] containing trajectory samples

Returns

trajectory [Trajectory object] Object holding time series

ind_rad [int] radar index

pyrad.proc.**process_traj_atplane**(*procstatus*, *dscfg*, *radar_list=None*, *trajectory=None*)
    Return time series according to trajectory

Parameters

procstatus [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

dscfg [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

datatype [list of string. Dataset keyword] The input data types

data_is_log [dict. Dataset keyword] Dictionary specifying for each field if it is in log (True) or linear units (False). Default False

ang_tol [float. Dataset keyword] Factor that multiplies the angle resolution. Used when determining the neighbouring rays. Default 1.2

radar_list [list of Radar objects] Optional. list of radar objects

trajectory [Trajectory object] containing trajectory samples

Returns

trajectory [Trajectory object] Object holding time series

ind_rad [int] radar index

pyrad.proc.**process_traj_lightning**(*procstatus*, *dscfg*, *radar_list=None*, *trajectory=None*)
Return time series according to lightning trajectory

Parameters

procstatus [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

dscfg [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

datatype [list of string. Dataset keyword] The input data types

data_is_log [dict. Dataset keyword] Dictionary specifying for each field if it is in log (True) or linear units (False). Default False

ang_tol [float. Dataset keyword] Factor that multiplies the angle resolution. Used when determining the neighbouring rays. Default 1.2

radar_list [list of Radar objects] Optional. list of radar objects

trajectory [Trajectory object] containing trajectory samples

Returns

trajectory [Trajectory object] Object holding time series

ind_rad [int] radar index

pyrad.proc.**process_traj_trt**(*procstatus*, *dscfg*, *radar_list=None*, *trajectory=None*)
Processes data according to TRT trajectory

Parameters

procstatus [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

dscfg [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

datatype [list of string. Dataset keyword] The input data types

time_tol [float. Dataset keyword] tolerance between reference time of the radar volume and that of the TRT cell [s]. Default 100.

alt_min, alt_max [float. Dataset keyword] Minimum and maximum altitude of the data inside the TRT cell to retrieve [m MSL]. Default None

radar_list [list of Radar objects] Optional. list of radar objects

trajectory [Trajectory object] containing trajectory samples

> **Returns**
>
> > **trajectory** [Trajectory object] Object holding time series
> >
> > **ind_rad** [int] radar index

pyrad.proc.**process_trajectory**(*procstatus*, *dscfg*, *radar_list=None*, *trajectory=None*)

> Return trajectory
>
> > **Parameters**
> >
> > > **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing
> > >
> > > **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:
> > >
> > > > **datatype** [list of string. Dataset keyword] The input data types
> > >
> > > **radar_list** [list of Radar objects] Optional. list of radar objects
> > >
> > > **trajectory** [Trajectory object] containing trajectory samples
> >
> > **Returns**
> >
> > > **new_dataset** [Trajectory object] radar object
> > >
> > > **ind_rad** [int] None

pyrad.proc.**process_vad**(*procstatus*, *dscfg*, *radar_list=None*)

> Estimates vertical wind profile using the VAD (velocity Azimuth Display) technique
>
> > **Parameters**
> >
> > > **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing
> > >
> > > **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:
> > >
> > > > **datatype** [string. Dataset keyword] The input data type
> > >
> > > **radar_list** [list of Radar objects] Optional. list of radar objects
> >
> > **Returns**
> >
> > > **new_dataset** [dict] dictionary containing the output
> > >
> > > **ind_rad** [int] radar index

pyrad.proc.**process_vol_refl**(*procstatus*, *dscfg*, *radar_list=None*)

> Computes the volumetric reflectivity in 10log10(cm^2 km^-3)
>
> > **Parameters**
> >
> > > **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing
> > >
> > > **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:
> > >
> > > > **datatype** [list of string. Dataset keyword] The input data types
> > > >
> > > > **freq** [float. Dataset keyword] The radar frequency
> > > >
> > > > **kw** [float. Dataset keyword] The water constant
> > >
> > > **radar_list** [list of Radar objects] Optional. list of radar objects
> >
> > **Returns**
> >
> > > **new_dataset** [dict] dictionary containing the output
> > >
> > > **ind_rad** [int] radar index

pyrad.proc.**process_weighted_time_avg**(*procstatus*, *dscfg*, *radar_list=None*)
 computes the temporal mean of a field weighted by the reflectivity

> **Parameters**

> **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

> **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

>> **datatype** [list of string. Dataset keyword] The input data types

>> **period** [float. Dataset keyword] the period to average [s]. Default 3600.

>> **start_average** [float. Dataset keyword] when to start the average [s from midnight UTC]. Default 0.

> **radar_list** [list of Radar objects] Optional. list of radar objects

> **Returns**

> **new_dataset** [Radar] radar object

> **ind_rad** [int] radar index

pyrad.proc.**process_wind_vel**(*procstatus*, *dscfg*, *radar_list=None*)
 Estimates the horizontal or vertical component of the wind from the radial velocity

> **Parameters**

> **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

> **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

>> **datatype** [string. Dataset keyword] The input data type

>> **vert_proj** [Boolean] If true the vertical projection is computed. Otherwise the horizontal projection is computed

> **radar_list** [list of Radar objects] Optional. list of radar objects

> **Returns**

> **new_dataset** [dict] dictionary containing the output

> **ind_rad** [int] radar index

pyrad.proc.**process_windshear**(*procstatus*, *dscfg*, *radar_list=None*)
 Estimates the wind shear from the wind velocity

> **Parameters**

> **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

> **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

>> **datatype** [string. Dataset keyword] The input data type

>> **az_tol** [float] The tolerance in azimuth when looking for gates on top of the gate when computation is performed

> **radar_list** [list of Radar objects] Optional. list of radar objects

> **Returns**

> **new_dataset** [dict] dictionary containing the output

> **ind_rad** [int] radar index

pyrad.proc.**process_zdr_column**(*procstatus*, *dscfg*, *radar_list=None*)

    Detects ZDR columns

        Parameters

            procstatus [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

            dscfg [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

                datatype [list of string. Dataset keyword] The input data types

            radar_list [list of Radar objects] Optional. list of radar objects

        Returns

            new_dataset [dict] dictionary containing the output

            ind_rad [int] radar index

pyrad.proc.**process_zdr_precip**(*procstatus*, *dscfg*, *radar_list=None*)

    Keeps only suitable data to evaluate the differential reflectivity in moderate rain or precipitation (for vertical scans)

        Parameters

            procstatus [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing

            dscfg [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:

                datatype [list of string. Dataset keyword] The input data types

                ml_filter [boolean. Dataset keyword] indicates if a filter on data in and above the melting layer is applied. Default True.

                rmin [float. Dataset keyword] minimum range where to look for rain [m]. Default 1000.

                rmax [float. Dataset keyword] maximum range where to look for rain [m]. Default 50000.

                Zmin [float. Dataset keyword] minimum reflectivity to consider the bin as precipitation [dBZ]. Default 20.

                Zmax [float. Dataset keyword] maximum reflectivity to consider the bin as precipitation [dBZ] Default 22.

                RhoHVmin [float. Dataset keyword] minimum RhoHV to consider the bin as precipitation Default 0.97

                PhiDPmax [float. Dataset keyword] maximum PhiDP to consider the bin as precipitation [deg] Default 10.

                elmax [float. Dataset keyword] maximum elevation angle where to look for precipitation [deg] Default None.

                ml_thickness [float. Dataset keyword] assumed thickness of the melting layer. Default 700.

                fzl [float. Dataset keyword] The default freezing level height. It will be used if no temperature field name is specified or the temperature field is not in the radar object. Default 2000.

            radar_list [list of Radar objects] Optional. list of radar objects

        Returns

            new_dataset [dict] dictionary containing the output

            ind_rad [int] radar index

pyrad.proc.**process_zdr_snow**(*procstatus*, *dscfg*, *radar_list=None*)
    Keeps only suitable data to evaluate the differential reflectivity in snow

> **Parameters**
>
>> **procstatus** [int] Processing status: 0 initializing, 1 processing volume, 2 post-processing
>>
>> **dscfg** [dictionary of dictionaries] data set configuration. Accepted Configuration Keywords:
>>
>>> **datatype** [list of string. Dataset keyword] The input data types
>>>
>>> **rmin** [float. Dataset keyword] minimum range where to look for rain [m]. Default 1000.
>>>
>>> **rmax** [float. Dataset keyword] maximum range where to look for rain [m]. Default 50000.
>>>
>>> **Zmin** [float. Dataset keyword] minimum reflectivity to consider the bin as snow [dBZ]. Default 0.
>>>
>>> **Zmax** [float. Dataset keyword] maximum reflectivity to consider the bin as snow [dBZ] Default 30.
>>>
>>> **SNRmin** [float. Dataset keyword] minimum SNR to consider the bin as snow [dB]. Default 10.
>>>
>>> **SNRmax** [float. Dataset keyword] maximum SNR to consider the bin as snow [dB] Default 50.
>>>
>>> **RhoHVmin** [float. Dataset keyword] minimum RhoHV to consider the bin as snow Default 0.97
>>>
>>> **PhiDPmax** [float. Dataset keyword] maximum PhiDP to consider the bin as snow [deg] Default 10.
>>>
>>> **elmax** [float. Dataset keyword] maximum elevation angle where to look for snow [deg] Default None.
>>>
>>> **KDPmax** [float. Dataset keyword] maximum KDP to consider the bin as snow [deg] Default None
>>>
>>> **TEMPmin** [float. Dataset keyword] minimum temperature to consider the bin as snow [deg C]. Default None
>>>
>>> **TEMPmax** [float. Dataset keyword] maximum temperature to consider the bin as snow [deg C] Default None
>>>
>>> **hydroclass** [list of ints. Dataset keyword] list of hydrometeor classes to keep for the analysis Default [1] (dry snow)
>>
>> **radar_list** [list of Radar objects] Optional. list of radar objects
>
> **Returns**
>
>> **new_dataset** [dict] dictionary containing the output
>>
>> **ind_rad** [int] radar index

PRODUCTS GENERATION (`PYRAD.PROD`)

Initiate the products generation.

3.1 Auxiliary functions

`get_dsformat_func`	

3.2 Product generation

`generate_occurrence_products`(dataset, prdcfg)	generates occurrence products
`generate_cosmo_coord_products`(dataset, prdcfg)	generates COSMO coordinates products
`generate_sun_hits_products`(dataset, prdcfg)	generates sun hits products
`generate_intercomp_products`(dataset, prdcfg)	Generates radar intercomparison products.
`generate_colocated_gates_products`(dataset, …)	Generates colocated gates products
`generate_time_avg_products`(dataset, prdcfg)	generates time average products
`generate_qvp_products`(dataset, prdcfg)	Generates quasi vertical profile products.
`generate_vol_products`(dataset, prdcfg)	Generates radar volume products.
`generate_timeseries_products`(dataset, prdcfg)	Generates time series products
`generate_monitoring_products`(dataset, prdcfg)	generates a monitoring product
`generate_grid_products`(dataset, prdcfg)	generates grid products
`generate_traj_product`(traj, prdcfg)	Generates trajectory products
`generate_ml_products`(dataset, prdcfg)	Generates melting layer products.

`pyrad.prod.`**`generate_colocated_gates_products`**(*dataset*, *prdcfg*)

> Generates colocated gates products
>
> > **Parameters**
> >
> > > **dataset** [tuple] radar objects and colocated gates dictionary
> > >
> > > **prdcfg** [dictionary of dictionaries] product configuration dictionary of dictionaries
> >
> > **Returns**

filename [str] the name of the file created. None otherwise

pyrad.prod.**generate_cosmo_coord_products**(*dataset*, *prdcfg*)
    generates COSMO coordinates products

> **Parameters**
>
> > **dataset** [tuple] radar object containing the COSMO coordinates
> >
> > **prdcfg** [dictionary of dictionaries] product configuration dictionary of dictionaries
>
> **Returns**
>
> > **filename** [str] the name of the file created. None otherwise

pyrad.prod.**generate_grid_products**(*dataset*, *prdcfg*)
    generates grid products

> **Parameters**
>
> > **dataset** [grid] grid object
> >
> > **prdcfg** [dictionary of dictionaries] product configuration dictionary of dictionaries
>
> **Returns**
>
> > **no return**

pyrad.prod.**generate_intercomp_products**(*dataset*, *prdcfg*)
    Generates radar intercomparison products.

> **Parameters**
>
> > **dataset** [tuple] values of colocated gates dictionary
> >
> > **prdcfg** [dictionary of dictionaries] product configuration dictionary of dictionaries
>
> **Returns**
>
> > **filename** [str] the name of the file created. None otherwise

pyrad.prod.**generate_ml_products**(*dataset*, *prdcfg*)
    Generates melting layer products.

> **Parameters**
>
> > **dataset** [dict] dictionary containing the radar object and a keyword stating the status of the
> > processing
> >
> > **prdcfg** [dictionary of dictionaries] product configuration dictionary of dictionaries
>
> **Returns**
>
> > **filename** [str] the name of the file created. None otherwise

pyrad.prod.**generate_monitoring_products**(*dataset*, *prdcfg*)
    generates a monitoring product

> **Parameters**
>
> > **dataset** [dictionary] dictionary containing a histogram object and some metadata
> >
> > **prdcfg** [dictionary of dictionaries] product configuration dictionary of dictionaries
>
> **Returns**
>
> > **filename** [str] the name of the file created. None otherwise

pyrad.prod.**generate_occurrence_products**(*dataset*, *prdcfg*)
> generates occurrence products

> > **Parameters**

> > > **dataset** [tuple] radar object and metadata dictionary

> > > **prdcfg** [dictionary of dictionaries] product configuration dictionary of dictionaries

> > **Returns**

> > > **filename** [str] the name of the file created. None otherwise

pyrad.prod.**generate_qvp_products**(*dataset*, *prdcfg*)
> Generates quasi vertical profile products. Quasi vertical profiles come from azimuthal averaging of polarimetric radar data.

> > **Parameters**

> > > **dataset** [dict] dictionary containing the radar object and a keyword stating the status of the processing

> > > **prdcfg** [dictionary of dictionaries] product configuration dictionary of dictionaries

> > **Returns**

> > > **filename** [str] the name of the file created. None otherwise

pyrad.prod.**generate_sun_hits_products**(*dataset*, *prdcfg*)
> generates sun hits products

> > **Parameters**

> > > **dataset** [tuple] radar object and sun hits dictionary

> > > **prdcfg** [dictionary of dictionaries] product configuration dictionary of dictionaries

> > **Returns**

> > > **filename** [str] the name of the file created. None otherwise

pyrad.prod.**generate_time_avg_products**(*dataset*, *prdcfg*)
> generates time average products

> > **Parameters**

> > > **dataset** [tuple] radar objects and colocated gates dictionary

> > > **prdcfg** [dictionary of dictionaries] product configuration dictionary of dictionaries

> > **Returns**

> > > **filename** [str] the name of the file created. None otherwise

pyrad.prod.**generate_timeseries_products**(*dataset*, *prdcfg*)
> Generates time series products

> > **Parameters**

> > > **dataset** [dictionary] radar object

> > > **prdcfg** [dictionary of dictionaries] product configuration dictionary of dictionaries

> > **Returns**

> > > **no return**

pyrad.prod.**generate_traj_product**(*traj*, *prdcfg*)
> Generates trajectory products

> **Parameters**
>
> > **traj** [Trajectory object]
> >
> > **prdcfg** [dictionary of dictionaries] product configuration dictionary of dictionaries
>
> **Returns**
>
> > **None**

pyrad.prod.**generate_vol_products**(*dataset*, *prdcfg*)

> Generates radar volume products.
>
> > **Parameters**
> >
> > > **dataset** [dict] dictionary with key radar_out containing a radar object
> > >
> > > **prdcfg** [dictionary of dictionaries] product configuration dictionary of dictionaries
> >
> > **Returns**
> >
> > > **no return**

pyrad.prod.**get_prodgen_func**(*dsformat*, *dsname*, *dstype*)

> maps the dataset format into its processing function
>
> > **Parameters**
> >
> > > **dsformat** [str] dataset group, i.e. 'VOL', etc.
> >
> > **Returns**
> >
> > > **func** [function] pyrad function used to generate the products

---

INPUT AND OUTPUT (`PYRAD.IO`)

Functions to read and write data and configuration files.

4.1 Reading configuration files

read_config(fname[, cfg])	Read a pyrad config file.

4.2 Reading radar data

get_data(voltime, datatypesdescr, cfg)	Reads pyrad input data.

4.3 Reading cosmo data

cosmo2radar_data(radar, cosmo_coord, cosmo_data)	get the COSMO value corresponding to each radar gate using nearest neighbour interpolation
cosmo2radar_coord(radar, cosmo_coord[, . . .])	Given the radar coordinates find the nearest COSMO model pixel
hzt2radar_data(radar, hzt_coord, hzt_data[, . . .])	get the HZT value corresponding to each radar gate using nearest neighbour interpolation
hzt2radar_coord(radar, hzt_coord[, . . .])	Given the radar coordinates find the nearest HZT pixel
get_cosmo_fields(cosmo_data, cosmo_ind[, . . .])	Get the COSMO data corresponding to each radar gate using a precomputed look up table of the nearest neighbour
get_iso0_field(hzt_data, hzt_ind, z_radar[, . . .])	Get the height over iso0 data corresponding to each radar gate using a precomputed look up table of the nearest neighbour
read_cosmo_data(fname[, field_names, celsius])	Reads COSMO data from a netcdf file
read_cosmo_coord(fname[, zmin])	Reads COSMO coordinates from a netcdf file
read_hzt_data(fname[, chy0, chx0])	Reads iso-0 degree data from an HZT file

4.4 Reading other data

[read_last_state](fname)	Reads a file containing the date of acquisition of the last volume processed
[read_status](voltime, cfg[, ind_rad])	Reads rad4alp xml status file.
[read_rad4alp_cosmo](fname, datatype[, ngates])	Reads rad4alp COSMO data binary file.
[read_rad4alp_vis](fname, datatype)	Reads rad4alp visibility data binary file.
[read_excess_gates](fname)	Reads a csv files containing the position of gates exceeding a given percentile of frequency of occurrence
[read_colocated_gates](fname)	Reads a csv files containing the position of colocated gates
[read_colocated_data](fname)	Reads a csv files containing colocated data
[read_timeseries](fname)	Reads a time series contained in a csv file
[read_ts_cum](fname)	Reads a time series of precipitation accumulation contained in a csv file
[read_monitoring_ts](fname[, sort_by_date])	Reads a monitoring time series contained in a csv file
[read_intercomp_scores_ts](fname[, sort_by_date])	Reads a radar intercomparison scores csv file
[get_sensor_data](date, datatype, cfg)	Gets data from a point measurement sensor (rain gauge or disdrometer)
[read_smn](fname)	Reads SwissMetNet data contained in a csv file
[read_smn2](fname)	Reads SwissMetNet data contained in a csv file with format station,time,value
[read_disdro_scattering](fname)	Reads scattering parameters computed from disdrometer data contained in a text file
[read_sun_hits](fname)	Reads sun hits data contained in a csv file
[read_sun_hits_multiple_days](cfg, time_ref[, …])	Reads sun hits data from multiple file sources
[read_sun_retrieval](fname)	Reads sun retrieval data contained in a csv file
[read_solar_flux](fname)	Reads solar flux data from the DRAO observatory in Canada
[read_selfconsistency](fname)	Reads a self-consistency table with Zdr, Kdp/Zh columns
[read_antenna_pattern](fname[, linear, twoway])	Read antenna pattern from file
[read_meteorage](fname)	Reads METEORAGE lightning data contained in a text file.
[read_lightning](fname[, filter_data])	Reads lightning data contained in a text file.
[read_lightning_traj](fname)	Reads lightning trajectory data contained in a csv file.
[read_lightning_all](fname[, labels])	Reads a file containing lightning data and co-located polarimetric data.
[read_trt_scores](fname)	Reads the TRT scores contained in a text file.
[read_trt_data](fname)	Reads the TRT data contained in a text file.
[read_trt_traj_data](fname)	Reads the TRT cell data contained in a text file.
[read_trt_cell_lightning](fname)	Reads the lightning data of a TRT cell.
[read_rhi_profile](fname[, labels])	Reads a monitoring time series contained in a csv file
[read_histogram](fname)	Reads a histogram contained in a csv file
[read_quantiles](fname)	Reads quantiles contained in a csv file
[read_profile_ts](fname_list, labels[, hres, …])	Reads a colection of profile data file and creates a time series
[read_histogram_ts](fname_list, datatype[, t_res])	Reads a colection of histogram data file and creates a time series
[read_quantiles_ts](fname_list[, step, qmin, …])	Reads a colection of quantiles data file and creates a time series

Continued on next page

Table 4 – continued from previous page

read_ml_ts(fname)	Reads a melting layer time series contained in a csv file

4.5 Writing data

write_ts_lightning(flashnr, time_data, . . .)	writes the LMA sources data and the value of the colocated polarimetric variables
send_msg(sender, receiver_list, subject, fname)	sends the content of a text file by email
write_alarm_msg(radar_name, param_name_unit, . . .)	writes an alarm file
write_last_state(datetime_last, fname)	writes SwissMetNet data in format datetime,avg_value, std_value
write_smn(datetime_vec, value_avg_vec, . . .)	writes SwissMetNet data in format datetime,avg_value, std_value
write_trt_cell_data(traj_ID, yyyymmd-dHHMM, . . .)	writes TRT cell data
write_trt_cell_scores(traj_ID, . . .)	writes TRT cells scores
write_trt_cell_lightning(cell_ID, cell_time, . . .)	writes the lightning data for each TRT cell
write_rhi_profile(hvec, data, nvalid_vec, . . .)	writes the values of an RHI profile in a text file
write_field_coverage(quantiles, values, . . .)	writes the quantiles of the coverage on a particular sector
write_cdf(quantiles, values, ntot, nnan, . . .)	writes a cumulative distribution function
write_histogram(bin_edges, values, fname[, . . .])	writes a histogram
write_quantiles(quantiles, values, fname[, . . .])	writes quantiles
write_ts_polar_data(dataset, fname)	writes time series of data
write_ts_cum(dataset, fname)	writes time series accumulation of data
write_monitoring_ts(start_time, np_t, . . . [, . . .])	writes time series of data
write_excess_gates(excess_dict, fname)	Writes the position and values of gates that have a frequency of occurrence higher than a particular threshold
write_intercomp_scores_ts(start_time, stats, . . .)	writes time series of radar intercomparison scores
write_colocated_gates(coloc_gates, fname)	Writes the position of gates colocated with two radars
write_colocated_data(coloc_data, fname)	Writes the data of gates colocated with two radars
write_colocated_data_time_avg(coloc_data, fname)	Writes the time averaged data of gates colocated with two radars
write_sun_hits(sun_hits, fname)	Writes sun hits data.
write_sun_retrieval(sun_retrieval, fname)	Writes sun retrieval data.

4.6 Auxiliary functions

map_hydro(hydro_data_op)	maps the operational hydrometeor classification identifiers to the ones used by Py-ART
map_Doppler(Doppler_data_bin, Nyquist_vel)	maps the binary METRANET Doppler data to actual Doppler velocity
get_save_dir(basepath, procname, dsname, prd-name)	obtains the path to a product directory and eventually creates it

Table 6 – continued from previous page

make_filename(prdtype, dstype, dsname, ext_list)	creates a product file name
generate_field_name_str(datatype)	Generates a field name in a nice to read format.
get_fieldname_pyart(datatype)	maps the config file radar data type name into the corresponding rainbow Py-ART field name
get_fieldname_cosmo(field_name)	maps the Py-ART field name into the corresponding COSMO variable name
get_field_unit(datatype)	Return unit of datatype.
get_file_list(datadescriptor, starttime, . . .)	gets the list of files with a time period
get_trtfile_list(datapath, starttime, endtime)	gets the list of TRT files with a time period
get_new_rainbow_file_name(master_fname, . . .)	get the rainbow file name containing datatype from a master file name and data type
get_datatype_fields(datadescriptor)	splits the data type descriptor and provides each individual member
get_dataset_fields(datasetdescr)	splits the dataset type descriptor and provides each individual member
get_datetime(fname, datadescriptor)	Given a data descriptor gets date and time from file name
find_raw_cosmo_file(voltime, datatype, cfg)	Search a COSMO file in netcdf format
find_hzt_file(voltime, cfg[, ind_rad])	Search an ISO-0 degree file in HZT format
_get_datetime(fname, datagroup[, ftime_format])	Given a data group gets date and time from file name

4.7 Trajectory

Trajectory(filename[, starttime, endtime, . . .])	A class for reading and handling trajectory data from a file.

4.8 TimeSeries

TimeSeries(desc[, timevec, timeformat, . . .])	Holding timeseries data and metadata.

class pyrad.io.**TimeSeries**(*desc*, *timevec=None*, *timeformat=None*, *maxlength=None*, *datatype=”*)
   Bases: object

   Holding timeseries data and metadata.

   Attributes

   description [array of str] Description of the data of the time series.

   time_vector [array of datetime objects]

   timeformat [how to print the time (default:] 'Date, UTC [seconds since midnight]'

   dataseries [List of _dataSeries object holding the] data

   Methods

add_dataseries(label, unit_name, unit[, . . .])	Add a new data series to the timeseries object.
add_timesample(dt, values)	Add a new sample to the time series.

Continued on next page

Table 9 – continued from previous page	
[*plot*](fname[, ymin, ymax])	Make a figure of a time series
[*plot_hist*](fname[, step])	Make histograms of time series
[*write*](fname)	Write time series output

__class__
    alias of `builtins.type`

__delattr__(*$self*, *name*, */*)
    Implement delattr(self, name).

__dict__ = mappingproxy({'__module__': 'pyrad.io.timeseries', '__doc__': "\n Holding

__dir__() → list
    default dir() implementation

__eq__(*$self*, *value*, */*)
    Return self==value.

__format__()
    default object formatter

__ge__(*$self*, *value*, */*)
    Return self>=value.

__getattribute__(*$self*, *name*, */*)
    Return getattr(self, name).

__gt__(*$self*, *value*, */*)
    Return self>value.

__hash__(*$self*, */*)
    Return hash(self).

__init__(*desc*, *timevec=None*, *timeformat=None*, *maxlength=None*, *datatype=''*)
    Initalize the object.

> **Parameters**
>
>> **desc** [array of str]
>>
>> **timevec** [array of datetime]
>>
>> **timeformat** [specifies time format]
>>
>> **maxlength** [Maximal length of the time series]
>>
>> **num_el** [Number of values in the time series]

__init_subclass__()
    This method is called when a class is subclassed.

    The default implementation does nothing. It may be overridden to extend subclasses.

__le__(*$self*, *value*, */*)
    Return self<=value.

__lt__(*$self*, *value*, */*)
    Return self<value.

__module__ = 'pyrad.io.timeseries'

__ne__(*$self*, *value*, */*)
    Return self!=value.

__new__ (*$type, *args, **kwargs*)
    Create and return a new object. See help(type) for accurate signature.

__reduce__ ()
    helper for pickle

__reduce_ex__ ()
    helper for pickle

__repr__ (*$self, /*)
    Return repr(self).

__setattr__ (*$self, name, value, /*)
    Implement setattr(self, name, value).

__sizeof__ () → int
    size of object in memory, in bytes

__str__ (*$self, /*)
    Return str(self).

__subclasshook__ ()
    Abstract classes can override this to customize issubclass().

    This is invoked early on by abc.ABCMeta.__subclasscheck__(). It should return True, False or NotImplemented. If it returns NotImplemented, the normal algorithm is used. Otherwise, it overrides the normal algorithm (and the outcome is cached).

__weakref__
    list of weak references to the object (if defined)

add_dataseries (*label, unit_name, unit, dataseries=None, plot=True, color=None, linestyle=None*)
    Add a new data series to the timeseries object. The length of the data vector must be the same as the length of the time vector.

add_timesample (*dt, values*)
    Add a new sample to the time series.

plot (*fname, ymin=None, ymax=None*)
    Make a figure of a time series

plot_hist (*fname, step=None*)
    Make histograms of time series

write (*fname*)
    Write time series output

class pyrad.io.**Trajectory** (*filename, starttime=None, endtime=None, trajtype='plane', flashnr=0*)
    Bases: `object`

    A class for reading and handling trajectory data from a file.

    Attributes

        filename [str] Path and name of the trajectory definition file

        starttime [datetime] Start time of trajectory processing.

        endtime [datetime] End time of trajectory processing.

        trajtype [str]

        Type of trajectory. Can be 'plane' or 'lightning'

        time_vector [Array of datetime objects] Array containing the trajectory time samples

wgs84_lat_deg [Array of floats] WGS84 latitude samples in radian

wgs84_lon_deg [Array of floats] WGS84 longitude samples in radian

wgs84_alt_m [Array of floats] WGS84 altitude samples in m

nsamples [int]

Number of samples in the trajectory

_swiss_grid_done [Bool] Indicates that convertion to Swiss coordinates has been performed

swiss_chy, swiss_chx, swiss_chh [Array of floats] Swiss coordinates in m

radar_list [list] List of radars for which trajectories are going to be computed

flashnr [int] For 'lightning' only. Number of flash for which trajectory data is going to be computed. If 0 all all flashes are going to be considered.

time_in_flash [array of floats] For 'lightning' only. Time within flash (sec)

flashnr_vec [array of ints] For 'lightning' only. Flash number of each data sample

dBm [array of floats] For 'lightning' only. Lightning power (dBm)

Methods

add_radar(radar)	Add the coordinates (WGS84 longitude, latitude and non WGS84 altitude) of a radar to the radar_list.
calculate_velocities(radar)	Calculate velocities.
get_end_time()	Get time of last trajectory sample.
get_samples_in_period([start, end])	"
get_start_time()	Get time of first trajectory sample.

__class__
    alias of builtins.type

__delattr__(*$self*, *name*, */*)
    Implement delattr(self, name).

__dict__ = mappingproxy({'__module__': 'pyrad.io.trajectory', '__doc__': "\n A class

__dir__() → list
    default dir() implementation

__eq__(*$self*, *value*, */*)
    Return self==value.

__format__()
    default object formatter

__ge__(*$self*, *value*, */*)
    Return self>=value.

__getattribute__(*$self*, *name*, */*)
    Return getattr(self, name).

__gt__(*$self*, *value*, */*)
    Return self>value.

__hash__ (*$self*, */*)
    Return hash(self).

__init__ (*filename*, *starttime=None*, *endtime=None*, *trajtype='plane'*, *flashnr=0*)
    Initalize the object.

> **Parameters**
>
> > **filename** [str] Filename containing the trajectory samples.
> >
> > **starttime** [datetime] Start time of trajectory processing. If not given, use the time of the first trajectory sample.
> >
> > **endtime** [datetime] End time of trajectory processing. If not given, use the time of the last trajectory sample.
> >
> > **trajtype** [str] type of trajectory. Can be plane or lightning
> >
> > **flashnr** [int] If type of trajectory is lightning, the flash number to check the trajectory. 0 means all flash numbers included

__init_subclass__ ()
    This method is called when a class is subclassed.

    The default implementation does nothing. It may be overridden to extend subclasses.

__le__ (*$self*, *value*, */*)
    Return self<=value.

__lt__ (*$self*, *value*, */*)
    Return self<value.

__module__ = 'pyrad.io.trajectory'

__ne__ (*$self*, *value*, */*)
    Return self!=value.

__new__ (*$type*, **args*, ***kwargs*)
    Create and return a new object. See help(type) for accurate signature.

__reduce__ ()
    helper for pickle

__reduce_ex__ ()
    helper for pickle

__repr__ (*$self*, */*)
    Return repr(self).

__setattr__ (*$self*, *name*, *value*, */*)
    Implement setattr(self, name, value).

__sizeof__ () $\rightarrow$ int
    size of object in memory, in bytes

__str__ (*$self*, */*)
    Return str(self).

__subclasshook__ ()
    Abstract classes can override this to customize issubclass().

    This is invoked early on by abc.ABCMeta.__subclasscheck__(). It should return True, False or NotImplemented. If it returns NotImplemented, the normal algorithm is used. Otherwise, it overrides the normal algorithm (and the outcome is cached).

__weakref__
    list of weak references to the object (if defined)

_convert_traj_to_swissgrid()
    Convert trajectory samples from WGS84 to Swiss CH1903 coordinates

_get_total_seconds(*x*)
    Return total seconds of timedelta object

_read_traj()
    Read trajectory from file

_read_traj_lightning(*flashnr=0*)
    Read trajectory from lightning file

        Parameters

            flashnr [int] the flash number to keep. If 0 data from all flashes will be kept

_read_traj_trt()
    Read trajectory from TRT file

add_radar(*radar*)
    Add the coordinates (WGS84 longitude, latitude and non WGS84 altitude) of a radar to the radar_list.

        Parameters

            radar [pyart radar object] containing the radar coordinates

calculate_velocities(*radar*)
    Calculate velocities.

get_end_time()
    Get time of last trajectory sample.

get_samples_in_period(*start=None*, *end=None*)
    " Get indices of samples of the trajectory within given time period.

get_start_time()
    Get time of first trajectory sample.

pyrad.io.**add_field**(*radar_dest*, *radar_orig*)
    adds the fields from orig radar into dest radar. If they are not in the same grid, interpolates them to dest grid

        Parameters

            radar_dest [radar object] the destination radar

            radar_orig [radar object] the radar object containing the original field

        Returns

            field_dest [dict] interpolated field and metadata

pyrad.io.**cosmo2radar_coord**(*radar*, *cosmo_coord*, *slice_xy=True*, *slice_z=False*, *field_name=None*)
    Given the radar coordinates find the nearest COSMO model pixel

        Parameters

            radar [Radar] the radar object containing the information on the position of the radar gates

            cosmo_coord [dict] dictionary containing the COSMO coordinates

            slice_xy [boolean] if true the horizontal plane of the COSMO field is cut to the dimensions of the radar field

> **slice_z** [boolean] if true the vertical plane of the COSMO field is cut to the dimensions of the radar field
>
> **field_name** [str] name of the field
>
> Returns
>
> > **cosmo_ind_field** [dict] dictionary containing a field of COSMO indices and metadata

pyrad.io.**cosmo2radar_data**(*radar, cosmo_coord, cosmo_data, time_index=0, slice_xy=True, slice_z=False, field_names=['temperature']*)
    get the COSMO value corresponding to each radar gate using nearest neighbour interpolation

> Parameters
>
> > **radar** [Radar] the radar object containing the information on the position of the radar gates
> >
> > **cosmo_coord** [dict] dictionary containing the COSMO coordinates
> >
> > **cosmo_data** [dict] dictionary containing the COSMO data
> >
> > **time_index** [int] index of the forecasted data
> >
> > **slice_xy** [boolean] if true the horizontal plane of the COSMO field is cut to the dimensions of the radar field
> >
> > **slice_z** [boolean] if true the vertical plane of the COSMO field is cut to the dimensions of the radar field
> >
> > **field_names** [str] names of COSMO fields to convert (default temperature)
>
> Returns
>
> > **cosmo_fields** [list of dict] list of dictionary with the COSMO fields and metadata

pyrad.io.**find_hzt_file**(*voltime*, *cfg*, *ind_rad=0*)
    Search an ISO-0 degree file in HZT format

> Parameters
>
> > **voltime** [datetime object] volume scan time
> >
> > **cfg** [dictionary of dictionaries] configuration info to figure out where the data is
> >
> > **ind_rad** [int] radar index
>
> Returns
>
> > **fname** [str] Name of HZT file if it exists. None otherwise

pyrad.io.**find_raw_cosmo_file**(*voltime*, *datatype*, *cfg*, *ind_rad=0*)
    Search a COSMO file in netcdf format

> Parameters
>
> > **voltime** [datetime object] volume scan time
> >
> > **datatype** [str] type of COSMO data to look for
> >
> > **cfg** [dictionary of dictionaries] configuration info to figure out where the data is
> >
> > **ind_rad** [int] radar index
>
> Returns
>
> > **fname** [str] Name of COSMO file if it exists. None otherwise

pyrad.io.**generate_field_name_str**(*datatype*)
    Generates a field name in a nice to read format.

Parameters

 datatype [str] The data type

Returns

 field_str [str] The field name

pyrad.io.**get_cosmo_fields**(*cosmo_data, cosmo_ind, time_index=0, field_names=['temperature']*)
 Get the COSMO data corresponding to each radar gate using a precomputed look up table of the nearest neighbour

 Parameters

  cosmo_data [dict] dictionary containing the COSMO data and metadata

  cosmo_ind [dict] dictionary containing a field of COSMO indices and metadata

  time_index [int] index of the forecasted data

  field_names [str] names of COSMO parameters (default temperature)

 Returns

  cosmo_fields [list of dict] dictionary with the COSMO fields and metadata

pyrad.io.**get_data**(*voltime*, *datatypesdescr*, *cfg*)
 Reads pyrad input data.

 Parameters

  voltime [datetime object] volume scan time

  datatypesdescr [list] list of radar field types to read. Format : [radar file type]:[datatype]

  cfg: dictionary of dictionaries configuration info to figure out where the data is

 Returns

  radar [Radar] radar object

pyrad.io.**get_dataset_fields**(*datasetdescr*)
 splits the dataset type descriptor and provides each individual member

 Parameters

  datasetdescr [str] dataset type. Format : [processing level]:[dataset type]

 Returns

  proclevel [str] dataset processing level

  dataset [str] dataset type, i.e. dBZ, ZDR, ISO0, . . .

pyrad.io.**get_datatype_fields**(*datadescriptor*)
 splits the data type descriptor and provides each individual member

 Parameters

  datadescriptor [str] radar field type. Format : [radar file type]:[datatype]

 Returns

  radarnr [str] radar number, i.e. RADAR1, RADAR2, . . .

  datagroup [str] data type group, i.e. RAINBOW, RAD4ALP, ODIM, CFRADIAL, COSMO, MXPOL . . .

  datatype [str] data type, i.e. dBZ, ZDR, ISO0, . . .

> **dataset** [str] dataset type (for saved data only)
>
> **product** [str] product type (for saved data only)

pyrad.io.**get_datetime**(*fname*, *datadescriptor*)

> Given a data descriptor gets date and time from file name
>
> **Parameters**
>
> > **fname** [str] file name
> >
> > **datadescriptor** [str] radar field type. Format : [radar file type]:[datatype]
>
> **Returns**
>
> > **fdatetime** [datetime object] date and time in file name

pyrad.io.**get_field_unit**(*datatype*)

> Return unit of datatype.
>
> **Parameters**
>
> > **datatype** [str] The data type
>
> **Returns**
>
> > **unit** [str] The unit

pyrad.io.**get_fieldname_cosmo**(*field_name*)

> maps the Py-ART field name into the corresponding COSMO variable name
>
> **Parameters**
>
> > **field_name** [str] Py-ART field name
>
> **Returns**
>
> > **cosmo_name** [str] Py-ART variable name

pyrad.io.**get_fieldname_pyart**(*datatype*)

> maps the config file radar data type name into the corresponding rainbow Py-ART field name
>
> **Parameters**
>
> > **datatype** [str] config file radar data type name
>
> **Returns**
>
> > **field_name** [str] Py-ART field name

pyrad.io.**get_file_list**(*datadescriptor*, *starttime*, *endtime*, *cfg*, *scan=None*)

> gets the list of files with a time period
>
> **Parameters**
>
> > **datadescriptor** [str] radar field type. Format : [radar file type]:[datatype]
> >
> > **starttime** [datetime object] start of time period
> >
> > **endtime** [datetime object] end of time period
> >
> > **cfg: dictionary of dictionaries** configuration info to figure out where the data is
> >
> > **scan** [str] scan name
>
> **Returns**
>
> > **filelist** [list of strings] list of files within the time period

pyrad.io.**get_iso0_field**(*hzt_data*, *hzt_ind*, *z_radar*, *field_name='height_over_iso0'*)

>   Get the height over iso0 data corresponding to each radar gate using a precomputed look up table of the nearest neighbour

>>   **Parameters**

>>>   **hzt_data** [dict] dictionary containing the HZT data and metadata

>>>   **hzt_ind** [dict] dictionary containing a field of HZT indices and metadata

>>>   **z_radar** [ndarray] gates altitude [m MSL]

>>>   **field_name** [str] names of HZT parameters (default height_over_iso0)

>>   **Returns**

>>>   **iso0_field** [list of dict] dictionary with the height over iso0 field and metadata

pyrad.io.**get_new_rainbow_file_name**(*master_fname*, *master_datadescriptor*, *datatype*)

>   get the rainbow file name containing datatype from a master file name and data type

>>   **Parameters**

>>>   **master_fname** [str] the master file name

>>>   **master_datadescriptor** [str] the master data type descriptor

>>>   **datatype** [str] the data type of the new file name to be created

>>   **Returns**

>>>   **new_fname** [str] the new file name

pyrad.io.**get_save_dir**(*basepath*, *procname*, *dsname*, *prdname*, *timeinfo=None*, *timeformat='%Y-%m-%d'*, *create_dir=True*)

>   obtains the path to a product directory and eventually creates it

>>   **Parameters**

>>>   **basepath** [str] product base path

>>>   **procname** [str] name of processing space

>>>   **dsname** [str] data set name

>>>   **prdname** [str] product name

>>>   **timeinfo** [datetime] time info to generate the date directory. If None there is no time format in the path

>>>   **timeformat** [str] Optional. The time format.

>>>   **create_dir** [boolean] If True creates the directory

>>   **Returns**

>>>   **savedir** [str] path to product

pyrad.io.**get_sensor_data**(*date*, *datatype*, *cfg*)

>   Gets data from a point measurement sensor (rain gauge or disdrometer)

>>   **Parameters**

>>>   **date** [datetime object] measurement date

>>>   **datatype** [str] name of the data type to read

>>>   **cfg** [dictionary] dictionary containing sensor information

>>   **Returns**

> **sensordate , sensorvalue, label, period** [tupple] date, value, type of sensor and measurement
> period

pyrad.io.**get_trtfile_list**(*datapath*, *starttime*, *endtime*)
    gets the list of TRT files with a time period

> **Parameters**
>
> > **datapath** [str] directory where to look for data
> >
> > **startime** [datetime object] start of time period
> >
> > **endtime** [datetime object] end of time period
>
> **Returns**
>
> > **filelist** [list of strings] list of files within the time period

pyrad.io.**hzt2radar_coord**(*radar*, *hzt_coord*, *slice_xy=True*, *field_name=None*)
    Given the radar coordinates find the nearest HZT pixel

> **Parameters**
>
> > **radar** [Radar] the radar object containing the information on the position of the radar gates
> >
> > **hzt_coord** [dict] dictionary containing the HZT coordinates
> >
> > **slice_xy** [boolean] if true the horizontal plane of the HZT field is cut to the dimensions of the
> > radar field
> >
> > **field_name** [str] name of the field
>
> **Returns**
>
> > **hzt_ind_field** [dict] dictionary containing a field of HZT indices and metadata

pyrad.io.**hzt2radar_data**(*radar*,   *hzt_coord*,   *hzt_data*,   *slice_xy=True*,
                     field_name='height_over_iso0')
    get the HZT value corresponding to each radar gate using nearest neighbour interpolation

> **Parameters**
>
> > **radar** [Radar] the radar object containing the information on the position of the radar gates
> >
> > **hzt_coord** [dict] dictionary containing the HZT coordinates
> >
> > **hzt_data** [dict] dictionary containing the HZT data
> >
> > **slice_xy** [boolean] if true the horizontal plane of the COSMO field is cut to the dimensions of
> > the radar field
> >
> > **field_name** [str] name of HZT fields to convert (default height_over_iso0)
>
> **Returns**
>
> > **hzt_fields** [list of dict] list of dictionary with the HZT fields and metadata

pyrad.io.**interpol_field**(*radar_dest*, *radar_orig*, *field_name*, *fill_value=None*, *ang_tol=0.5*)
    interpolates field field_name contained in radar_orig to the grid in radar_dest

> **Parameters**
>
> > **radar_dest** [radar object] the destination radar
> >
> > **radar_orig** [radar object] the radar object containing the original field
> >
> > **field_name: str** name of the field to interpolate
> >
> > **fill_value: float** The fill value

> **ang_tol** [float] angle tolerance to determine whether the radar origin sweep is the radar destination sweep

Returns

> **field_dest** [dict] interpolated field and metadata

pyrad.io.**make_filename**(*prdtype*, *dstype*, *dsname*, *ext_list*, *prdcfginfo=None*, *timeinfo=None*, *timeformat='%Y%m%d%H%M%S'*, *runinfo=None*)

> creates a product file name

Parameters

> **timeinfo** [datetime] time info to generate the date directory
>
> **prdtype** [str] product type, i.e. 'ppi', etc.
>
> **dstype** [str] data set type, i.e. 'raw', etc.
>
> **dsname** [str] data set name
>
> **ext_list** [list of str] file name extensions, i.e. 'png'
>
> **prdcfginfo** [str] Optional. string to add product configuration information, i.e. 'el0.4'
>
> **timeformat** [str] Optional. The time format
>
> **runinfo** [str] Optional. Additional information about the test (e.g. 'RUN01', 'TS011')

Returns

> **fname_list** [list of str] list of file names (as many as extensions)

pyrad.io.**map_Doppler**(*Doppler_data_bin*, *Nyquist_vel*)

> maps the binary METRANET Doppler data to actual Doppler velocity

Parameters

> **Doppler_data_bin** [numpy array] The binary METRANET data

Returns

> **Doppler_data** [numpy array] The Doppler veloctiy in [m/s]

pyrad.io.**map_hydro**(*hydro_data_op*)

> maps the operational hydrometeor classification identifiers to the ones used by Py-ART

Parameters

> **hydro_data_op** [numpy array] The operational hydrometeor classification data

Returns

> **hydro_data_py** [numpy array] The pyart hydrometeor classification data

pyrad.io.**read_antenna_pattern**(*fname*, *linear=False*, *twoway=False*)

> Read antenna pattern from file

Parameters

> **fname** [str] path of the antenna pattern file
>
> **linear** [boolean] if true the antenna pattern is given in linear units
>
> **twoway** [boolean] if true the attenuation is two-way

Returns

> **pattern** [dict] dictionary with the fields angle and attenuation

pyrad.io.**read_colocated_data**(*fname*)
> Reads a csv files containing colocated data

> > **Parameters**

> > > **fname** [str] path of time series file

> > **Returns**

> > > **rad1_time, rad1_ray_ind, rad1_rng_ind, rad1_ele, rad1_azi, rad1_rng,**

> > > **rad1_val, rad2_time, rad2_ray_ind, rad2_rng_ind, rad2_ele, rad2_azi,**

> > > **rad2_rng, rad2_val** [tupple] A tupple with the data read. None otherwise

pyrad.io.**read_colocated_gates**(*fname*)
> Reads a csv files containing the position of colocated gates

> > **Parameters**

> > > **fname** [str] path of time series file

> > **Returns**

> > > **rad1_ray_ind, rad1_rng_ind, rad1_ele, rad1_azi, rad1_rng,**

> > > **rad2_ray_ind, rad2_rng_ind, rad2_ele, rad2_azi, rad2_rng** [tupple] A tupple with the data read. None otherwise

pyrad.io.**read_config**(*fname*, *cfg=None*)
> Read a pyrad config file.

> > **Parameters**

> > > **fname** [str] Name of the configuration file to read.

> > > **cfg** [dict of dicts, optional] dictionary of dictionaries containing configuration parameters where the new parameters will be placed

> > **Returns**

> > > **cfg** [dict of dicts] dictionary of dictionaries containing the configuration parameters

pyrad.io.**read_cosmo_coord**(*fname*, *zmin=None*)
> Reads COSMO coordinates from a netcdf file

> > **Parameters**

> > > **fname** [str] name of the file to read

> > **Returns**

> > > **cosmo_coord** [dictionary] dictionary with the data and metadata

pyrad.io.**read_cosmo_data**(*fname, field_names=['temperature'], celsius=True*)
> Reads COSMO data from a netcdf file

> > **Parameters**

> > > **fname** [str] name of the file to read

> > > **field_names** [str] name of the variable to read

> > > **celsius** [Boolean] if True and variable temperature converts data from Kelvin to Centigrade

> > **Returns**

> > > **cosmo_data** [dictionary] dictionary with the data and metadata

pyrad.io.**read_disdro_scattering**(*fname*)

> Reads scattering parameters computed from disdrometer data contained in a text file

> > **Parameters**

> > > **fname** [str] path of time series file

> > **Returns**

> > > **date, preciptype, lwc, rr, zh, zv, zdr, ldr, ah, av, adiff, kdp, deltaco,**

> > > **rhohv** [tupple] The read values

pyrad.io.**read_excess_gates**(*fname*)

> Reads a csv files containing the position of gates exceeding a given percentile of frequency of occurrence

> > **Parameters**

> > > **fname** [str] path of time series file

> > **Returns**

> > > **rad1_ray_ind, rad1_rng_ind, rad1_ele, rad1_azi, rad1_rng,**

> > > **rad2_ray_ind, rad2_rng_ind, rad2_ele, rad2_azi, rad2_rng** [tupple] A tupple with the data read. None otherwise

pyrad.io.**read_histogram**(*fname*)

> Reads a histogram contained in a csv file

> > **Parameters**

> > > **fname** [str] path of time series file

> > **Returns**

> > > **hist , bin_edges** [tupple] The read data. None otherwise

pyrad.io.**read_histogram_ts**(*fname_list*, *datatype*, *t_res=300.0*)

> Reads a colection of histogram data file and creates a time series

> > **Parameters**

> > > **fname_list** [str] list of files to read

> > > **datatype** [str] The data type (dBZ, ZDR, etc.)

> > > **t_res** [float] time resolution [s]. If None the time resolution is taken as the median

> > **Returns**

> > > **tbin_edges, bin_edges, data_ma, datetime_arr[0]** [tupple] The read data. None otherwise

pyrad.io.**read_hzt_data**(*fname*, *chy0=255.0*, *chx0=-160.0*)

> Reads iso-0 degree data from an HZT file

> > **Parameters**

> > > **fname** [str] name of the file to read

> > > **chy0, chx0: south west point of grid in Swiss coordinates [km]**

> > **Returns**

> > > **hzt_data** [dictionary] dictionary with the data and metadata

pyrad.io.**read_intercomp_scores_ts**(*fname*, *sort_by_date=False*)

> Reads a radar intercomparison scores csv file

> **Parameters**
>
> > **fname** [str] path of time series file
> >
> > **sort_by_date** [bool] if True, the read data is sorted by date prior to exit
>
> **Returns**
>
> > **date_vec, np_vec, meanbias_vec, medianbias_vec, quant25bias_vec,**
> >
> > **quant75bias_vec, modebias_vec, corr_vec, slope_vec, intercep_vec,**
> >
> > **intercep_slope1_vec** [tupple] The read data. None otherwise

pyrad.io.**read_last_state**(*fname*)

> Reads a file containing the date of acquisition of the last volume processed
>
> > **Parameters**
> >
> > > **fname** [str] name of the file to read
> >
> > **Returns**
> >
> > > **last_state** [datetime object] the date

pyrad.io.**read_lightning**(*fname*, *filter_data=True*)

> Reads lightning data contained in a text file. The file has the following fields:
>
> > flashnr: (0 is for noise) UTC seconds of the day Time within flash (in seconds) Latitude (decimal degrees) Longitude (decimal degrees) Altitude (m MSL) Power (dBm)
>
> > **Parameters**
> >
> > > **fname** [str] path of time series file
> > >
> > > **filter_data** [Boolean] if True filter noise (flashnr = 0)
> >
> > **Returns**
> >
> > > **flashnr, time_data, time_in_flash, lat, lon, alt, dBm** [tupple] A tupple containing the read values. None otherwise

pyrad.io.**read_lightning_all**(*fname, labels=['hydro [-]', 'KDPc [deg/Km]', 'dBZc [dBZ]', 'Rho-HVc [-]', 'TEMP [deg C]', 'ZDRc [dB]']*)

> Reads a file containing lightning data and co-located polarimetric data. fields:
>
> > flashnr time data Time within flash (in seconds) Latitude (decimal degrees) Longitude (decimal degrees) Altitude (m MSL) Power (dBm) Polarimetric values at flash position
>
> > **Parameters**
> >
> > > **fname** [str] path of time series file
> > >
> > > **labels** [list of str] The polarimetric variables labels
> >
> > **Returns**
> >
> > > **flashnr, time_data, time_in_flash, lat, lon, alt, dBm,**
> > >
> > > **pol_vals_dict** [tupple] A tupple containing the read values. None otherwise

pyrad.io.**read_lightning_traj**(*fname*)

> Reads lightning trajectory data contained in a csv file. The file has the following fields:

Date UTC [seconds since midnight] # Flash Flash Power (dBm) Value at flash Mean value in a 3x3x3 polar box Min value in a 3x3x3 polar box Max value in a 3x3x3 polar box # valid values in the polar box

Parameters

> **fname** [str] path of time series file

Returns

> **time_flash, flashnr, dBm, val_at_flash, val_mean, val_min, val_max,**
>
> **nval** [tupple] A tupple containing the read values. None otherwise

pyrad.io.**read_meteorage**(*fname*)

> Reads METEORAGE lightning data contained in a text file. The file has the following fields:
>
> date: date + time + time zone lon: longitude [degree] lat: latitude [degree] intens: amplitude [kilo amperes] ns: number of strokes of the flash mode: kind of localization [0,15] intra: 1 = intra-cloud , 0 = cloud-to-ground ax: length of the semi-major axis of the ellipse [km] ki2: standard deviation on the localization computation (Ki^2) ecc: eccentricity (major-axis / minor-axis) incl: ellipse inclination (angle with respect to the North, +90° is
>
> > East) [degrees]
>
> sind: stroke index within the flash

Parameters

> **fname** [str] path of time series file

Returns

> **stroke_time, lon, lat, intens, ns, mode, intra, ax, ki2, ecc, incl,**
>
> **sind** [tupple] A tupple containing the read values. None otherwise

pyrad.io.**read_ml_ts**(*fname*)

> Reads a melting layer time series contained in a csv file

Parameters

> **fname** [str] path of time series file

Returns

> **dt_ml, ml_top_avg, ml_top_std, thick_avg, thick_std, nrays_valid,**
>
> **nrays_total** [tupple] The read data. None otherwise

pyrad.io.**read_monitoring_ts**(*fname*, *sort_by_date=False*)

> Reads a monitoring time series contained in a csv file

Parameters

> **fname** [str] path of time series file
>
> **sort_by_date** [bool] if True, the read data is sorted by date prior to exit

Returns

> **date , np_t, central_quantile, low_quantile, high_quantile** [tupple] The read data. None otherwise

pyrad.io.**read_profile_ts**(*fname_list*, *labels*, *hres=None*, *label_nr=0*, *t_res=300.0*)
   Reads a colection of profile data file and creates a time series

   Parameters

   > **fname_list** [str] list of files to read
   >
   > **labels** [list of str] The data labels
   >
   > **hres** [float] Height resolution
   >
   > **label_nr** [int] the label nr of the data that will be used in the time series
   >
   > **t_res** [float] time resolution [s]. If None the time resolution is taken as the median

   Returns

   > **tbin_edges, hbin_edges, np_ma, data_ma, datetime_arr[0]** [tuple] The read data. None otherwise

pyrad.io.**read_quantiles**(*fname*)
   Reads quantiles contained in a csv file

   Parameters

   > **fname** [str] path of time series file

   Returns

   > **quantiles, values** [tuple] The read data. None otherwise

pyrad.io.**read_quantiles_ts**(*fname_list*, *step=5.0*, *qmin=0.0*, *qmax=100.0*, *t_res=300.0*)
   Reads a colection of quantiles data file and creates a time series

   Parameters

   > **fname_list** [str] list of files to read
   >
   > **step, qmin, qmax** [float] The minimum, maximum and step quantiles
   >
   > **t_res** [float] time resolution [s]. If None the time resolution is taken as the median

   Returns

   > **tbin_edges, qbin_edges, data_ma, datetime_arr[0]** [tuple] The read data. None otherwise

pyrad.io.**read_rad4alp_cosmo**(*fname*, *datatype*, *ngates=0*)
   Reads rad4alp COSMO data binary file.

   Parameters

   > **fname** [str] name of the file to read
   >
   > **datatype** [str] name of the data type
   >
   > **ngates** [int] maximum number of range gates per ray. If larger than 0 the radar field will be cut accordingly.

   Returns

   > **field** [dictionary] The data field

pyrad.io.**read_rad4alp_vis**(*fname*, *datatype*)
   Reads rad4alp visibility data binary file.

   Parameters

   > **fname** [str] name of the file to read

> **datatype** [str] name of the data type

> **Returns**

> > **field_list** [list of dictionaries] A data field. Each element of the list corresponds to one elevation

pyrad.io.**read_rhi_profile**(*fname, labels=['50.0-percentile', '25.0-percentile', '75.0-percentile']*)
    Reads a monitoring time series contained in a csv file

> **Parameters**

> > **fname** [str] path of time series file

> > **labels** [list of str] The data labels

> **Returns**

> > **height, np_t, vals** [tupple] The read data. None otherwise

pyrad.io.**read_selfconsistency**(*fname*)
    Reads a self-consistency table with Zdr, Kdp/Zh columns

> **Parameters**

> > **fname** [str] path of time series file

> **Returns**

> > **zdr, kdpzh** [arrays] The read values

pyrad.io.**read_smn**(*fname*)
    Reads SwissMetNet data contained in a csv file

> **Parameters**

> > **fname** [str] path of time series file

> **Returns**

> > **smn_id, date , pressure, temp, rh, precip, wspeed, wdir** [tupple] The read values

pyrad.io.**read_smn2**(*fname*)
    Reads SwissMetNet data contained in a csv file with format station,time,value

> **Parameters**

> > **fname** [str] path of time series file

> **Returns**

> > **smn_id, date , value** [tupple] The read values

pyrad.io.**read_solar_flux**(*fname*)
    Reads solar flux data from the DRAO observatory in Canada

> **Parameters**

> > **fname** [str] path of time series file

> **Returns**

> > **flux_datetime** [datetime array] the date and time of the solar flux retrievals

> > **flux_value** [array] the observed solar flux

pyrad.io.**read_status**(*voltime*, *cfg*, *ind_rad=0*)
    Reads rad4alp xml status file.

> **Parameters**

       voltime [datetime object] volume scan time

       cfg: dictionary of dictionaries configuration info to figure out where the data is

       ind_rad: int radar index

    Returns

       root [root element object] The information contained in the status file

pyrad.io.**read_sun_hits**(*fname*)

    Reads sun hits data contained in a csv file

    Parameters

       fname [str] path of time series file

    Returns

       date, ray, nrng, rad_el, rad_az, sun_el, sun_az, ph, ph_std, nph, nvalh,

       pv, pv_std, npv, nvalv, zdr, zdr_std, nzdr, nvalzdr [tupple] Each parameter is an array containing a time series of information on a variable

pyrad.io.**read_sun_hits_multiple_days**(*cfg*, *time_ref*, *nfiles=1*)

    Reads sun hits data from multiple file sources

    Parameters

       cfg [dict] dictionary with configuration data to find out the right file

       time_ref [datetime object] reference time

       nfiles [int] number of files to read

    Returns

       date, ray, nrng, rad_el, rad_az, sun_el, sun_az, ph, ph_std, nph, nvalh,

       pv, pv_std, npv, nvalv, zdr, zdr_std, nzdr, nvalzdr [tupple] Each parameter is an array containing a time series of information on a variable

pyrad.io.**read_sun_retrieval**(*fname*)

    Reads sun retrieval data contained in a csv file

    Parameters

       fname [str] path of time series file

    Returns

       first_hit_time, last_hit_time, nhits_h, el_width_h, az_width_h, el_bias_h,

       az_bias_h, dBm_sun_est, std_dBm_sun_est, sf_h,

       nhits_v, el_width_v, az_width_v, el_bias_v, az_bias_v, dBmv_sun_est,

       std_dBmv_sun_est, sf_v,

       nhits_zdr, zdr_sun_est, std_zdr_sun_est,

       sf_ref, ref_time [tupple] Each parameter is an array containing a time series of information on a variable

pyrad.io.**read_timeseries**(*fname*)

    Reads a time series contained in a csv file

    Parameters

> **fname** [str] path of time series file

> **Returns**

>> **date , value** [tupple] A datetime object array containing the time and a numpy masked array containing the value. None otherwise

pyrad.io.**read_trt_cell_lightning**(*fname*)
> Reads the lightning data of a TRT cell. The file has the following fields:

>> traj_ID yyyymmddHHMM lon lat area RANKr nflashes flash_dens

>> **Parameters**

>>> **fname** [str] path of the TRT data file

>> **Returns**

>>> **A tupple containing the read values. None otherwise**

pyrad.io.**read_trt_data**(*fname*)
> Reads the TRT data contained in a text file. The file has the following fields:

>> traj_ID yyyymmddHHMM

>> Description of ellipsis: lon [deg] lat [deg] ell_L [km] long ell_S [km] short ell_or [deg] orientation area [km2]

>> Cell speed: vel_x [km/h] vel_y [km/h] det [dBZ]: detection threshold RANKr from 0 to 40 (int)

>> Lightning information: CG- number (int) CG+ number (int) CG number (int) %CG+ [%]

>> Echo top information: ET45 [km] echotop 45 max ET45m [km] echotop 45 median ET15 [km] echotop 15 max ET15m [km] echotop 15 median

>> VIL and max echo: VIL [kg/m2] vertical integrated liquid content maxH [km] height of maximum reflectivity (maximum on the cell) maxHm [km] height of maximum reflectivity (median per cell)

>> POH [%] RANK (deprecated)

>> standard deviation of the current time step cell velocity respect to the previous time: Dvel_x [km/h] Dvel_y [km/h]

>> cell_contour_lon-lat

>> **Parameters**

>>> **fname** [str] path of the TRT data file

>> **Returns**

>>> **A tupple containing the read values. None otherwise**

pyrad.io.**read_trt_scores**(*fname*)
> Reads the TRT scores contained in a text file. The file has the following fields:

>> traj ID max flash density time max flash density rank max flash density max rank time max rank

>> **Parameters**

>>> **fname** [str] path of the TRT data file

>> **Returns**

>>> **A tupple containing the read values. None otherwise**

pyrad.io.**read_trt_traj_data**(*fname*)

> Reads the TRT cell data contained in a text file. The file has the following fields:

>> traj_ID yyyymmddHHMM

>> lon [deg] lat [deg] ell_L [km] long ell_S [km] short ell_or [deg] orientation area [km2]

>> vel_x [km/h] cell speed vel_y [km/h] det [dBZ] detection threshold RANKr from 0 to 40 (int)

>> CG- number (int) CG+ number (int) CG number (int) %CG+ [%]

>> ET45 [km] echotop 45 max ET45m [km] echotop 45 median ET15 [km] echotop 15 max ET15m [km] echotop 15 median VIL [kg/m2] vertical integrated liquid content maxH [km] height of maximum reflectivity (maximum on the cell) maxHm [km] height of maximum reflectivity (median per cell) POH [%] RANK (deprecated)

>> Standard deviation of the current time step cell velocity respect to the previous time: Dvel_x [km/h] Dvel_y [km/h]

>> cell_contour_lon-lat

> **Parameters**

>> **fname** [str] path of the TRT data file

> **Returns**

>> **A tupple containing the read values. None otherwise**

pyrad.io.**read_ts_cum**(*fname*)

> Reads a time series of precipitation accumulation contained in a csv file

>> **Parameters**

>>> **fname** [str] path of time series file

>> **Returns**

>>> **date, np_radar, radar_value, np_sensor, sensor_value** [tupple] The data read

pyrad.io.**send_msg**(*sender*, *receiver_list*, *subject*, *fname*)

> sends the content of a text file by email

>> **Parameters**

>>> **sender** [str] the email address of the sender

>>> **receiver_list** [list of string] list with the email addresses of the receiver

>>> **subject** [str] the subject of the email

>>> **fname** [str] name of the file containing the content of the email message

>> **Returns**

>>> **fname** [str] the name of the file containing the content

pyrad.io.**write_alarm_msg**(*radar_name*, *param_name_unit*, *date_last*, *target*, *tol_abs*, *np_trend*, *value_trend*, *tol_trend*, *nevents*, *np_last*, *value_last*, *fname*)

> writes an alarm file

>> **Parameters**

>>> **radar_name** [str] Name of the radar being controlled

>>> **param_name_unit** [str] Parameter and units

>>> **date_last** [datetime object] date of the current event

target, tol_abs [float] Target value and tolerance

np_trend [int] Total number of points in trend

value_trend, tol_trend [float] Trend value and tolerance

nevents: int Number of events in trend

np_last [int] Number of points in the current event

value_last [float] Value of the current event

fname [str] Name of file where to store the alarm information

Returns

fname [str] the name of the file where data has written

pyrad.io.**write_cdf**(*quantiles*, *values*, *ntot*, *nnan*, *nclut*, *nblocked*, *nprec_filter*, *noutliers*, *ncdf*, *fname*, *use_nans=False*, *nan_value=0.0*, *filterprec=[]*, *vismin=None*, *sector=None*, *datatype=None*, *timeinfo=None*)
  writes a cumulative distribution function

Parameters

quantiles [datetime array] array containing the measurement time

values [float array] array containing the average value

fname [float array] array containing the standard deviation

sector [str] file name where to store the data

Returns

fname [str] the name of the file where data has written

pyrad.io.**write_colocated_data**(*coloc_data*, *fname*)
  Writes the data of gates colocated with two radars

Parameters

coloc_data [dict] dictionary containing the colocated data parameters

fname [str] file name where to store the data

Returns

fname [str] the name of the file where data has written

pyrad.io.**write_colocated_data_time_avg**(*coloc_data*, *fname*)
  Writes the time averaged data of gates colocated with two radars

Parameters

coloc_data [dict] dictionary containing the colocated data parameters

fname [str] file name where to store the data

Returns

fname [str] the name of the file where data has written

pyrad.io.**write_colocated_gates**(*coloc_gates*, *fname*)
  Writes the position of gates colocated with two radars

Parameters

coloc_gates [dict] dictionary containing the colocated gates parameters

> **fname** [str] file name where to store the data

> > **Returns**

> > > **fname** [str] the name of the file where data has written

pyrad.io.**write_excess_gates**(*excess_dict*, *fname*)

> Writes the position and values of gates that have a frequency of occurrence higher than a particular threshold

> > **Parameters**

> > > **excess_dict** [dict] dictionary containing the gates parameters

> > > **fname** [str] file name where to store the data

> > **Returns**

> > > **fname** [str] the name of the file where data has written

pyrad.io.**write_field_coverage**(*quantiles*, *values*, *ele_start*, *ele_stop*, *azi_start*, *azi_stop*, *threshold*, *nvalid_min*, *datatype*, *timeinfo*, *fname*)

> writes the quantiles of the coverage on a particular sector

> > **Parameters**

> > > **quantiles** [datetime array] array containing the quantiles computed

> > > **values** [float array] quantile value

> > > **ele_start, ele_stop, azi_start, azi_stop** [float] The limits of the sector

> > > **threshold** [float] The minimum value to consider the data valid

> > > **nvalid_min** [int] the minimum number of points to consider that there are values in a ray

> > > **datatype** [str] data type and units

> > > **timeinfo** [datetime object] the time stamp of the data

> > > **fname** [str] name of the file where to write the data

> > **Returns**

> > > **fname** [str] the name of the file where data has written

pyrad.io.**write_histogram**(*bin_edges*, *values*, *fname*, *datatype='undefined'*, *step=0*)

> writes a histogram

> > **Parameters**

> > > **bin_edges** [float array] array containing the histogram bin edges

> > > **values** [int array] array containing the number of points in each bin

> > > **fname** [str] file name

> > > **datatype :str** The data type

> > > **step** [str] The bin step

> > **Returns**

> > > **fname** [str] the name of the file where data has written

pyrad.io.**write_intercomp_scores_ts**(*start_time*, *stats*, *field_name*, *fname*, *rad1_name='RADAR001'*, *rad2_name='RADAR002'*, *rewrite=False*)

> writes time series of radar intercomparison scores

> > **Parameters**

start_time [datetime object or array of date time objects] the time of the intercomparison

stats [dict] dictionary containing the statistics

field_name [str] The name of the field

fname [str] file name where to store the data

rad1_name, rad2_name [str] Name of the radars intercompared

rewrite [bool] if True a new file is created

> Returns

fname [str] the name of the file where data has written

pyrad.io.**write_last_state**(*datetime_last*, *fname*)

writes SwissMetNet data in format datetime,avg_value, std_value

> Parameters

datetime_last [datetime object] date and time of the last state

fname [str] file name where to store the data

> Returns

fname [str] the name of the file where data has written

pyrad.io.**write_monitoring_ts**(*start_time*, *np_t*, *values*, *quantiles*, *datatype*, *fname*, *rewrite=False*)

writes time series of data

> Parameters

start_time [datetime object or array of date time objects] the time of the monitoring

np_t [int or array of ints] the total number of points

values: float array with 3 elements of array of arrays the values at certain quantiles

quantiles: float array with 3 elements the quantiles computed

datatype [str] The data type

fname [str] file name where to store the data

rewrite [bool] if True a new file is created

> Returns

fname [str] the name of the file where data has written

pyrad.io.**write_quantiles**(*quantiles*, *values*, *fname*, *datatype='undefined'*)

writes quantiles

> Parameters

quantiles [float array] array containing the quantiles to write

values [float array] array containing the value of each quantile

fname [str] file name

datatype :str The data type

> Returns

fname [str] the name of the file where data has written

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pyrad.io.**write_rhi_profile**(*hvec*, *data*, *nvalid_vec*, *labels*, *fname*, *datatype=None*, *timeinfo=None*, *sector=None*)

   writes the values of an RHI profile in a text file

   Parameters

   hvec [float array] array containing the alitude in m MSL

   data [list of float array] the quantities at each altitude

   nvalid_vec [int array] number of valid data points used to compute the quantiles

   labels [list of strings] label specifying the quantitites in data

   fname [str] file name where to store the data

   datatype [str] the data type

   timeinfo [datetime object] time of the rhi profile

   sector [dict] dictionary specying the sector limits

   Returns

   fname [str] the name of the file where data has been written

pyrad.io.**write_smn**(*datetime_vec*, *value_avg_vec*, *value_std_vec*, *fname*)

   writes SwissMetNet data in format datetime,avg_value, std_value

   Parameters

   datetime_vec [datetime array] array containing the measurement time

   value_avg_vec [float array] array containing the average value

   value_std_vec [float array] array containing the standard deviation

   fname [str] file name where to store the data

   Returns

   fname [str] the name of the file where data has written

pyrad.io.**write_sun_hits**(*sun_hits*, *fname*)

   Writes sun hits data.

   Parameters

   sun_hits [dict] dictionary containing the sun hits parameters

   fname [str] file name where to store the data

   Returns

   fname [str] the name of the file where data has written

pyrad.io.**write_sun_retrieval**(*sun_retrieval*, *fname*)

   Writes sun retrieval data.

   Parameters

   sun_retrieval [dict] dictionary containing the sun retrieval parameters

   fname [str] file name where to store the data

   Returns

   fname [str] the name of the file where data has written

pyrad.io.**write_trt_cell_data**(*traj_ID*, *yyyymmddHHMM*, *lon*, *lat*, *ell_L*, *ell_S*, *ell_or*, *area*,
        vel_x, *vel_y*, *det*, *RANKr*, *CG_n*, *CG_p*, *CG*, *CG_percent_p*, *ET45*,
        ET45m, *ET15*, *ET15m*, *VIL*, *maxH*, *maxHm*, *POH*, *RANK*, *Dvel_x*,
        Dvel_y, *cell_contour*, *fname*)

> writes TRT cell data

> > **Parameters**

> > > **traj_ID, yyyymmddHHMM, lon, lat, ell_L, ell_S, ell_or, area,**

> > > **vel_x, vel_y, det, RANKr, CG_n, CG_p, CG, CG_percent_p, ET45,**

> > > **ET45m, ET15, ET15m, VIL, maxH, maxHm, POH, RANK, Dvel_x,**

> > > **Dvel_y, cell_contour:** the cell parameters

> > > **fname** [str] file name where to store the data

> > **Returns**

> > > **fname** [str] the name of the file where data has written

pyrad.io.**write_trt_cell_lightning**(*cell_ID*, *cell_time*, *lon*, *lat*, *area*, *rank*, *nflash*, *flash_density*,
        fname)

> writes the lightning data for each TRT cell

> > **Parameters**

> > > **cell_ID** [array of ints] the cell ID

> > > **cell_time** [array of datetime] the time step

> > > **lon, lat** [array of floats] the latitude and longitude of the center of the cell

> > > **area** [array of floats] the area of the cell

> > > **rank** [array of floats] the rank of the cell

> > > **nflash** [array of ints] the number of flashes/sources within the cell

> > > **flash_density** [array of floats] the flash/source density

> > > **fname** [str] file name where to store the data

> > **Returns**

> > > **fname** [str] the name of the file where data has written

pyrad.io.**write_trt_cell_scores**(*traj_ID*, *flash_density_max_time*, *flash_density_max_rank*,
        nflashes_max_list, *area_flash_max_list*, *flash_density_max*,
        rank_max_time, *rank_max*, *fname*)

> writes TRT cells scores

> > **Parameters**

> > > **traj_ID** [array of ints] The ID of the cells

> > > **flash_density_max_time** [array of date times] The time at which the maximum flash density
> > > was reached for each cell

> > > **flash_density_max_rank** [array of floats] The rank when the maximum flash density was
> > > reached for each cell

> > > **nflashes_max_list** [array of ints] the number of flashes when the max flash density was reached

> > > **area_flash_max_list** [array of floats] The area when the max flash density was reached

> > > **flash_density_max** [array of floats] The maximum flash density for each cell

> **rank_max_time** [array of datetime] the time at wich the maximum rank of each cell was reached
>
> **rank_max** [array of float] the rank when the maximum rank of each cell was reached
>
> **fname** [str] file name where to store the data

> **Returns**

> **fname** [str] the name of the file where data has written

pyrad.io.**write_ts_cum**(*dataset*, *fname*)
    writes time series accumulation of data

> **Parameters**

> **dataset** [dict] dictionary containing the time series parameters
>
> **fname** [str] file name where to store the data

> **Returns**

> **fname** [str] the name of the file where data has written

pyrad.io.**write_ts_lightning**(*flashnr*, *time_data*, *time_in_flash*, *lat*, *lon*, *alt*, *dBm*, *vals_list*, *fname*, *pol_vals_labels*)
    writes the LMA sources data and the value of the colocated polarimetric variables

> **Parameters**

> **flashnr** [int] flash number
>
> **time_data** [datetime object] flash source time
>
> **time_in_flash** [float] seconds since start of flash
>
> **lat, lon, alt** [float] latitude, longitude [deg] and altitude [m MSL] of the flash source
>
> **dBm** [float] flash power
>
> **vals_list** [list of arrays] List containing the data for each polarimetric variable
>
> **fname** [str] the name of the file containing the content
>
> **pol_values_labels** [list of strings] List containing strings identifying each polarimetric variable

> **Returns**

> **fname** [str] the name of the file containing the content

pyrad.io.**write_ts_polar_data**(*dataset*, *fname*)
    writes time series of data

> **Parameters**

> **dataset** [dict] dictionary containing the time series parameters
>
> **fname** [str] file name where to store the data

> **Returns**

> **fname** [str] the name of the file where data has written

PLOTTING (`PYRAD.GRAPH`)

Functions to plot graphics.

5.1 Plots

plot_surface(grid, field_name, level, . . .)	plots a surface from gridded data
plot_latitude_slice(grid, field_name, lon, . . .)	plots a latitude slice from gridded data
plot_longitude_slice(grid, field_name, lon, . . .)	plots a longitude slice from gridded data
plot_latlon_slice(grid, field_name, coord1, . . .)	plots a croos section crossing two points in the grid
plot_ppi(radar, field_name, ind_el, prdcfg, . . .)	plots a PPI
plot_ppi_contour(radar, field_name, ind_el, . . .)	plots contour data on a PPI
plot_ppi_map(radar, field_name, ind_el, . . .)	plots a PPI on a geographic map
plot_rhi(radar, field_name, ind_az, prdcfg, . . .)	plots an RHI
plot_rhi_contour(radar, field_name, ind_az, . . .)	plots contour data on an RHI
plot_bscope(radar, field_name, ind_sweep, . . .)	plots a B-Scope (angle-range representation)
plot_time_range(radar, field_name, . . .)	plots a time-range plot
plot_rhi_profile(data_list, hvec, fname_list)	plots an RHI profile
plot_along_coord(xval_list, yval_list, . . .)	plots a time series
plot_field_coverage(xval_list, yval_list, . . .)	plots a time series
plot_density(hist_obj, hist_type, . . . [, . . .])	density plot (angle-values representation)
plot_cappi(radar, field_name, altitude, . . .)	plots a Constant Altitude Plan Position Indicator CAPPI
plot_traj(rng_traj, azi_traj, ele_traj, . . .)	plots a trajectory on a Cartesian surface
plot_pos(lat, lon, alt, fname_list[, ax, . . .])	plots a trajectory on a Cartesian surface
plot_quantiles(quant, value, fname_list[, . . .])	plots quantiles
plot_histogram(bin_edges, values, fname_list)	computes and plots histogram
plot_histogram2(bin_centers, hist, fname_list)	plots histogram
plot_antenna_pattern(antpattern, fname_list)	plots an antenna pattern
plot_timeseries(tvec, data_list, fname_list)	plots a time series
plot_timeseries_comp(date1, value1, date2, . . .)	plots 2 time series in the same graph
plot_monitoring_ts(date, np_t, cquant, . . .)	plots a time series of monitoring data
plot_scatter_comp(value1, value2, fname_list)	plots the scatter between two time series
plot_intercomp_scores_ts(date_vec, np_vec, . . .)	plots a time series of radar intercomparison scores
plot_ml_ts(dt_ml_arr, ml_top_avg_arr, . . . [, . . .])	plots a time series of melting layer data
plot_sun_hits(field, field_name, fname_list, . . .)	plots the sun hits

Continued on next page

Table 1 – continued from previous page

plot_sun_retrieval_ts(sun_retrieval, ...[, ...])	plots sun retrieval time series series
get_colobar_label(field_dict, field_name)	creates the colorbar label using field metadata
get_field_name(field_dict, field)	Return a nice field name for a particular field
_plot_time_range(rad_time, rad_range, ...[, ...])	plots a time-range plot

pyrad.graph.**get_colobar_label**(*field_dict*, *field_name*)
> creates the colorbar label using field metadata

>> **Parameters**

>>> **field_dict** [dict] dictionary containing field metadata

>>> **field_name** [str] name of the field

>> **Returns**

>>> **label** [str] colorbar label

pyrad.graph.**get_field_name**(*field_dict*, *field*)
> Return a nice field name for a particular field

>> **Parameters**

>>> **field_dict** [dict] dictionary containing field metadata

>>> **field** [str] name of the field

>> **Returns**

>>> **field_name** [str] the field name

pyrad.graph.**plot_along_coord**(*xval_list*, *yval_list*, *fname_list*, *labelx='coord'*, *labely='Value'*, *labels=None*, *title='Plot along coordinate'*, *colors=None*, *linestyles=None*, *ymin=None*, *ymax=None*, *dpi=72*)
> plots a time series

>> **Parameters**

>>> **xval_list** [list of float arrays] the x values, range, azimuth or elevation

>>> **yval_list** [list of float arrays] the y values. Parameter to plot

>>> **fname_list** [list of str] list of names of the files where to store the plot

>>> **labelx** [str] The label of the X axis

>>> **labely** [str] The label of the Y axis

>>> **labels** [array of str] The label of the legend

>>> **title** [str] The figure title

>>> **colors** [array of str] Specifies the colors of each line

>>> **linestyles** [array of str] Specifies the line style of each line

>>> **ymin, ymax: float** Lower/Upper limit of y axis

>>> **dpi** [int] dots per inch

>> **Returns**

>>> **fname_list** [list of str] list of names of the created plots

pyrad.graph.**plot_antenna_pattern**(*antpattern*, *fname_list*, *labelx='Angle [Deg]'*, *linear=False*, *twoway=False*, *title='Antenna Pattern'*, *ymin=None*, *ymax=None*, *dpi=72*)

    plots an antenna pattern

        Parameters

            antpattern [dict] dictionary with the angle and the attenuation

            value [float array] values of the time series

            fname_list [list of str] list of names of the files where to store the plot

            labelx [str] The label of the X axis

            linear [boolean] if true data is in linear units

            linear [boolean] if true data represents the two way attenuation

            titl [str] The figure title

            ymin, ymax: float Lower/Upper limit of y axis

            dpi [int] dots per inch

        Returns

            fname_list [list of str] list of names of the created plots

pyrad.graph.**plot_bscope**(*radar*, *field_name*, *ind_sweep*, *prdcfg*, *fname_list*)

    plots a B-Scope (angle-range representation)

        Parameters

            radar [Radar object] object containing the radar data to plot

            field_name [str] name of the radar field to plot

            ind_sweep [int] sweep index to plot

            prdcfg [dict] dictionary containing the product configuration

            fname_list [list of str] list of names of the files where to store the plot

        Returns

            fname_list [list of str] list of names of the created plots

pyrad.graph.**plot_cappi**(*radar*, *field_name*, *altitude*, *prdcfg*, *fname_list*, *save_fig=True*)

    plots a Constant Altitude Plan Position Indicator CAPPI

        Parameters

            radar [Radar object] object containing the radar data to plot

            field_name [str] name of the radar field to plot

            altitude [float] the altitude [m MSL] to be plotted

            prdcfg [dict] dictionary containing the product configuration

            fname_list [list of str] list of names of the files where to store the plot

            save_fig [bool] if true save the figure. If false it does not close the plot and returns the handle to the figure

        Returns

            fname_list [list of str or]

---

fig, ax [tupple] list of names of the saved plots or handle of the figure an axes

pyrad.graph.**plot_density**(*hist_obj, hist_type, field_name, ind_sweep, prdcfg, fname_list, quantiles=[25.0, 50.0, 75.0], ref_value=0.0, vmin=None, vmax=None*)

density plot (angle-values representation)

> **Parameters**
>
>> **hist_obj** [histogram object] object containing the histogram data to plot
>>
>> **hist_type** [str] type of histogram (instantaneous data or cumulative)
>>
>> **field_name** [str] name of the radar field to plot
>>
>> **ind_sweep** [int] sweep index to plot
>>
>> **prdcfg** [dict] dictionary containing the product configuration
>>
>> **fname_list** [list of str] list of names of the files where to store the plot
>>
>> **quantiles** [array] the quantile lines to plot
>>
>> **ref_value** [float] the reference value
>>
>> **vmin, vmax** [float] Minim and maximum extend of the vertical axis
>
> **Returns**
>
>> **fname_list** [list of str] list of names of the created plots

pyrad.graph.**plot_field_coverage**(*xval_list, yval_list, fname_list, labelx='Azimuth (deg)', labely='Range extension [m]', labels=None, title='Field coverage', ymin=None, ymax=None, xmeanval=None, ymeanval=None, labelmeanval=None, dpi=72*)

plots a time series

> **Parameters**
>
>> **xval_list** [list of float arrays] the x values, azimuth
>>
>> **yval_list** [list of float arrays] the y values. Range extension
>>
>> **fname_list** [list of str] list of names of the files where to store the plot
>>
>> **labelx** [str] The label of the X axis
>>
>> **labely** [str] The label of the Y axis
>>
>> **labels** [array of str] The label of the legend
>>
>> **title** [str] The figure title
>>
>> **ymin, ymax** [float] Lower/Upper limit of y axis
>>
>> **xmeanval, ymeanval** [float array] the x and y values of a mean along elevation
>>
>> **labelmeanval** [str] the label of the mean
>>
>> **dpi** [int] dots per inch
>
> **Returns**
>
>> **fname_list** [list of str] list of names of the created plots

pyrad.graph.**plot_histogram**(*bin_edges, values, fname_list, labelx='bins', labely='Number of Samples', titl='histogram', dpi=72*)

computes and plots histogram

> **Parameters**

> > **bin_edges** [array] histogram bin edges
>
> > **values** [array] data values
>
> > **fname_list** [list of str] list of names of the files where to store the plot
>
> > **labelx** [str] The label of the X axis
>
> > **labely** [str] The label of the Y axis
>
> > **titl** [str] The figure title
>
> > **dpi** [int] dots per inch
>
> **Returns**
>
> > **fname_list** [list of str] list of names of the created plots

pyrad.graph.**plot_histogram2**(*bin_centers*, *hist*, *fname_list*, *labelx='bins'*, *labely='Number of Samples'*, *titl='histogram'*, *dpi=72*, *ax=None*, *fig=None*, *save_fig=True*, *color=None*, *alpha=None*, *invert_xaxis=False*)

> plots histogram
>
> **Parameters**
>
> > **bin_centers** [array] histogram bin centers
>
> > **hist** [array] values for each bin
>
> > **fname_list** [list of str] list of names of the files where to store the plot
>
> > **labelx** [str] The label of the X axis
>
> > **labely** [str] The label of the Y axis
>
> > **titl** [str] The figure title
>
> > **dpi** [int] dots per inch
>
> > **fig** [Figure] Figure to add the colorbar to. If none a new figure will be created
>
> > **ax** [Axis] Axis to plot on. if fig is None a new axis will be created
>
> > **save_fig** [bool] if true save the figure. If false it does not close the plot and returns the handle to the figure
>
> > **color** [str] color of the bars
>
> > **alpha** [float] parameter controling the transparency
>
> > **invert_xaxis** [bool] If true inverts the x axis
>
> **Returns**
>
> > **fname_list or fig, ax: list of str** list of names of the created plots

pyrad.graph.**plot_intercomp_scores_ts**(*date_vec*, *np_vec*, *meanbias_vec*, *medianbias_vec*, *quant25bias_vec*, *quant75bias_vec*, *modebias_vec*, *corr_vec*, *slope_vec*, *intercep_vec*, *intercep_slope1_vec*, *fname_list*, *ref_value=0.0*, *np_min=0*, *corr_min=0.0*, *labelx='Time UTC'*, *titl='RADAR001-RADAR002 intercomparison'*, *dpi=72*)

> plots a time series of radar intercomparison scores
>
> **Parameters**
>
> > **date_vec** [datetime object] time of the time series
>
> > **np_vec** [int array] number of points

meanbias_vec, medianbias_vec, modebias_vec [float array] mean, median and mode bias

quant25bias_vec, quant75bias_vec: 25th and 75th percentile of the bias

corr_vec [float array] correlation

slope_vec, intercep_vec [float array] slope and intercep of a linear regression

intercep_slope1_vec [float] the intercep point of a inear regression of slope 1

ref_value [float] the reference value

np_min [int] The minimum number of points to consider the result valid

corr_min [float] The minimum correlation to consider the results valid

labelx [str] The label of the X axis

titl [str] The figure title

Returns

fname_list [list of str] list of names of the created plots

pyrad.graph.**plot_latitude_slice**(*grid*, *field_name*, *lon*, *lat*, *prdcfg*, *fname_list*)
    plots a latitude slice from gridded data

Parameters

grid [Grid object] object containing the gridded data to plot

field_name [str] name of the radar field to plot

lon, lat [float] coordinates of the slice to plot

prdcfg [dict] dictionary containing the product configuration

fname_list [list of str] list of names of the files where to store the plot

Returns

fname_list [list of str] list of names of the created plots

pyrad.graph.**plot_latlon_slice**(*grid*, *field_name*, *coord1*, *coord2*, *prdcfg*, *fname_list*)
    plots a croos section crossing two points in the grid

Parameters

grid [Grid object] object containing the gridded data to plot

field_name [str] name of the radar field to plot

coord1 [tupple of floats] lat, lon of the first point

coord2 [tupple of floats] lat, lon of the second point

fname_list [list of str] list of names of the files where to store the plot

Returns

fname_list [list of str] list of names of the created plots

pyrad.graph.**plot_longitude_slice**(*grid*, *field_name*, *lon*, *lat*, *prdcfg*, *fname_list*)
    plots a longitude slice from gridded data

Parameters

grid [Grid object] object containing the gridded data to plot

field_name [str] name of the radar field to plot

> **lon, lat** [float] coordinates of the slice to plot
>
> **prdcfg** [dict] dictionary containing the product configuration
>
> **fname_list** [list of str] list of names of the files where to store the plot

> **Returns**
>
> **fname_list** [list of str] list of names of the created plots

pyrad.graph.**plot_ml_ts**(*dt_ml_arr*, *ml_top_avg_arr*, *ml_top_std_arr*, *thick_avg_arr*, *thick_std_arr*, *nrays_valid_arr*, *nrays_total_arr*, *fname_list*, *labelx='Time UTC'*, *titl='Melting layer time series'*, *dpi=72*)

> plots a time series of melting layer data

> **Parameters**
>
> **dt_ml_arr** [datetime object] time of the time series
>
> **np_vec** [int array] number of points
>
> **meanbias_vec, medianbias_vec, modebias_vec** [float array] mean, median and mode bias
>
> **quant25bias_vec, quant75bias_vec: 25th and 75th percentile of the bias**
>
> **corr_vec** [float array] correlation
>
> **slope_vec, intercep_vec** [float array] slope and intercep of a linear regression
>
> **intercep_slope1_vec** [float] the intercep point of a inear regression of slope 1
>
> **ref_value** [float] the reference value
>
> **np_min** [int] The minimum number of points to consider the result valid
>
> **corr_min** [float] The minimum correlation to consider the results valid
>
> **labelx** [str] The label of the X axis
>
> **titl** [str] The figure title

> **Returns**
>
> **fname_list** [list of str] list of names of the created plots

pyrad.graph.**plot_monitoring_ts**(*date*, *np_t*, *cquant*, *lquant*, *hquant*, *field_name*, *fname_list*, *ref_value=None*, *vmin=None*, *vmax=None*, *np_min=0*, *labelx='Time [UTC]'*, *labely='Value'*, *titl='Time Series'*, *dpi=72*)

> plots a time series of monitoring data

> **Parameters**
>
> **date** [datetime object] time of the time series
>
> **np_t** [int array] number of points
>
> **cquant, lquant, hquant** [float array] values of the central, low and high quantiles
>
> **field_name** [str] name of the field
>
> **fname_list** [list of str] list of names of the files where to store the plot
>
> **ref_value** [float] the reference value
>
> **vmin, vmax** [float] The limits of the y axis
>
> **np_min** [int] minimum number of points to consider the sample plotable
>
> **labelx** [str] The label of the X axis

> > > **labely** [str] The label of the Y axis
> > >
> > > **titl** [str] The figure title
> > >
> > > **dpi** [int] dots per inch
> >
> > **Returns**
> >
> > > **fname_list** [list of str] list of names of the created plots

pyrad.graph.**plot_pos**(*lat, lon, alt, fname_list, ax=None, fig=None, save_fig=True, sort_altitude='No', dpi=72, alpha=1.0, cb_label='height [m MSL]', titl='Position', xlabel='Lon [Deg]', ylabel='Lat [Deg]', limits=None, vmin=None, vmax=None*)

> plots a trajectory on a Cartesian surface
>
> > **Parameters**
> >
> > > **lat, lon, alt** [float array] Points coordinates
> > >
> > > **fname_list** [list of str] list of names of the files where to store the plot
> > >
> > > **fig** [Figure] Figure to add the colorbar to. If none a new figure will be created
> > >
> > > **ax** [Axis] Axis to plot on. if fig is None a new axis will be created
> > >
> > > **save_fig** [bool] if true save the figure if false it does not close the plot and returns the handle to the figure
> > >
> > > **sort_altitude** [str] String indicating whether to sort the altitude data. Can be 'No', 'Lowest_on_top' or 'Highest_on_top'
> > >
> > > **dpi** [int] Pixel density
> > >
> > > **alpha** [float] Transparency
> > >
> > > **cb_label** [str] Color bar label
> > >
> > > **titl** [str] Plot title
> > >
> > > **limits** [tupple or None] The limits of the field to plot
> >
> > **Returns**
> >
> > > **fname_list** [list of str or]
> > >
> > > **fig, ax** [tupple] list of names of the saved plots or handle of the figure an axes

pyrad.graph.**plot_ppi**(*radar, field_name, ind_el, prdcfg, fname_list, plot_type='PPI', titl=None, step=None, quantiles=None, save_fig=True*)

> plots a PPI
>
> > **Parameters**
> >
> > > **radar** [Radar object] object containing the radar data to plot
> > >
> > > **field_name** [str] name of the radar field to plot
> > >
> > > **ind_el** [int] sweep index to plot
> > >
> > > **prdcfg** [dict] dictionary containing the product configuration
> > >
> > > **fname_list** [list of str] list of names of the files where to store the plot
> > >
> > > **plot_type** [str] type of plot (PPI, QUANTILES or HISTOGRAM)
> > >
> > > **titl** [str] Plot title
> > >
> > > **step** [float] step for histogram plotting

> **quantiles** [float array] quantiles to plot
>
> **save_fig** [bool] if true save the figure. If false it does not close the plot and returns the handle to the figure

> **Returns**
>
> **fname_list** [list of str] list of names of the created plots

pyrad.graph.**plot_ppi_contour**(*radar*, *field_name*, *ind_el*, *prdcfg*, *fname_list*, *contour_values=None*, *linewidths=1.5*, *ax=None*, *fig=None*, *save_fig=True*)

> plots contour data on a PPI

> **Parameters**
>
> **radar** [Radar object] object containing the radar data to plot
>
> **field_name** [str] name of the radar field to plot
>
> **ind_el** [int] sweep index to plot
>
> **prdcfg** [dict] dictionary containing the product configuration
>
> **fname_list** [list of str] list of names of the files where to store the plot
>
> **contour_values** [float array] list of contours to plot
>
> **linewidths** [float] width of the contour lines
>
> **fig** [Figure] Figure to add the colorbar to. If none a new figure will be created
>
> **ax** [Axis] Axis to plot on. if fig is None a new axis will be created
>
> **save_fig** [bool] if true save the figure if false it does not close the plot and returns the handle to the figure

> **Returns**
>
> **fname_list** [list of str or]
>
> **fig, ax** [tupple] list of names of the saved plots or handle of the figure an axes

pyrad.graph.**plot_ppi_map**(*radar*, *field_name*, *ind_el*, *prdcfg*, *fname_list*)

> plots a PPI on a geographic map

> **Parameters**
>
> **radar** [Radar object] object containing the radar data to plot
>
> **field_name** [str] name of the radar field to plot
>
> **ind_el** [int] sweep index to plot
>
> **prdcfg** [dict] dictionary containing the product configuration
>
> **fname_list** [list of str] list of names of the files where to store the plot

> **Returns**
>
> **fname_list** [list of str] list of names of the created plots

pyrad.graph.**plot_quantiles**(*quant*, *value*, *fname_list*, *labelx='quantile'*, *labely='value'*, *titl='quantile'*, *vmin=None*, *vmax=None*, *dpi=72*)

> plots quantiles

> **Parameters**
>
> **quant** [array] quantiles to be plotted

> **value** [array] values of each quantile
>
> **fname_list** [list of str] list of names of the files where to store the plot
>
> **labelx** [str] The label of the X axis
>
> **labely** [str] The label of the Y axis
>
> **titl** [str] The figure title
>
> **vmin, vmax: float** Lower/Upper limit of data values
>
> **dpi** [int] dots per inch

> **Returns**

> **fname_list** [list of str] list of names of the created plots

pyrad.graph.**plot_rhi**(*radar*, *field_name*, *ind_az*, *prdcfg*, *fname_list*, *plot_type='RHI'*, *titl=None*, *step=None*, *quantiles=None*, *save_fig=True*)

> plots an RHI

> **Parameters**

> **radar** [Radar object] object containing the radar data to plot
>
> **field_name** [str] name of the radar field to plot
>
> **ind_az** [int] sweep index to plot
>
> **prdcfg** [dict] dictionary containing the product configuration
>
> **fname_list** [list of str] list of names of the files where to store the plot
>
> **plot_type** [str] type of plot (PPI, QUANTILES or HISTOGRAM)
>
> **titl** [str] Plot title
>
> **step** [float] step for histogram plotting
>
> **quantiles** [float array] quantiles to plot
>
> **save_fig** [bool] if true save the figure. If false it does not close the plot and returns the handle to the figure

> **Returns**

> **fname_list** [list of str] list of names of the created plots
>
> **fig, ax** [tupple] list of names of the saved plots or handle of the figure an axes

pyrad.graph.**plot_rhi_contour**(*radar*, *field_name*, *ind_az*, *prdcfg*, *fname_list*, *contour_values=None*, *linewidths=1.5*, *ax=None*, *fig=None*, *save_fig=True*)

> plots contour data on an RHI

> **Parameters**

> **radar** [Radar object] object containing the radar data to plot
>
> **field_name** [str] name of the radar field to plot
>
> **ind_az** [int] sweep index to plot
>
> **prdcfg** [dict] dictionary containing the product configuration
>
> **fname_list** [list of str] list of names of the files where to store the plot
>
> **contour_values** [float array] list of contours to plot

> **linewidths** [float] width of the contour lines
>
> **fig** [Figure] Figure to add the colorbar to. If none a new figure will be created
>
> **ax** [Axis] Axis to plot on. if fig is None a new axis will be created
>
> **save_fig** [bool] if true save the figure if false it does not close the plot and returns the handle to the figure

> **Returns**

> **fname_list** [list of str or]
>
> **fig, ax** [tupple] list of names of the saved plots or handle of the figure an axes

pyrad.graph.**plot_rhi_profile**(*data_list, hvec, fname_list, labelx='Value', labely='Height (m MSL)', labels=['Mean'], title='RHI profile', colors=None, linestyles=None, vmin=None, vmax=None, hmin=None, hmax=None, dpi=72*)

> plots an RHI profile

> **Parameters**

> **data_list** [list of float array] values of the profile
>
> **hvec** [float array] height points of the profile
>
> **fname_list** [list of str] list of names of the files where to store the plot
>
> **labelx** [str] The label of the X axis
>
> **labely** [str] The label of the Y axis
>
> **labels** [array of str] The label of the legend
>
> **title** [str] The figure title
>
> **colors** [array of str] Specifies the colors of each line
>
> **linestyles** [array of str] Specifies the line style of each line
>
> **vmin, vmax: float** Lower/Upper limit of data values
>
> **hmin, hmax: float** Lower/Upper limit of altitude
>
> **dpi** [int] dots per inch

> **Returns**

> **fname_list** [list of str] list of names of the created plots

pyrad.graph.**plot_scatter**(*bin_edges1, bin_edges2, hist_2d, field_name1, field_name2, fname_list, prdcfg, metadata=None, lin_regr=None, lin_regr_slope1=None, rad1_name='RADAR001', rad2_name='RADAR002'*)

> 2D histogram

> **Parameters**

> **bin_edges1, bin_edges2** [float array2] the bins of each field
>
> **hist_2d** [ndarray 2D] the 2D histogram
>
> **field_name1, field_name2** [str] the names of each field
>
> **fname_list** [list of str] list of names of the files where to store the plot
>
> **prdcfg** [dict] product configuration dictionary
>
> **metadata** [str] a string with metadata to write in the plot

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   lin_regr [tupple with 2 values] the coefficients for a linear regression

   lin_regr_slope1 [float] the intercep point of a linear regression of slope 1

   rad1_name, rad2_name [str] name of the radars which data is used

  Returns

   fname_list [list of str] list of names of the created plots

pyrad.graph.**plot_scatter_comp**(*value1*, *value2*, *fname_list*, *labelx='Sensor 1'*, *labely='Sensor 2'*, *titl='Scatter'*, *axis=None*, *metadata=None*, *dpi=72*)

  plots the scatter between two time series

  Parameters

   value1 [float array] values of the first time series

   value2 [float array] values of the second time series

   fname_list [list of str] list of names of the files where to store the plot

   labelx [str] The label of the X axis

   labely [str] The label of the Y axis

   titl [str] The figure title

   axis [str] type of axis

   metadata [string] a string containing metadata

   dpi [int] dots per inch

  Returns

   fname_list [list of str] list of names of the created plots

pyrad.graph.**plot_sun_hits**(*field*, *field_name*, *fname_list*, *prdcfg*)

  plots the sun hits

  Parameters

   radar [Radar object] object containing the radar data to plot

   field_name [str] name of the radar field to plot

   altitude [float] the altitude [m MSL] to be plotted

   prdcfg [dict] dictionary containing the product configuration

   fname_list [list of str] list of names of the files where to store the plot

  Returns

   fname_list [list of str] list of names of the created plots

pyrad.graph.**plot_sun_retrieval_ts**(*sun_retrieval*, *data_type*, *fname_list*, *labelx='Date'*, *titl='Sun retrieval Time Series'*, *dpi=72*)

  plots sun retrieval time series series

  Parameters

   sun_retrieval [tuple] tuple containing the retrieved parameters

   data_type [str] parameter to be plotted

   fname_list [list of str] list of names of the files where to store the plot

   labelx [str] the x label

titl [str] the title of the plot

dpi [int] dots per inch

Returns

fname_list [list of str] list of names of the created plots

pyrad.graph.**plot_surface**(*grid*, *field_name*, *level*, *prdcfg*, *fname_list*)
plots a surface from gridded data

Parameters

grid [Grid object] object containing the gridded data to plot

field_name [str] name of the radar field to plot

level [int] level index

prdcfg [dict] dictionary containing the product configuration

fname_list [list of str] list of names of the files where to store the plot

Returns

fname_list [list of str] list of names of the created plots

pyrad.graph.**plot_time_range**(*radar*, *field_name*, *ind_sweep*, *prdcfg*, *fname_list*)
plots a time-range plot

Parameters

radar [Radar object] object containing the radar data to plot

field_name [str] name of the radar field to plot

ind_sweep [int] sweep index to plot

prdcfg [dict] dictionary containing the product configuration

fname_list [list of str] list of names of the files where to store the plot

Returns

fname_list [list of str] list of names of the created plots

pyrad.graph.**plot_timeseries**(*tvec, data_list, fname_list, labelx='Time [UTC]', labely='Value', labels=['Sensor'], title='Time Series', period=0, timeformat=None, colors=None, linestyles=None, markers=None, ymin=None, ymax=None, dpi=72*)
plots a time series

Parameters

tvec [datetime object] time of the time series

data_list [list of float array] values of the time series

fname_list [list of str] list of names of the files where to store the plot

labelx [str] The label of the X axis

labely [str] The label of the Y axis

labels [array of str] The label of the legend

title [str] The figure title

period [float] measurement period in seconds used to compute accumulation. If 0 no accumulation is computed

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> **timeformat** [str] Specifies the tvec and time format on the x axis
>
> **colors** [array of str] Specifies the colors of each line
>
> **linestyles** [array of str] Specifies the line style of each line
>
> **markers: array of str** Specify the markers to be used for each line
>
> **ymin, ymax: float** Lower/Upper limit of y axis
>
> **dpi** [int] dots per inch

> **Returns**
>
> **fname_list** [list of str] list of names of the created plots

pyrad.graph.**plot_timeseries_comp**(*date1*, *value1*, *date2*, *value2*, *fname_list*, *labelx='Time [UTC]'*, *labely='Value'*, *label1='Sensor 1'*, *label2='Sensor 2'*, *titl='Time Series Comparison'*, *period1=0*, *period2=0*, *ymin=None*, *ymax=None*, *dpi=72*)

> plots 2 time series in the same graph

> **Parameters**
>
> **date1** [datetime object] time of the first time series
>
> **value1** [float array] values of the first time series
>
> **date2** [datetime object] time of the second time series
>
> **value2** [float array] values of the second time series
>
> **fname_list** [list of str] list of names of the files where to store the plot
>
> **labelx** [str] The label of the X axis
>
> **labely** [str] The label of the Y axis
>
> **label1, label2** [str] legend label for each time series
>
> **titl** [str]
>
>> The figure title
>
>> **period1, period2** [float] measurement period in seconds used to compute accumulation. If 0 no accumulation is computed
>
> **dpi** [int] dots per inch
>
> **ymin, ymax** [float] The limits of the Y-axis. None will keep the default limit.

> **Returns**
>
> **fname_list** [list of str] list of names of the created plots

pyrad.graph.**plot_traj**(*rng_traj*, *azi_traj*, *ele_traj*, *time_traj*, *prdcfg*, *fname_list*, *rad_alt=None*, *rad_tstart=None*, *ax=None*, *fig=None*, *save_fig=True*)

> plots a trajectory on a Cartesian surface

> **Parameters**
>
> **rng_traj, azi_traj, ele_traj** [float array] antenna coordinates of the trajectory [m and deg]
>
> **time_traj** [datetime array] trajectory time
>
> **prdcfg** [dict] dictionary containing the product configuration
>
> **fname_list** [list of str] list of names of the files where to store the plot

rad_alt [float or None] radar altitude [m MSL]

rad_tstart [datetime object or None] start time of the radar scan

surface_alt [float] surface altitude [m MSL]

color_ref [str] What the color code represents. Can be 'None', 'rel_altitude', 'altitude' or 'time'

fig [Figure] Figure to add the colorbar to. If none a new figure will be created

ax [Axis] Axis to plot on. if fig is None a new axis will be created

save_fig [bool] if true save the figure if false it does not close the plot and returns the handle to the figure

Returns

fname_list [list of str or]

fig, ax [tupple] list of names of the saved plots or handle of the figure an axes

UTILITIES (`PYRAD.UTIL`)

Functions to read and write data and configuration files.

6.1 Radar Utilities

get_ROI(radar, fieldname, sector)	filter out any data outside the region of interest defined by sector
rainfall_accumulation(t_in_vec, val_in_vec)	Computes the rainfall accumulation of a time series over a given period
time_series_statistics(t_in_vec, val_in_vec)	Computes statistics over a time-averaged series
join_time_series(t1, val1, t2, val2[, dropnan])	joins time_series
get_range_bins_to_avg(rad1_rng, rad2_rng)	Compares the resolution of two radars and determines if and which radar has to be averaged and the length of the averaging window
find_ray_index(ele_vec, azi_vec, ele, azi[, . . .])	Find the ray index corresponding to a particular elevation and azimuth
find_rng_index(rng_vec, rng[, rng_tol])	Find the range index corresponding to a particular range
find_nearest_gate	
find_neighbour_gates(radar, azi, rng[, . . .])	Find the neighbouring gates within +-delta_azi and +-delta_rng
find_colocated_indexes(radar1, radar2, . . .)	Given the theoretical elevation, azimuth and range of the co-located gates of two radars and a given tolerance returns the indices of the gates for the current radars
get_target_elevations(radar_in)	Gets RHI taget elevations
time_avg_range(timeinfo, avg_starttime, . . .)	finds the new start and end time of an averaging
get_closest_solar_flux(hit_datetime_list, . . .)	finds the solar flux measurement closest to the sun hit
create_sun_hits_field(rad_el, rad_az, . . .)	creates a sun hits field from the position and power of the sun hits
create_sun_retrieval_field(par, field_name, . . .)	creates a sun retrieval field from the retrieval parameters
compute_quantiles(field[, quantiles])	computes quantiles
compute_quantiles_from_hist(bin_centers, hist)	computes quantiles from histograms
compute_quantiles_sweep(field, ray_start, . . .)	computes quantiles of a particular sweep
compute_2d_hist(field1, field2, field_name1, . . .)	computes a 2D histogram of the data
compute_1d_stats(field1, field2)	returns statistics of data
compute_2d_stats(field1, field2, . . . [, . . .])	computes a 2D histogram and statistics of the data

Continued on next page

Table 1 – continued from previous page

compute_histogram(field, field_name[, ...])	computes histogram of the data
compute_histogram_sweep(field, ray_start, ...)	computes histogram of the data in a particular sweep
belongs_roi_indices(lat, lon, roi)	Get the indices of points that belong to roi in a list of points
compute_profile_stats(field, gate_altitude, ...)	Compute statistics of vertical profile
compute_directional_stats(field[, avg_type, ...])	Computes the mean or the median along one of the axis (ray or range)
project_to_vertical(data_in, data_height, ...)	Projects radar data to a regular vertical grid
quantiles_weighted(values[, weight_vector, ...])	Given a set of values and weights, compute the weighted quantile(s).

pyrad.util.**belongs_roi_indices**(*lat*, *lon*, *roi*)
> Get the indices of points that belong to roi in a list of points

> > **Parameters**

> > > **lat, lon** [float arrays] latitudes and longitudes to check

> > > **roi** [dict] Dictionary describing the region of interest

> > **Returns**

> > > **inds** [array of ints] list of indices of points belonging to ROI

> > > **is_roi** [str] Whether the list of points is within the region of interest. Can be 'All', 'None', 'Some'

pyrad.util.**compute_1d_stats**(*field1*, *field2*)
> returns statistics of data

> > **Parameters**

> > > **field1, field2** [ndarray 1D] the two fields to compare

> > **Returns**

> > > **stats** [dict] a dictionary with statistics

pyrad.util.**compute_2d_hist**(*field1*, *field2*, *field_name1*, *field_name2*, *step1=None*, *step2=None*)
> computes a 2D histogram of the data

> > **Parameters**

> > > **field1, field2** [ndarray 2D] the radar fields

> > > **field_name1, field_name2** [str] field names

> > > **step1, step2** [float] size of the bins

> > **Returns**

> > > **H** [float array 2D] The bi-dimensional histogram of samples x and y

> > > **xedges, yedges** [float array] the bin edges along each dimension

pyrad.util.**compute_2d_stats**(*field1*, *field2*, *field_name1*, *field_name2*, *step1=None*, *step2=None*)
> computes a 2D histogram and statistics of the data

> > **Parameters**

> > > **field1, field2** [ndarray 2D] the two fields

> > > **field_name1, field_nam2: str** the name of the fields

step1, step2 [float] size of bin

Returns

hist_2d [array] the histogram

bin_edges1, bin_edges2 [float array] The bin edges

stats [dict] a dictionary with statistics

pyrad.util.**compute_directional_stats**(*field*, *avg_type='mean'*, *nvalid_min=1*, *axis=0*)
Computes the mean or the median along one of the axis (ray or range)

Parameters

field [ndarray] the radar field

avg_type :str the type of average: 'mean' or 'median'

nvalid_min [int] the minimum number of points to consider the stats valid. Default 1

axis [int] the axis along which to compute (0=ray, 1=range)

Returns

values [ndarray 1D] The resultant statistics

nvalid [ndarray 1D] The number of valid points used in the computation

pyrad.util.**compute_histogram**(*field*, *field_name*, *bin_edges=None*, *step=None*, *vmin=None*, *vmax=None*)
computes histogram of the data

Parameters

field [ndarray 2D] the radar field

field_name: str or none name of the field

bins_edges :ndarray 1D the bin edges

step [float] size of bin

vmin, vmax [float] The minimum and maximum value of the histogram

Returns

bin_edges [float array] interval of each bin

values [float array] values at each bin

pyrad.util.**compute_histogram_sweep**(*field*, *ray_start*, *ray_end*, *field_name*, *step=None*)
computes histogram of the data in a particular sweep

Parameters

field [ndarray 2D] the radar field

ray_start, ray_end [int] starting and ending ray indexes

field_name: str name of the field

step [float] size of bin

Returns

bin_edges [float array] interval of each bin

values [float array] values at each bin

pyrad.util.**compute_profile_stats**(*field*, *gate_altitude*, *h_vec*, *h_res*, *quantity='quantiles'*, *quantiles=array([0.25, 0.5, 0.75])*, *nvalid_min=4*, *std_field=None*, *np_field=None*, *make_linear=False*, *include_nans=False*)

>   Compute statistics of vertical profile

>> **Parameters**

>>> **field** [ndarray] the radar field

>>> **gate_altitude: ndarray** the altitude at each radar gate [m MSL]

>>> **h_vec** [1D ndarray] height vector [m MSL]

>>> **h_res** [float] heigh resolution [m]

>>> **quantity** [str] The quantity to compute. Can be ['quantiles', 'mode', 'regression_mean', 'mean']. If 'mean', the min, max, and average is computed.

>>> **quantiles** [1D ndarray] the quantiles to compute

>>> **nvalid_min** [int] the minimum number of points to consider the stats valid

>>> **std_field** [ndarray] the standard deviation of the regression at each range gate

>>> **np_field** [ndarray] the number of points used to compute the regression at each range gate

>>> **make_linear** [Boolean] If true the data is transformed into linear coordinates before taking the mean

>>> **include_nans** [Boolean] If true NaN will be considered as zeros

>> **Returns**

>>> **vals** [ndarray 2D] The resultant statistics

>>> **val_valid** [ndarray 1D] The number of points to compute the stats used at each height level

pyrad.util.**compute_quantiles**(*field*, *quantiles=None*)

>   computes quantiles

>> **Parameters**

>>> **field** [ndarray 2D] the radar field

>>> **ray_start, ray_end** [int] starting and ending ray indexes

>>> **quantiles: float array** list of quantiles to compute

>> **Returns**

>>> **quantiles** [float array] list of quantiles

>>> **values** [float array] values at each quantile

pyrad.util.**compute_quantiles_from_hist**(*bin_centers*, *hist*, *quantiles=None*)

>   computes quantiles from histograms

>> **Parameters**

>>> **bin_centers** [ndarray 1D] the bins

>>> **hist** [ndarray 1D] the histogram

>>> **quantiles: float array** list of quantiles to compute

>> **Returns**

>>> **quantiles** [float array] list of quantiles

>>> **values** [float array] values at each quantile

pyrad.util.**compute_quantiles_sweep**(*field*, *ray_start*, *ray_end*, *quantiles=None*)
    computes quantiles of a particular sweep

>   **Parameters**

>   > **field** [ndarray 2D] the radar field

>   > **ray_start, ray_end** [int] starting and ending ray indexes

>   > **quantiles: float array** list of quantiles to compute

>   **Returns**

>   > **quantiles** [float array] list of quantiles

>   > **values** [float array] values at each quantile

pyrad.util.**create_sun_hits_field**(*rad_el*, *rad_az*, *sun_el*, *sun_az*, *data*, *imgcfg*)
    creates a sun hits field from the position and power of the sun hits

>   **Parameters**

>   > **rad_el, rad_az, sun_el, sun_az** [ndarray 1D] azimuth and elevation of the radar and the sun
>   > respectively in degree

>   > **data** [masked ndarray 1D] the sun hit data

>   > **imgcfg: dict** a dictionary specifying the ranges and resolution of the field to create

>   **Returns**

>   > **field** [masked ndarray 2D] the sun hit field

pyrad.util.**create_sun_retrieval_field**(*par*, *field_name*, *imgcfg*, *lant=0.0*)
    creates a sun retrieval field from the retrieval parameters

>   **Parameters**

>   > **par** [ndarray 1D] the 5 retrieval parameters

>   > **imgcfg: dict** a dictionary specifying the ranges and resolution of the field to create

>   **Returns**

>   > **field** [masked ndarray 2D] the sun retrieval field

pyrad.util.**find_colocated_indexes**(*radar1*, *radar2*, *rad1_ele*, *rad1_azi*, *rad1_rng*, *rad2_ele*, *rad2_azi*, *rad2_rng*, *ele_tol=0.5*, *azi_tol=0.5*, *rng_tol=50.0*)
    Given the theoretical elevation, azimuth and range of the co-located gates of two radars and a given tolerance returns the indices of the gates for the current radars

>   **Parameters**

>   > **radar1, radar2** [radar objects] the two radar objects

>   > **rad1_ele, rad1_azi, rad1_rng** [array of floats] the radar coordinates of the radar1 gates

>   > **rad2_ele, rad2_azi, rad2_rng** [array of floats] the radar coordinates of the radar2 gates

>   > **ele_tol, azi_tol** [floats] azimuth and elevation angle tolerance [deg]

>   > **rng_tol** [float] range Tolerance [m]

>   **Returns**

>   > **ind_ray_rad1, ind_rng_rad1, ind_ray_rad2, ind_rng_rad2** [array of ints] the ray and range
>   > indexes of each radar gate

pyrad.util.**find_neighbour_gates**(*radar*, *azi*, *rng*, *delta_azi=None*, *delta_rng=None*)
    Find the neighbouring gates within +-delta_azi and +-delta_rng

> **Parameters**
>
> > **radar** [radar object] the radar object
> >
> > **azi, rng** [float] The azimuth [deg] and range [m] of the central gate
> >
> > **delta_azi, delta_rng** [float] The extend where to look for
>
> **Returns**
>
> > **inds_ray_aux, ind_rng_aux** [int] The indices (ray, rng) of the neighbouring gates

pyrad.util.**find_ray_index**(*ele_vec*, *azi_vec*, *ele*, *azi*, *ele_tol=0.0*, *azi_tol=0.0*, *nearest='azi'*)
    Find the ray index corresponding to a particular elevation and azimuth

> **Parameters**
>
> > **ele_vec, azi_vec** [float arrays] The elevation and azimuth data arrays where to look for
> >
> > **ele, azi** [floats] The elevation and azimuth to search
> >
> > **ele_tol, azi_tol** [floats] Tolerances [deg]
> >
> > **nearest** [str] criteria to define wich ray to keep if multiple rays are within tolerance. azi: nearest azimuth, ele: nearest elevation
>
> **Returns**
>
> > **ind_ray** [int] The ray index

pyrad.util.**find_rng_index**(*rng_vec*, *rng*, *rng_tol=0.0*)
    Find the range index corresponding to a particular range

> **Parameters**
>
> > **rng_vec** [float array] The range data array where to look for
> >
> > **rng** [float] The range to search
> >
> > **rng_tol** [float] Tolerance [m]
>
> **Returns**
>
> > **ind_rng** [int] The range index

pyrad.util.**get_ROI**(*radar*, *fieldname*, *sector*)
    filter out any data outside the region of interest defined by sector

> **Parameters**
>
> > **radar** [radar object] the radar object where the data is
> >
> > **fieldname** [str] name of the field to filter
> >
> > **sector** [dict] a dictionary defining the region of interest
>
> **Returns**
>
> > **roi_flag** [ndarray] a field array with ones in gates that are in the Region of Interest

pyrad.util.**get_closest_solar_flux**(*hit_datetime_list*, *flux_datetime_list*, *flux_value_list*)
    finds the solar flux measurement closest to the sun hit

> **Parameters**
>
> > **hit_datetime_list** [datetime array] the date and time of the sun hit

> > **flux_datetime_list** [datetime array] the date and time of the solar flux measurement
>
> > **flux_value_list: ndarray 1D** the solar flux values
>
> > Returns
>
> > > **flux_datetime_closest_list** [datetime array] the date and time of the solar flux measurement closest to sun hit
> >
> > > **flux_value_closest_list** [ndarray 1D] the solar flux values closest to the sun hit time

pyrad.util.**get_range_bins_to_avg**(*rad1_rng*, *rad2_rng*)

> Compares the resolution of two radars and determines if and which radar has to be averaged and the length of the averaging window
>
> > Parameters
>
> > > **rad1_rng** [array] the range of radar 1
> >
> > > **rad2_rng** [datetime] the range of radar 2
>
> > Returns
>
> > > **avg_rad1, avg_rad2** [Boolean] Booleans specifying if the radar data has to be average in range
> >
> > > **avg_rad_lim** [array with two elements] the limits to the average (centered on each range gate)

pyrad.util.**get_target_elevations**(*radar_in*)

> Gets RHI taget elevations
>
> > Parameters
>
> > > **radar_in** [Radar object] current radar object
>
> > Returns
>
> > > **target_elevations** [1D-array] Azimuth angles
> >
> > > **el_tol** [float] azimuth tolerance

pyrad.util.**join_time_series**(*t1*, *val1*, *t2*, *val2*, *dropnan=False*)

> joins time_series
>
> > Parameters
>
> > > **t1** [datetime array] time of first series
> >
> > > **val1** [float array] value of first series
> >
> > > **t2** [datetime array] time of second series
> >
> > > **val2** [float array] value of second series
> >
> > > **dropnan** [boolean] if True remove NaN from the time series
>
> > Returns
>
> > > **t_out_vec** [datetime array] the resultant date time after joining the series
> >
> > > **val1_out_vec** [float array] value of first series
> >
> > > **val2_out_vec** [float array] value of second series

pyrad.util.**project_to_vertical**(*data_in*, *data_height*, *grid_height*, *interp_kind='none'*, *fill_value=-9999.0*)

> Projects radar data to a regular vertical grid
>
> > Parameters
>
> > > **data_in** [ndarray 1D] the radar data to project

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> **data_height** [ndarray 1D] the height of each radar point
>
> **grid_height** [ndarray 1D] the regular vertical grid to project to
>
> **interp_kind** [str] The type of interpolation to use: 'none' or 'nearest'
>
> **fill_value** [float] The fill value used for interpolation

> Returns

> **data_out** [ndarray 1D] The projected data

pyrad.util.**quantiles_weighted**(*values*, *weight_vector=None*, *quantiles=array([0.5])*, *weight_threshold=None*, *data_is_log=False*)

Given a set of values and weights, compute the weighted quantile(s).

pyrad.util.**rainfall_accumulation**(*t_in_vec*, *val_in_vec*, *cum_time=3600.0*, *base_time=0.0*, *dropnan=False*)

Computes the rainfall accumulation of a time series over a given period

> Parameters

> **t_in_vec** [datetime array] the input date and time array
>
> **val_in_vec** [float array] the input values array [mm/h]
>
> **cum_time** [int] accumulation time [s]
>
> **base_time** [int] base time [s]
>
> **dropnan** [boolean] if True remove NaN from the time series

> Returns

> **t_out_vec** [datetime array] the output date and time array
>
> **val_out_vec** [float array] the output values array
>
> **np_vec** [int array] the number of samples at each period

pyrad.util.**time_avg_range**(*timeinfo*, *avg_starttime*, *avg_endtime*, *period*)

finds the new start and end time of an averaging

> Parameters

> **timeinfo** [datetime] the current volume time
>
> **avg_starttime** [datetime] the current average start time
>
> **avg_endtime: datetime** the current average end time
>
> **period: float** the averaging period

> Returns

> **new_starttime** [datetime] the new average start time
>
> **new_endtime** [datetime] the new average end time

pyrad.util.**time_series_statistics**(*t_in_vec*, *val_in_vec*, *avg_time=3600*, *base_time=1800*, *method='mean'*, *dropnan=False*)

Computes statistics over a time-averaged series

> Parameters

> **t_in_vec** [datetime array] the input date and time array
>
> **val_in_vec** [float array] the input values array
>
> **avg_time** [int] averaging time [s]

base_time [int] base time [s]

method [str] statistical method

dropnan [boolean] if True remove NaN from the time series

Returns

t_out_vec [datetime array] the output date and time array

val_out_vec [float array] the output values array

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