**QVP extraction**

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The main function is in *qvp\_extraction.py*.

*python qvp\_extraction.py from\_directory elevation to\_directory -s eventT000000 -e eventT235959 -c 134 -a 45,185*

Provided arguments should be input directory (*from\_directory*), elevation angle (*elevation*) and the output directory (*to\_directory*).

It is assumed, that the events subdirectories are in the input directory and that the elevation angle is in the list of elevations in the volume radar data file.

The name of the output file will be generated automatically based on the date from the start (-s) option and on the elevation angle. It will look like *20170517\_QVP\_20deg.nc* and will be placed in the output directory at the end of the run.

**Options**

The possible 8 options in the function include:

-d, —debug : output debug messages during program execution;

-v, --verbose: print messages (debug,info,warning,...) about the program execution to the console (stderr);

-s , --start time (included): date and time in format: yyyymmdd'T'HHMMSS;

-e , --end time (included): date and time in format: yyyymmdd'T'HHMMSS;

-f , --fields for QVP generation of variables for QVP calculation;

-z , --zoom time-interval: Time interval to zoom, Formatted as (yyyymmdd'T'HHMMSS,yyyymmdd'T'HHMMSS);

-c , --count threshold: Minimal number of points for the mean value calculation at each range;

-a , --azimuth bounds to exclude: Azimuths, that should be excluded in the mean value calculation. Format [star1,end1;start2,end2];

-s and -e options allow to make a QVP over several days, providing input directory and assuming each day (event - YYYYmmdd) is inside a subdirectory with a corresponding name (e.g. ./20170203/ and ./20170204/ in the directory ./). For the 90 deg. elevation subfolder ver/ is assumed after the event subdirectory (e.g. ./20170203/ver/). The format of these options is: '*20170517T000000*'. First part before “T” is the date, the second part is the time (HHMMSS). Setting up these options to *-s $eventT000000 -e $eventT235959*, where $event is the date will collect all the nc-files from the event’s subdirectory.

-f option is the list of variables to be included in QVP file. It’s assumed, that all these variables can be found in the input nc-files. (e.g. current default list is *['dBuZ', 'dBuZv', 'dBZv',' dBZ', 'KDP\_UKMO', 'KDP', 'ZDR', 'ZDRu', 'RhoHV', 'RhoHVu', 'uPhiDP', 'PhiDP', 'SQI', 'SNR', 'V','Vu','W','DOP','DOPu','temperature\_4']*)

-z option allows to zoom into a part of the day event. Might be redundant as it was used before adding -s and -e options.

-c option is the count threshold that is used as a minimum number of non-NAN azimuthal values to be used for the calculation of an azimuthal mean. The value used here should be proportional (e.g. 2/3) to the remaining number of azimuthal directions if -z option is used. Another way to ignore it, is to set it to 1, so that any azimuth with at least one non-NaN value will be used.

-a option provides azimuth bounds to exclude from the average calculation. Possible values are from 0 to 359 (e.g. 45,185). This option can be used to remove certain azimuthal directions from the calculation if there is an obstacle or a known artefact influencing the observations.

**Function run**

The function runs as follows it collects all the files inside the directory formed based on input directory and strings in -s and -e options.

With this list of files *time\_height\_qvp finction* from *qvp\_functions.py* library will be called.

**Subfunctions**

*time\_height\_qvp finction*

Inside this subfunction for each file in the provided list of files pre-processing function *preprocssing* from *preprocessing\_qvp.py* will be run. This pre-processing removes the nearest to the radar fields (<400 m range from the radar). After that the *KDP\_UKMO* field is generated, we calculate *psidp\_field* based on ZDR data.

After this pre-processing for each field in the list of fields averaging values are calculated by *altitude\_parameter\_averaging\_qvp* function. These averaging profiles are added to the array (timeline) of QVPs and the work of the *time\_height\_qvp finction* is done.

The arrays (timelines) of QVPs are written to the output nc-file and the QVP-extraction is performed.