1 Usage

After installation the RMextract package can be imported in a python environment. There are five main packages:

1. EMM: This is a tiny python wrapper around some of the functionalities of the GeoMagnetism Library that is provided by the WMM [*Chulliat et al*(2014)]. Can be used both with the WMM coefficients or the higher resolution EMM.

2. PosTools: a set of tools to read metadata from a MS, calculate line of sights and piercepoints through an ionospheric screen.

3. getIONEX: For downloading and combining and reading relevant IONEX files. Also does the interpolation of TEC values at a given piercepoint.

4. getTEC: Uses getIONEX and PosTools to get vTEC, airmass and timegrid, either for a given MS or for a user defined timerange, station and source position.

5. getRM: combines EMM, PosTools and getIONEX to extract RM values for a given MS or a user defined timerange, station and source position.

Examples of how to use the tools can be found in the *examples* directory.

1.1 LOFAR Tools

For usage within the LOFAR sofware environment, a script was developed: *createRMParmdb*. This script automatically creates the parmdb for a given Measurement Set (MS) with RotationMeasures to be used in BBS (or NDPPP) to correct the data. The correction is calculated for the phase center of the MS and can be applied as a direction independent effect. Since the main distortion to polarised data is in fact the *time* variation of the Faraday rotation as opposed to a field of view variation, this results in a good first order correction of your polarised data. However, at the time of writing, a direction independent rotation measure has not been implemented in BBS or DPPP yet. Therefore, one needs to specify the name of a source (any source) in the skymodel. And make sure that in the BBS parset the correction is applied in the direction of the source with the same name. For long baselines it can be useful to calculate the RM per station, this is optional in the *createRMParmdb* script. The parameter names in the parmdb are *RotationMeasure:*⟨ *stationname*⟩ *:*⟨ *sourcename*⟩ .

1.1.1 Options

The following list of otions is availble for the createRMParmdb script:

- -o,–out : Name of the output parmdb. If it exists the RM paramters will be added to the parmdb, unless the -r or –overwrite options is used. default: *RMParmdb*

- -r,–overwrite: overwrite existing parmdb.
- -p,–patch : name of the patch or source for which to create the values. This will end up in the parameter name and is important for BBS when it looks up the parameter for correction. It needs to be the same as specified in the BBS parset and it should be existing in the sky model. Otherwise, since the correction are calculated for the phase center only, it really does not matter which source name is used. default: *phase_center*.
- –IONprefix: this is the name of the IONEX server, e.g. CODG, ROBR,JPLG, etc. The IONEX files are usually named:⟨ IONprefix⟩⟨ doy⟩ 0.⟨ year%2000⟩ I.Z. doy is number of the day in the year. Note that the data should be available on the selected ftp-server, given with –IONserver. Default: *CODG*
- –IONserver: name of the ftp-server for IONEX files. for CODG it is the default: *ftp://ftp.unibe.ch/aiub/CODE/*. For ROBR use: *ftp://gnss.oma.be/gnss/products/IONEX/*. There are other servers available, e.g. *ftp://cddis.gsfc.nasa.gov/gnss/products/ionex/*, but the directory structure is hardcoded at the moment and should be the same as that of the CODE server ⟨ year⟩ . If needed, ask the developer to implement another directory structure for you prefered server.
- –IONpath: location where the IONEX files are stored locally. Default: ./
- -a,–all: Create an RM value per station. Since the RM variation over the array is usual minimal, the default is to only calculate for the center of LOFAR (postion of CS002LBA). However, when using long baselines, this option can be useful.
- -t,–timestep: timestep in seconds. The IONEX maps have a time resolution of 15 mintues to 2 hours. Although interpolation is applied, it is usually not necessary to use a time resolution smaller than 15 minutes. Caclulating the corrections at full resolution can be time consuming. Default: 900 seconds
- -e,–smart_interpol': Float parameter describing how much of the Earth rotation is taken in to account in interpolation of the IONEX files. 1.0 means time interpolation assumes ionosphere rotates in opposite direction of the Earth. 0.0 (default) means no rotation applied. See [*Schaer et al*(1997)] for description of this interpolation method.

References

[*Chulliat et al*(2014)] Chulliat A., Macmillan S., Alken P., Beggan C., Nair M., Hamilton B., Woods A., Ridley V., Maus S., Thomson A. (2014), *The US/UK World Magnetic Model for 2015-2020, NOAA National Geophysical Data Center, Boulder, CO*, doi: 10.7289/V5TH8JNW.

[*Schaer et al*(1997)] Schaer, S., W. Gurtner, and J. Feltens (1997), *IONEX: The IONosphere Map EXchange Format Version 1*, February 25, 1998, in *Proceedings of the 1998 IGS Analysis Centers Workshop, ESOC, Darmstadt, Germany, February 9-11, 1998.*