

Swiss Confederation Pyrad: a Real-Time Weather Radar Data Processing Framework Based on Py-ART

Jordi Figueras i Ventura, A. Leuenberger, Z.Künsch, J. Grazioli, U. Germann

MeteoSwiss, Locarno Monti, Switzerland

jordi.figuerasiventura@meteoswiss.ch

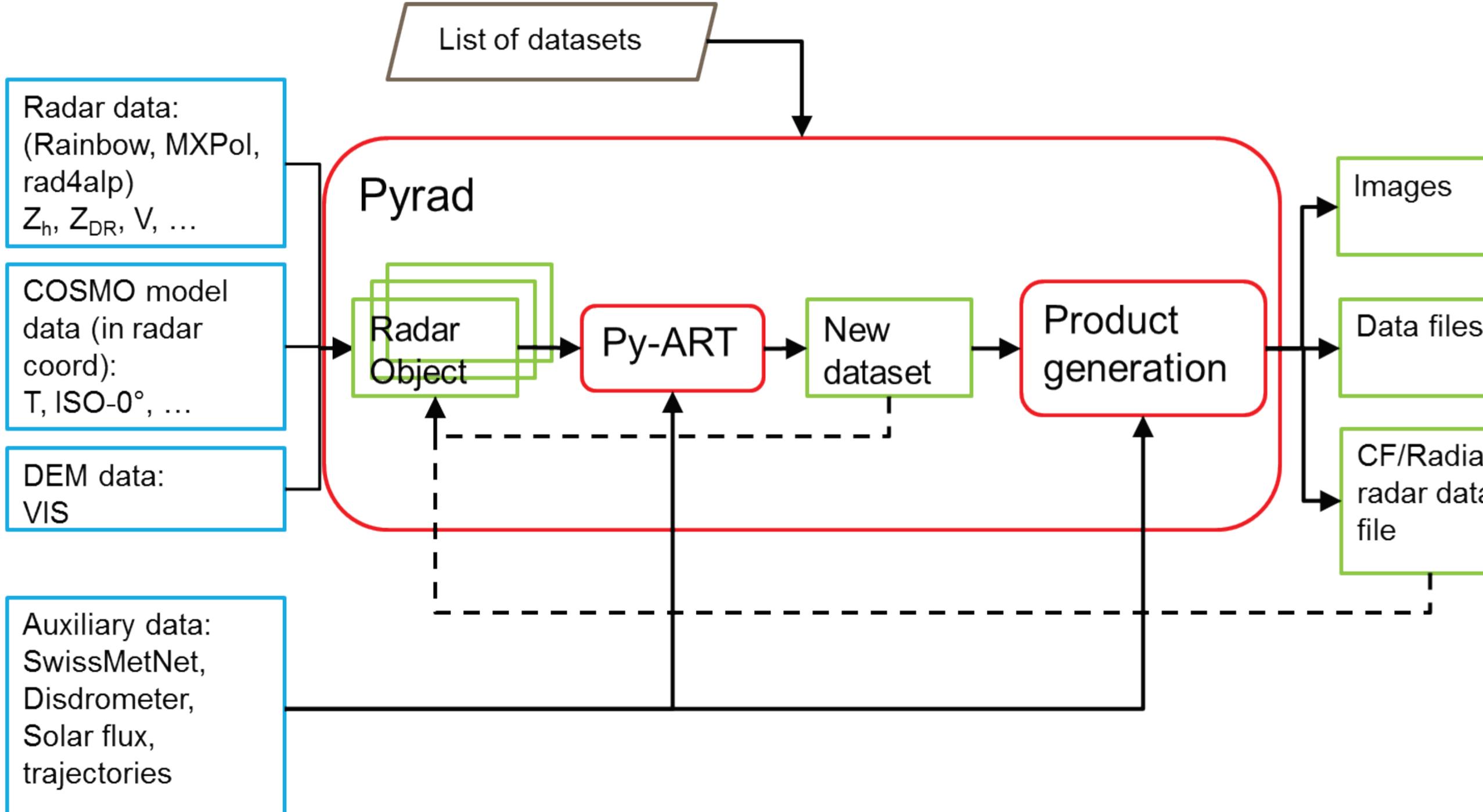
Summary

Pyrad is a real-time data processing framework developed by MeteoSwiss aimed at processing and visualizing data from individual Swiss weather radars both off-line and in real time. The signal processing and part of the data visualization is performed by a MeteoSwiss developed version of the Py-ART toolkit which contains enhanced features. Various processing techniques from literature as well as MeteoSwiss own developments are implemented. The framework is built around the concept of datasets and products. Multiple levels of processing can be performed. At each level multiple new datasets can be generated from input data (i.e. hydrometeor classification fields) and for each dataset multiple products can be created (i.e. PPIs at different altitudes, CAPPIs, RHIs etc. from the hydrometeor classification field). The datasets generated in previous processing levels can be kept in memory and used in higher processing levels (i.e. using the hydrometeor classification in a hydrometeor based QPE algorithm).

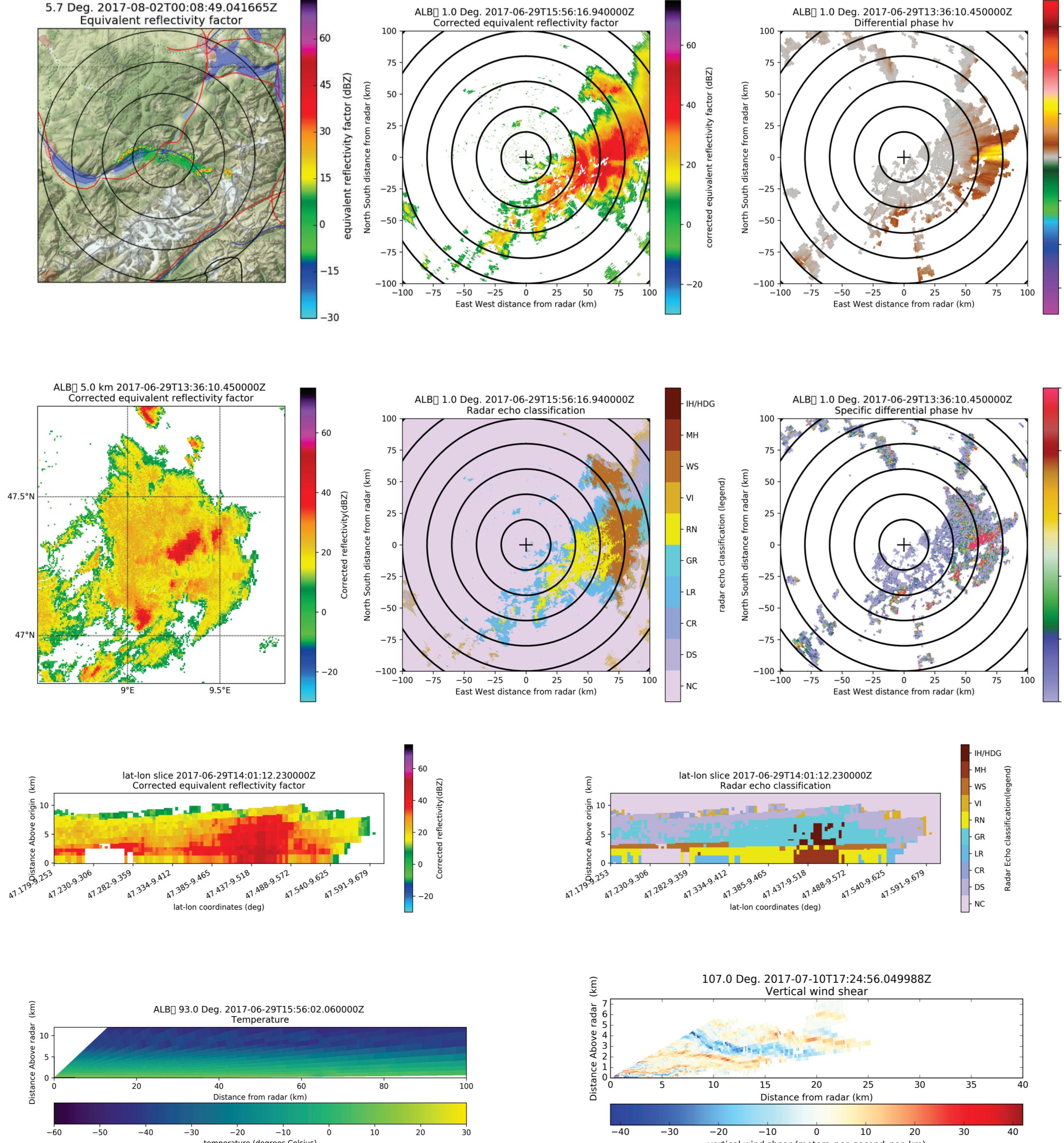
Capabilites:

Echo classification & filtering	Ψ_{DP} processing and attenuation correction	Monitoring, calibration & noise correction	Retrievals	Special functions
<ul style="list-style-type: none"> - Clutter ID and filtering - SNR filter - Visibility filter - Outlier filter - Hydrometeor classification (semi-supervised cluster) 	<ul style="list-style-type: none"> - Φ_{DP0} correction - Φ_{DP} smoothing (1, 2 windows) - Least square K_{DP} retrieval (1, 2 windows) - Φ_{DP}, K_{DP} retrieval Maesaka - Linear Programming Φ_{DP}, K_{DP} retrieval - Φ_{DP}, K_{DP} retrieval Vulpiani - Φ_{DP}, K_{DP} Kalman Filter retrieval - ZPhi & PhiLinear attenuation correction 	<ul style="list-style-type: none"> - Bias correction - ρ_{HV} noise correction - Z_{DR} and ρ_{HV} in rain estimation - Zdr of vertically pointing radar - Self-consistency Z_h bias estimation - Time averaging - Radar inter-comparison - Sun signal monitoring - Data histograms 	<ul style="list-style-type: none"> - Signal power - SNR - L parameter - CDR - Wind velocity - Wind shear - Various rain rate algorithms 	<ul style="list-style-type: none"> - Trajectory - Point of interest - Data gridding - Cumulative distribution functions

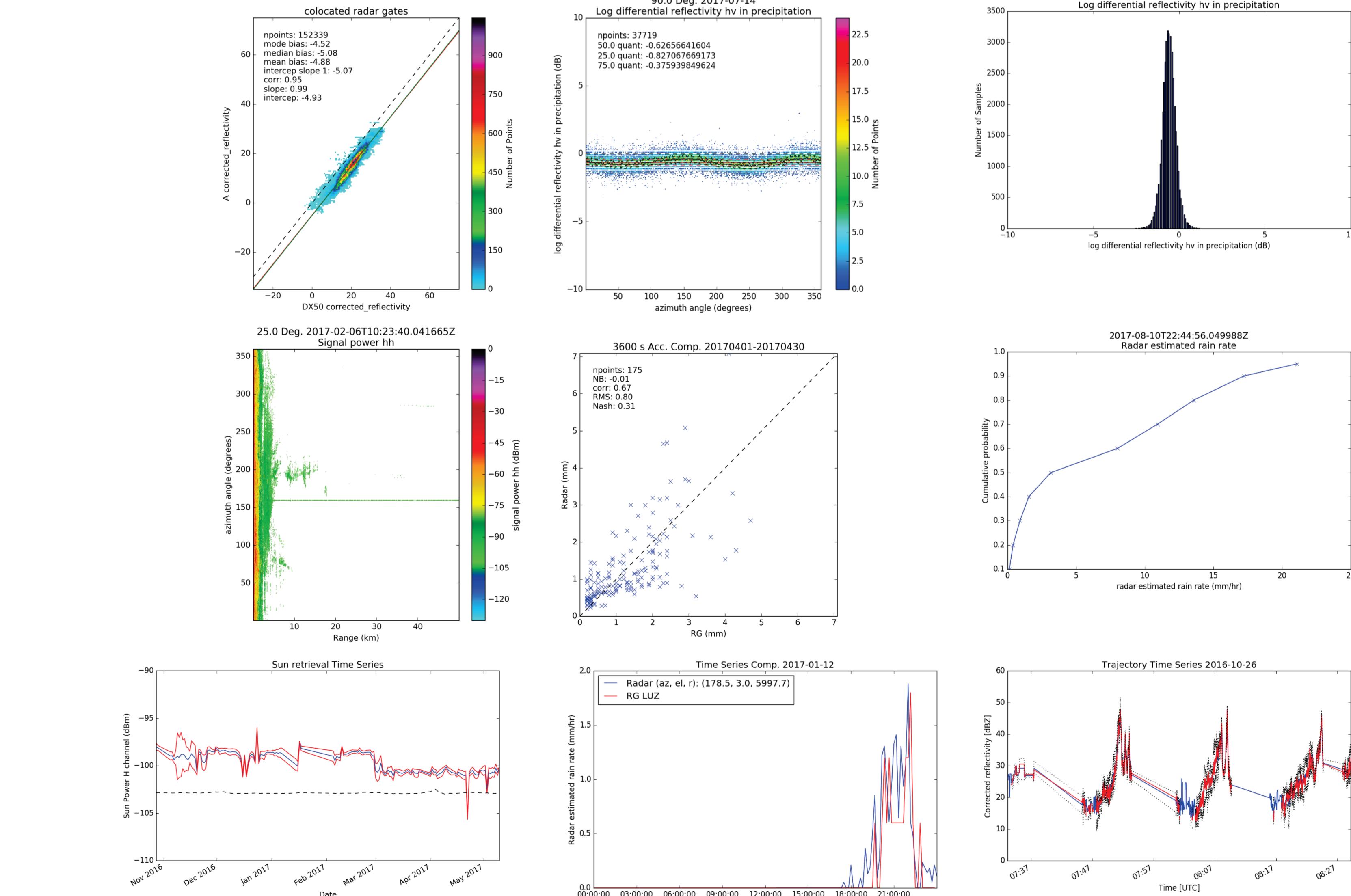
Software architecture



Volumetric data images (examples)



Quality control, monitoring, etc. (examples)



Characteristics

- Python-based, open source, version controlled (github)
- Core based on ARM-DOE Py-ART ([Helmus, J.J & Collis, S.M. \(2016\). The Python ARM Radar Toolkit \(Py-ART\), a Library for Working with Weather Radar Data in the Python Programming Language. Journal of Open Research Software. 4\(1\), p.e25.](#)) (MeteoSwiss major contributor)
- 3 simple configuration files control the entire processing
- Ingests polarimetric and Doppler moments, secondary radar products and auxiliary data (NWP temperature, DEM-based visibility, etc.)
- Possibility to ingest multiple radars
- Multiple levels of processing. Intermediate data can be saved
- Automatic documentation based on doc-strings

Conclusion and Future work

- (Continuous) Transfer of the MCH Py-ART capabilities to ARM-DOE Py-ART
- Implementation of IQ and spectral processing
- Implementation of new products (Quasi vertical profiles, etc.)
- Collaboration with external partners is desired and encouraged!