LROSE Tools to Estimate Surface Rain Rate

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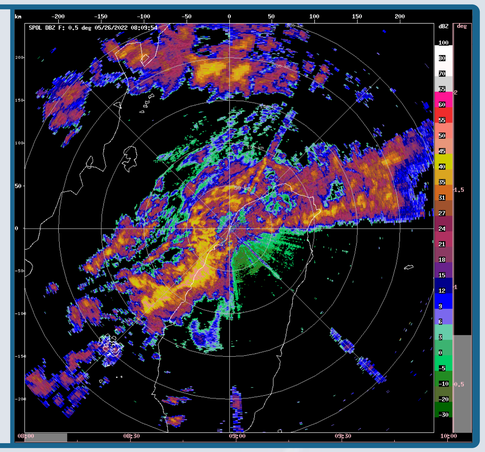
RadxConvert

Convert radar and lidar data across 24 different formats. While conversion is simple, there is a lot of user flexibility and options for advanced use cases. Popular formats include:

- CfRadial
- NEXRAD Level 2/3
- SIGMET
- MDV Radial

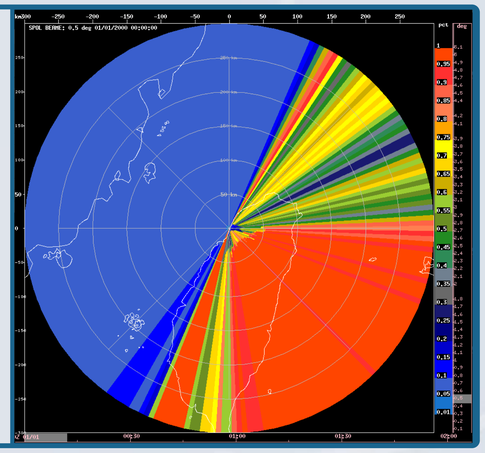
S-Pol data during the PRECIP field campaign on 26 May 2022 will serve as a test case of the LROSE workflow. Seen here is radar reflectivity at 0.5° tilt at 0800 UTC 26 May 2022 converted into CfRadial using RadxConvert.



RadxBeamBlock

Taking elevation data, the radar location, and radar characteristics, terrain blockage is estimated over a volume scan. Supported digital elevation models include the Shuttle Radar Topography Mission (SRTM) and ESRI grid data. Radar characteristics can be found using RadxPrint.

Seen here is cumulative beam extinction fraction of S-Pol at 0.5° tilt computed using RadxBeamBlock and SRTM data. Beam blockage only needs to be computed at one time step and can be applied across a time series of data.

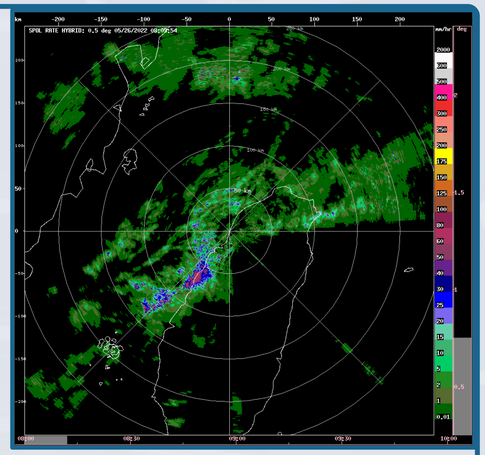


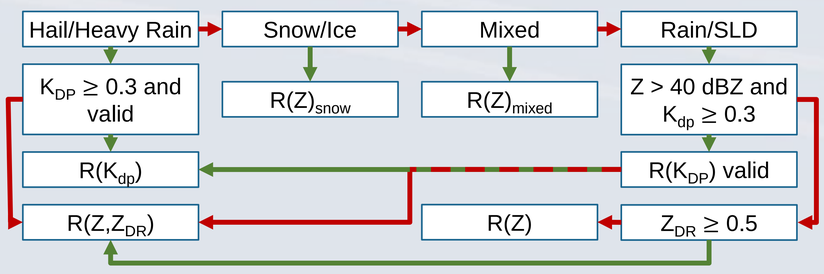
RadxRate

Building upon RadxKdp and RadxPid, RadxRate computes various rain rate algorithms in polar space with user flexibility on coefficients and filtering. Popular polarimetric algorithms include:

- **NCAR Hybrid**
- CSU HIDRO
- Bringi Hybrid
- NCAR PID

Seen here is the NCAR Hybrid rain rate algorithm at 0.5° tilt at 0800 UTC 26 May 2022 computed using RadxRate. Below is the flowchart for the NCAR Hybrid rain rate algorithm which uses PID, K_{dp}, Z, and Z_{dr}.

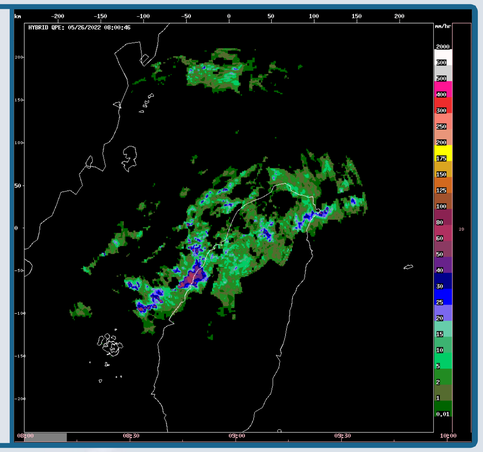




RadxQpe

Synthesizes the best estimate for surface rainfall using output from RadxRate. RadxBeamBlock data is used to collapse the 3D rain rate to a 2D grid with output in both cartesian (MDV) and polar (CfRadial) formats. Additional parameters such as maximum height and minimum rainfall can also be set.

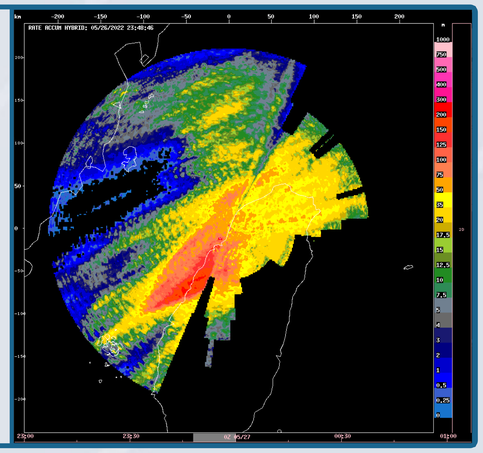
Seen here is the same NCAR Hybrid algorithm but processed through RadxQpe and converted into a cartesian format. An additional melting layer parameter was set and limits the range.



RateAccum

Cartesian output from RadxQpe is integrated over user defined periods to produce rainfall accumulation. The most common integration period is 24-hour periods, but there is flexibility to expand this for longer or shorter periods.

Seen here is total rainfall accumulation for 26 May 2022 using the NCAR Hybrid algorithm.

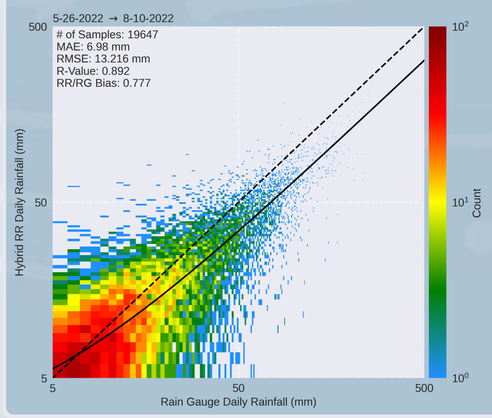


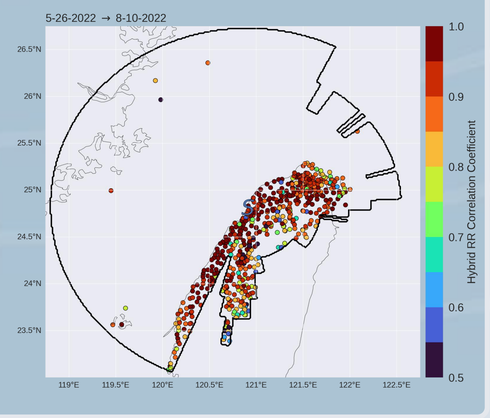
Outside Tools

While much of utility of workflow is self-contained within LROSE, output from each step can be processed using outside tools. Common tools used to process radar data within the Python catalog include:

- CSU Radartools
- Py-ART
- ωradlib
- MetPy

Seen here are two examples of postprocessing of output from RateAccum for the PRECIP field campaign. On the left is a statistical analysis of daily rainfall accumulation using the NCAR Hybrid algorithm compared to rain gauges. On the right are the locations of all the rain gauges within the S-Pol domain with colors representing the correlation coefficient of the NCAR Hybrid algorithm collocated with a given rain gauge. Each was processed using Py-ART and basic Python libraries.





The Lidar Radar Open Software Environment (LROSE)

provides high-quality software tools that read and convert most binary radar and lidar data formats. The LROSE tools interactively display, quality control, and grid radar and lidar data. LROSE also provides tools for echo and wind analysis. The LROSE tools can be assemble into trusted, reproducible workflows that accomplish complex scientific tasks such as estimating surface rain rate. A common workflow to estimate surface rain rate spotlights the most popular tools: RadxConvert, RadxBeamblock, RadxRate, RadxQpe, and RateAccum. At each step of the workflow, multiple parameters add flexibility and the opportunity to customize each of the tools. Once a workflow is tuned, shell scripts and files store all the steps and parameters for reproducibility.

Documentation

Installation instructions and further documentation on all LROSE's products can be found at **lrose.net**

Acknowledgments

This research is funded by: NSF Grants [a]AGS-2013743 and [b,c]AGS-2103776