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Lidar Radar Open Software Environment (LROSE)
Award # 1550597

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Overall Goals

- take 25 years of good quality legacy software
- plus current development work
- modernize it and upgrade it
- test it as much as practical
- make it easy to build and install
- make it readily available to the user community via GitHub or a similar site
- document so it is easy to use
- provide training opportunities to the users

Important Lessons

- carefully limit the scope
- concentrate on fewer apps, but the important ones
- streamline the build and distribution process
- work diligently to support multiple platforms
- Docker is useful, but not a complete solution
- refactor for long-term stability
- build documentation into the source
- fund graduate students to help with testing and documentation

Introduction

Radars and lidars are critical for protecting society from high impact weather and understanding the atmosphere and biosphere, but they are complex instruments that produce copious quantities of data that pose many challenges for students, researchers, and instrument developers.

LROSE is an NSF-funded project developing open source tools to meet these challenges and help with the 'big data' problem faced by users in the lidar and radar communities.

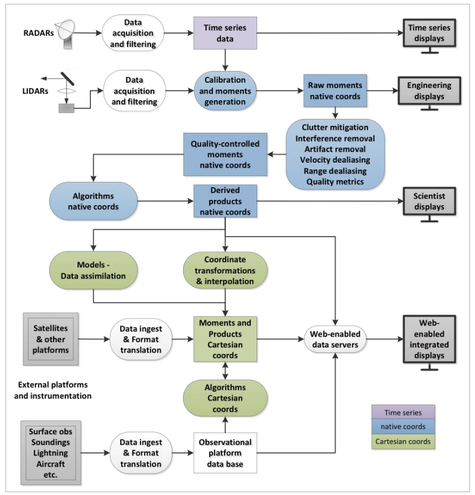


Figure 1: High-level data flow for modern end-to-end analysis of radar and lidar data

Release schedule – by year

Blaze 2018 | Cyclone 2019 | Elle 2020 | Jade 2021 | Topaz – out years

Principal applications

LROSE comprises over 300 applications, many of which are specialized and not often used. The following are the most commonly used.

Convert

- ***RadxPrint*** - Query files to determine properties and support by the Radx engine
- ***RadxConvert*** - Convert 24 different lidar and radar formats to CfRadial NetCDF format
- ***RadxBufr*** - convert Bufr format to CfRadial

Display

- ***HawkEye*** - Real-time and research display for both scanning and vertically pointing radars. New editing features have been added to Cyclone, and more in progress (including boundary editor)

Grid

- ***Radx2Grid*** - 3-D Cartesian gridding (x, y, z), Cartesian PPIs (x, y, elevation), Regular polar grid (range, azimuth, elevation)

Echo – dual polarization applications

- ***RadxKdp*** - KDP and Attenuation calculations
- ***RadxPid*** - NCAR Particle Identification algorithm
- ***RadxRate*** - Polarimetric rain rate calculations
- ***RadxQpe*** - Accumulated quantitative precipitation estimation
- ***RadxBeamBlock*** - Beam blockage estimation

Wind – single and dual Doppler applications

- ***RadxEvad*** - Extended Velocity Azimuth Display single-Doppler retrieval
- ***FRACTL*** - Fast Reorder and CEDRIC Technique in LROSE traditional multi-Doppler retrieval
- ***SAMURAI*** - Variational multi-Doppler retrieval and analysis package
- ***VORTRAC*** - Vortex Objective Radar Tracking and Circulation single-Doppler retrieval

Format	I/O Capability	Format	I/O Capability
CfRadial-1	Read-write	HRD (Hurricane Research Division)	Read-only
CfRadial-2 (WMO)	Read-write (in development)	Leosphere (LIDAR)	Read-only
BUFR	Read-only (in development)	NEXRAD Level 2	Read-write
CFARR	Read-only	NEXRAD Level 1,3	Read-only
D3R	Read-only	NOXP	Read-only
DOE	Read-only	NSSL-MRD	Read-only
DORADE	Read-write	ODIM-H5	Read-write (in development)
EEC-Edge	Read-only (work in progress)	RAPIC	Read-only
FORAY	Read-write	SIGMET Raw (Vaisala)	Read-only
Gamic	Read-only	TDWR	Read-only
Gematronik Rainbow	Read-only (writeable with python script)	TWOLF	Read-only
HSRL (LIDAR)	Read-only	UF	Read-write

Table 1: Supported file formats by the Radx engine and I/O capabilities

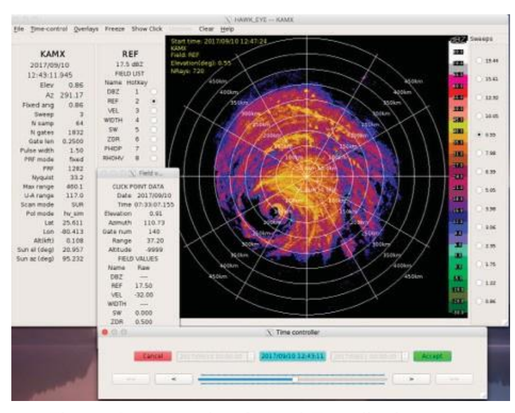


Figure 3: Example of HawkEye display showing NEXRAD data from Hurricane Irma (2017)

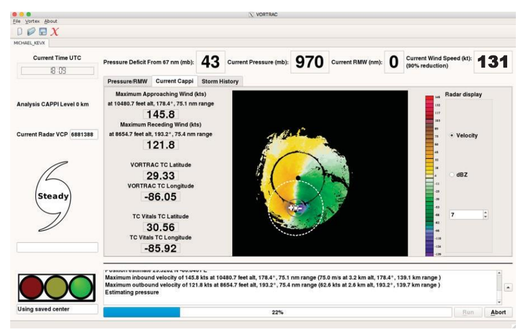


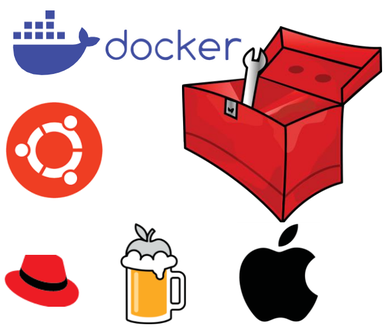
Figure 4: Example of VORTRAC display showing NEXRAD data from Hurricane Michael (2018)

LROSE VirtualToolbox and multi-platform support

LROSE can be installed from the '**Virtual Toolbox**', a light-weight Docker container that holds pre-built LROSE distribution with no compilation required. LROSE can also be installed from binary packages on Linux, Homebrew on Mac, or compiled in C++ on Linux or Mac.

'lrose' wrapper manages Docker options, images, disk mapping, and command execution

```
$ docker pull nsflrose/lrose-cyclone
$ lrose -- RadxConvert -f <file_list>
$ lrose -- HawkEye -f output/
```



LROSE.net Website

A website is available with expanded documentation through a community powered Wiki, and community forum for posting and discussion

- http://lrose.net/
- http://wiki.lrose.net/index.php/Main_Page
- http://forum.lrose.net/

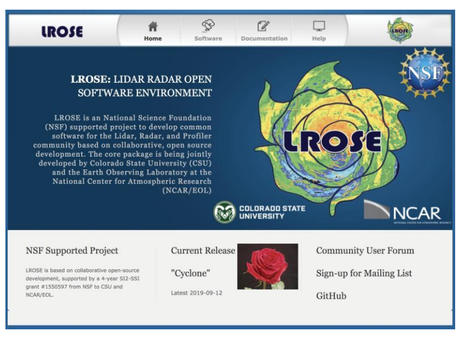


Figure 2: Screenshot of lrose.net home page

Join the LROSE Community

- Visit **LROSE.net**, install the latest release, and register to receive updates
- Post in our User Forum, post issues at Github, or email lrose-help
- Cite LROSE in your research: DOI 10.5281/zenodo.3361130

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