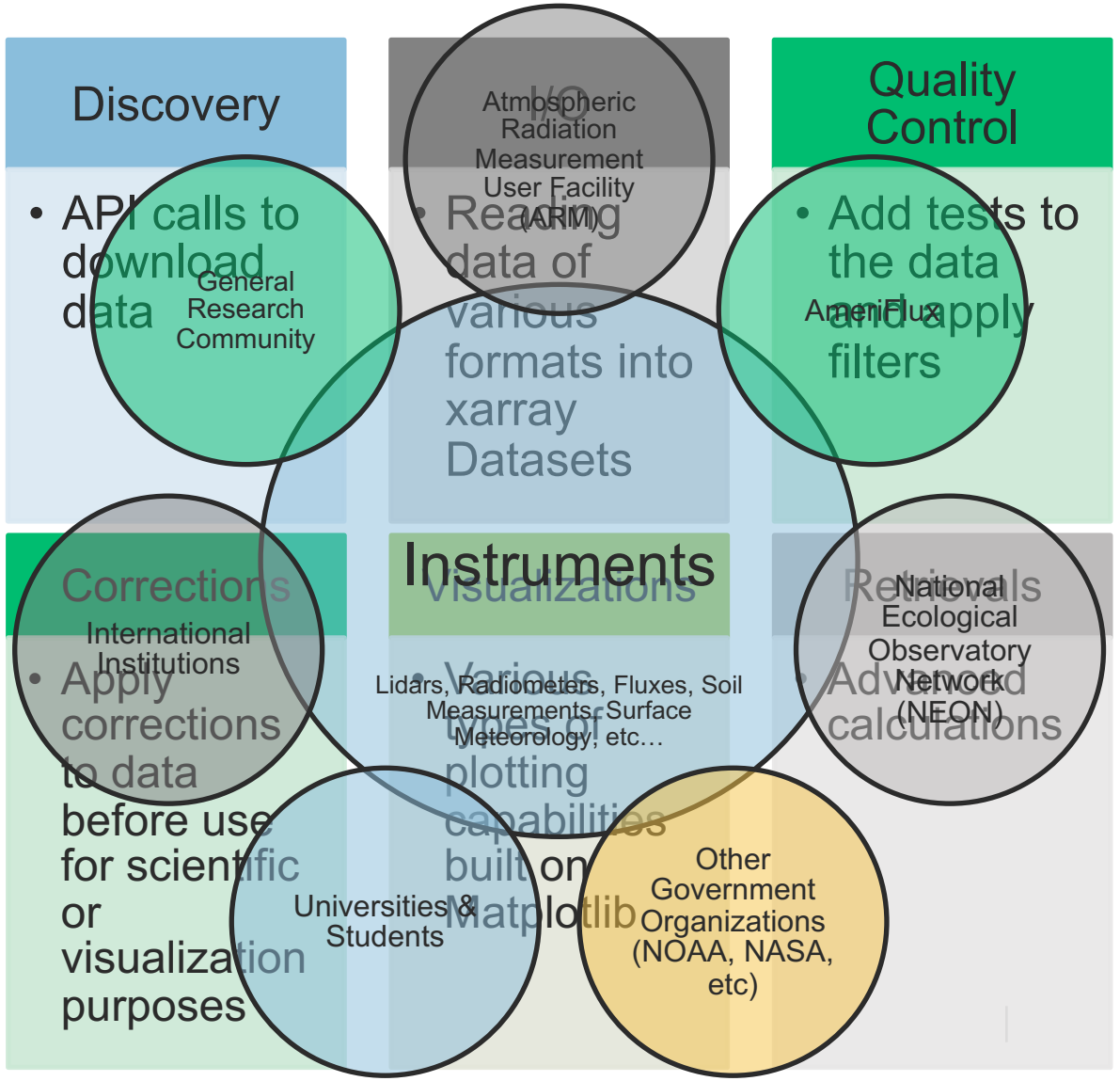
Atmospheric data Community Toolkit

ARM/ASR OPEN-SCIENCE WORKSHOP

ACT Development Team

What is ACT?

- Atmospheric data Community Toolkit (ACT)
  - Python toolkit for data exploration and analysis of atmospheric time-series datasets
  - Uses xarray, pandas, numpy, scipy, matplotlib, pulling from domain specific dependencies like MetPy, PyART, and others where appropriate
  - Modules for many aspects of the scientific life cycle
  - Goals
    - Bridge research communities
    - Reduce duplication of effort
    - Transparency
    - Flexibility



act-atmos

coverage 90% | DOI 10.5281/zenodo.3855537 | Anaconda.org 1.1.5

U.S. DEPARTMENT OF ENERGY

https://github.com/ARM-DOE/ACT

Core Practices

- We want to funnel citations to the papers behind the algorithms
  - Where we have the information, we have a “Reference” section in our documentation that point to the papers or technical reports the code is based on

References

Bradley, F. and Farall. C. (2007) A Guide to Making Climate Quality Meteorological and Flux Measurements at Sea. Boulder, CO, NOAA, Earth System Research Laboratory, Physical Sciences Division, 44pp. & appendices. (NOAA Technical Memorandum OAR PSD-311). http://hdl.handle.net/11329/386

- Contributors get added to the Author list on the DOI
  - Citation is auto-generated with each new release

Adam Theisen, Ken Kehoe, Bobby Jackson, Zach Sherman, Alyssa Sockol, Corey Godine, Jason Hemedinger, Jenni Kyrouac, Maxwell Levin, & Michael Giansiracusa. (2022). ARM-DOE/ACT: ACT Release 1.1.3 (v1.1.3). Zenodo. https://doi.org/10.5281/zenodo.6209346

- Unit test coverage stays above 90%

Roadmap - Goals and Priorities - High

Feature	Priority	Effort
Aircraft or UAS Related Functionality With ARM's continued UAS related efforts and a new aircraft on the horizon, along with requests from the Ameriflux meeting, the features for visualizing, applying QC, and other functionality will be useful.	High	High
Retrievals With the objective to appeal to the scientific user base, effort will be put forth to add additional retrieval functions with a focus on ARM VAPs.	High	High
Windows Compatibility Due to none of the development team having windows machines for testing, there has been a gap in troubleshooting and diagnosing issues from some of the users. Effort will be added to ensure windows compatibility.	High	Medium
ARM Data Surveyor As part of the efforts to incorporate ACT into the ADC quick look processing, a command line tool was developed to replace what was previously being done. If will be important to continue maintenance and support of that tool.	High	Medium
Performance Improvements Dask is already being used in some functions to improve speed, but there will be further investigation and development to improve the speed of ACT loading, processing, and visualization. Additionally, efforts to optimize the ACT package will be implemented.	High	Medium

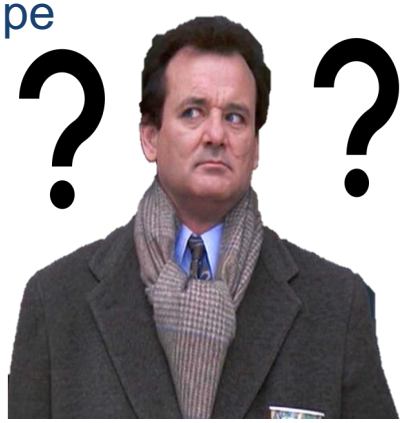
Roadmap - Goals and Priorities – Medium/Low

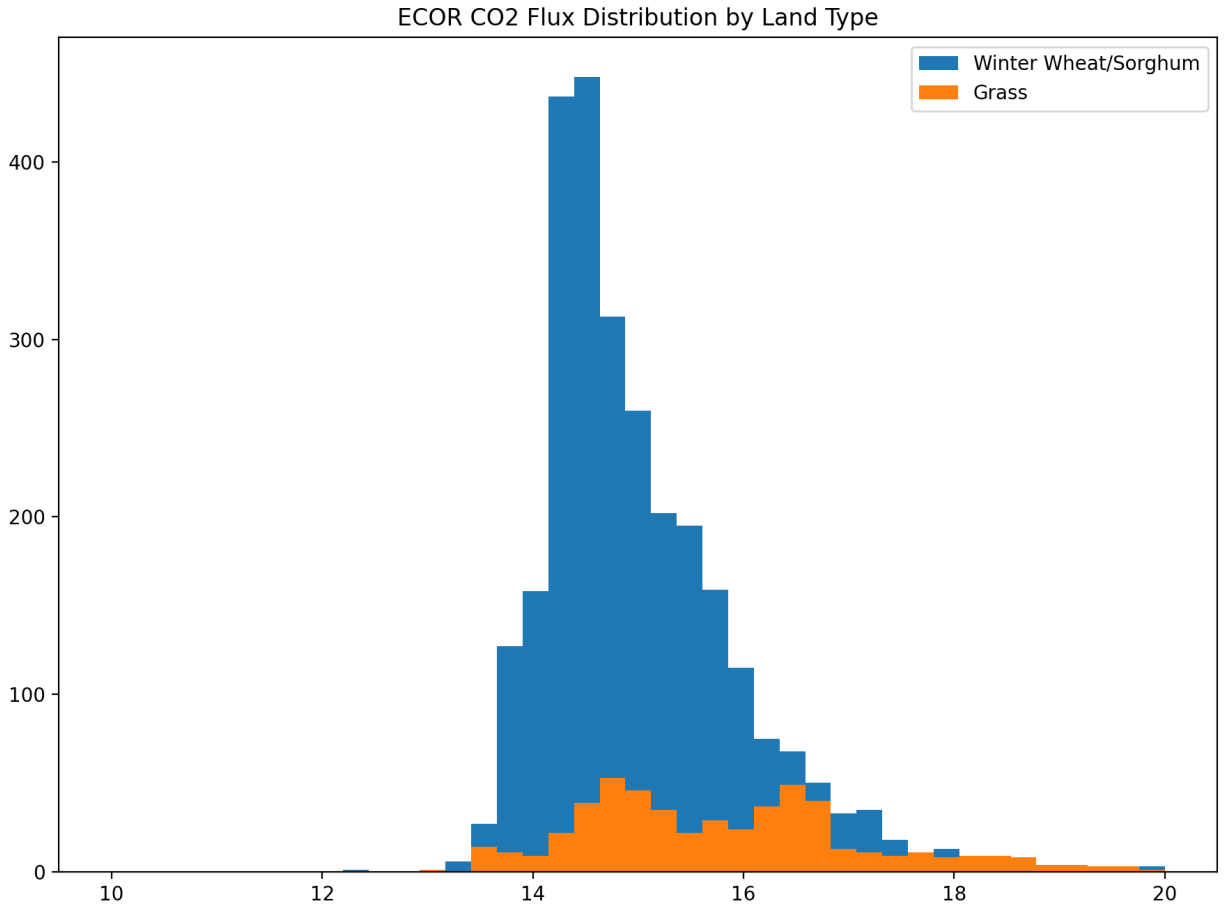
Statistics Tracking **A process to better track statistics of the repository will be developed in conjunction with Py-ART to provide more regular statistics.**	**Medium**	**Low**
I/O Improvements A number of survey respondents indicated that the ability to read ICARTT and GRIB would be beneficial. There are python libraries already in existence so the effort is expected to be low but could increase if there are integration problems.	Medium	Low
Tutorial and Example Development There was a large effort to overhaul ACT's documentation which saw major improvements to the auto-documentation process. To further improve user interactions, additional tutorials and examples will be produced.	Medium	Low
Discovery Improvements Carrying on from the first roadmap and responding to requests from the survey to add functions to download data from the NOAA FTP sites and EPA's AirNow portal, the discovery functions will be expanded where appropriate.	Low	High
Visualizations While ACT already has a lot of plotting capabilities, there are areas in which it could be expanded, including interactive plotting and 3-D plotting.	Low	Medium

Questions

So really, what does it do?

- Discovery
  - ARM Live Data Web Service (www.arm.gov)
    - Petabytes of data back to 1993 all free!
  - Automated Surface Observing Systems (ASOS) API from Iowa Environmental Mesonet
  - USDA CropScape





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Don’t get hung up on API for crop type!

- I/O
  - xarray for netcdf
  - Pandas read_csv for text/csv files, converting to Dataset
  - Specific readers for NOAA Global Monitoring Laboratory (GML) data
    - Surface Met, Radiation, Ozone, CO2, HALO
  - Binary micropulse lidar using MPL2NC from Peter Kuma
    - Convert data to a temporary netcdf file and read in
  - Clone data file structures from ARM program to create “empty” xarray Datasets
  - Write files out to better match Climate and Forecast Standards

```
Coordinates:
  * time                                (time) int64 0 1 2 3 ... 1437 1438 1439
  * drop_diameter                       (drop_diameter) int64 0 1 2 ... 47 48 49
Data variables: (12/36)
    base_time                           (time) float64 -9.999e+03 ... -9.999e+03
    time_offset                         (time) float64 -9.999e+03 ... -9.999e+03
    num_drops                           (time, drop_diameter) float64 -9.999e+...
    qc_num_drops                        (time, drop_diameter) float64 -9.999e+...
    num_density                         (time, drop_diameter) float64 -9.999e+...
    qc_num_density                      (time, drop_diameter) float64 -9.999e+...
    ...                                  ...
    moment5                             (time) float64 -9.999e+03 ... -9.999e+03
    moment6                             (time) float64 -9.999e+03 ... -9.999e+03
    radar_reflectivity                  (time) float64 -9.999e+03 ... -9.999e+03
    lat                                 (time) float64 -9.999e+03 ... -9.999e+03
    lon                                 (time) float64 -9.999e+03 ... -9.999e+03
    alt                                 (time) float64 -9.999e+03 ... -9.999e+03
Attributes: (12/23)
    command_line:
    process_version:
    dod_version:
    site_id:
    facility_id:
    input_source:
    ...                                 ...
    qc_bit_3_description:               Value is greater than the valid_max.
    qc_bit_3_assessment:                Bad
    qc_bit_4_description:               Difference between current and previous values e...
    qc_bit_4_assessment:                Indeterminate
    datastream:
    history:
```

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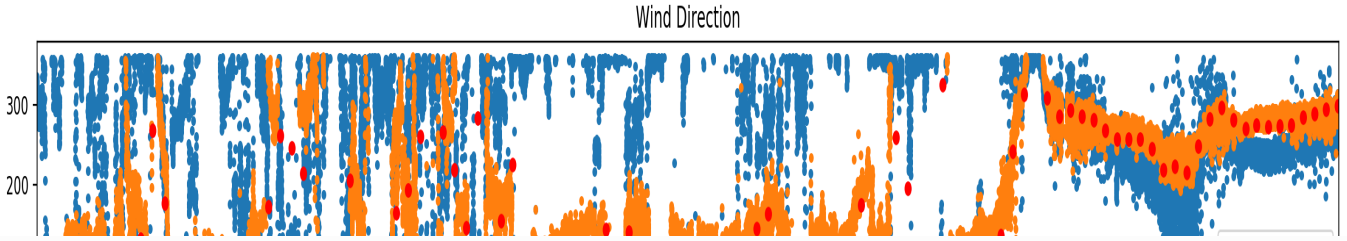
Is that it?

- Corrections
  - Correct lidar data like micropulse lidar for deadtime, afterpulse, overlap, etc…
  - Correcting ceilometer data for easier visual analysis
  - Wind-corrections for ship motion



References

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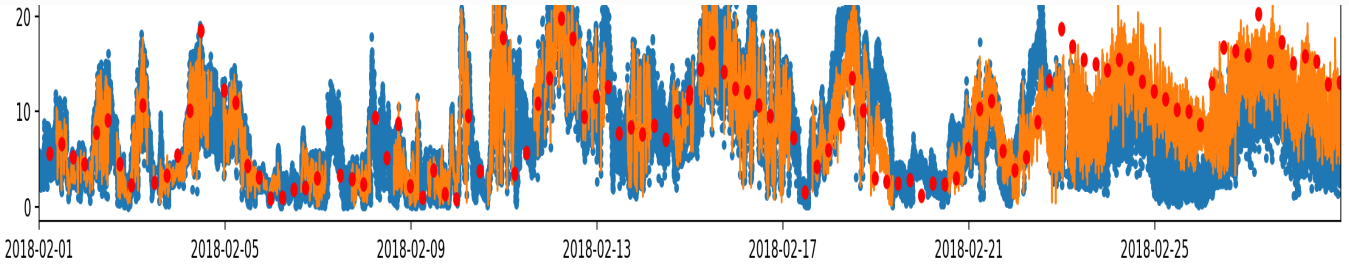

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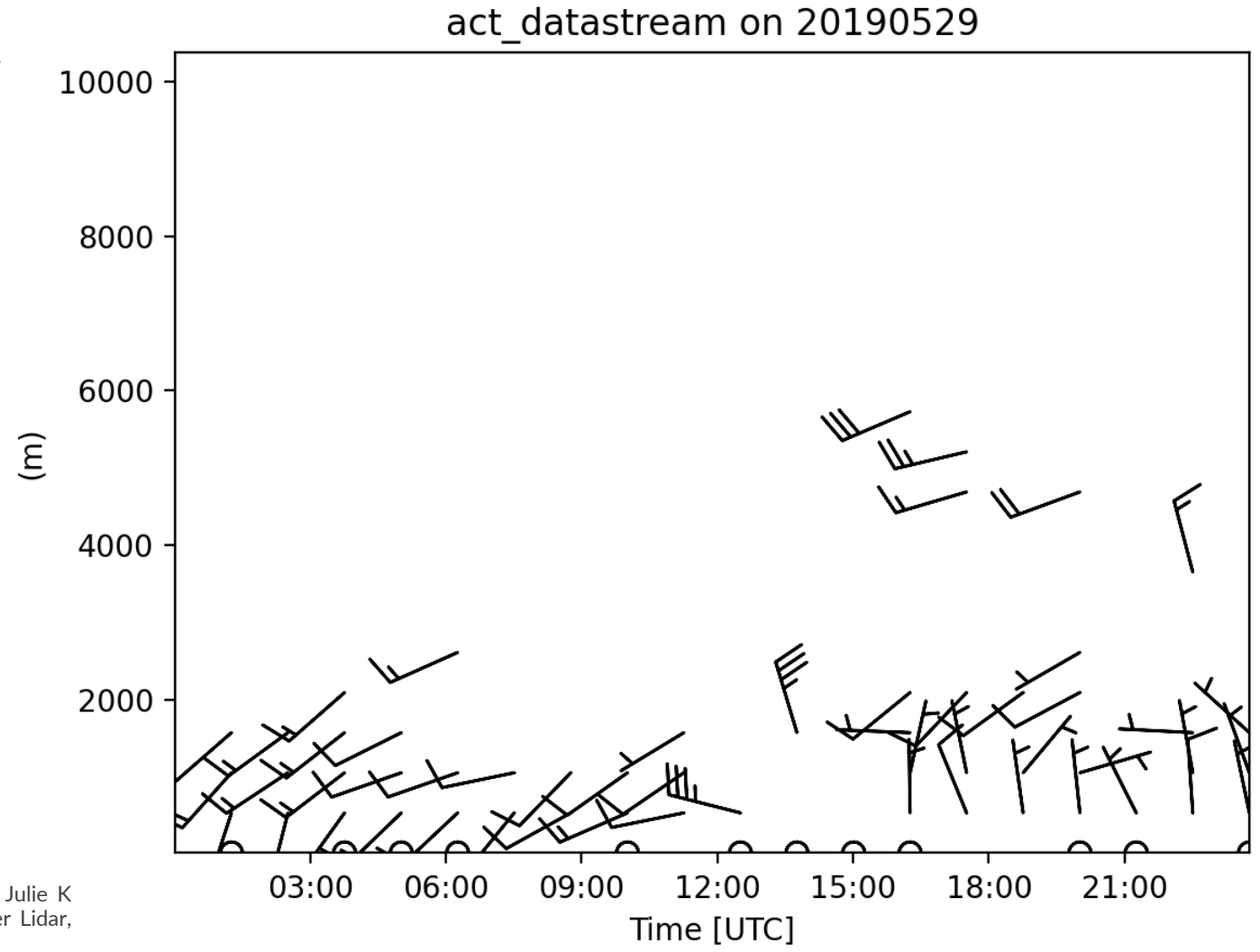
What else?

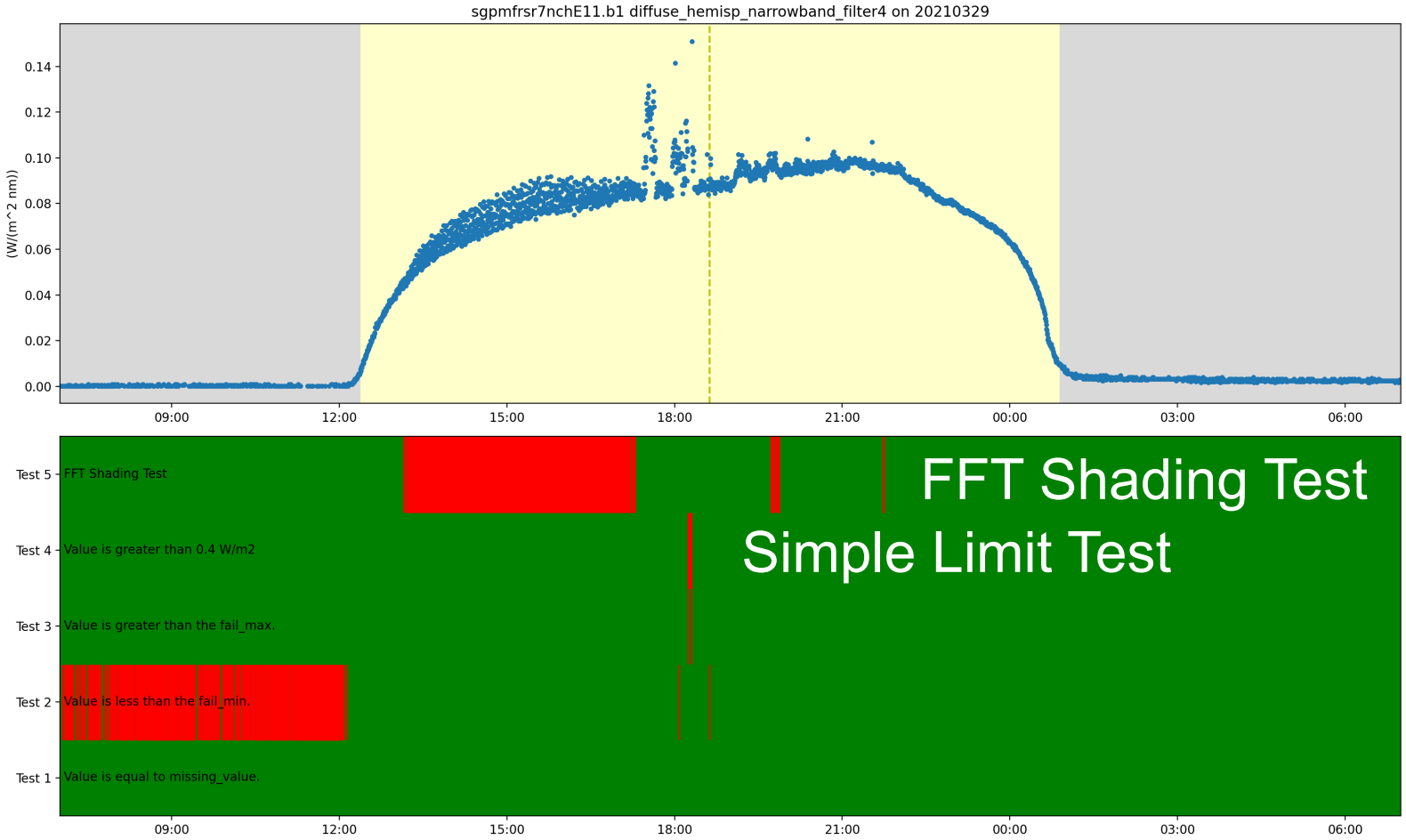
- Retrievals
  - Wind Profiles from Scanning Doppler Lidar (Newsom et al. 2016)
  - Sky infrared temperature from AERI irradiances
  - Solar radiation calculations
    - Net radiation, longwave radiance for cloudy/clear conditions
  - Sea surface temperature from infrared radiometer measurements
  - Want to grow more!



References
Rob K Newsom, Alan W Brewer, James M Wilczak, Daniel E Wolfe, Steven P Oncley and Julie K Lundquist ; Validating Precision Estimates in Horizontal Wind Measurements from a Doppler Lidar, Atmospheric Measurement Techniques Discussions 2016, 10, 1-30

But wait! There's more!

- Quality Control
  - Apply additional tests
    - Simple limit tests to more advanced like the FFT method to detect shading problems with shadowband radiometers
  - Using bit-packed QC to allow for multiple tests to be set at once
  - Plotting tools to visualize this information



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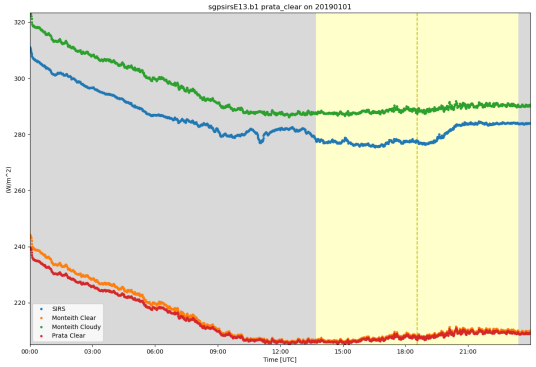
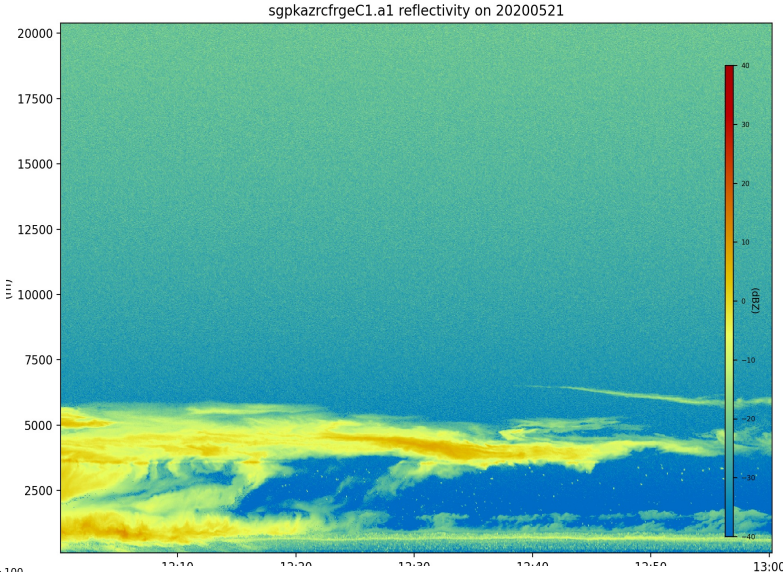
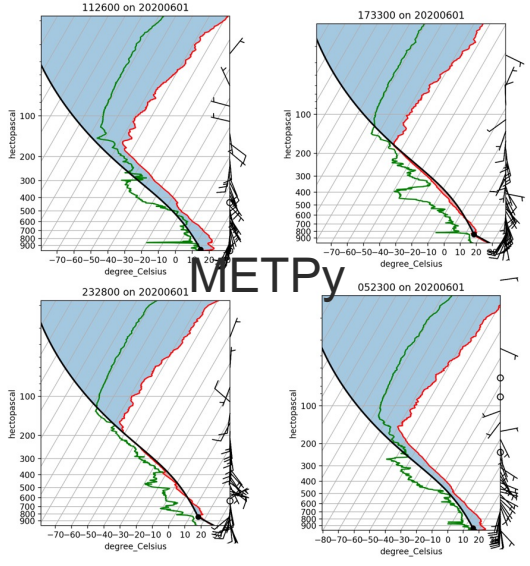
https://www.arm.gov/news/blog/post/69939

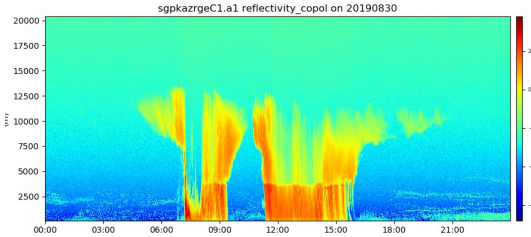
And more!

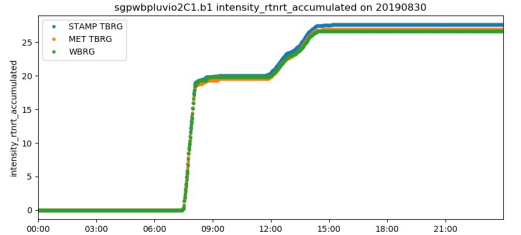


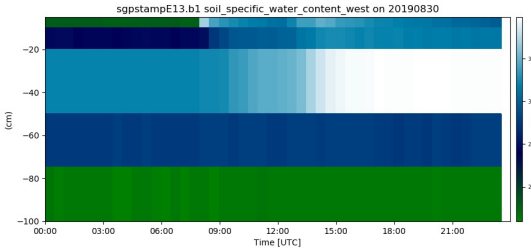


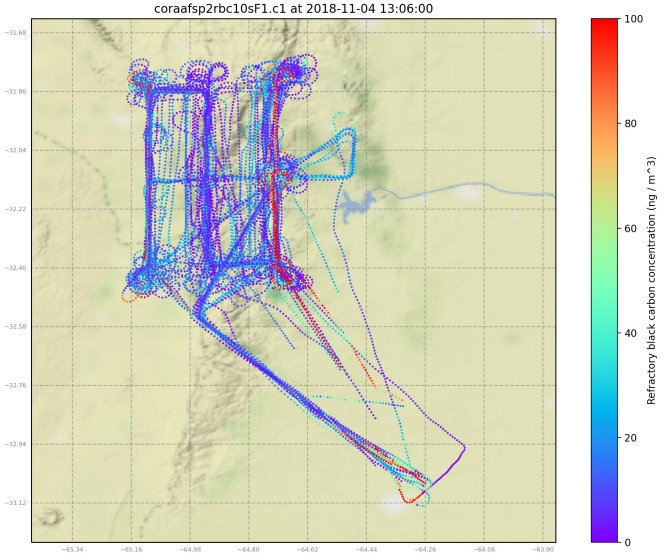


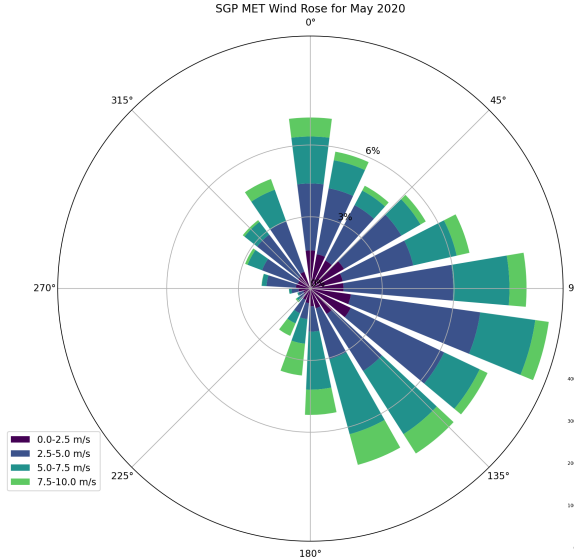
METPy

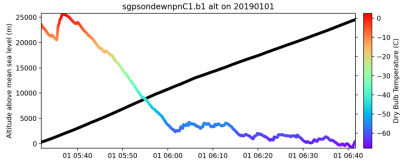


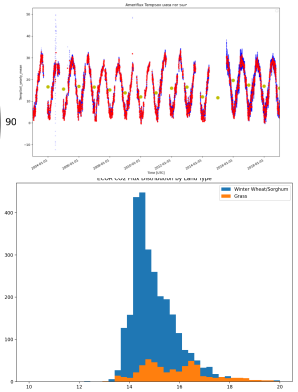


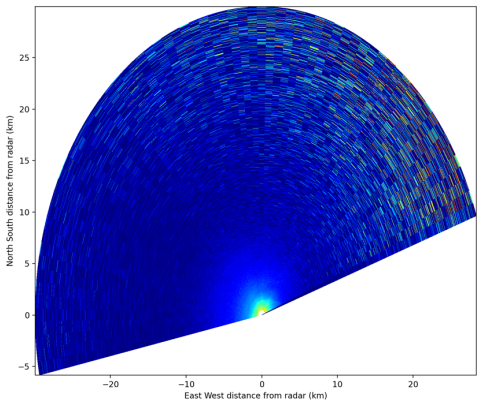


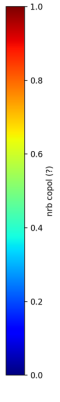


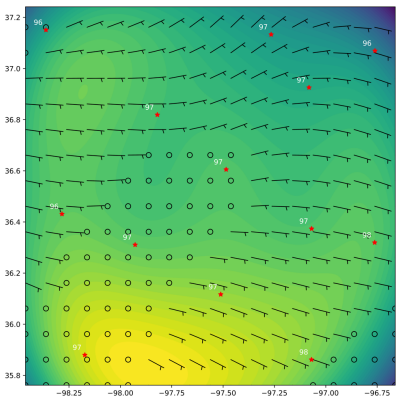












And Finally

- General Utilities
  - Precipitation accumulation
  - Weighted averaging
  - Solar calculations using Skyfield
    - Sunrise, sunset, dawn, dusk
  - Decode present weather detector based on WMO Table
  - Planck converter
    - Radiance to temperature and vice versa
    - Note, not everyone's constants are the same!