



Maximizing Science From ARM's Precipitation Tasked Radars

Some Faces of ARM Precipitation Radar Data



Bhupendra Raut



Ya-Chien Feng



Alyssa Matthews



Max Grover



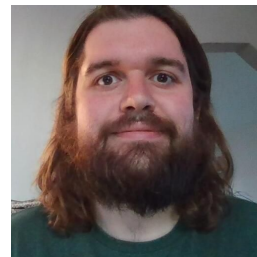
Zach Sherman



Andre (Iosif)
Lindenmaier



Bobby Jackson



Joe O'Brien

This does not include the many engineers who make radar data possible....

Engineering

Mentor Team

- Andrei Lindenmaier*
- Tim Wendler

Radar Engineer and Technician Team

- Pete Argay
- Todd Houchens
- Vagner Castro
- David Breedlove
- Brandon Androes
- TBD

National Laboratories, Vendors and Universities

Data Processing, Analysis, and QC

Mentor Team

- Ya-Chien Feng*
- Alyssa Matthews
- Eddie Schuman
- Karen Johnson
- Min Deng

Data Quality Office

- Ken Kehoe*
- Alyssa Sockol
- Corey Godine

Value Added Products & Tools

Cloud Radars

- Scott Giangrande*
- Karen Johnson
- Min Deng
- Lynn Ma
- Meng Wang

Precipitation Radars & Py-ART

- Scott Collis*
- Bobby Jackson
- Zach Sherman
- Max Grover
- Joe O'Brien
- Bhupendra Raut

Constituency Groups

Cloud and Precipitation Measurements and Science Group

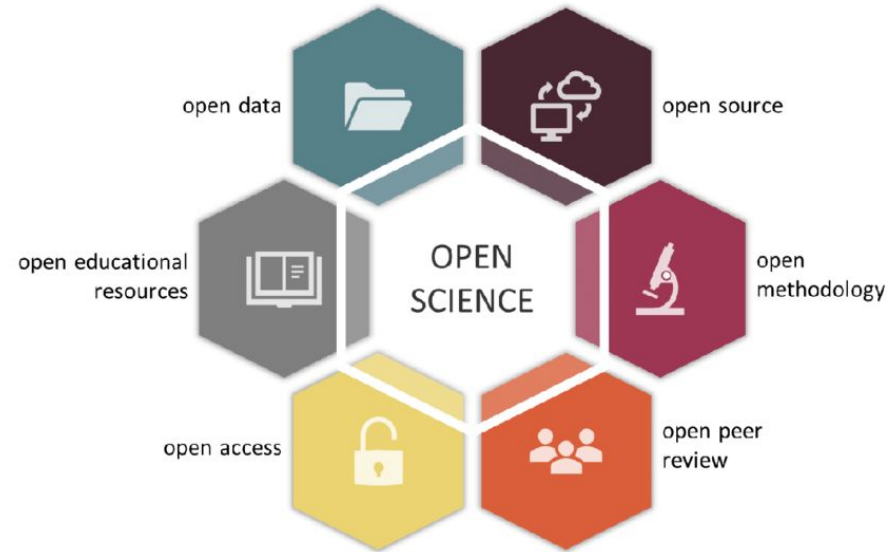
Deep Convection Working Group

* Denotes the lead in each area

ARM Radar Team

Overarching philosophy

- Open Science.
- As we work make cookbooks.
- Where impactful support radar engineering. We can't build products or facilitate science without data.
- Highest priority is quality gate based data. Start here and build into bespoke solutions.
- There will be corner cases. We will release and re-run.



Gallagher, Rachael & Falster, Daniel & Maitner, Brian & Salguero-Gómez, Roberto & Vandvik, Vigdis & Pearse, William & Schneider, Florian & Kattge, Jens & Alroy, John & Ankenbrand, Markus & Andrew, Samuel & Balk, Meghan & Bland, Lucie & Boyle, Brad & Bravo Avila, Catherine & Brennan, Ian & Carthey, Alexandra & Catullo, Renee & Cavazos, Brittany & Enquist, Brian. (2019). The Open Traits Network: Using Open Science principles to accelerate trait-based science across the Tree of Life. [10.32942/osf.io/kac45](https://doi.org/10.32942/osf.io/kac45).

THE PYTHON ARM RADAR TOOLKIT

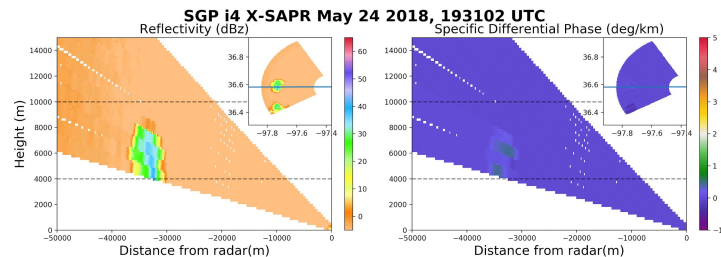
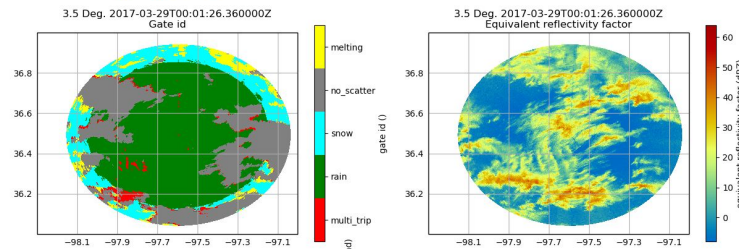
Philosophy: It's all about the data model.

<https://github.com/ARM-DOE/pyart>

- Py-ART's central core is a data model for gated data with pointing information.
- Py-ART created a way of representing radar data in the Python programming language that mirrors the CF-Radial standard.
- Py-ART has a cloud functions to correct, retrieve and grid radar data.
- By keeping a limited scope Py-ART aims to “do less better”.
- There is now a **rich ecosystem** of packages that interact: Py-DDA, CSU tools... etc..⁵

```
In [2]: import pyart
        radar = pyart.io.read('/data/cmac/raw/XSW170519002005.RAW54Y0')
        print(radar.ngates, radar.nrays, radar.nsweps)

501 9200 23
```

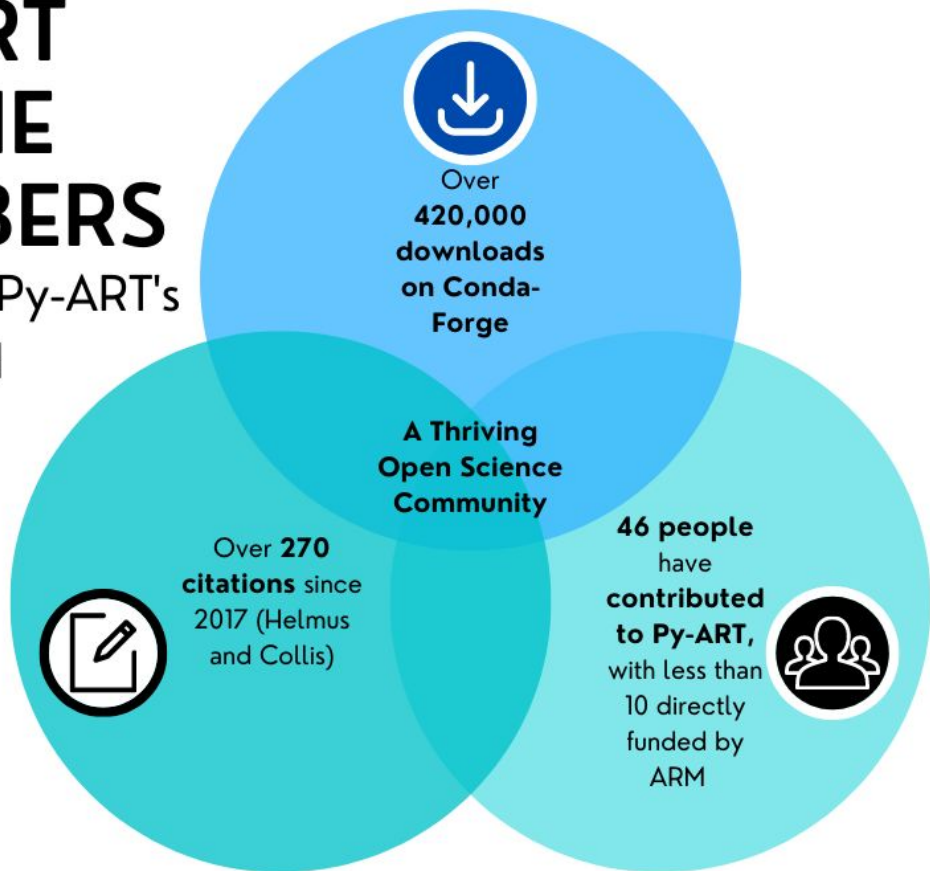


Animation courtesy of users Marcus van Lier-Walqui and Sara E. Lytle

Data: Andrei Lindenmaeir – ARM Mentor

PY-ART BY THE NUMBERS

Measuring Py-ART's
Impact and
Success



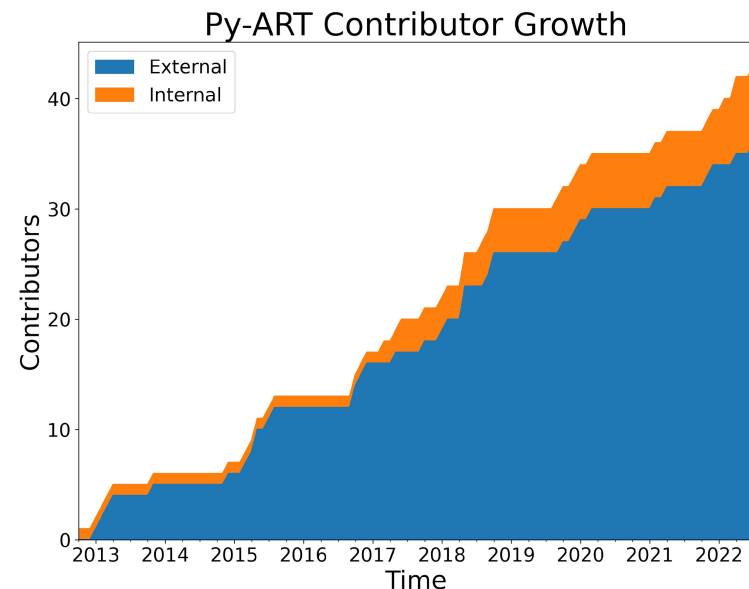
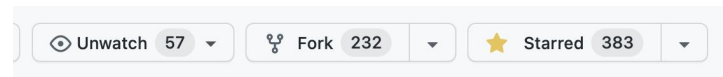
<https://github.com/openradar/erad2022>

THE PYTHON ARM RADAR TOOLKIT

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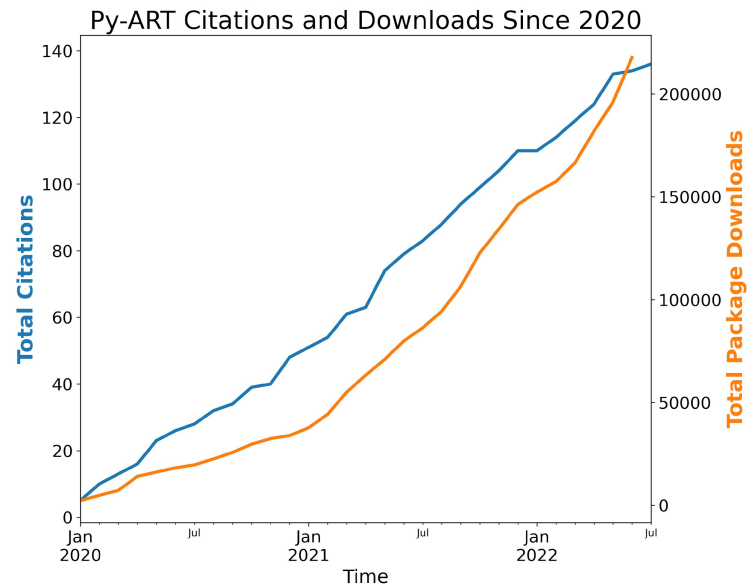
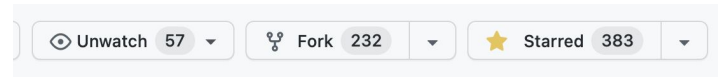


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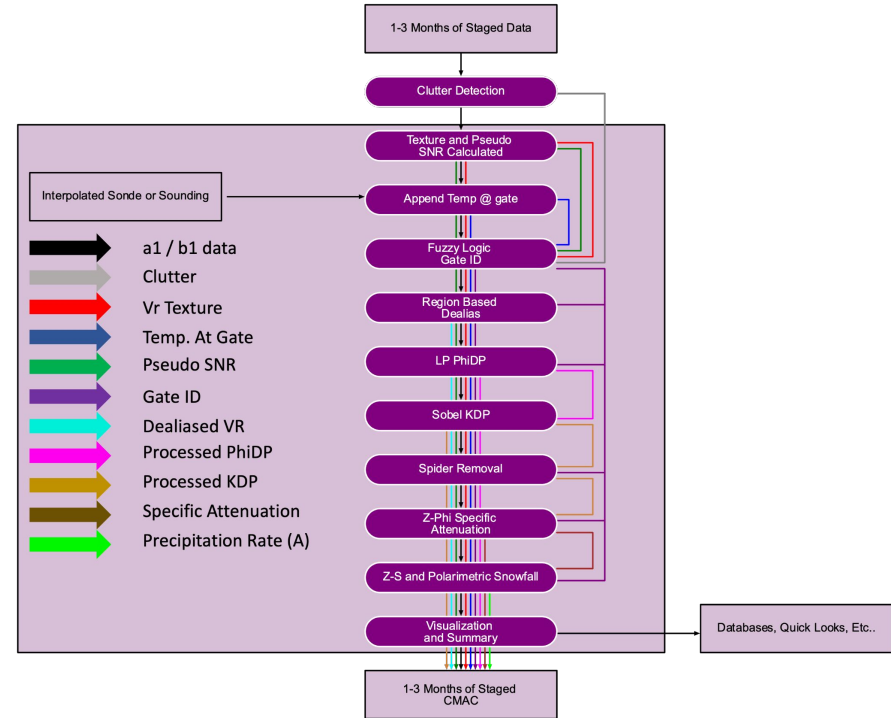
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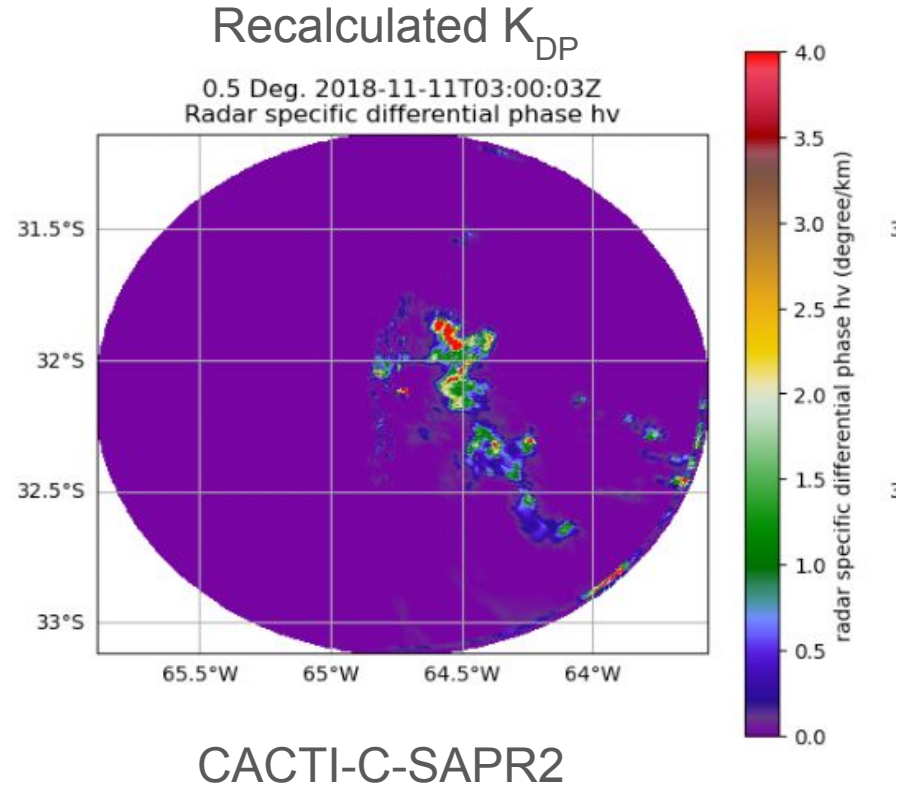
Corrected Moments in Antenna Coordinates (CMAC)

- CMAC (note we are dropping the “2.0”) is a workflow for ARM precipitation radars.
- At its core is the gate_ID. This early step creates tags that are used in downstream processing.
- Modules can be removed (eg if b/a level fields are of high quality) and different algorithms use.
- All leverages ADC HPC using Dask.



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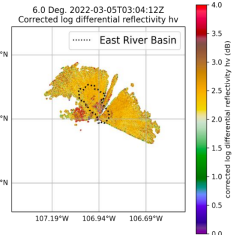
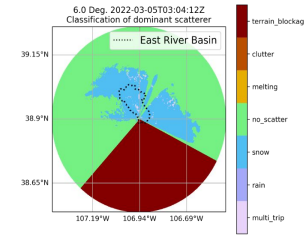
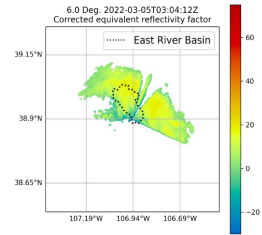
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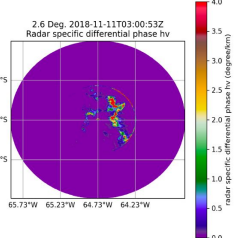
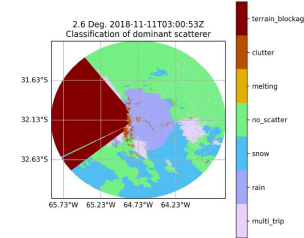
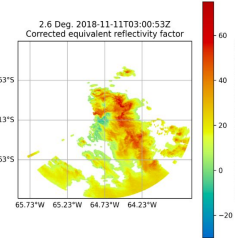
Latest CMAC Data

- C-SAPR2 CACTI:Start: 2018-10-12 2019-03-03
 - X-SAPR SGP Scanning Experiment: 2018-05-24 to 2018-09-17.
 - X-SAPR NSA: 2019-11-21 to 2020-09-24.
 - SAIL: March 2022 **any day!**
- For convection lovers Summer 2022 had some nice monsoon!

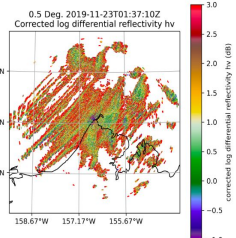
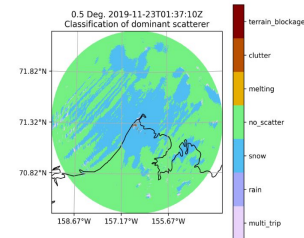
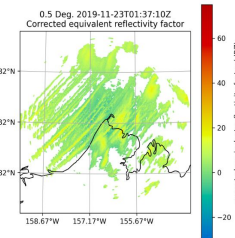
**Crested Butte
Colorado, USA**



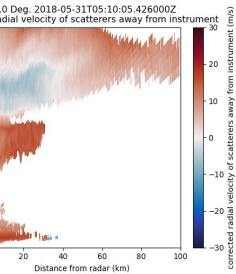
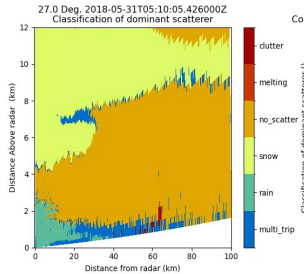
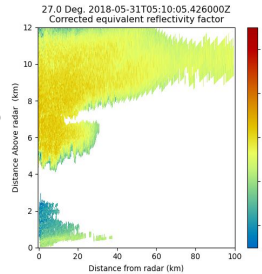
**Cordoba
Argentina**



**Utqiagvik
Alaska, USA**



**Southern Great Plains
Oklahoma, USA**



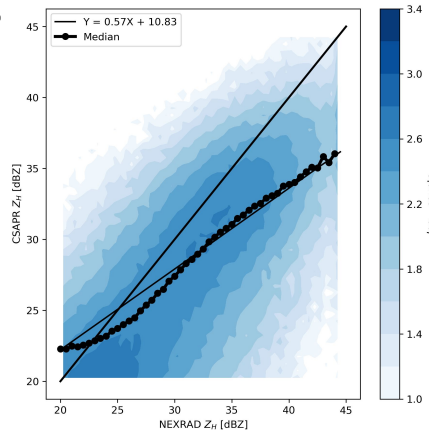
TRACER and TRACER Plans

- During TRACER focus was on data quality. New tools in Py-ART comparing C-SAPR2 <-> KHGX <-> Ground assets.
- Post IOP focus is on CMAC and the use of cookbooks and Py-ART to help make sense of the tracking.
- Facilitating ASR science!
- All open science.

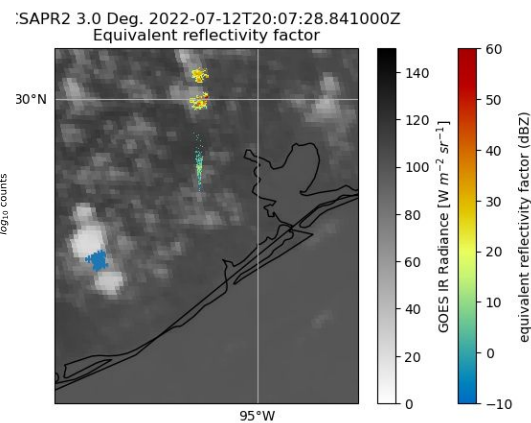


Follow and Join!

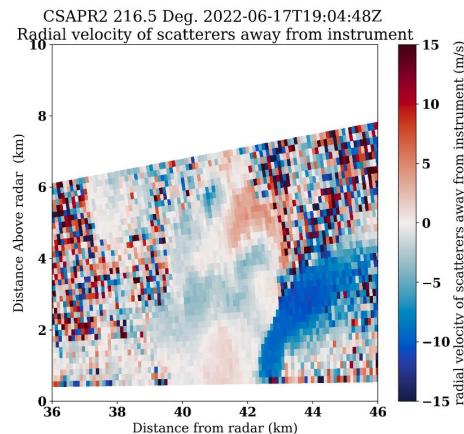
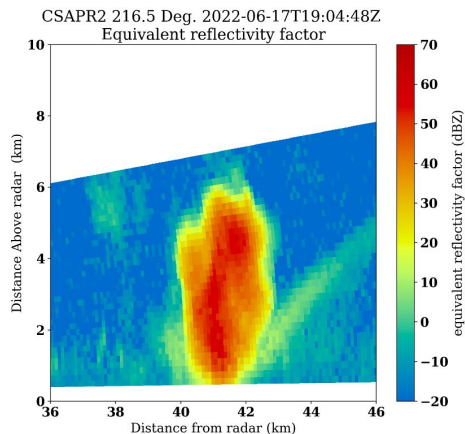
github.com/ARM-Development/tracer-radar



KHGX C-SAPR2 compare

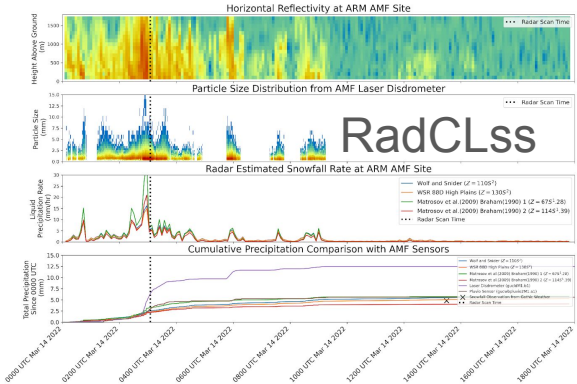


From Bobby in the cookbook repo

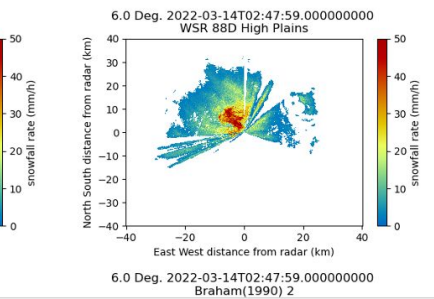
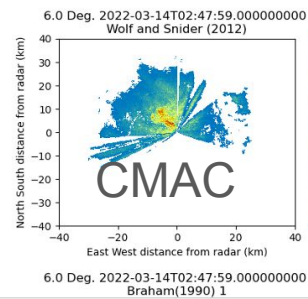
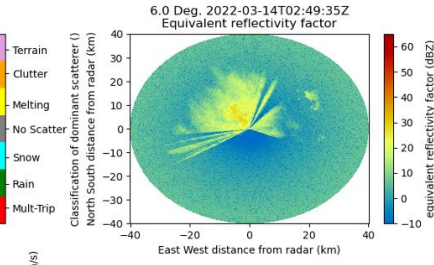
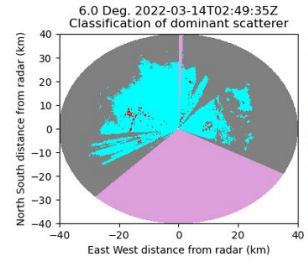
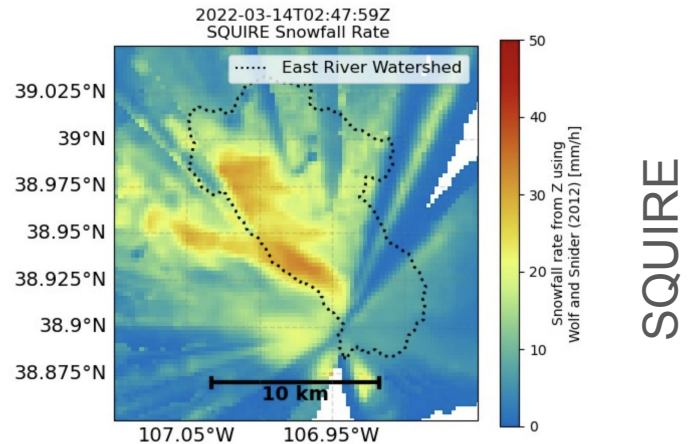


SAIL

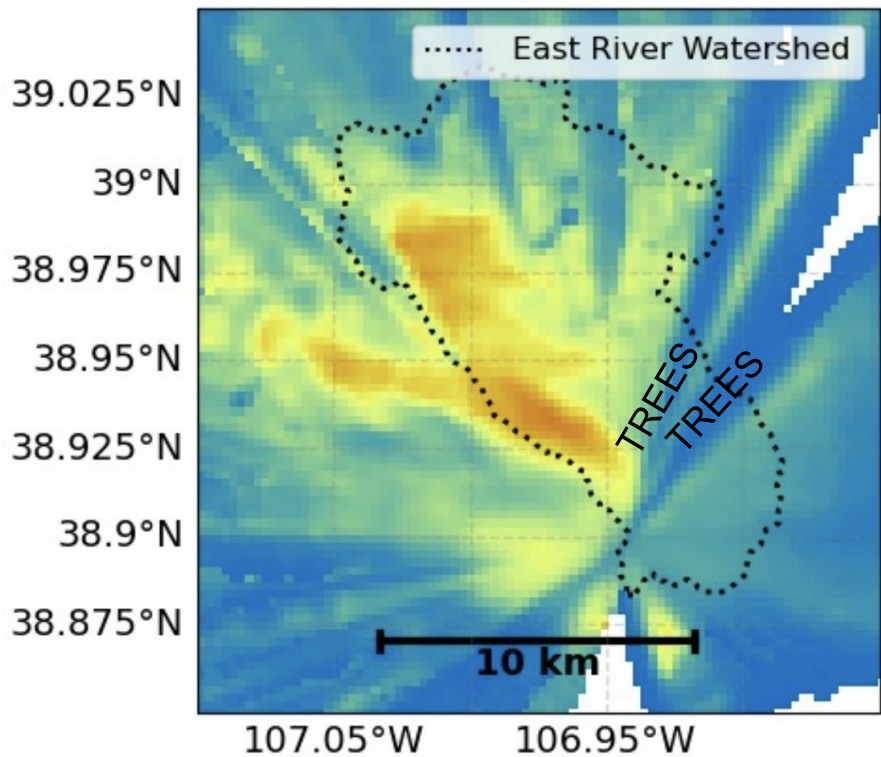
- For radar enthusiasts: CMAC.
- For radar retrievals, a new product, RadCLss. Columns over sensors.
- For hydrologists, modelers etc, a new product, SQUIRE, QPE at surface.
- All with for reflectivity based snow estimates.



Sergey Matrosov: Use KaZR for VPR.. (Good idea)



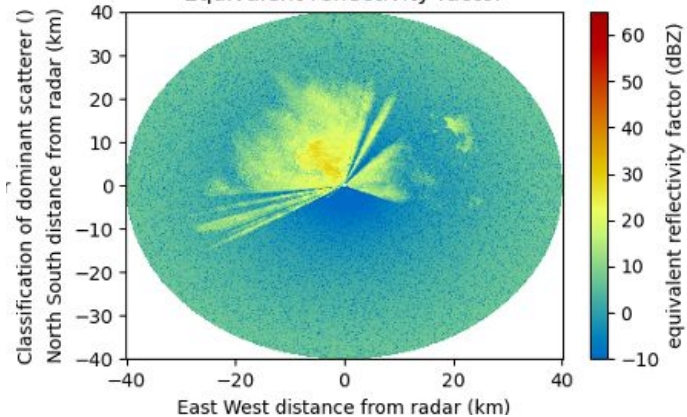
2022-03-14T02:47:59Z
SQUIRE Snowfall Rate



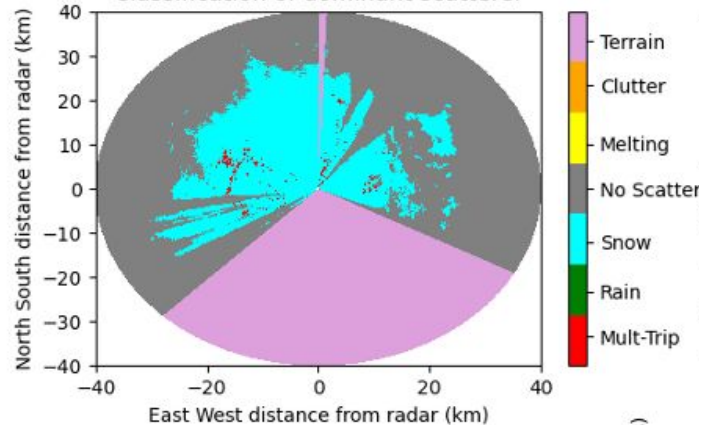
50
40
30
20
10
0

Snowfall rate from Z using
Wolf and Snider (2012) [mm/h]

6.0 Deg. 2022-03-14T02:49:35Z
Equivalent reflectivity factor



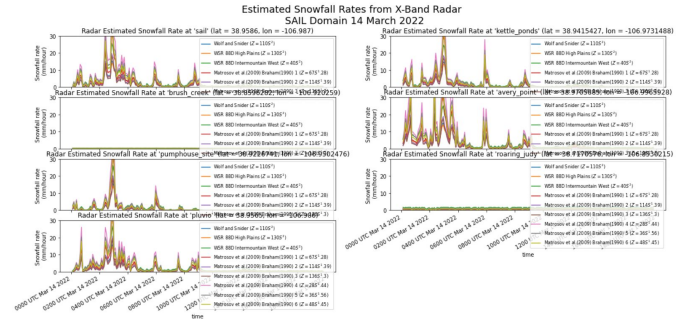
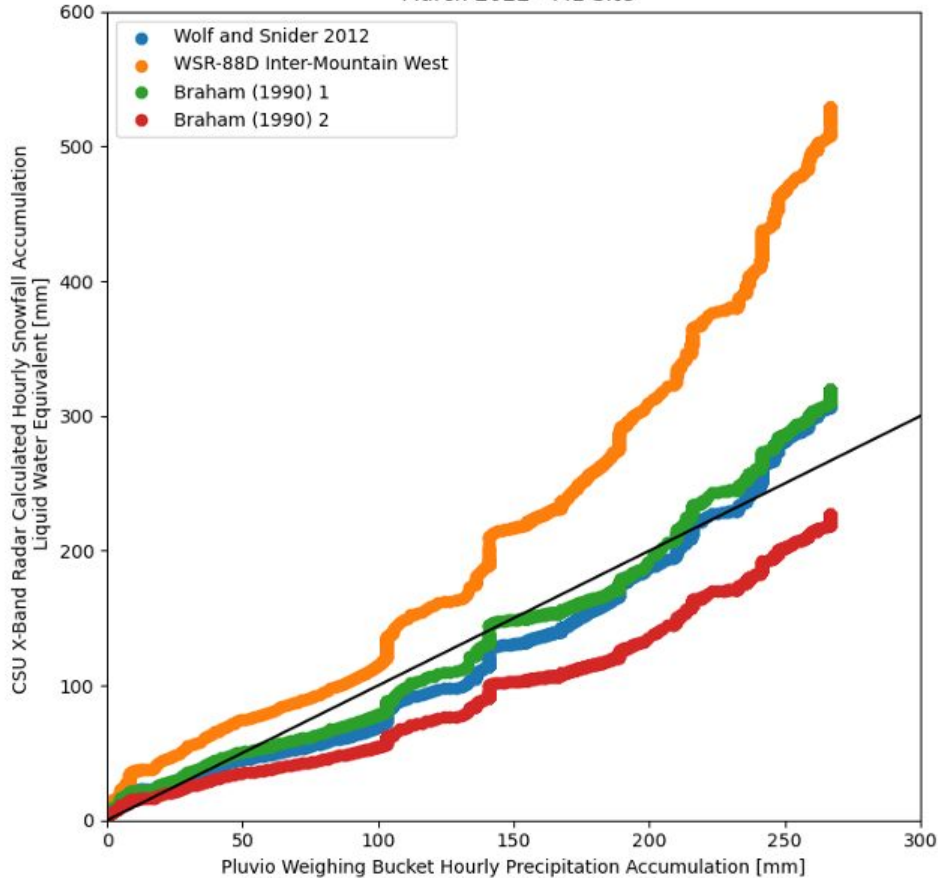
6.0 Deg. 2022-03-14T02:49:35Z
Classification of dominant scatterer



(/S)

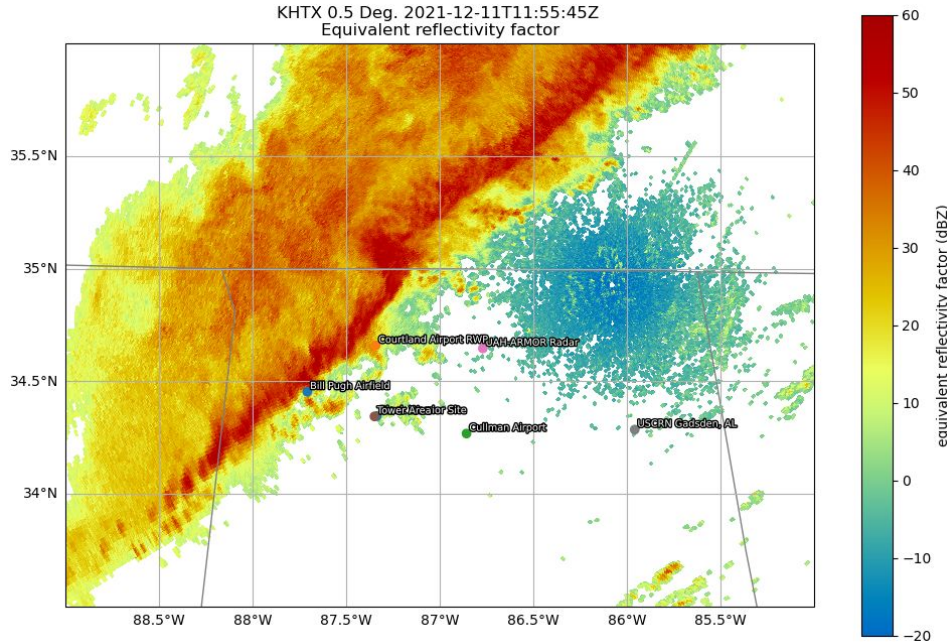
Cook Book Goodness

CSU X-Band Radar Hourly Precipitation Accumulation
March 2022 - M1 Site



Bankhead National Forest in Alabama

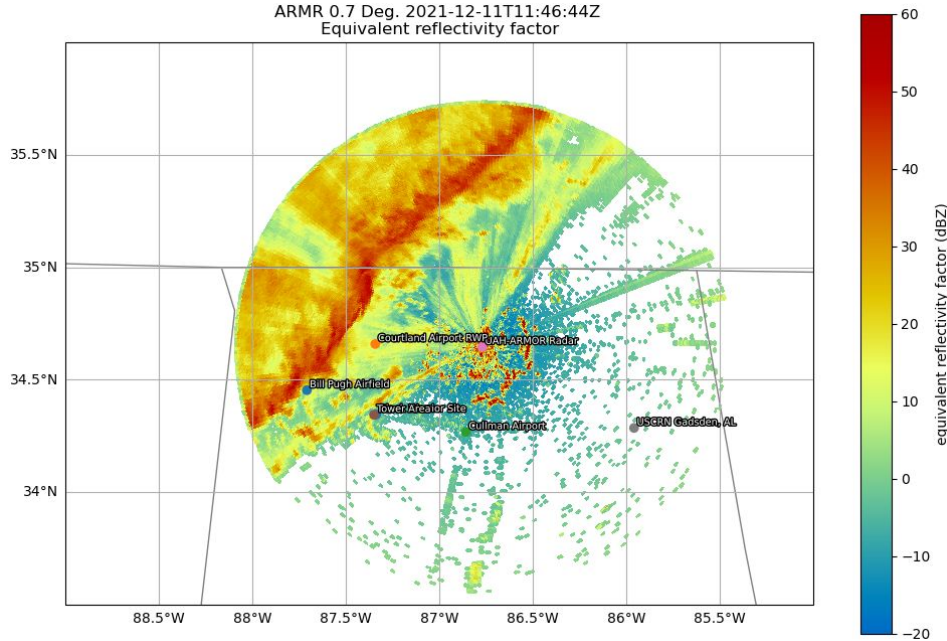
- Same philosophy.
- Extend to other datasets, NEXRAD, ARMOR. **We don't need to be the ones to this.** We can either do it or, better, facilitate scientists to create products for which they can get credit (we don't care about credit, we care about impact.)
- We think RadCLss is very well suited here.



<https://github.com/ARM-Development/amf3-radar-examples>

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