Deployment of the 3rd ARM Mobile Facility to the Southeastern United States:

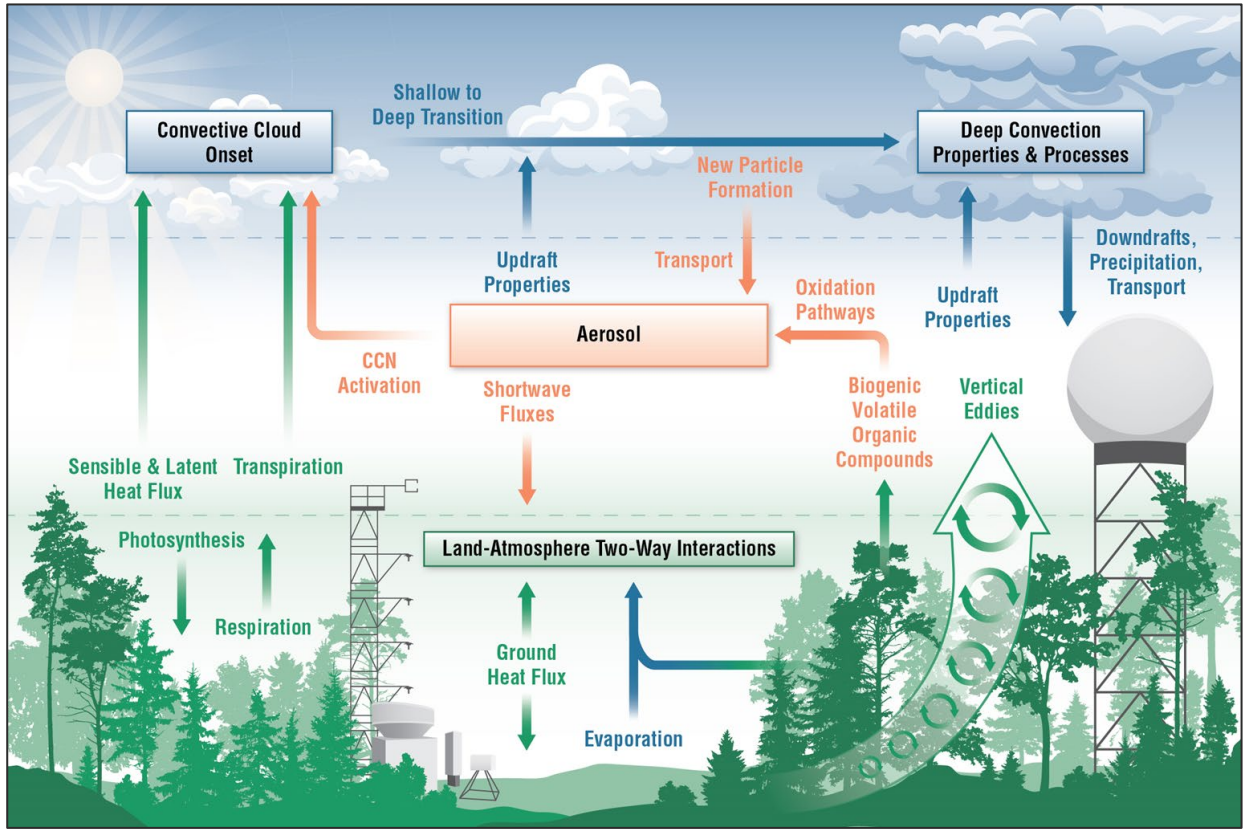
"Convective Clouds" Sub-Breakout

Sub-Breakout Leads: Scott Giangrande (BNL), Nicki Hickmon (ANL)
Invited Presentation by Tim Wagner (UWisc)

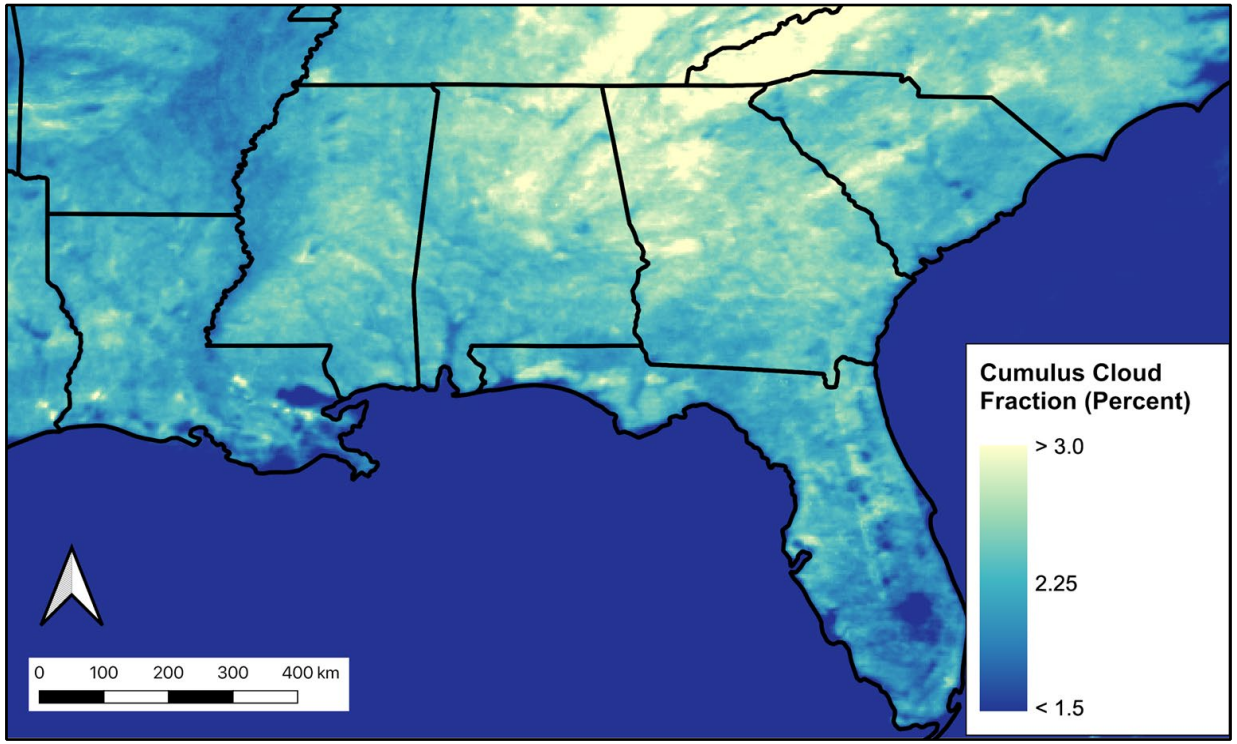
Why Study Convective Clouds in the Southeast US / Northern Alabama?

Northern Alabama is favorable for the study of convective clouds, triggering and/or onset:

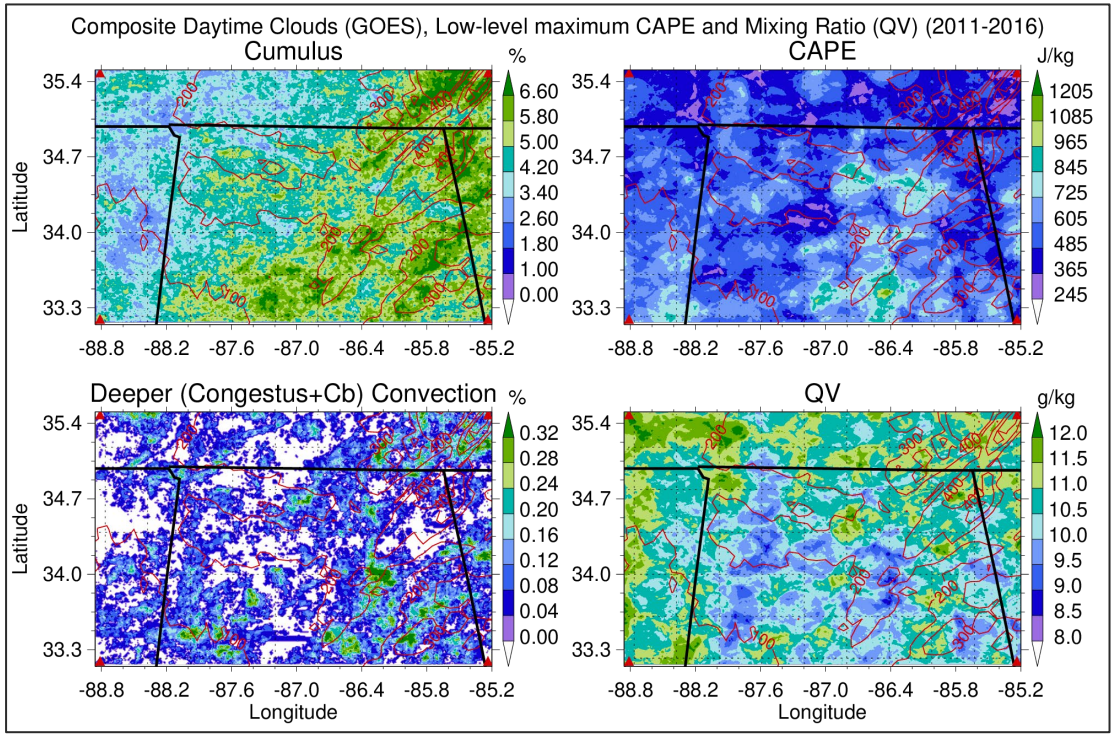
- Ample moisture supply from the Gulf of Mexico and high humidity above the BL is conducive to frequent clouds, deeper convective modes.
- The depth of the daytime CBL is shallower than SGP; This promotes a higher fraction of shallow cumulus.
- Northern AL favors frequent thunderstorms in a region that is increasingly vulnerable due to growth in population centers.



What Drives the Cloud Frequency and Diversity in Northern Alabama?



June through August cumulus cloud fraction (% of time over a 24 hour period) as derived from GOES satellites.



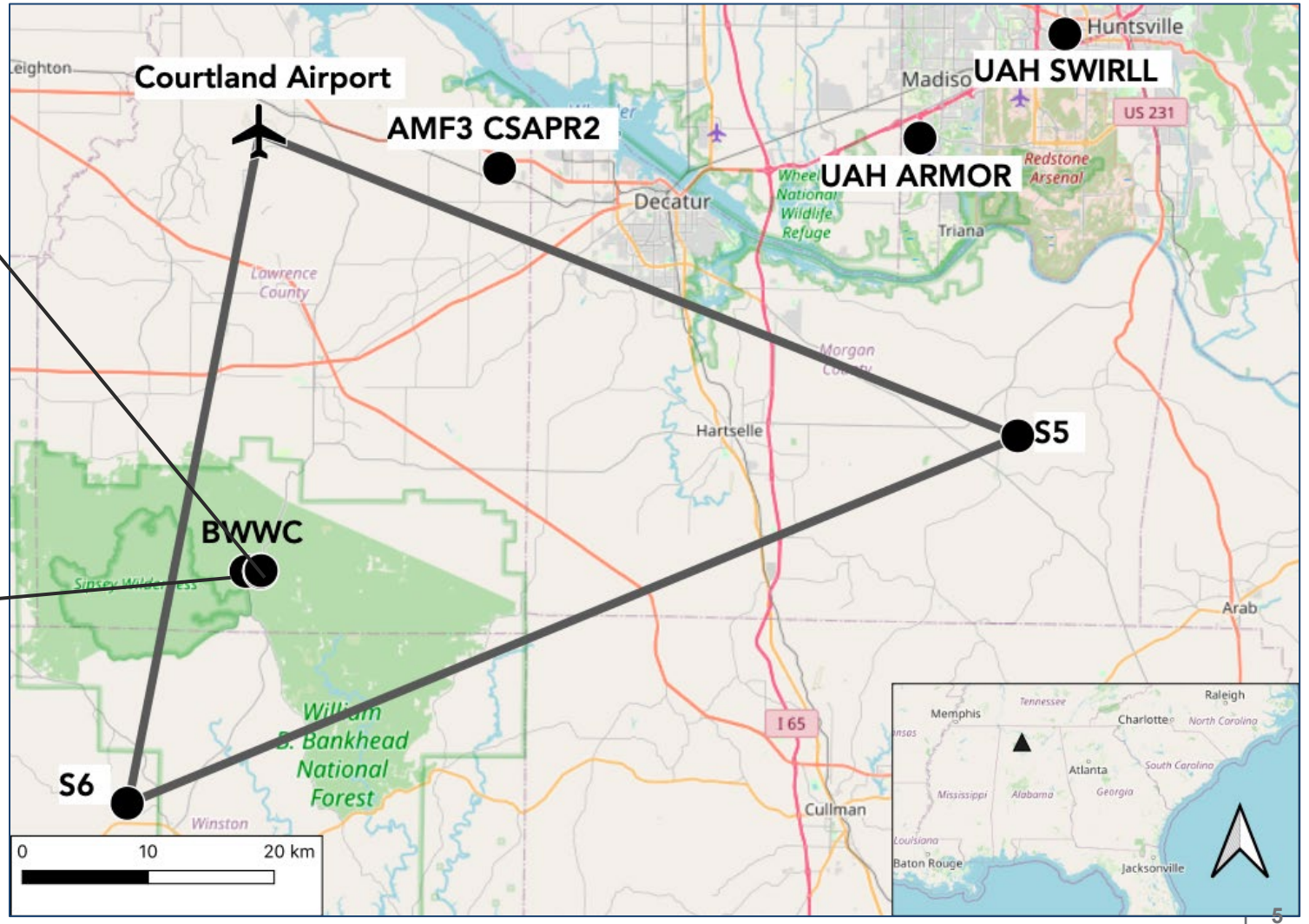
SST is interested in developing several longer-term datasets to explore connections between the local and larger-scales, the cloud fields, land surface and thermodynamic profiling.

Satellite cloud data provided by J. Mecikalski (UAH)

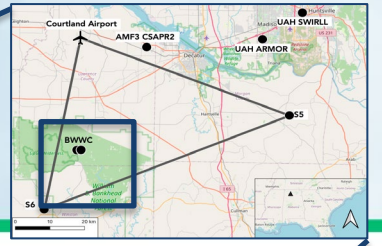
What are Some Key Convective Cloud Science Drivers for the SST for the BNF Deployment?

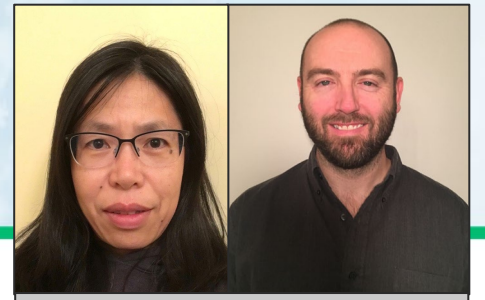
- What is the role of large-scale vs. meso-scale thermodynamic perturbations in the onset of convection?
- What are the key atmospheric processes that regulate the transition from shallow-to-deep convection?
- What are the factors that regulate the nature of convective updrafts and the size of thermals within cumulus updrafts above the PBL?
- How do convective updrafts relate to the nature of stratiform precipitation?

Proposed AMF3 Layout and the ARM Instrumentation For Northern Alabama

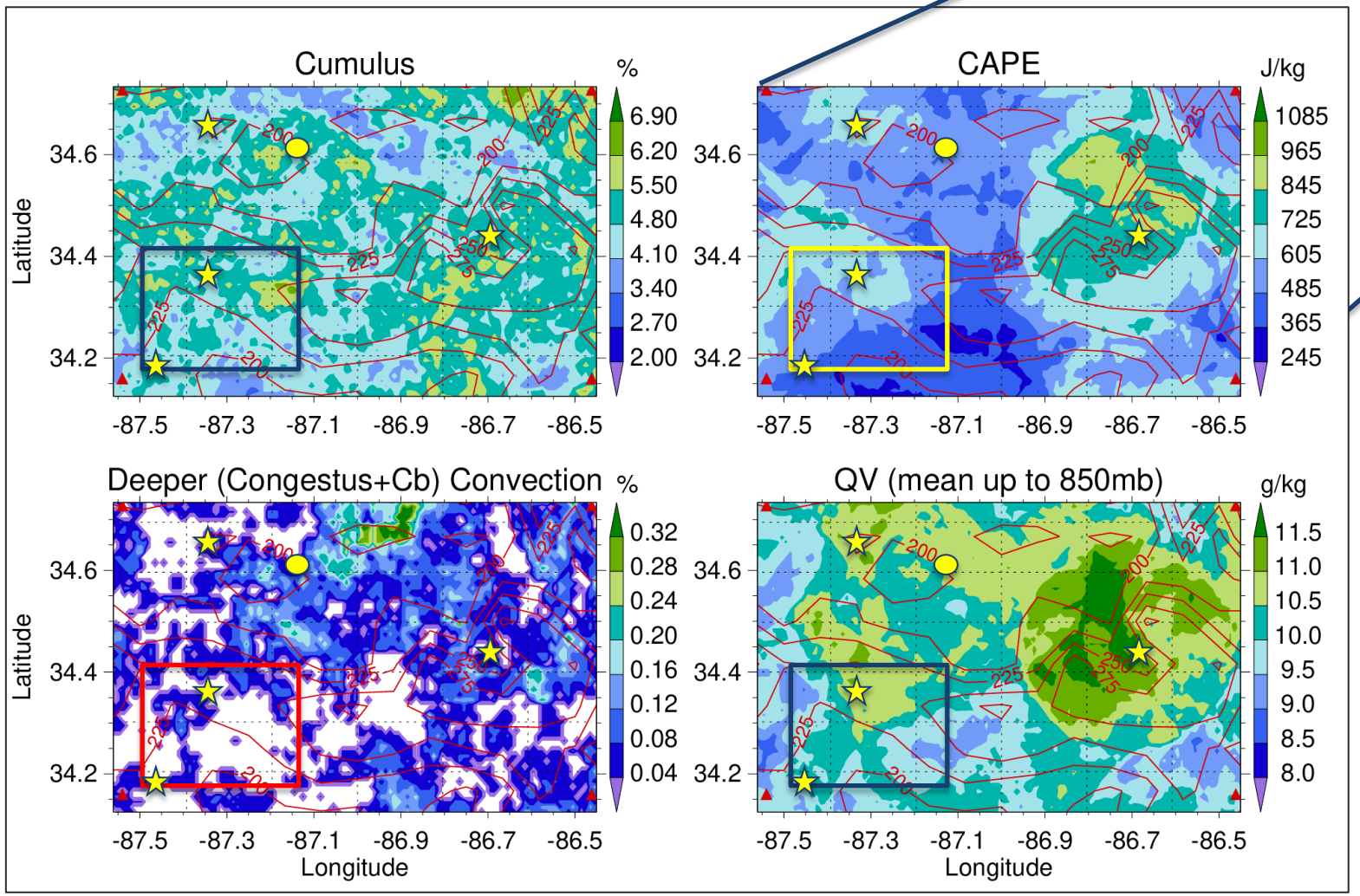


#TheSurfaceMatters





Jingbo Wu, Greg Elsaesser



- 6-year satellite (GOES) cloud frequency, thermodynamic profiling products (AQUA/AIRS) O [1-10 km].
- (Left) Summer-time months, non-frontal (undisturbed?) conditions plotted. Is this where the surface matters the most?
- Heterogeneity is good → Useful for distinguishing cloud environments, improvements to process representations and retrievals.

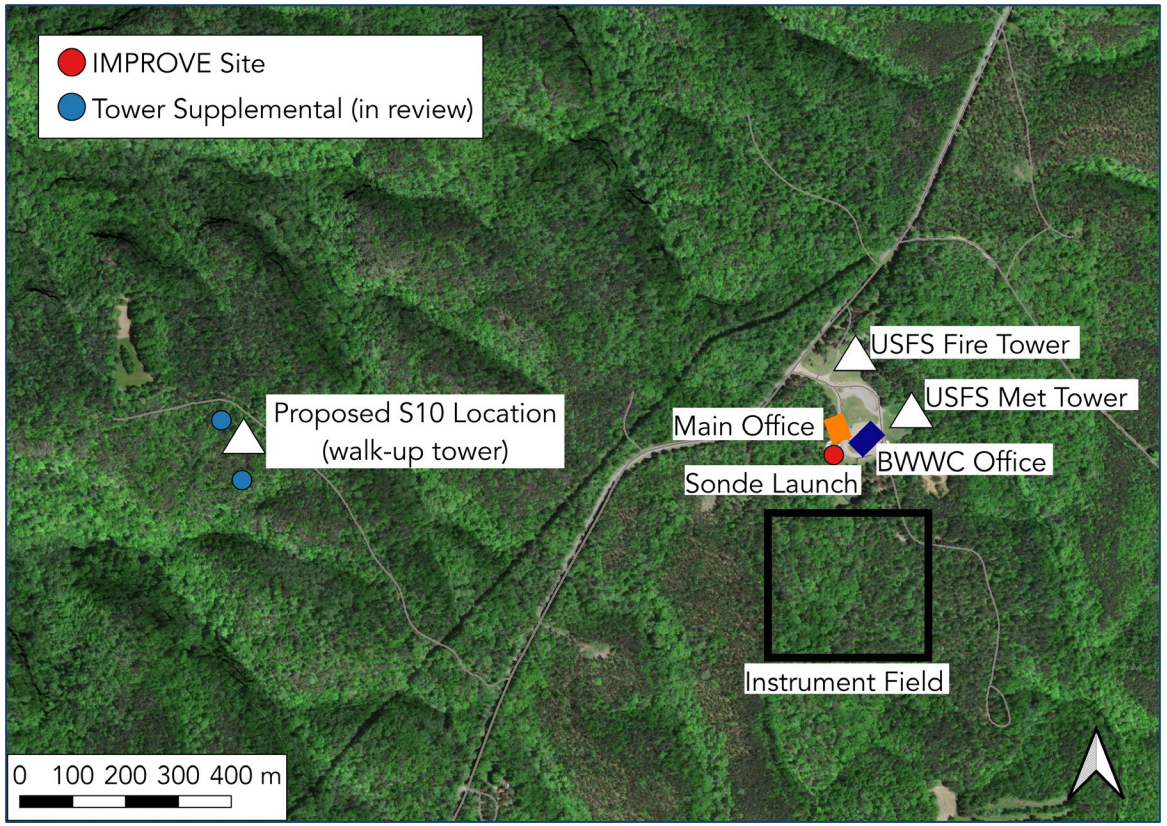
Topography contours (red lines)

Daytime climatology from May 1 - Aug 31
Satellite cloud data provided by J. Mecikalski (UAH)

Key Measurements / Instruments for the Main AMF3 Site?

- Atmospheric State / PBL Profiling
- Cloud Onset, Properties and Precipitation
- 2D/3D Cloud Mapping, Fraction
- Surface Properties / Fluxes
- In-Cloud/Sub-cloud Turbulence, Vertical Velocity

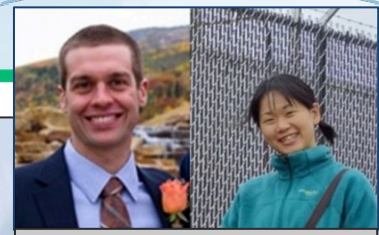
- MET / MAWS
- SONDE
- Raman Lidar
- HSRL
- Doppler Lidar
- CEIL
- SIRS
- CSPHOT
- STEREOCAM[1]
- KAZR
- MWR3C
- MPL
- AERI
- RWP
- VDIS/LDIS
- TSI
- CSAPR2[2]
- SACR[2]



Tower site will also include:
CEIL, MET, STAMP, TSI, LDIS

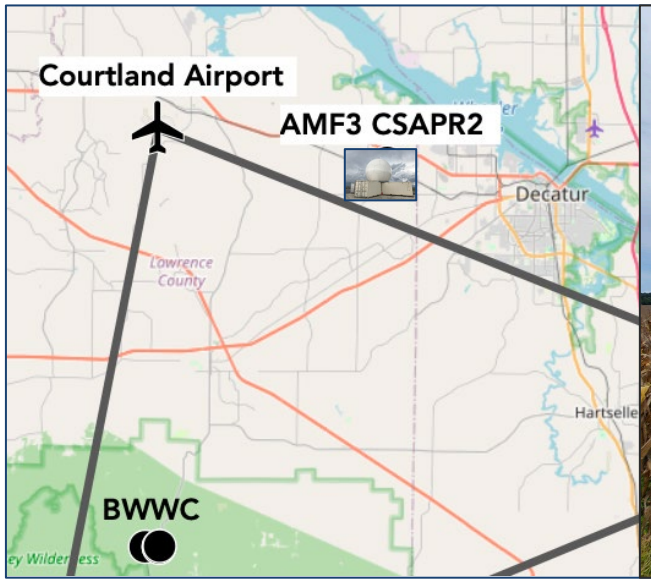
[1] Emerging technology / development to be discussed
[2] Supplemental site placement outside of the BNF

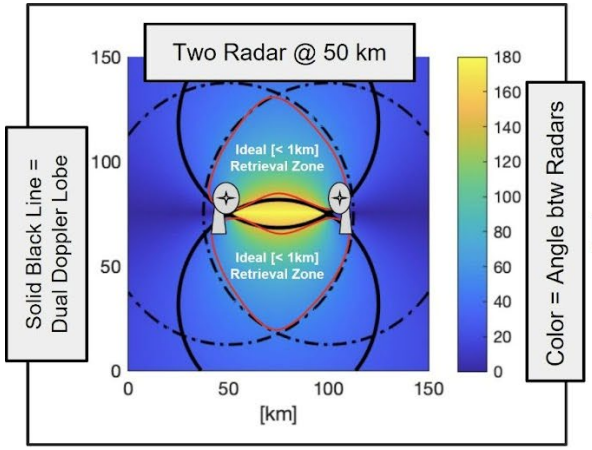
Supplemental AMF3 Sites: Surveillance Radar

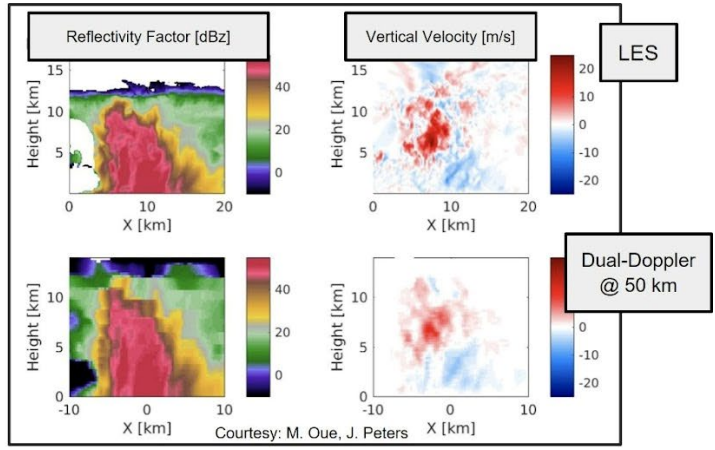


John Peters, Mariko Oue

- Community interest in precipitation properties, vertical air velocity, collocated measurements.
- Identified a relatively low-blockage CSAPR2 site < 40 km from the BNF.
- Partner UAH ARMOR radar → Conducive for dual-Doppler velocity retrievals. Surveillance also from multiple NEXRAD.
- Possible SACR placement for detailed sampling (Ka- and X-).







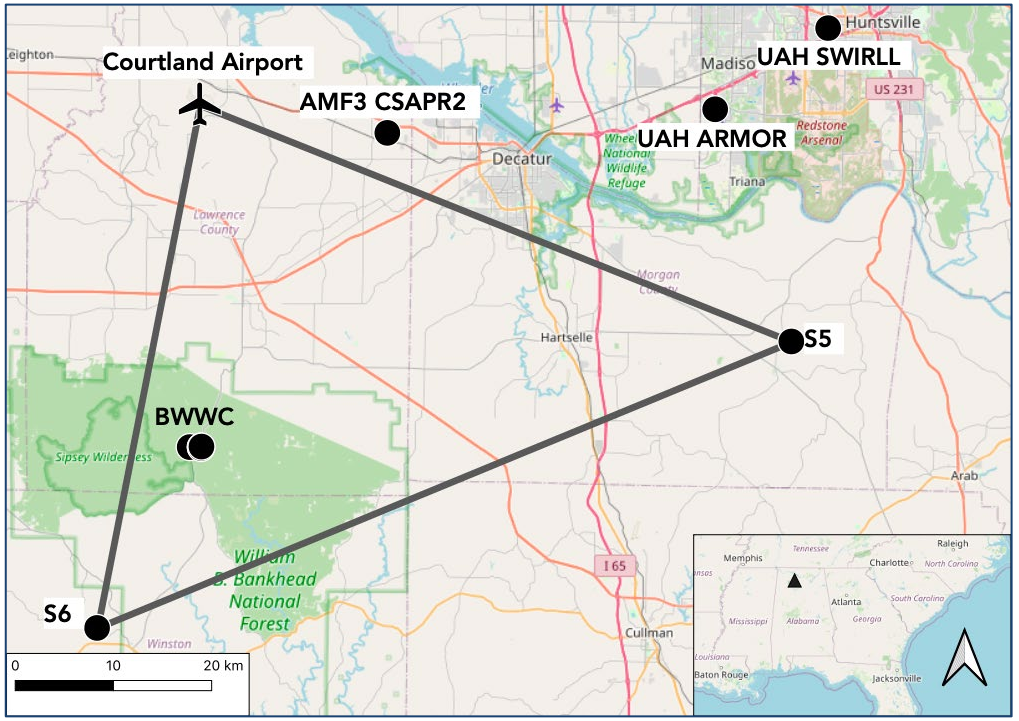
Supplemental AMF3 Sites: Profiling Network Key Instruments


Thijs Heus

To address environmental sampling & drivers for the onset of clouds and cloud processes, 3 profiling sites are proposed.

Request was for a triangular or similar site design around the BNF site. We anticipate the need for many of the same measurements at these sites. Profiling sites would include:

- AERI
- MWR3C
- Doppler Lidar
- ECOR
- LDIS
- IRT
- MET (TBRG)
- MFRSR
- SEBS
- SIRS
- STAMP
- TSI



A second RWP for profiling will be available at one supplemental site

Supplemental Siting: Factors that Influence Site Layout for Cloud Process Study

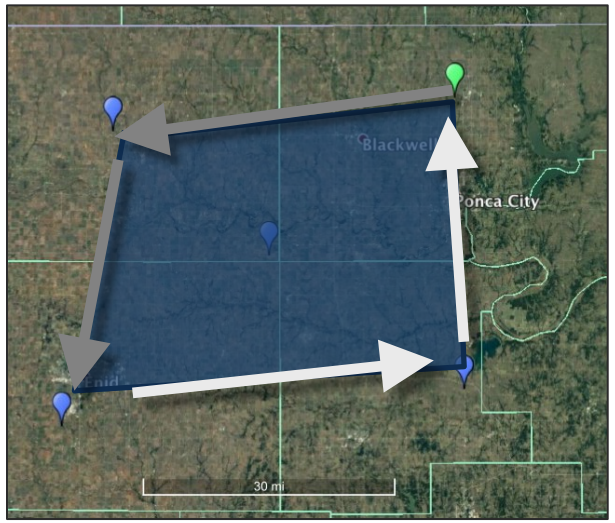
Tim Wagner
University of
Wisconsin-Madison

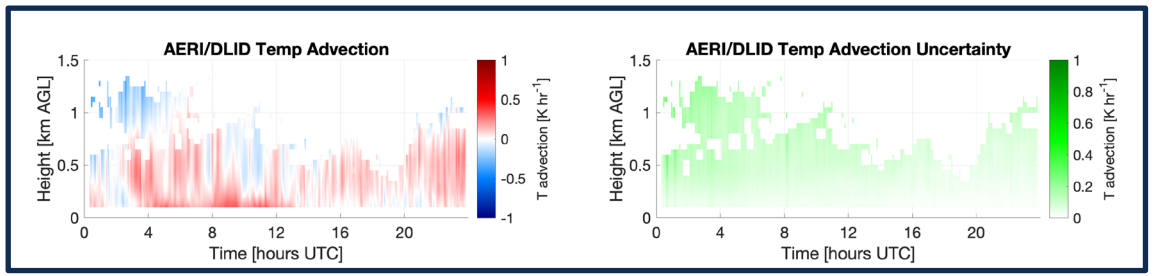
Supplemental Siting: Factors that Influence Site Layout for Cloud Process Study

Vertical profiles of derived field quantities from a profiling site network

- Use Green's Theorem and estimates of line integrals to calculate:
  - Advection
  - Vorticity
  - Divergence and Deformation
- Use profiling instruments (like DL, AERI) to obtain vertical profiles of advection, etc.

$$-\mathbf{V}\cdot\nabla\varphi = -\left(u\frac{d\varphi}{dx} + v\frac{d\varphi}{dy}\right) \approx \frac{-\Sigma\bar{\varphi}(\bar{u}\Delta y - \bar{v}\Delta x)}{A}$$





Supplemental Siting: Factors that Influence Site Layout for Cloud Process Study

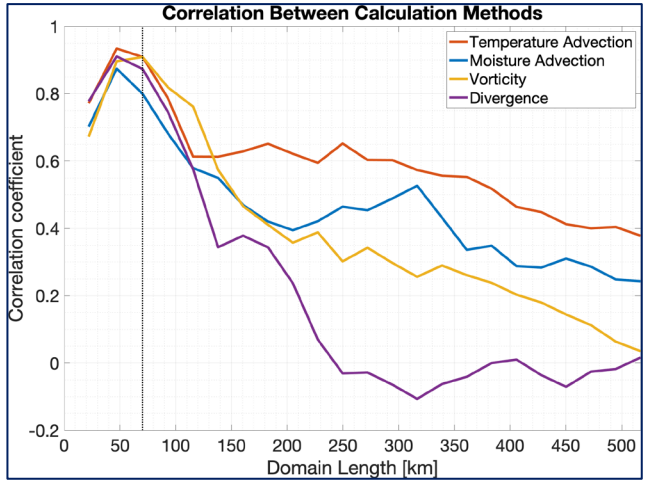
Q: How far apart should sites be spaced?
A: Use synthetic obs to investigate:

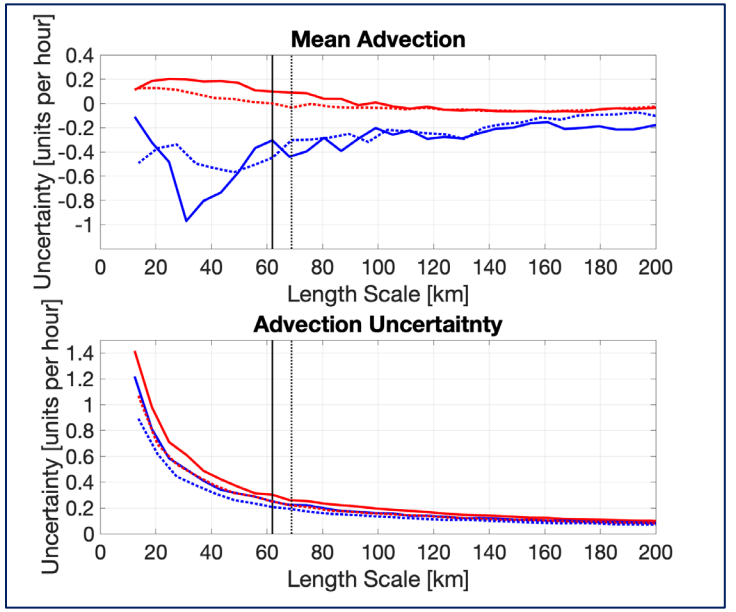
60-70 km is the "sweet spot":

- Advection tends to zero as area increases;
- Too small, and instrument error dominates;
- Correlations between Green's Theorem and finite differencing from model data are highest in this range

SGP happens to be situated at near-perfect spacing.

What about SE U.S.? Initial model analysis shows approximately the same performance, despite looking at 3 site layouts instead of 4.





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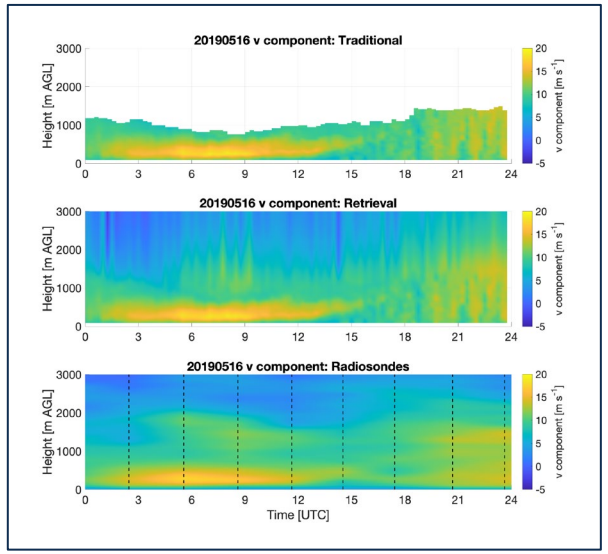
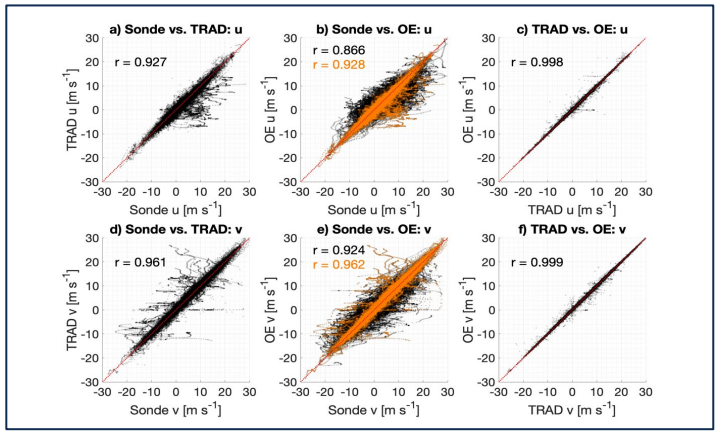
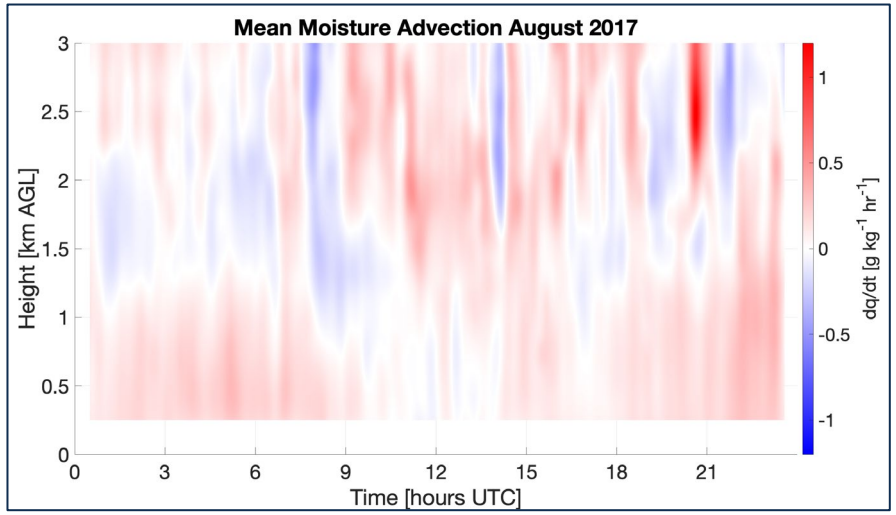






- Max height of Doppler Lidar (DL) profile varies substantially
- Advection profiles only as good as the worst profiler in the polygon
- Currently developing an OE technique to retrieve wind profiles from DL VAD

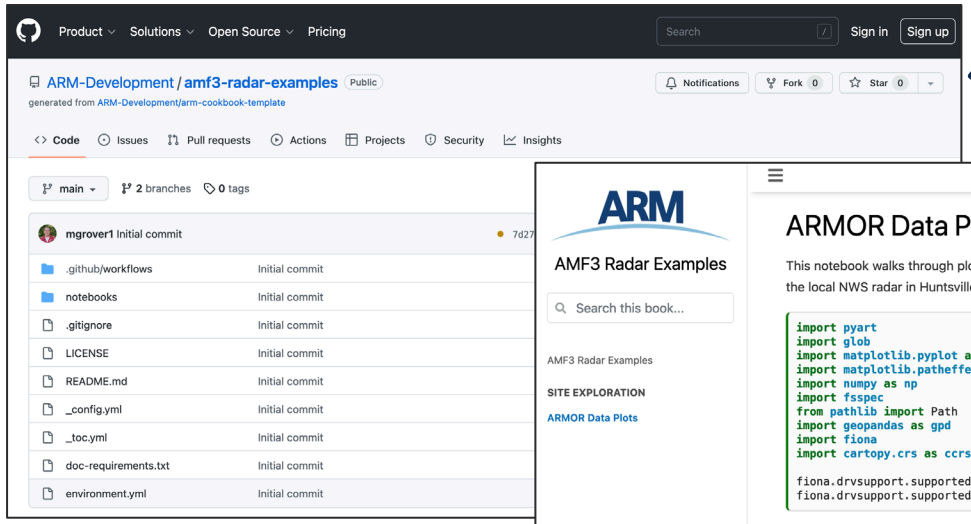
Responding to Community-Driven Requests and Emerging Technology / Concepts

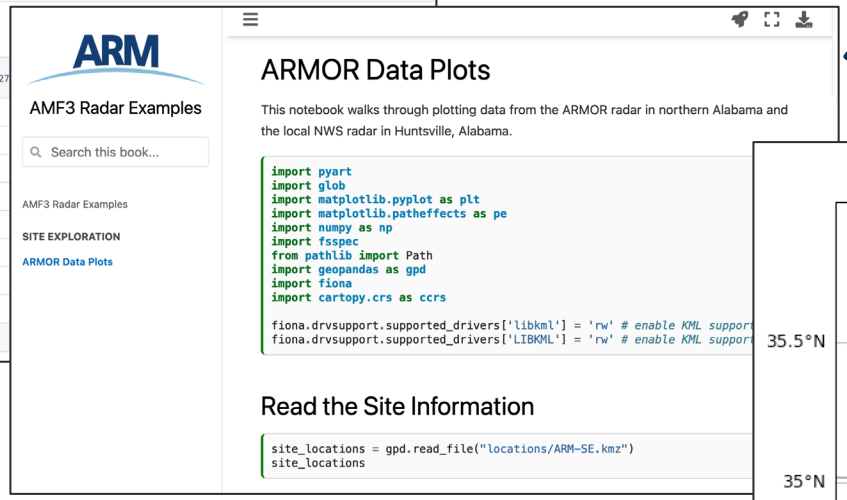
Evaluating the Effect of Tower Vibrations on Stereo Reconstruction (LBNL)

David Romps, Rusen Oktem, and Yi-Chuan Lu

- Low tolerance for angular uncertainty in stereo.
- Tower vibrations may confound reconstructions.
- Vibrational frequencies and magnitudes unknown.
- Testing to be performed at SGP → BWWC towers,
- High-res camera to be evaluated.

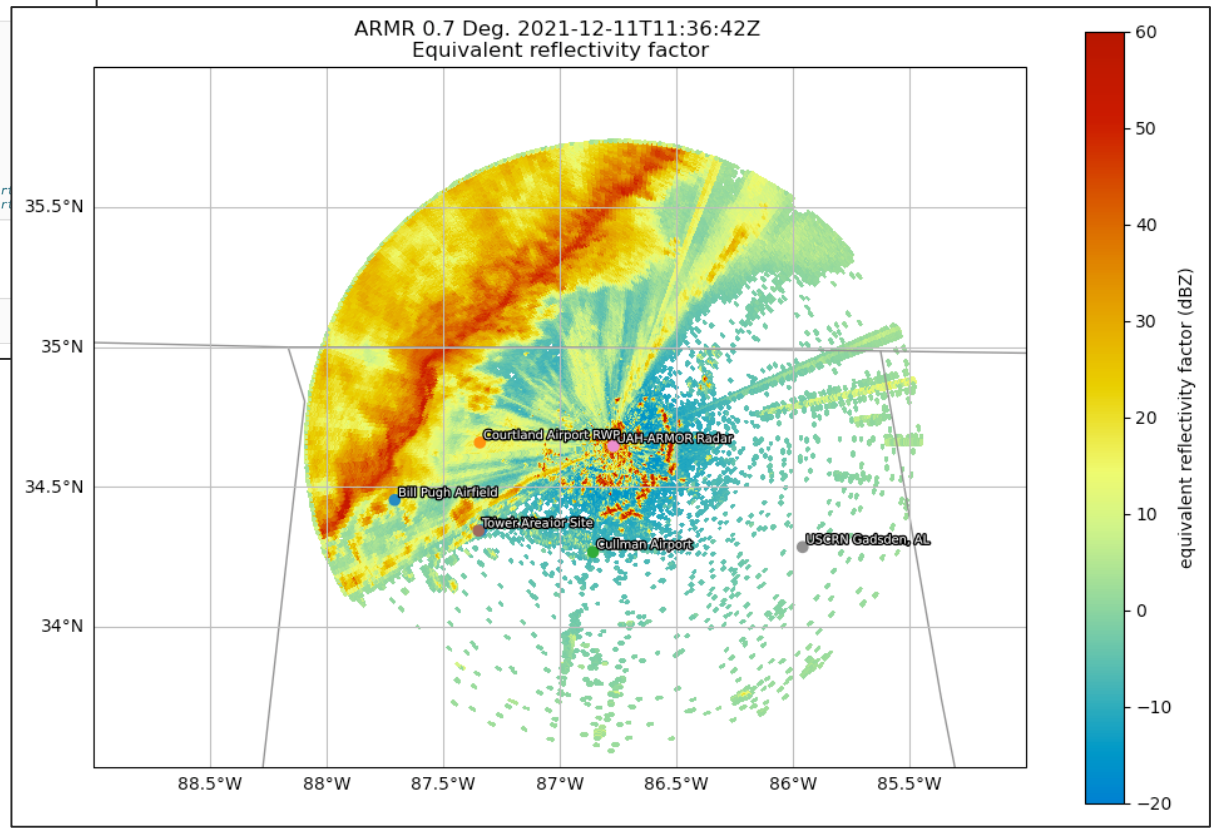
Developing Open-Community AMF3 Computing and Analysis Resources





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

Max Grover (ANL)



- Initial ‘data proximate’ development on ARM's HPC.
- Self-explaining “cookbooks” that facilitate early availability of in-demand products (i.e., rainfall rates, vertical air velocity)’
- Ability to merge, consolidate ARM data streams, visualize ARM datasets.

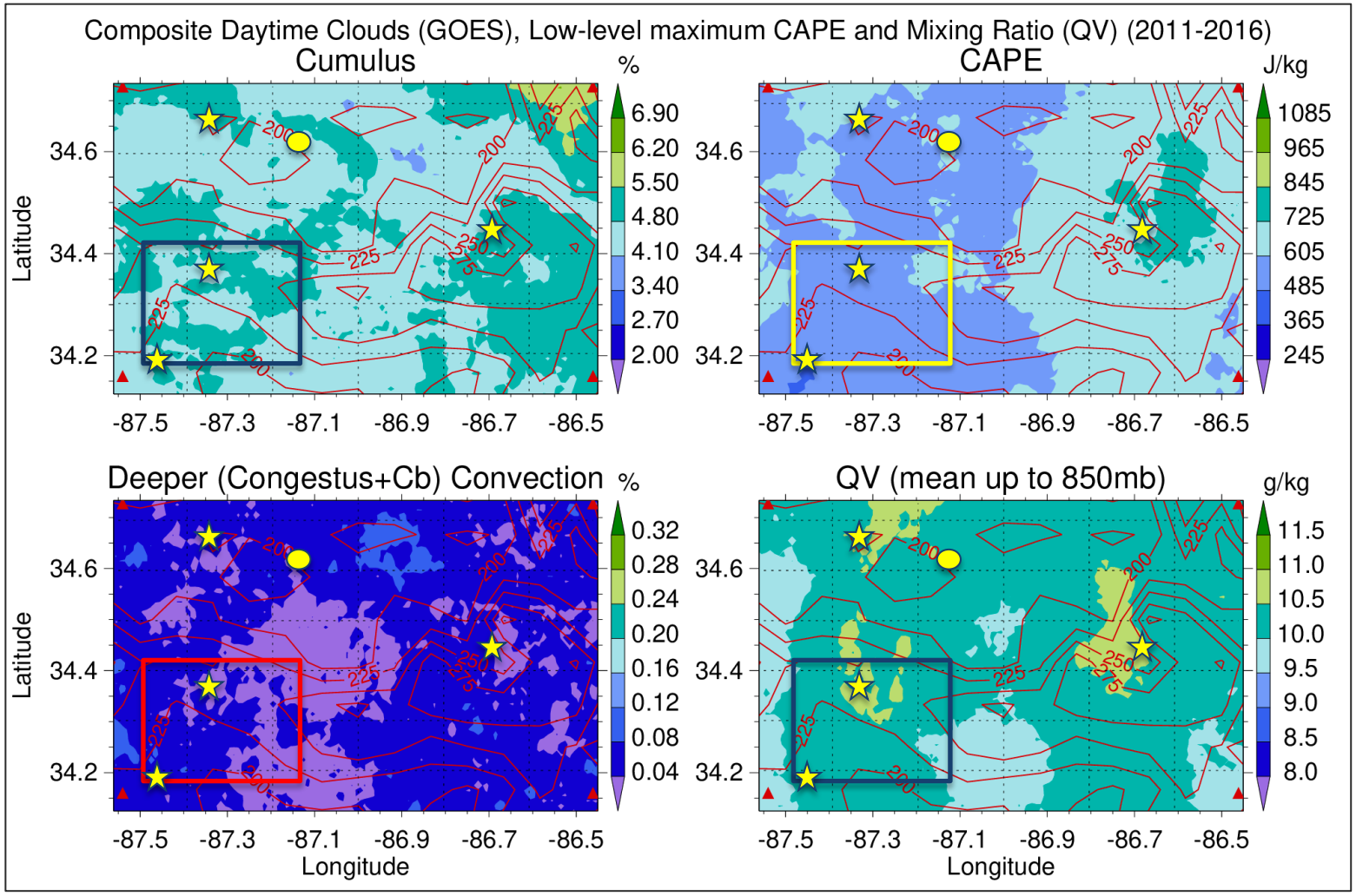
“Kick-off” Radar Scanning IOP

- Initial proposal for a ‘kickoff’ IOP for CSAPR2 operations (Mar - June, ’24).
- Prioritize ARM engineering / radar data mentor attention during these times; Ensure high-quality CSAPR2 datasets.
- Forecast/document convective cloud events → drive coordinated radar operations during this IOP. Maximize impact, minimize wear.
- Coordination with UAH-ARMOR faculty/staff to simultaneously operate, co-evaluate, and provide datasets → stable modes supportive of initial radar retrievals, multi-Doppler concepts.

Discussion

Extra Slides

Composite Climatology when Frontal Conditions are Included



Daytime climatology from May 1 - Aug 31

Topography contours (red lines)