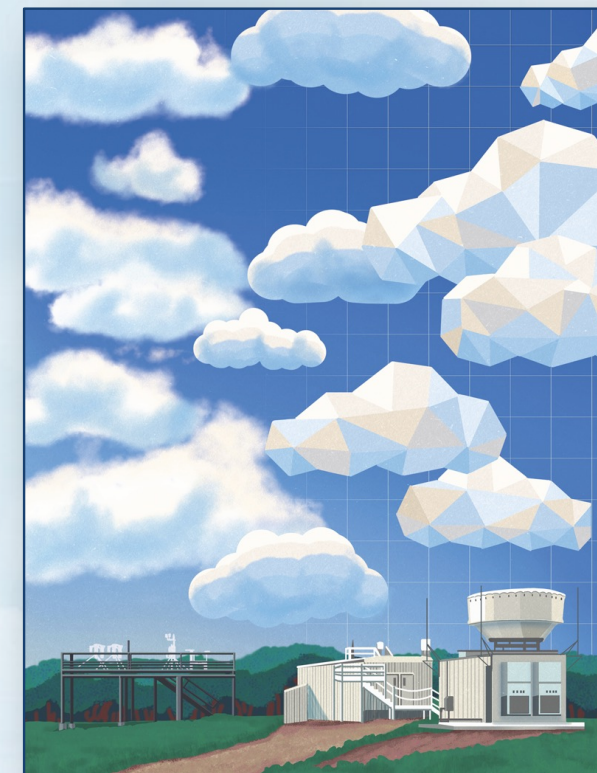


# Update: The LASSO-CACTI Scenario for Deep-Convection with Large-Eddy Simulation

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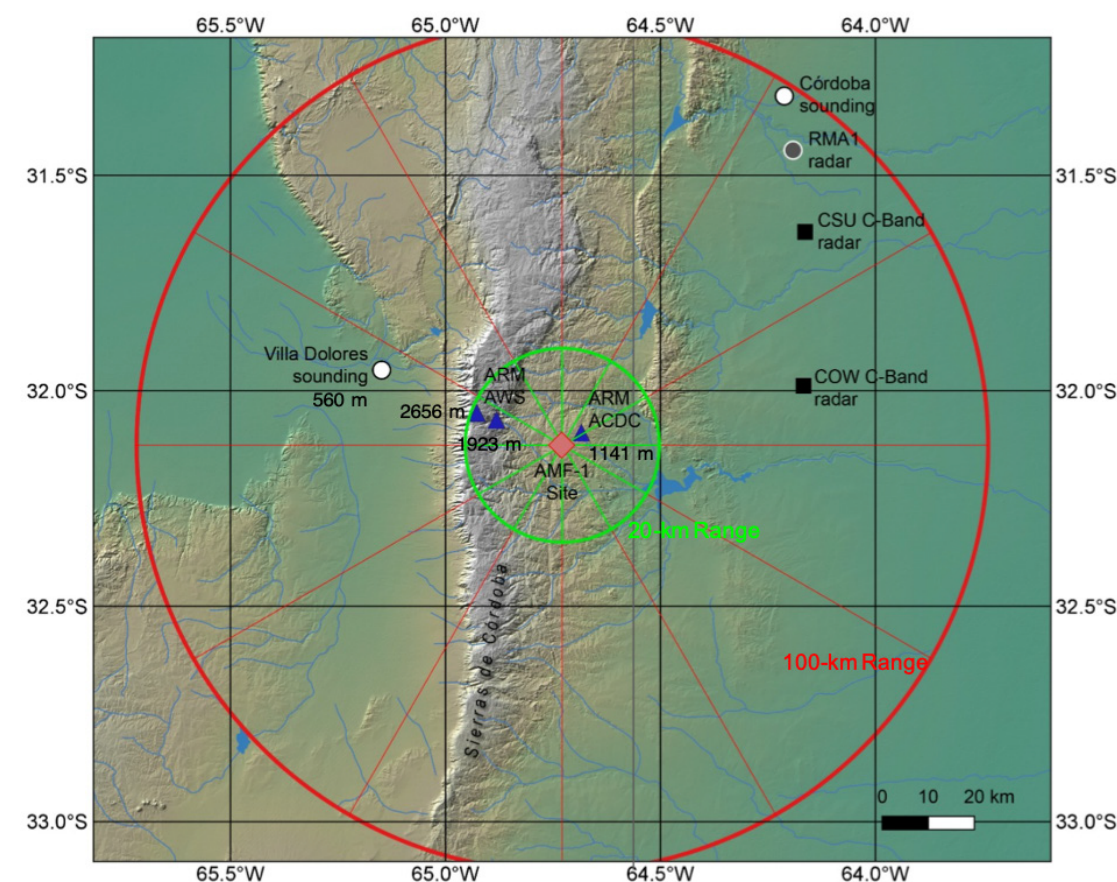
<sup>1</sup> Pacific Northwest National Laboratory, <sup>2</sup> Brookhaven National Laboratory



# What is LASSO & LASSO-CACTI?

- ▶ LASSO = LES ARM Symbiotic Simulation and Observation
- ▶ LASSO seeks to add value to ARM observations by using high-resolution modeling to bridge scale gaps and add context to observations
- ▶ The original scenario for shallow convection is now on hiatus to enable development of the new LASSO-CACTI scenario focusing on deep convection
- ▶ The CACTI field campaign occurred in 2018–2019 in Argentina with a focus on large-scale convection and its upscale growth
- ▶ LASSO will use large-eddy simulation (LES) to simulate ~10 CACTI cases with results released in 2022

## Map of CACTI Deployment in Argentina



# Mesoscale ensembles for case selection and LES boundary condition choices

## ► Selecting LASSO-CACTI cases

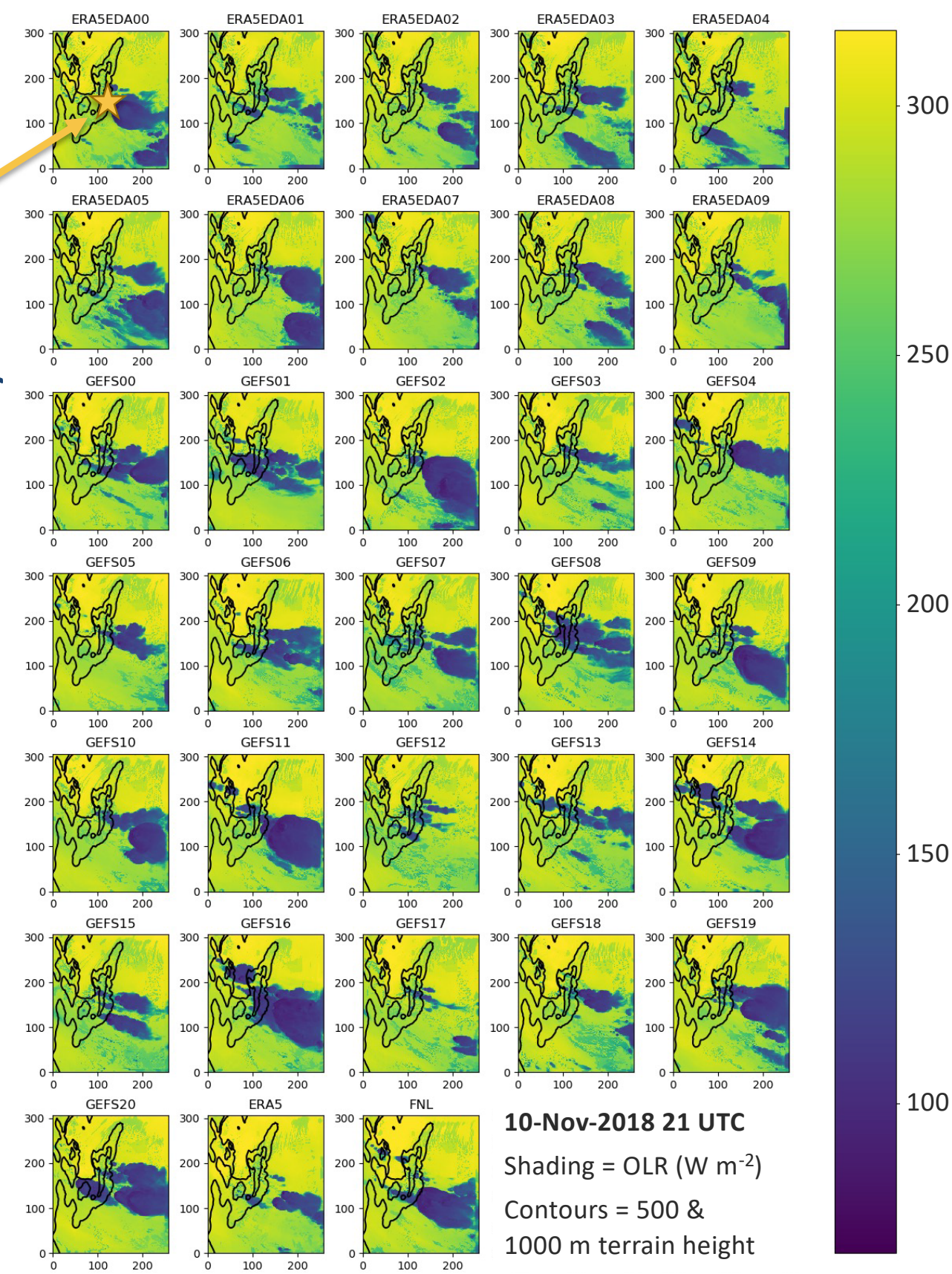
- We aim to release LES for about 10 case dates
- Selection of dates driven by convective initiation near the AMF site
- Down-selection involves using mesoscale ensembles to test boundary condition data

## ► Ran mesoscale ensembles for 20 candidate case dates—example for 10-Nov-2018 at right

- 33 ensemble members based on ERA5, ERA5 Ensemble, FNL, and GFS Ensemble
- Nested down to 2.5 km grid spacing
- Best performing ensemble members identified based on cloud comparison to GOES-16 IR data

AMF

OLR: Ensemble of  $\Delta x=2.5$  km Runs Based on Boundary Dataset



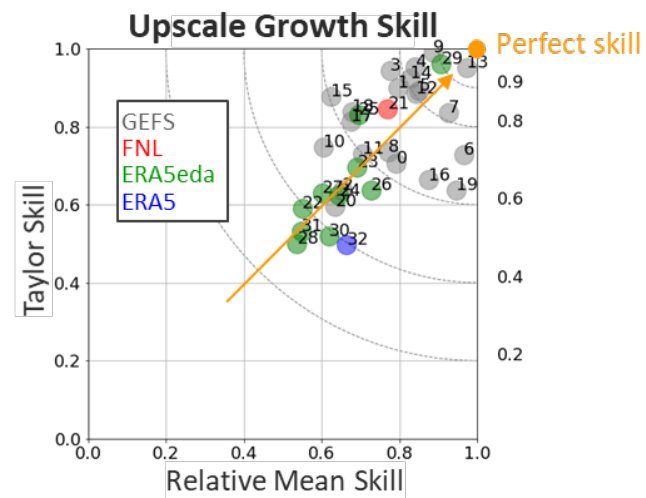
# Mesoscale ensemble comparison against GOES-16 IR data



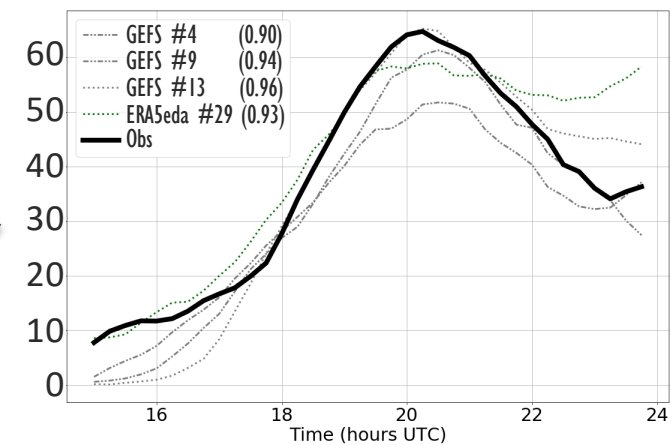
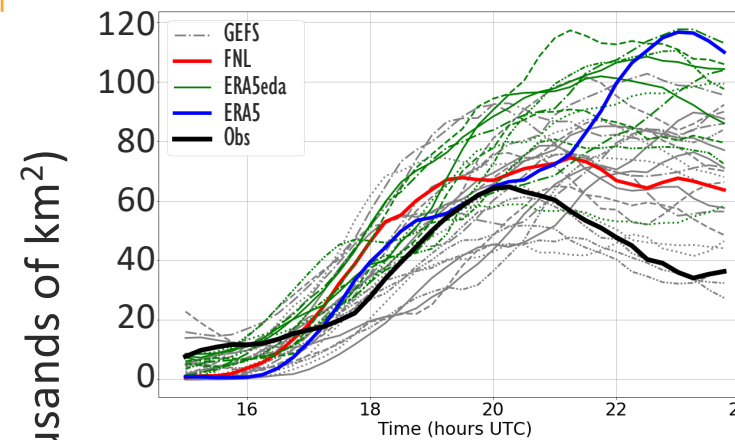
Time series of convective core area ( $T_B < 225$  K) is assessed during *upscale* growth (15–24 Z) and *pre-upscale* growth (3–15 Z)

## Upscale Growth Assessed Using a Taylor-based skill score

- Taylor skill is  $f(R, \sigma)$  for shape
- Relative mean for bias
- Range [0,1], 1 is perfect

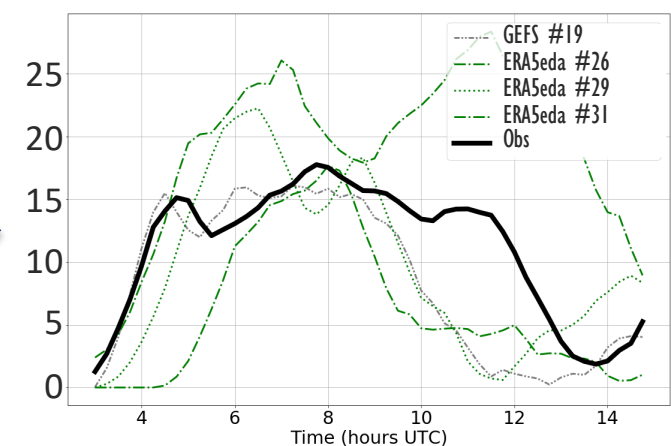
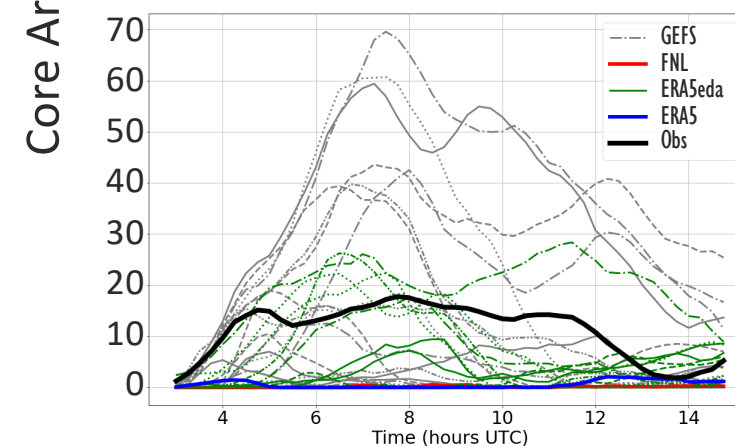
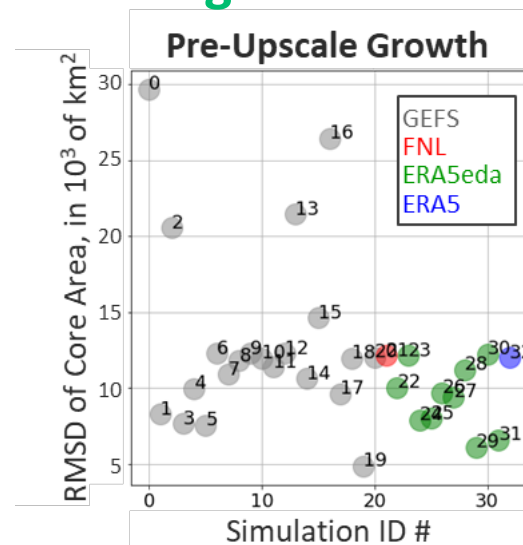


## Ensemble evaluations for 2019-01-23



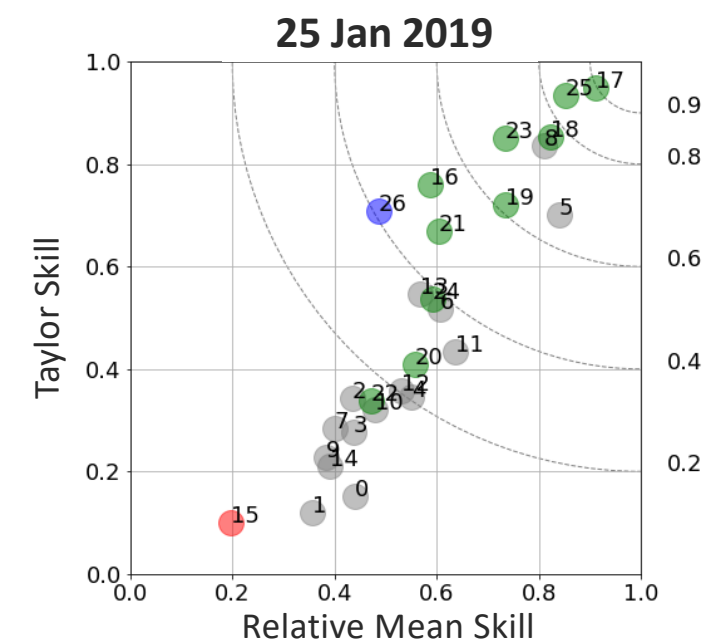
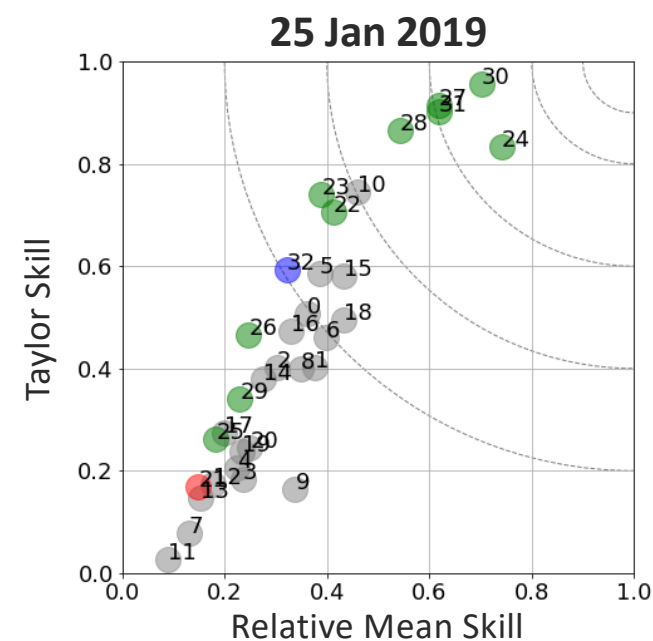
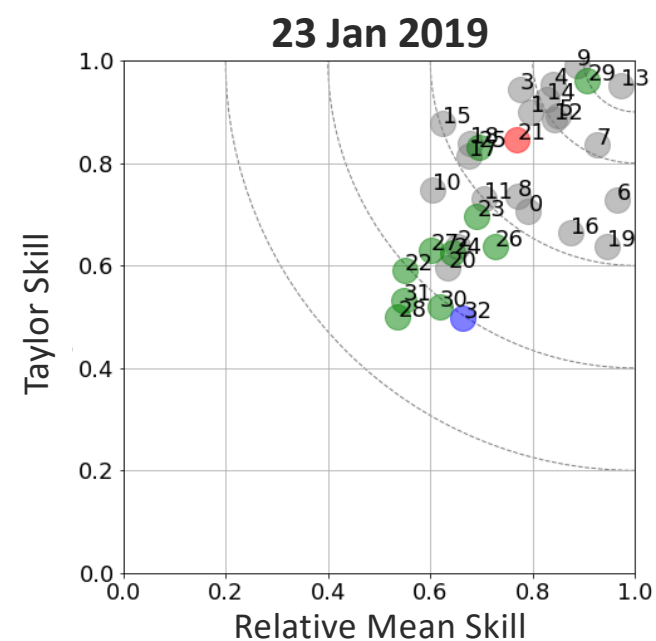
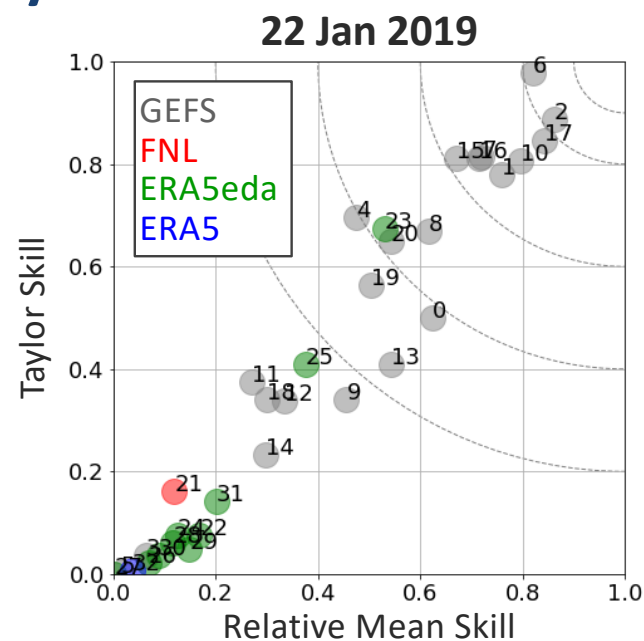
## Pre-Upscale Growth Assessed Using RMSD

- Lowest values are best

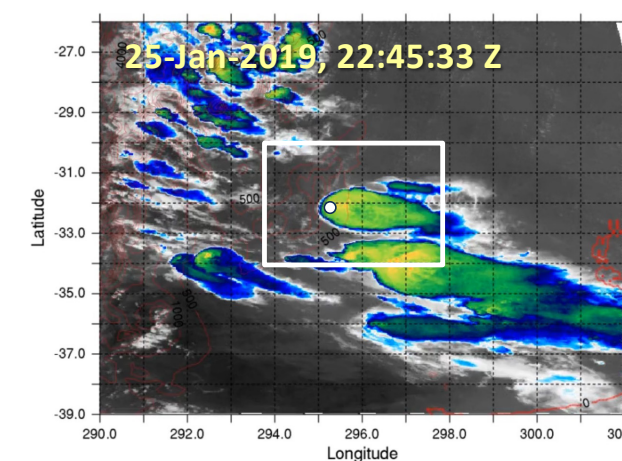
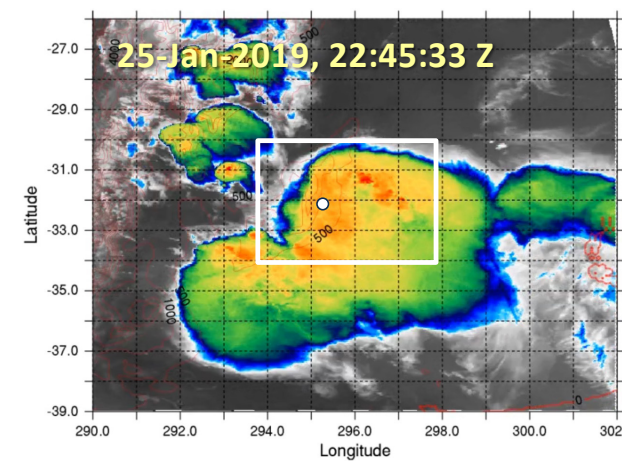
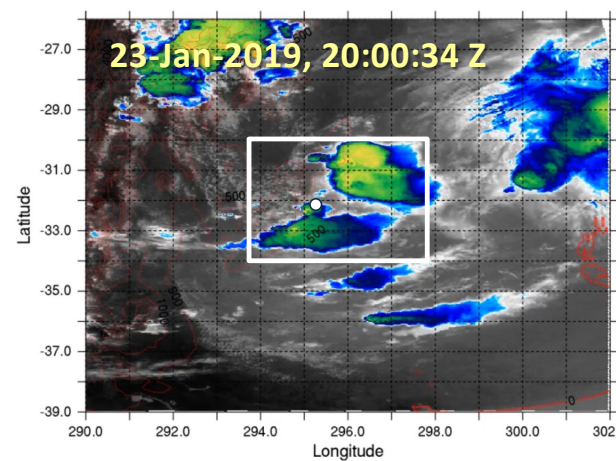
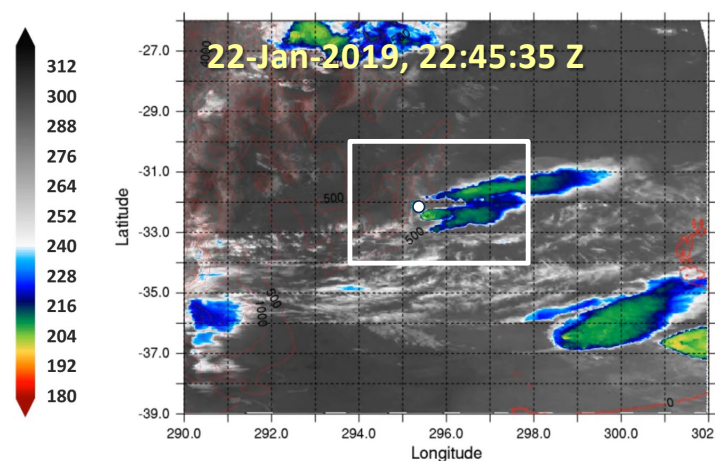


# Example ensemble comparison for upscale growth periods

## Taylor Skill



## Peak Area-IR- $T_B$ @ 11.2 $\mu\text{m}$ [K]



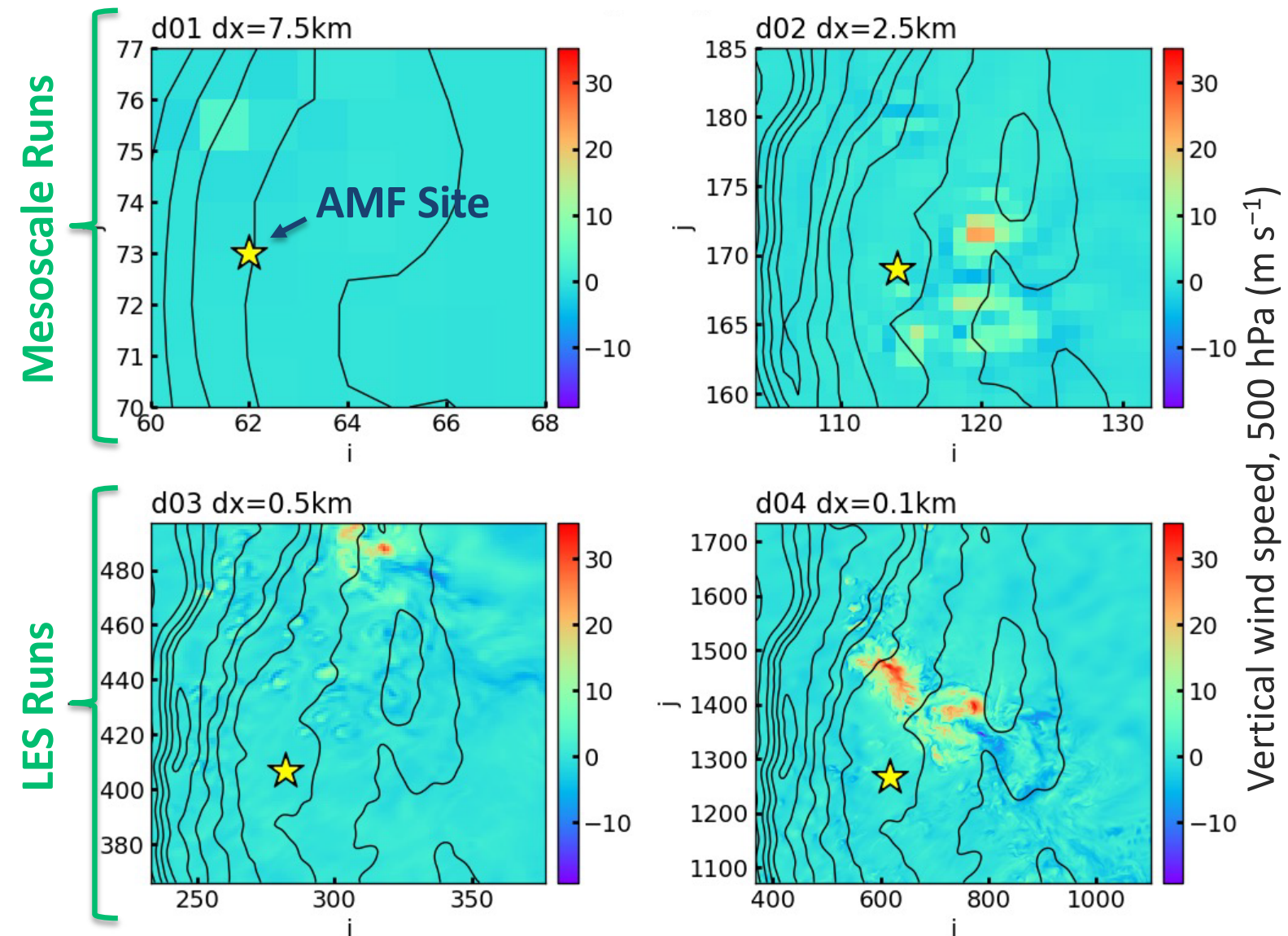
# Large-eddy simulations for CACTI

- ▶ WRF permits nested LES driven by reanalysis
- ▶ Using a 4-nest configuration  
 $\Delta x = 7.5 \text{ km} + 2.5 \text{ km}, \text{ Ndown to } 500 \text{ m} + 100 \text{ m}$
- ▶ Panels at right demonstrate increased detail available in up/down-drafts gained at  $\Delta x = 100 \text{ m}$ 
  - Topographic ridge & slope captured more accurately in terrain dataset at high resolution
  - Note ringing of downdrafts more prominently seen at  $\Delta x = 500 \text{ m}$  (d03)
  - Getting more natural, turbulent looking drafts at  $\Delta x = 100 \text{ m}$  (d04)

## Resolution Comparison for WRF Domains

### Vertical Velocity at 500 hPa

25-Jan-2019 20 UTC

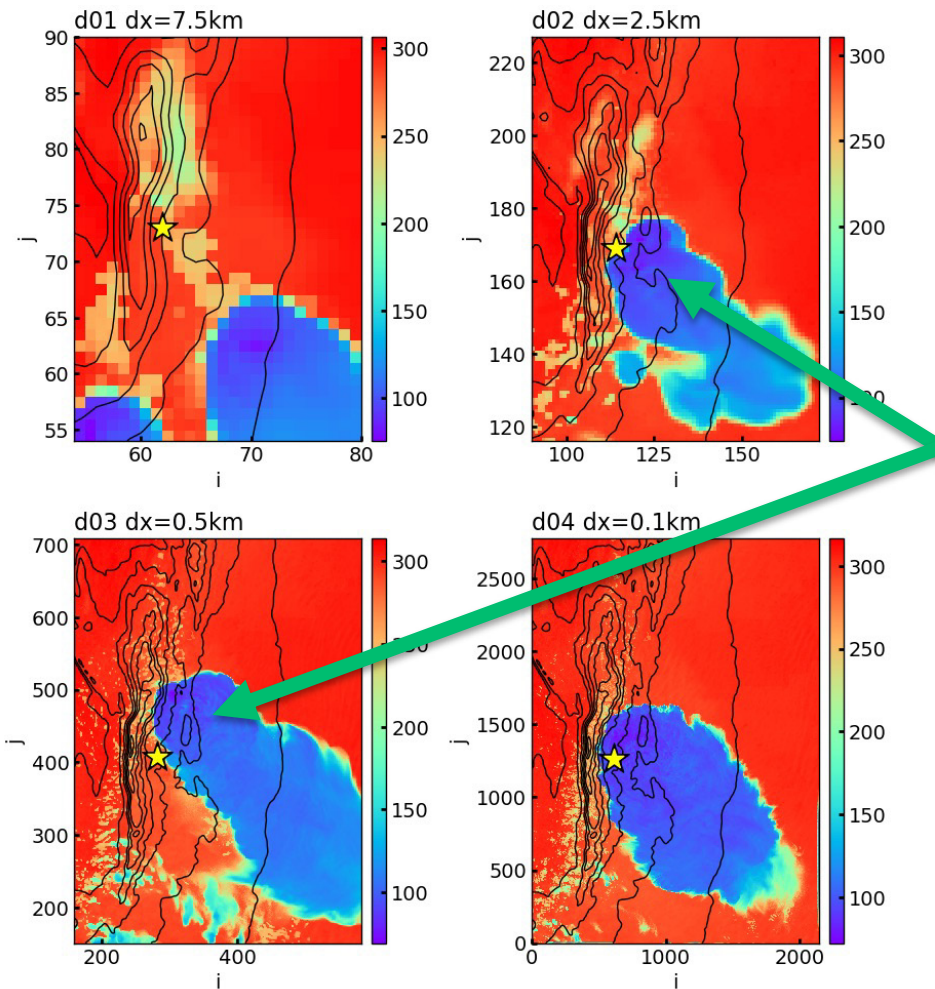


Contours = Terrain height, 300 m interval

# Mesoscale vs. large-eddy simulations

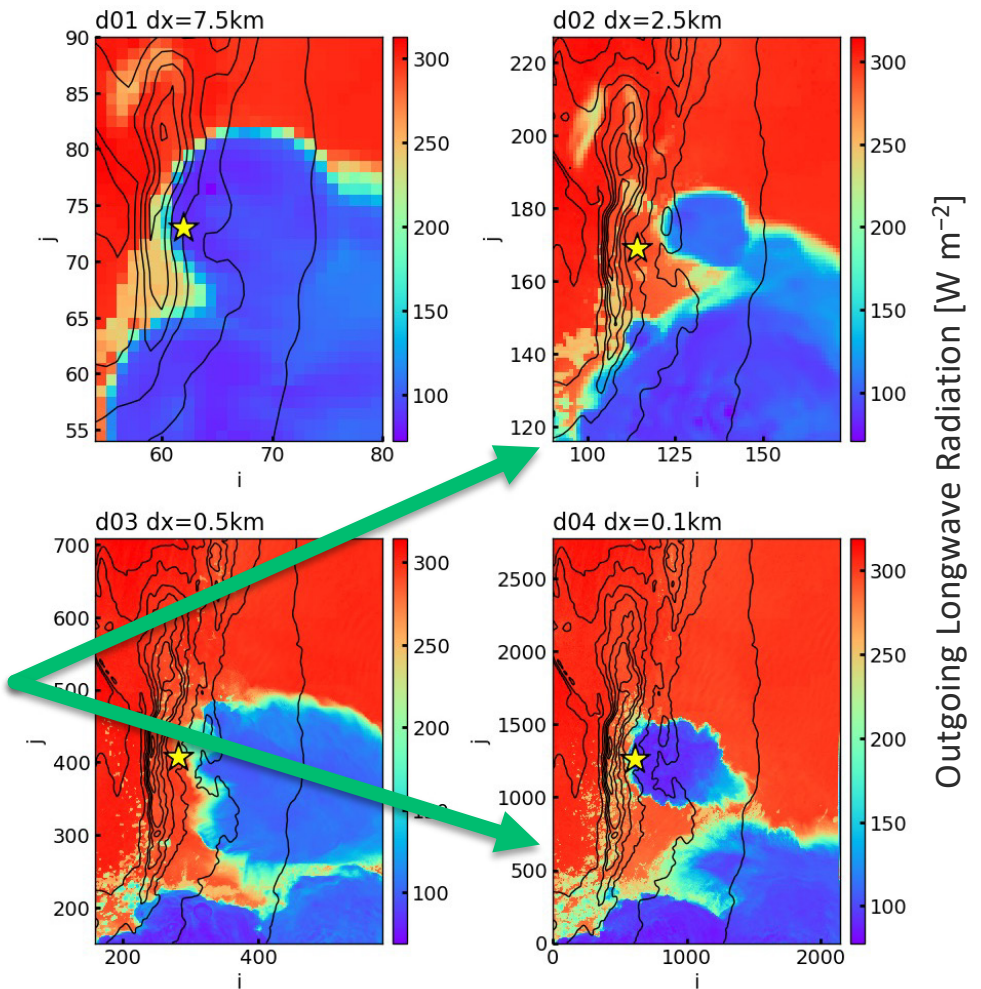
Finding that mesoscale simulations are only semi-predictive of cloud development within LES

WRF's OLR, 25-Jan-2019 20 UTC  
Forcing = GEFS Member #1



- ▶ Substantial variability between ensemble members with mesoscale grid spacings (d01 & d02) necessitates careful choice of boundary conditions
- ▶ Location of convective development shifts along ridge between grid spacings
- ▶ Size of cloud system varies between grid spacings

WRF's OLR, 25-Jan-2019 20 UTC  
Forcing = GEFS Member #2



Contours = Terrain height, 300 m interval

# Current status of LES runs

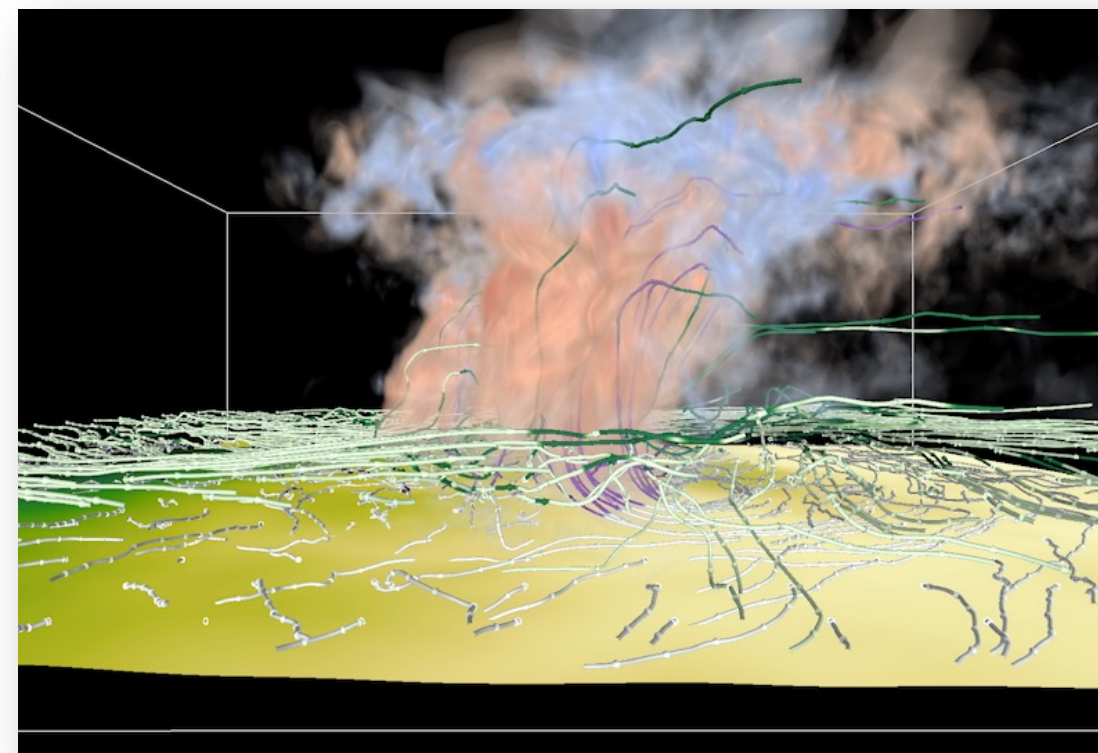
- ▶ Using 25-Jan-2019 for initial tests
  - Have run 3 GEFS ensemble members to examine predictability between scales
  - In process of starting a second date
- ▶ Worked through various technical difficulties
  - Broke the netCDF file conventions with our large domains – need to switch to CDF5 from the CDF2 format available in default WRF
  - Increased terrain dataset resolution and balanced with smoothing to get stable runs
- ▶ Still have some details and issues to work through
  - In process of using WRF-Hydro to generate improved soil initial conditions
  - Having issues with high cell count of ERA5 inputs on large domain—anybody else seen “ptop” error messages and knows how to get around them?
- ▶ Awaiting new nodes for Cumulus cluster, which will enable multiple, simultaneous LES runs



# What outputs should be provided?

- ▶ Beyond typical WRF output, what variables do you want to see from the LES?
  - Basic microphysical process rates
  - Variables necessary for running CR-SIM
  - Converted WRF nuances, e.g., destaggered winds, P+PB
  
- ▶ How frequently should output be provided for each scale?
  - $\Delta x = 7.5$  km and 2.5 km domains  $\rightarrow$  15 min.
  - $\Delta x = 500$  m  $\rightarrow$  15 min.
  - $\Delta x = 100$  m  $\rightarrow$  5 or 15 min. for full run  
1 min. for several hours around initiation  
10 sec. for short period (how long?)

## WRF, $\Delta x = 100$ m Vertical Velocity of Cloud Core Region and Streamlines, 25-Jan-2021 20 UTC



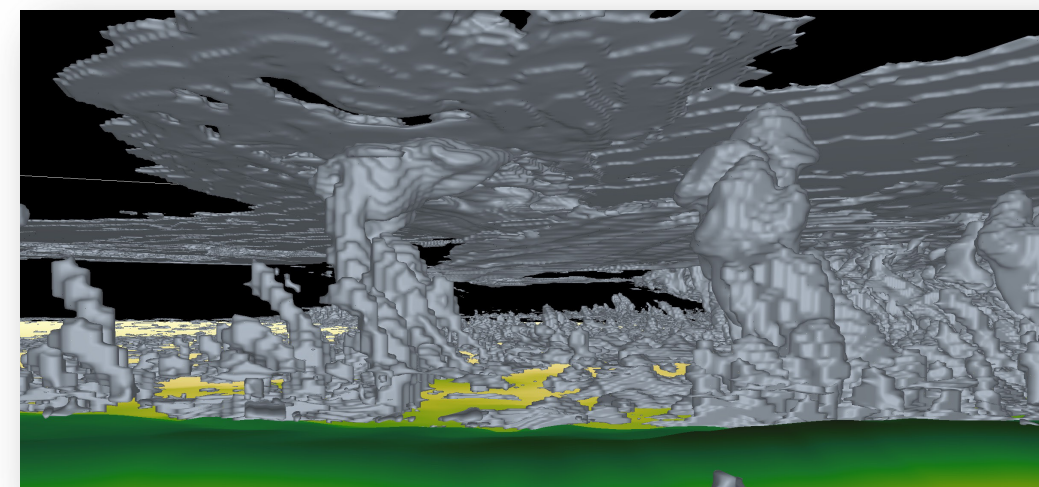
Shading: Red=W Up; Blue=W Down

Streamlines: Seeds at 2 km AMSL (white-to-purple) and  
5 km AMSL (light to dark green)

# Join us for a LASSO-CACTI session this summer!

- ▶ Join us for an online session to discuss finalizing LASSO-CACTI details
  - Which variables to output and their frequency
  - Case date selection
  - Options for working with the large dataset
  - Discuss your usage desires
- ▶ Date and time to be determined; will likely happen this summer
- ▶ We will advertise via the LASSO email list and the ARM newsletter
  - [Sign up link](#) for the LASSO email list

WRF Cloud Fraction  
25-Jan-2019 20 UTC,  $\Delta x=500$  m



Viewed from west of AMF Site



# Join the community! New online forum for LASSO

- ▶ Check out the new online forum for LASSO: <https://discourse.adc.arm.gov/>
- ▶ Use it for user support, discussing scenario development, and related topics around LASSO and ARM
- ▶ Aiming for it to become an online resource for LASSO information and support
- ▶ Other ARM topics besides LASSO are also possible—ask us if you would like a category added, e.g., for a field campaign or value-added product

The screenshot shows the ARM Forum website at discourse.adc.arm.gov. The page features a dark blue header with the ARM logo, navigation links for 'arm.gov', 'Sign Up', and 'Log In', and a search icon. Below the header is a welcome message: 'Welcome to the ARM Forum!' with a 'Close' button and a tagline: 'The world's premier ground-based observations facility advancing atmospheric and climate research'. The main content area displays a list of forum topics organized by category. The categories shown are 'Getting Started', 'LASSO', 'Uncategorized', and 'Site Feedback'. Each category lists the number of topics and the latest topic with its title, author, and date.

Category	Topics	Latest
<b>Getting Started</b> New to the ARM Forum? Learn more here about the Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) Facility, browse FAQs, learn where to go to get more information, and review rules that will help make the forum a helpful resource.	3	Welcome to the ARM Forum! 1 Mar 30
<b>LASSO</b> This category is devoted to the Large-Eddy Simulation (LES) ARM Symbiotic Simulation and Observation (LASSO) activity. LASSO enhances ARM observations by using LES modeling to provide context and a self-consistent representation of the atmosphere surrounding a particular ARM site. ■ General LASSO Discussion ■ LASSO Shallow-Cumulus Scenario ■ LASSO-CACTI Scenario	2	LASSO-COGS data now available 0 12d ■ LASSO Shallow-Cumulus Scenario Getting help about ARM 0 14d ■ Getting Started Forum Guidelines and Etiquette 1 20d ■ Getting Started Register for the LASSO Tutorial on 20-May-2021 0 25d ■ General LASSO Discussion
<b>Uncategorized</b> Topics that don't need a category, or don't fit into any other existing category.	1	ARM Commenting Guidelines 1 26d ■ Getting Started
<b>Site Feedback</b> ARM welcomes feedback on this forum and how we can	0	More