Andy retired to new pastures

LASSO Modeling for ENA and Other Enticing Tidbits

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LASSO Poster: Gustafson et al., Session 3, Tuesday 4:15 p.m., Board #22
LASSO Breakout: Session 4, Wednesday 2:00 p.m., Regency Rm.

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LASSO's high-resolution modeling library

- The **Large-Eddy Simulation (LES) ARM Symbiotic Simulation and Observation (LASSO)** activity supplements ARM observations with a library of high-resolution model simulations and forcing data

- LES modeling helps bridge the scale gap between ARM observations and coarse atmospheric models

- LASSO provides "scenarios" organized around selected locations and science drivers

Continental shallow convection for Southern Great Plains (SGP) observatory

Orographic deep convection for CACTI campaign

Marine clouds for Eastern North Atlantic (ENA) observatory

https://www.arm.gov/capabilities/modeling/lasso

LASSO adapts the modeling approach to each scenario's objectives

SGP Shallow Convection

- **Science drivers:** processes associated with surface-flux-driven continental shallow convection
- **Modeling approach**
  - Periodic domain boundaries, 25 km wide
  - Column-based forcing from (re)analyses
  - Surface fluxes from observations
- 95 case dates

CACTI Deep Convection

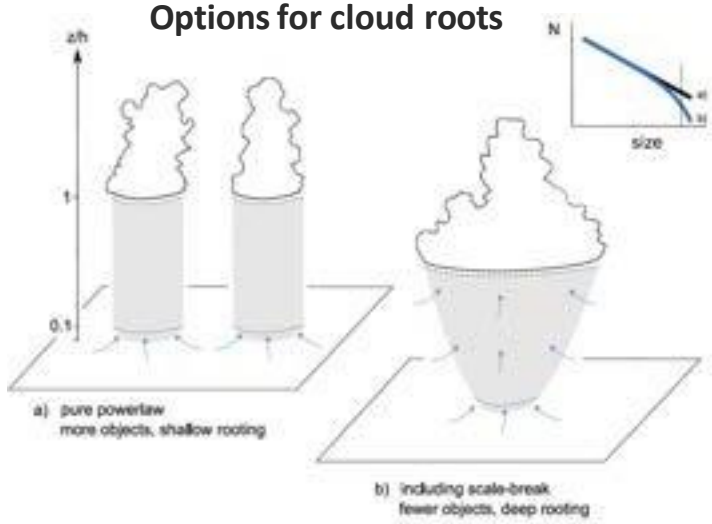
- **Science drivers:** convective initiation and growth of large, orographic deep convection
- **Modeling approach**
  - Nested domains, inner domain ~250 km wide
  - Space-time dependent boundary conditions
  - Online land/surface model
- 9 full-resolution case dates, supplemented with 21 days at km-scale

How have users applied LASSO?

Some examples…

- Developing a theory and parameterization for subgrid cloud organization via clustering of thermals, Neggers & Griewank (2022)

Options for cloud roots

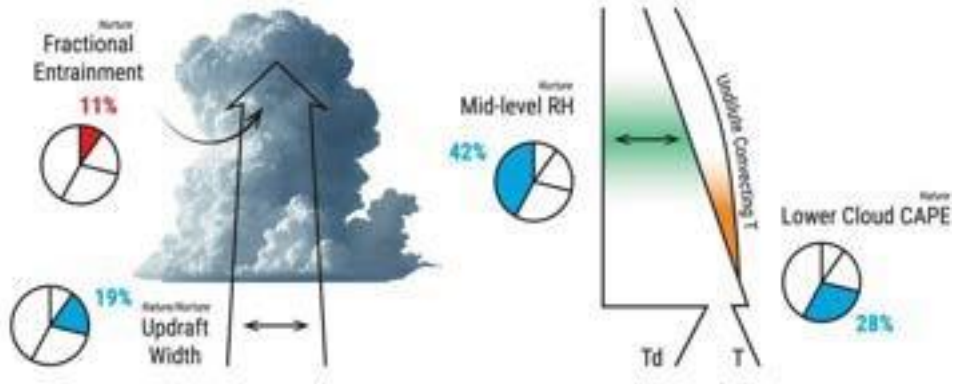


- Analysis of cloud parcels to quantify entrainment and factors leading to convective initiation, Jo et al. (JAS, in review)

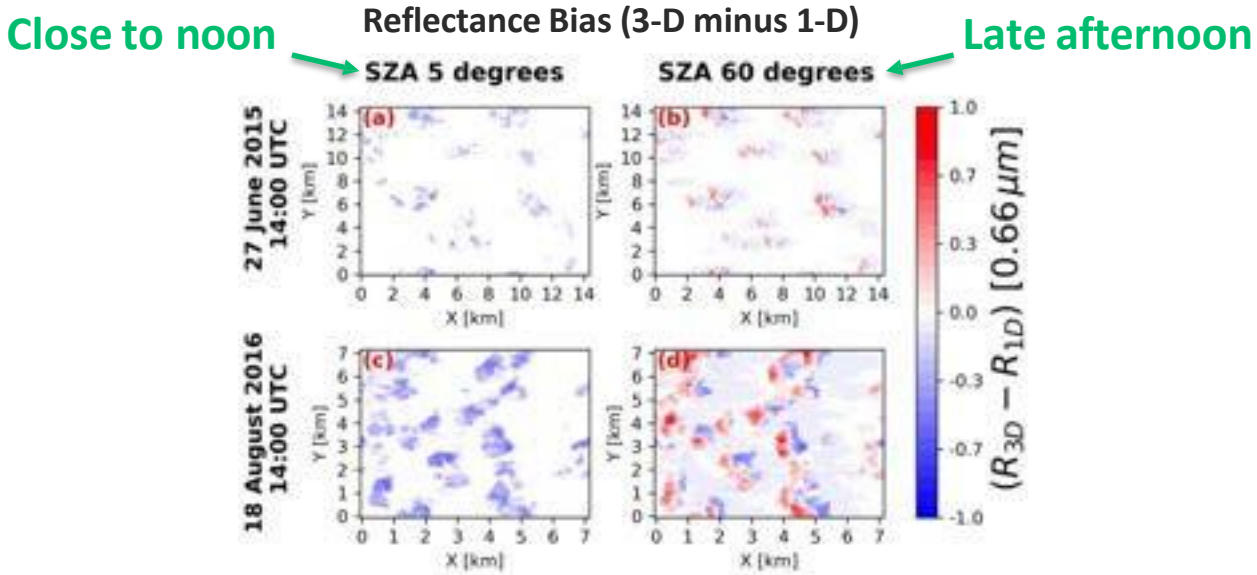
Related posters:

- Enoch Jo et al., Session 2 #59
- Zhe Feng et al., Session 2, #75
- Jim Marquis et al., Session 3 #46

Relative importance to convective initiation



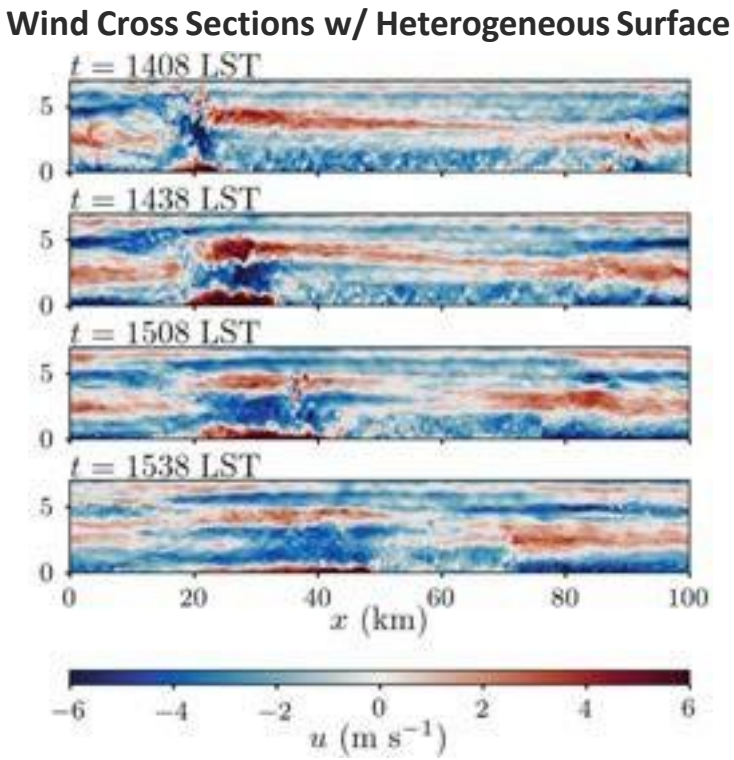
- Accuracy of calculating rCRE using 3-D vs. 1-D calculations, Ademakinwa et al. (2024)

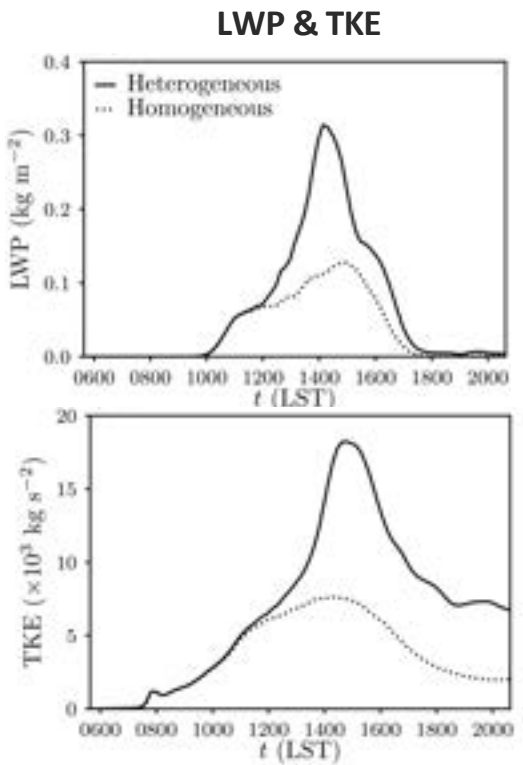


- Impact of surface heterogeneity on secondary circulations, surface fluxes, & clouds, Simon et al. (2021 & 2024)

Related poster:

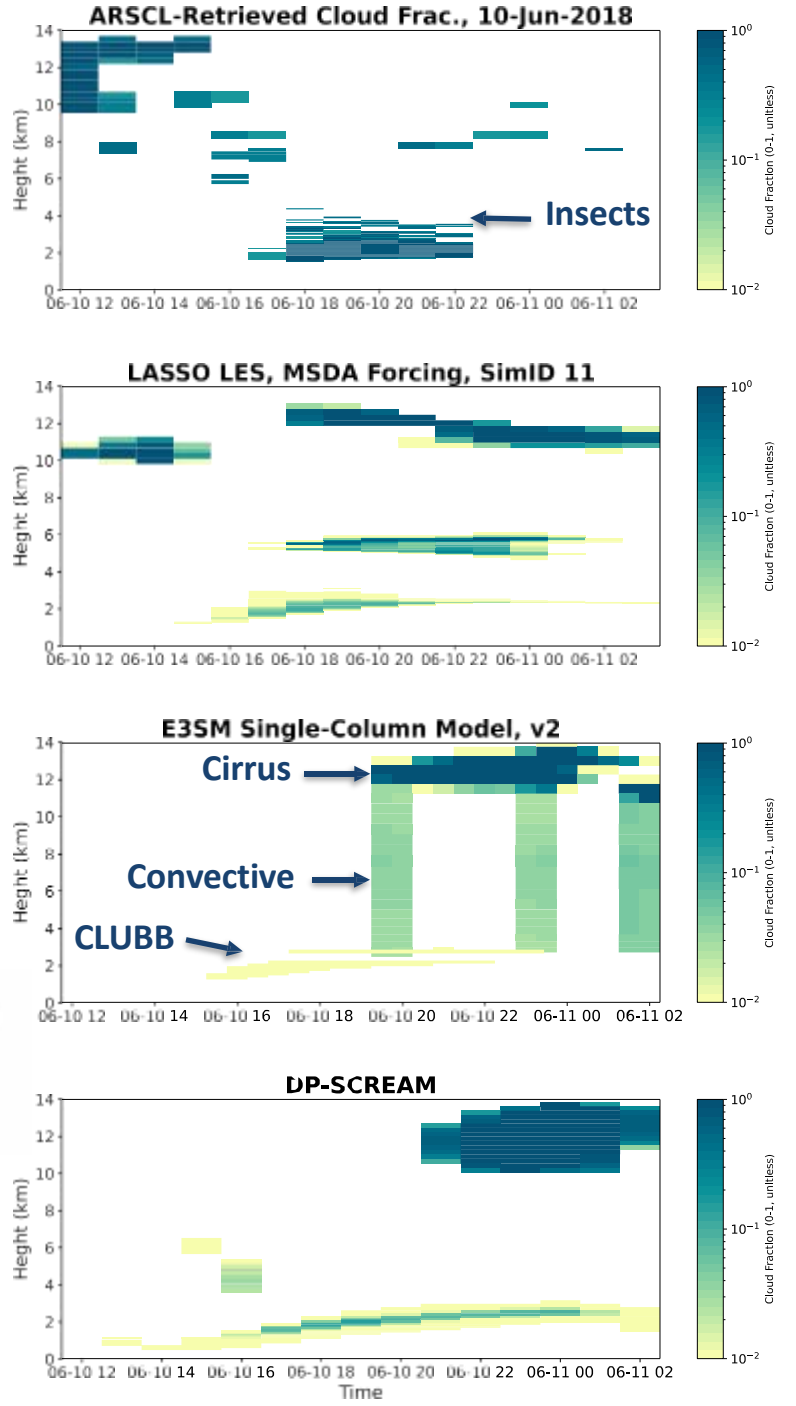
- Nathaniel Chaney et al., Session 1 #64





Linking LASSO to the large-scale modeling community

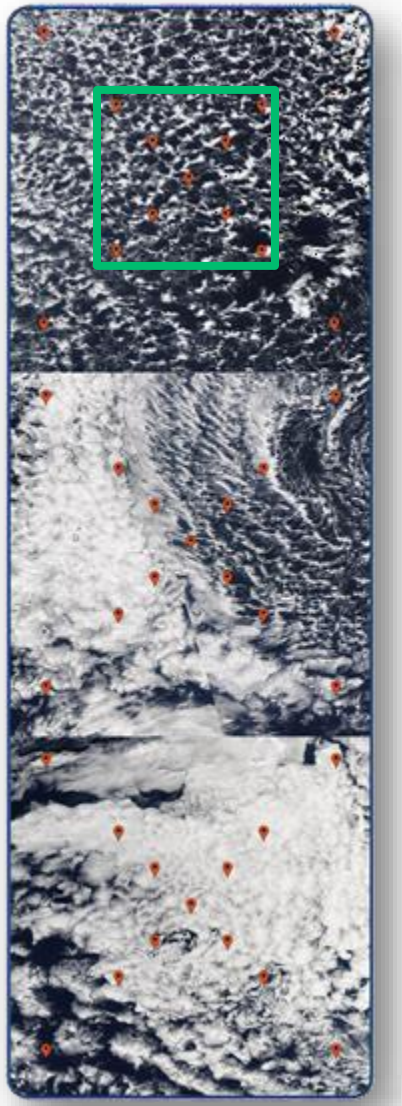
- LASSO forcings can drive other LES and single-column models (SCM)
  - SCMs and periodic LES ingest forcings similarly
  - Permits fair comparisons between LASSO simulations and other models
  - Can use LASSO ensembles to pre-select input data for other modeling studies
- E3SM SCM, SCREAM, and NOAA/NCAR's Global Modeling Testbed (GMTB) include the ability to ingest LASSO-ShCu input data



Cloud fraction at SGP from ARSCL retrieval, LASSO LES (Δx=100 m), E3SM SCM, and DP-SCREAM (Δx=3.25 km)

E3SM simulations courtesy of Cheng Tao, Yunyan Zhang, and Peter Bogenschutz (LLNL)

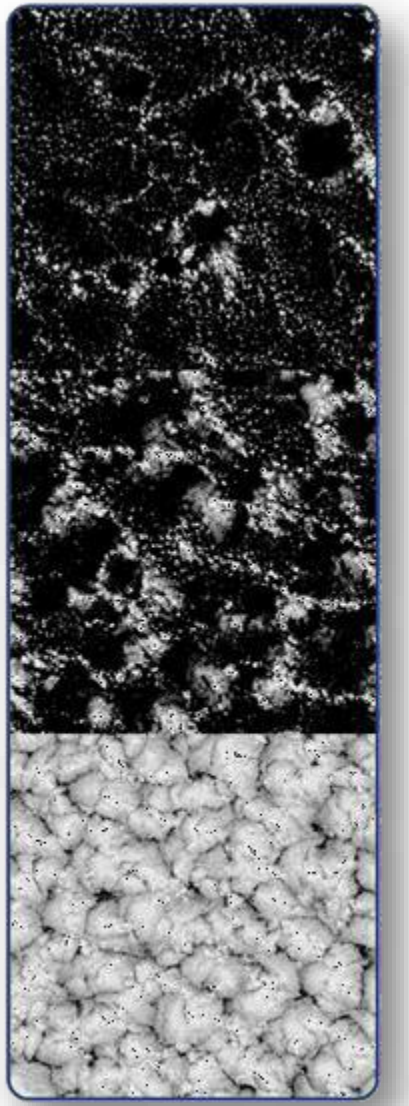
LASSO-ENA marine scenario in development



- Currently running simulations for the new ENA scenario focused on marine clouds in the vicinity of Graciosa Island
- Balancing two primary science drivers:
  - Mesoscale organization
  - Precipitation physics

MODIS observed clouds for example cloud regimes. Centered on ENA.

Simulated cloud regimes using SAM model and 250-km-wide periodic domain.

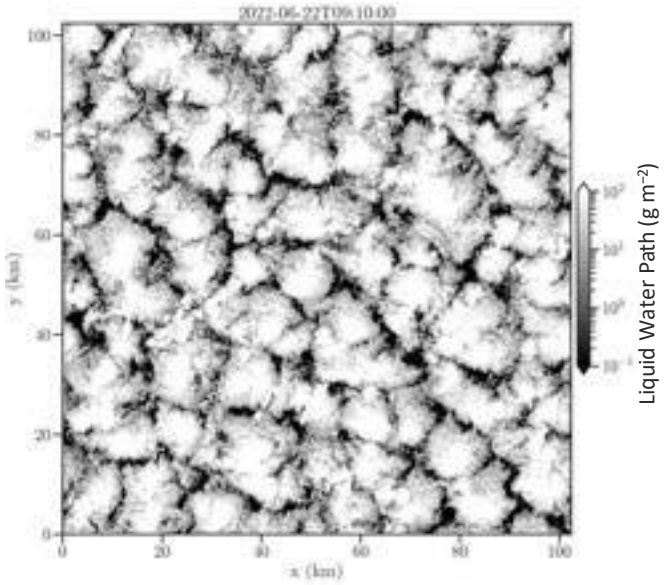


https://www.arm.gov/capabilities/modeling/lasso

ENA modeling approach

- Using two modeling methodologies…
- Periodic domains with SAM
  - Forced with profiles from ERA5, MERRA-2, and possibly others
  - Cheap domain for ensemble testing: 25-km wide and Δx=100 m
  - Large-domain for better organization: ~100-km domain and Δx=100 m
  - Microphysics
    - Initial runs with bulk-Morrison and specified cloud-droplet concentrations
    - Finding better behavior with spectral-bin microphysics
- Nested domains with WRF
  - 3 nests with Δx=2500, 500, & 100 m
  - Outermost domain 1125 km wide; innermost domain 175 km wide

SAM, 22-Jun-2022
100-km Domain, Δx=100 m

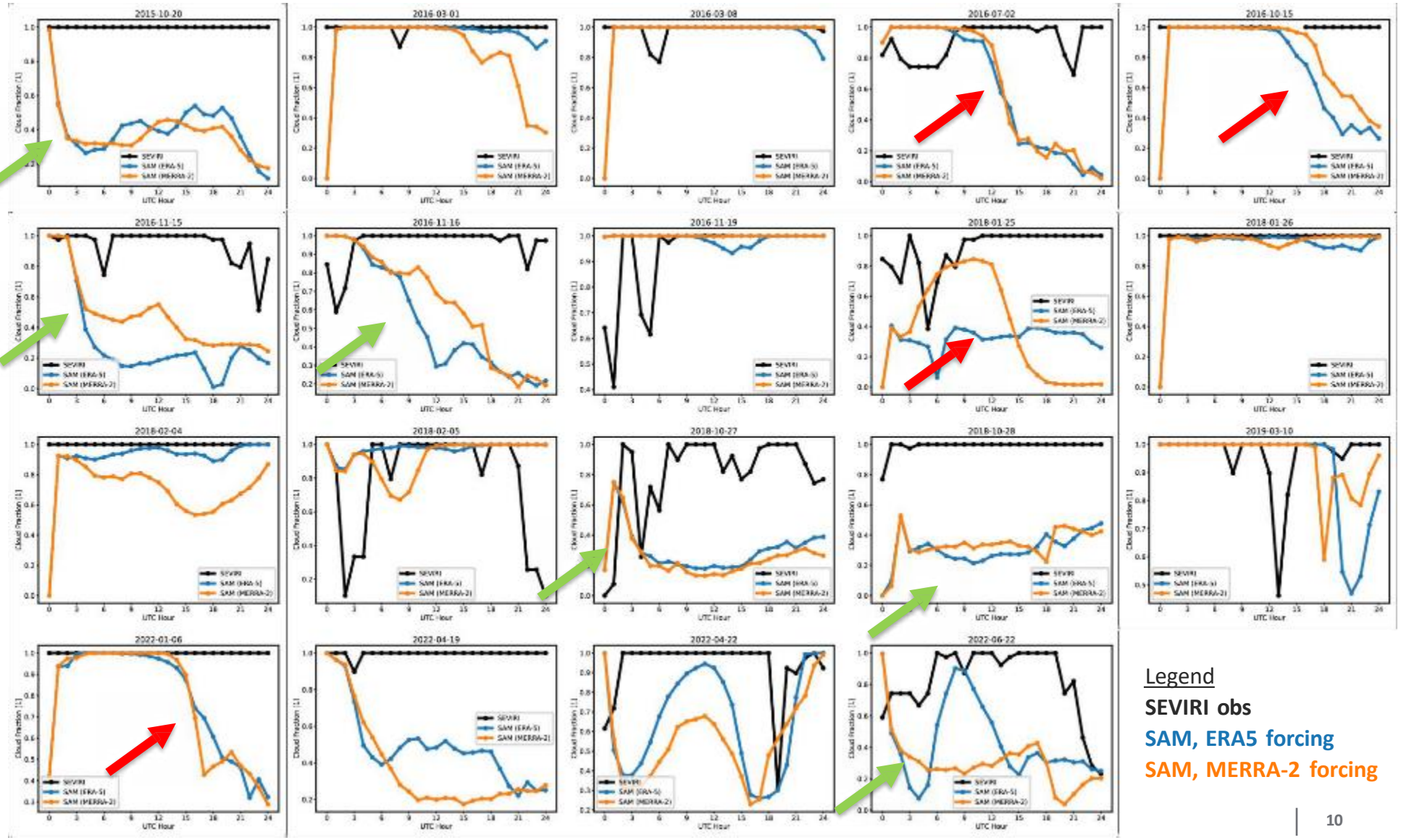


Small-domain prototyping with SAM:

Closed-cell cases

- Testing 63 cases with ERA5 and MERRA-2 forcing
- **ERA5** and **MERRA-2** forcing behave similarly
- Overcast cases do not maintain cloud deck with bulk Morrison microphysics

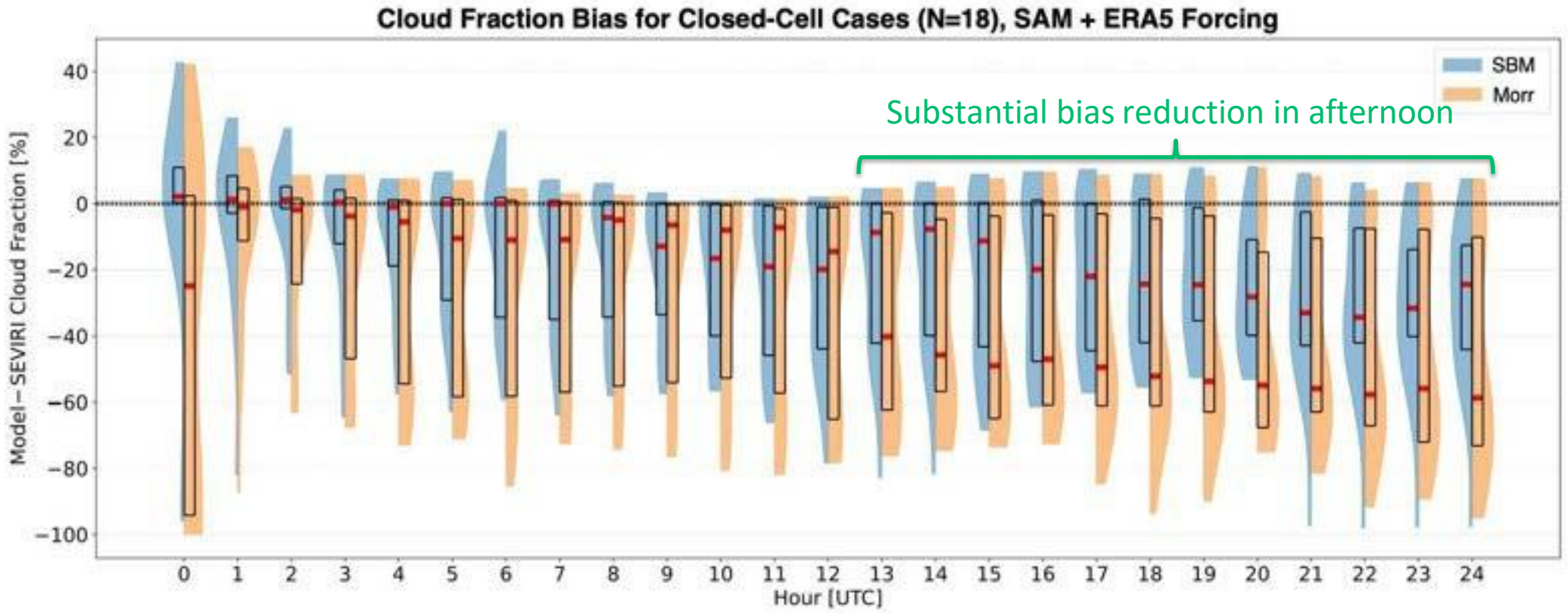
Cloud Fraction Time Series at ENA: Sims vs. SEVIRI



Legend
SEVIRI obs
SAM, ERA5 forcing
SAM, MERRA-2 forcing

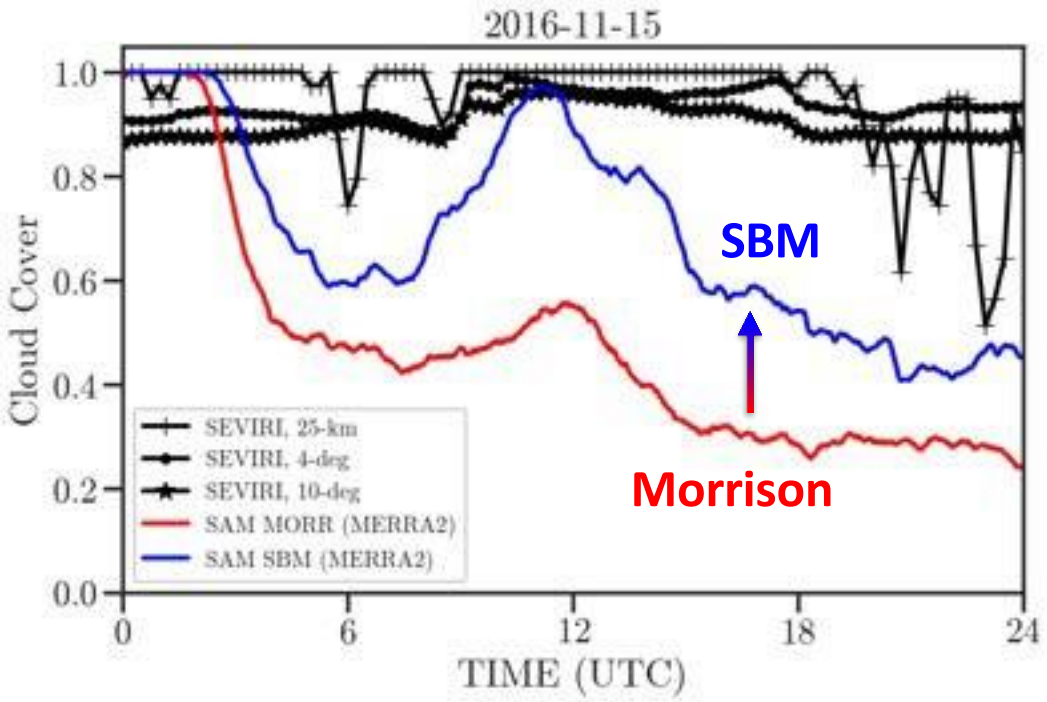
The one sensitivity test showing promise for overcast conditions…

- Spectral-bin microphysics reduces the cloud fraction bias
  - Originally used Morrison with fixed droplet number of 50 per cc
  - Default spectral-bin still rained out and did not maintain afternoon clouds—aerosols were depleted
  - **Spectral-bin with fixed total particle number is "the winner" right now**

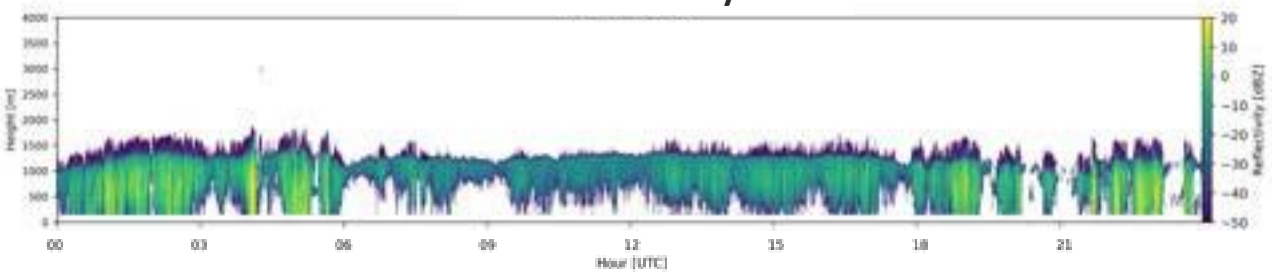


Impact of Spectral-Bin MP instead of Morrison

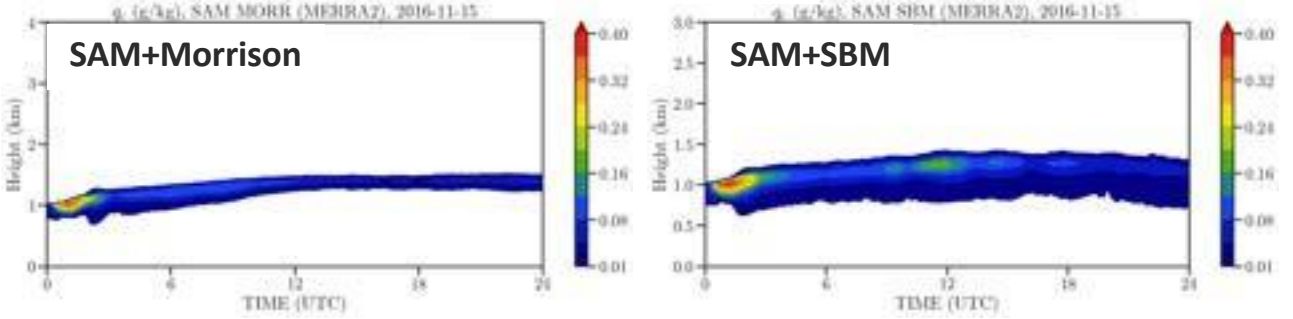
- Cloud fraction increases when using spectral-bin MP



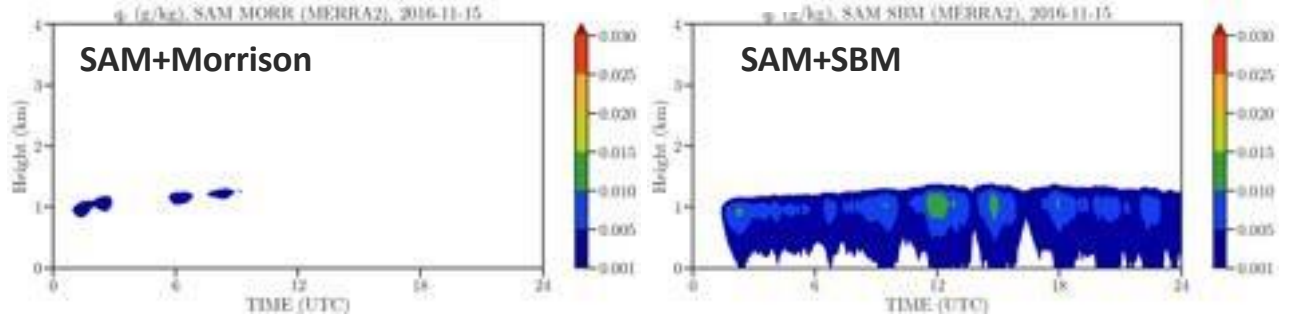
ARSCL Reflectivity at ENA



Cloud Water, Qc



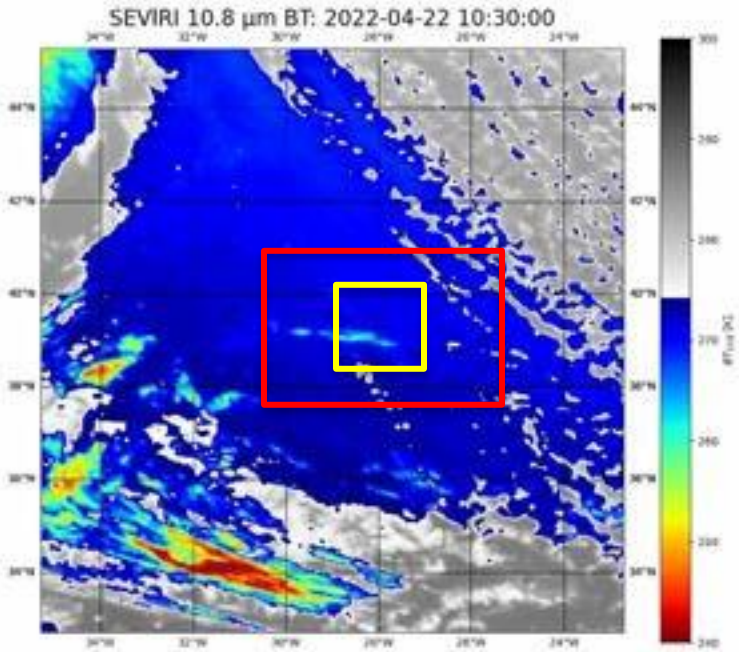
Rainwater, Qr



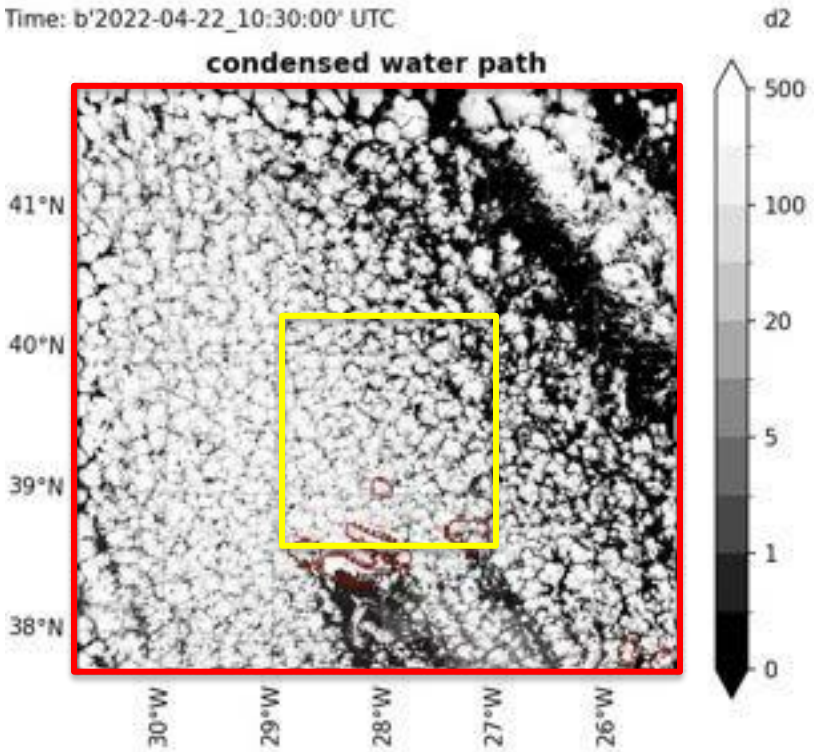
U.S. DEPARTMENT OF ENERGY

Nested WRF simulations capture aspects of synoptic patterns and islands

SEVIRI Satellite

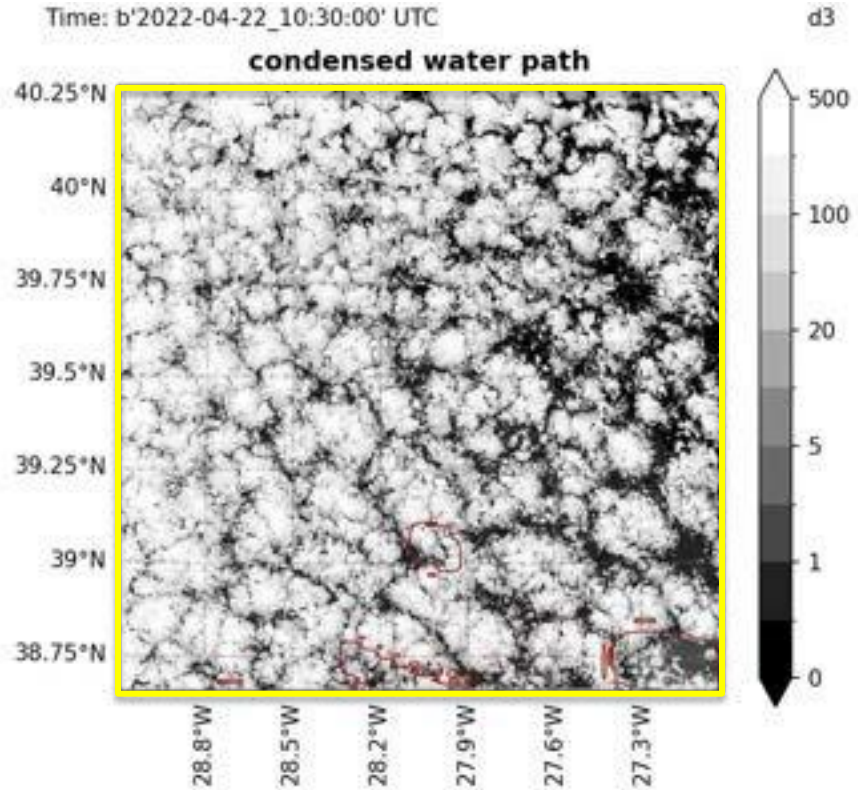


WRF – Domain 2



475 km, Δx=500 m

WRF – Domain 3



175 km, Δx=100 m

LASSO-ENA plans…

- Generating simulations in 2025
- Periodic domains for 20–40 cases with SAM
  - Spread across cloud regimes (open, closed, transitional)
  - Basic aerosol sensitivity tests
  - Likely with spectral-bin microphysics if results hold across cases
- Nested domains for a handful of cases with WRF
  - Larger domains will restrict number of cases we can save

- We want to know what will be used… where do you see value?
  - Come to the LASSO breakout, Wed. 2–4 p.m., and/or send your thoughts to lasso@arm.gov
  - Contact me if you would like access to the simulations before the formal release

Bankhead National Forest (BNF) scenario will be next!

- Seeking concept ideas that build on BNF science foci and would draw a swath of LASSO users
  - What aspects of ARM modeling support would you find most useful to empower your research?
  - How many cases would you need? How would you pick them?
- LASSO could focus on deep convection, canopy and PBL turbulence, SOA formation, …
- Come to the LASSO breakout session, Wed. 2–4 p.m. and/or send your thoughts to lasso@arm.gov

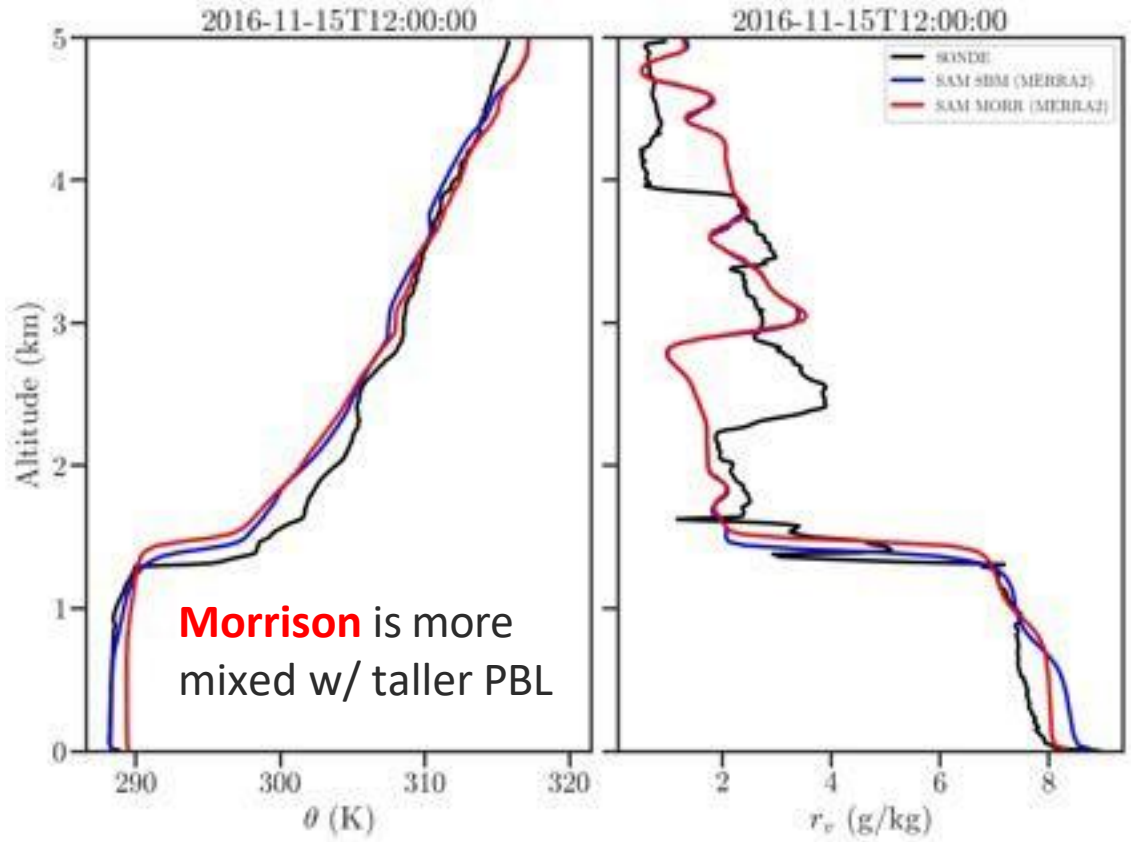
Getting more information for LASSO

- Website: https://www.arm.gov/capabilities/modeling/lasso
- Technical documents
  - LASSO-ShCu: https://www.arm.gov/publications/tech_reports/doe-sc-arm-tr-216.pdf
  - LASSO-CACTI: https://lasso-cacti-doc.arm.gov/latest/index.html
- Bundle browsers for data downloading
  - LASSO-ShCu: https://adc.arm.gov/lassobrowser
  - LASSO-CACTI: https://adc.arm.gov/lasso/#/cacti
- Questions and help
  - Discourse forum: https://discourse.arm.gov/c/lasso/
  - Support email: lasso@arm.gov

Spectral-Bin MP impact on thermodynamic profile

- Increased clouds due to SBM alter coupling to surface and often improve the profiles

15-Nov-2016 12 UTC (12 h into run)



16-Nov-2016 0 UTC (24 h into run)