LASSO Update and Visioning: CACTI Release, Starting ENA, and Beyond

William I. Gustafson Jr.[1] and Andrew M. Vogelmann[2]

[1] **Pacific Northwest National Laboratory; [2]Brookhaven National Laboratory**

Joint ARM-ASR Principal Investigator Meeting, 7-Aug-2023

Contact info: Bill and Andy at lasso@arm.gov
Community discussion at https://discourse.arm.gov/c/lasso

LASSO overview

- **Intent of LASSO:** Leverage high-resolution modeling to enhance the value of ARM's suite of observations for researchers
- Motivated by goal of bridging the gap between observations and scales used in forecast and climate models
  - Advancement of cloud and boundary layer theories and parameterizations
  - Enable model development and better link observations and models
- A library of observationally vetted large-eddy simulation (LES) provide plausible proxies for unobservable details
  - Increase understanding of relationships between different variables and process rates
  - Provide simulated environments to use for retrieval development
  - The vetted forcings can be used as a starting point for detailed modeling studies

Current LASSO scenarios

1. **Shallow-convection:** Generated 5 years of cases, available in ARM archive
   - Focus on daytime, continental, shallow convection
   - Southern Great Plains, Oklahoma

2. **LASSO-CACTI:** Beta release available now, full release imminent
   - Focus on convective initiation and upscale growth for deep convection
   - Córdoba, Argentina

3. **LASSO-ENA:** In development, simulations to be run in 2023 & 2024
   - Focus on maritime boundary layer clouds and related precipitation processes
   - Graciosa Island, Azores

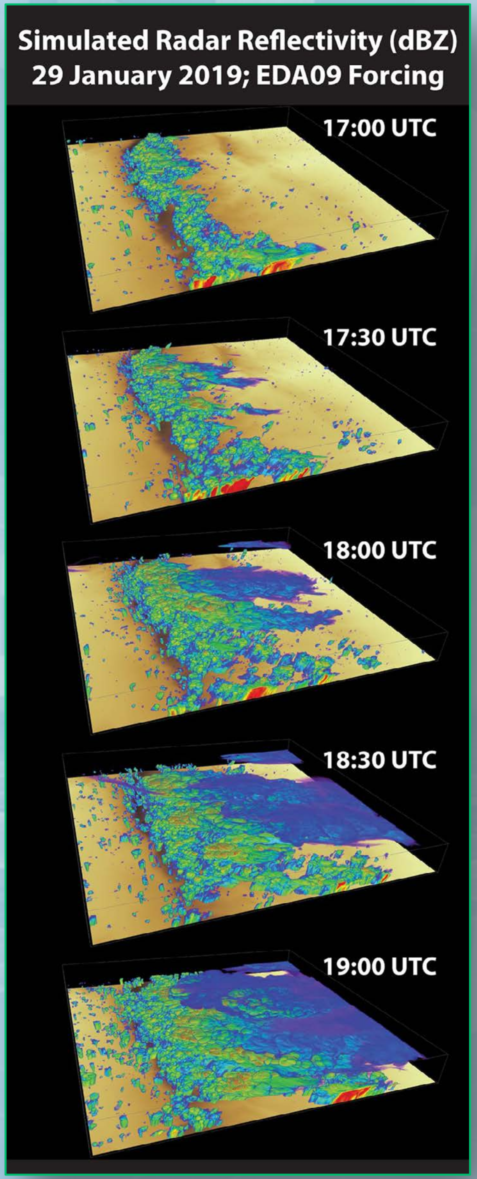
LASSO Tutorial, May 2023: https://www.arm.gov/news/blog/post/88870

Agenda

1. **LASSO-CACTI Release**
   - LASSO-CACTI description
   - User highlight by Zhe Feng, Enoch Jo, and Jim Marquis
   - Availability and working with LASSO-CACTI
   - Q&A and discussion

2. **LASSO-ENA Development**
   - The LASSO-ENA scenario
   - User highlights facilitated by Virendra Ghate
   - LASSO-ENA Scenario impressions
   - Input to guide LASSO-ENA development

3. **Future of LASSO Workshop this November**
   - Plans and forthcoming white paper solicitation
   - Q&A and discussion



LASSO-CACTI* Description

LASSO-CACTI Team
Bill Gustafson, Andy Vogelmann
Satoshi Endo, Mark Delgado, Eddie Schuman, and Heng Xiao

Consultant: Adam Varble, CACTI PI

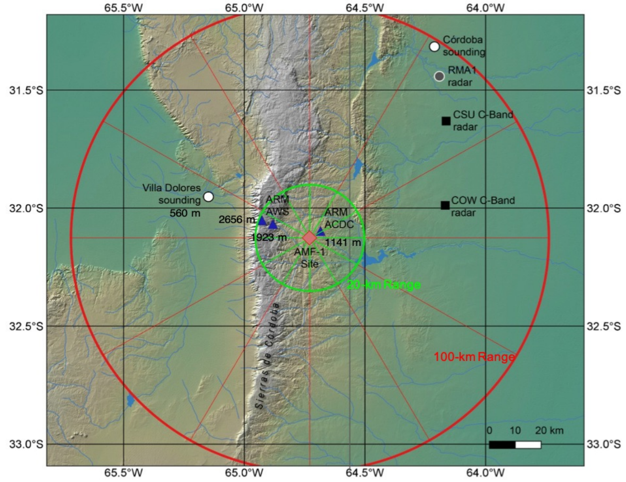
*Cloud, Aerosol, and Complex Terrain Interactions (CACTI)
Varble et al. (*BAMS*, 2021)

Overview of CACTI

- The DOE ARM CACTI field campaign
  - Focus on large-scale convection and its upscale growth
  - Conducted in the Sierras de Córdoba mountain range of north-central Argentina
  - Frequent terrain-induced convective initiation of mesoscale convective systems

- Assets
  - ARM Mobile Facility: 15 October 2018 to 30 April 2019
  - Intensive Operational Period: 30 October to 13 December 2018
    - ARM Aerial Facility G-1 flights
    - Multi-agency, NSF-led, RELAMPAGO* field campaign

CACTI AMF Deployment



*Remote sensing of Electrification, Lightning, And Mesoscale/microscale Processes with Adaptive Ground Observations (RELAMPAGO)
Nesbitt et al. (*BAMS*, 2021)

Science drivers guiding the LASSO-CACTI scenario design

- Convective cloud dynamics
  - Thermal-like structures, updraft strength, and entrainment and their relationship to critical features such as up- and downdraft mass fluxes, vertical transport, and shallow-to-deep transition
  - Convection-environment interactions, e.g., cold pools
  - Convective drafts in turbulent flow
- Microphysics-dynamics interactions
  - Especially in the context of cloud-scale eddies and smaller-scale turbulence
- Science drivers chosen to balance relevant science with computational capacity
  - LES resolution governed by cloud core requirements
  - Domain size determines portion of lifespan simulated
  - → Ensembles of mesoscale simulations with a small number of LES ensemble members per case

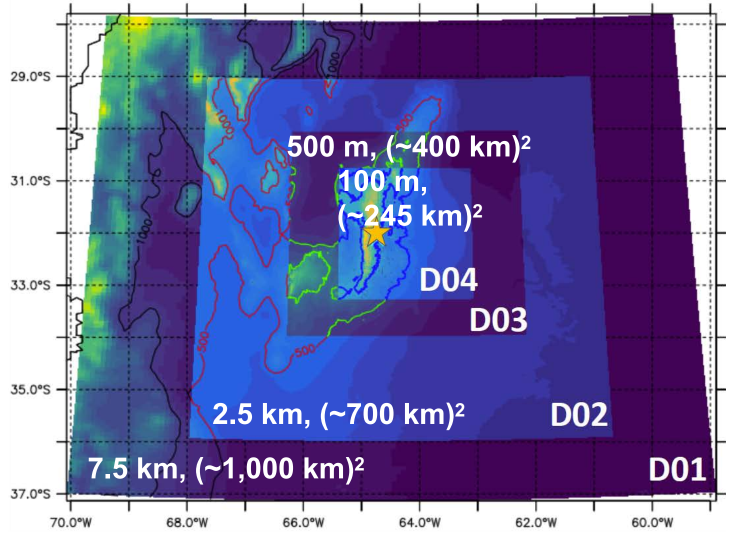
Simulation approach:
Focus on upscale growth of large-scale convection

- A 33-member mesoscale ensemble run for 20 candidate case days
  - Nested simulations (D01-D02) using 7.5 and 2.5 km grid spacing
  - Background fields from FNL, GEFS (21), ERA5, and ECMWF EDA (10)
  - Physics setup is a derivative of WRF's CONUS physics configuration
    - Aerosol-aware Thompson microphysics (GEOS-5 aerosol input), some also run w/ Morrison
  - Simulation quality initially assessed using GOES-16 IR data

- Down selection for LES simulations
  - Upscale growth initiated within the domain of the CSAPR2
  - Good performing mesoscale ensemble member(s)
  - Obtain a range of convective behavior and intensity (CAPEs)

- LES simulations run for 9 'primary' days
  - Nested (D03-D04) using 500 and 100 m grid spacing
  - Up to 4 LES per day

WRF Nested Domains



20 Case Dates: 9 Primary and 11 Secondary

Nine Primary Days (Mesoscale ensemble and select LES runs)		
Case	**Date**	**Description**
A	2018-11-29, R	Convective initiation with halted upscale growth
B	2018-12-04, R	Moderately sized system develops north of the AMF
C	2018-12-05, R	Three cells initiate and grow near the AMF into small sizes
D	2018-12-19	Convective initiation and growth over site within a complicated background field
E	2019-01-22	Two intense systems develop next to each other
F	2019-01-23	An intense, organized system is formed from multi-cell interactions
G	2019-01-25	Monster mesoscale convective system
H	2019-01-29	An intense case with CAPE similar to January 22nd but with less shear
I	2019-02-08	Many convective initiations over the site

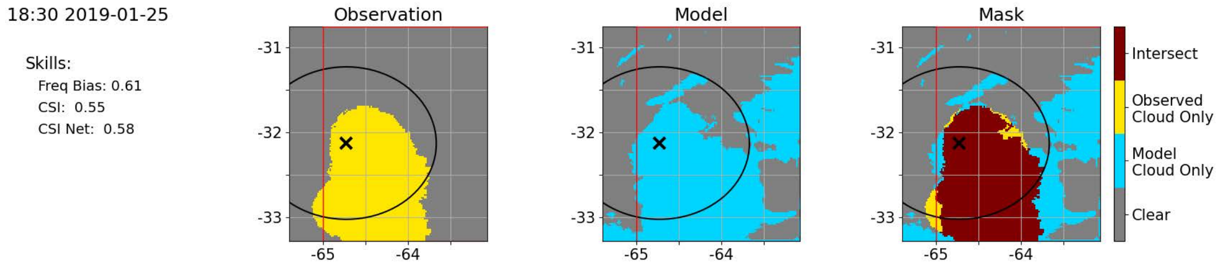
‘R’ indicates a RELAMPAGO IOP day

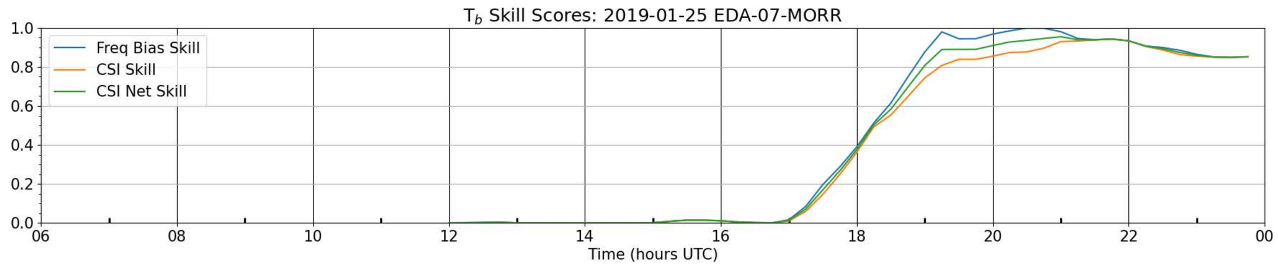
Eleven Secondary Days (Mesoscale ensemble, only)		
Case	**Date**	**Description**
J	2018-10-26	Propagating, isolated system
K	2018-11-04	Single, fleeting system
L	2018-11-05, R	Two systems influenced by merging from behind the ridgeline
M	2018-11-06, R	Convection originates from behind the ridgeline
N	2018-11-10, R	Single, deepening system that quickly exits the domain
O	2018-11-21, R	Deep congestus but does not initiate into anything intense.
P	2018-11-30, R	Multiple, small initiations influence by convection behind the ridgeline
Q	2019-01-31	Convective streak influence by convection behind the ridgeline
R	2019-02-23	A few pop-up cells occur in the target domain
S	2019-03-14	Small, isolated system
T	2019-03-15	Large convective system advects over site but the initiation was not observed

Skill Score Overview (1)

- Skill scores used to quantify level of agreement with observations
  - Values range from 0 to 1, where 1 is perfect agreement
  - Plots and CSV files available of the values
- Satellite Brightness Temperatures for Convective Area Development
  - GOES-16 (11.2 μm) brightness temperatures
  - Convective areas in the obs and sims are masked using an “anvil” threshold of 240 K
  - Skill score: Critical success index (CSI), frequency bias, and their combination in a Net CSI skill

Satellite Brightness Temperature Example: 25 Jan 2019 LES for EDA07 Morrison run

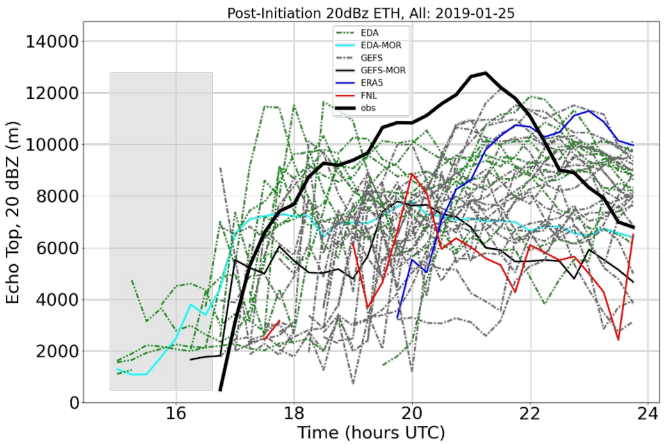




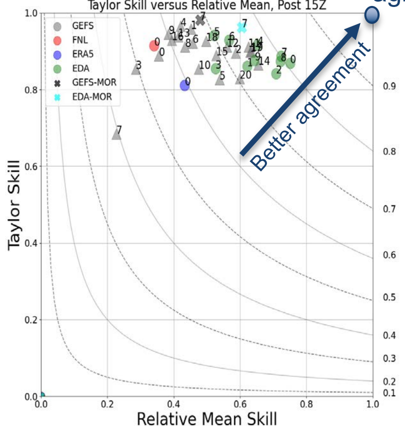
Skill Score Overview (2)

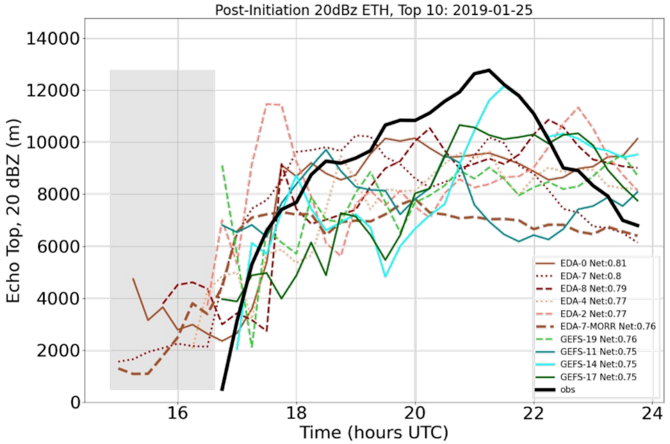
- Radar Echo-Top Heights (ETH) for Local Convective Intensity
  - Use the CSAPR2 echo-top height at 20 dBz (Taranis dataset)
    - The metric is only applied to the CSAPR2 scan region east of the ridgeline, approx. −65°W longitude.
  - Skill score: Taylor skill score, its relative mean skill, and their combination in a Net Taylor skill.
- Surface rainfall
  - Taranis/CSAPR2 data; Uses same skill score method as ETH

ETH Example: 25 Jan 2019 Mesoscale Ensemble

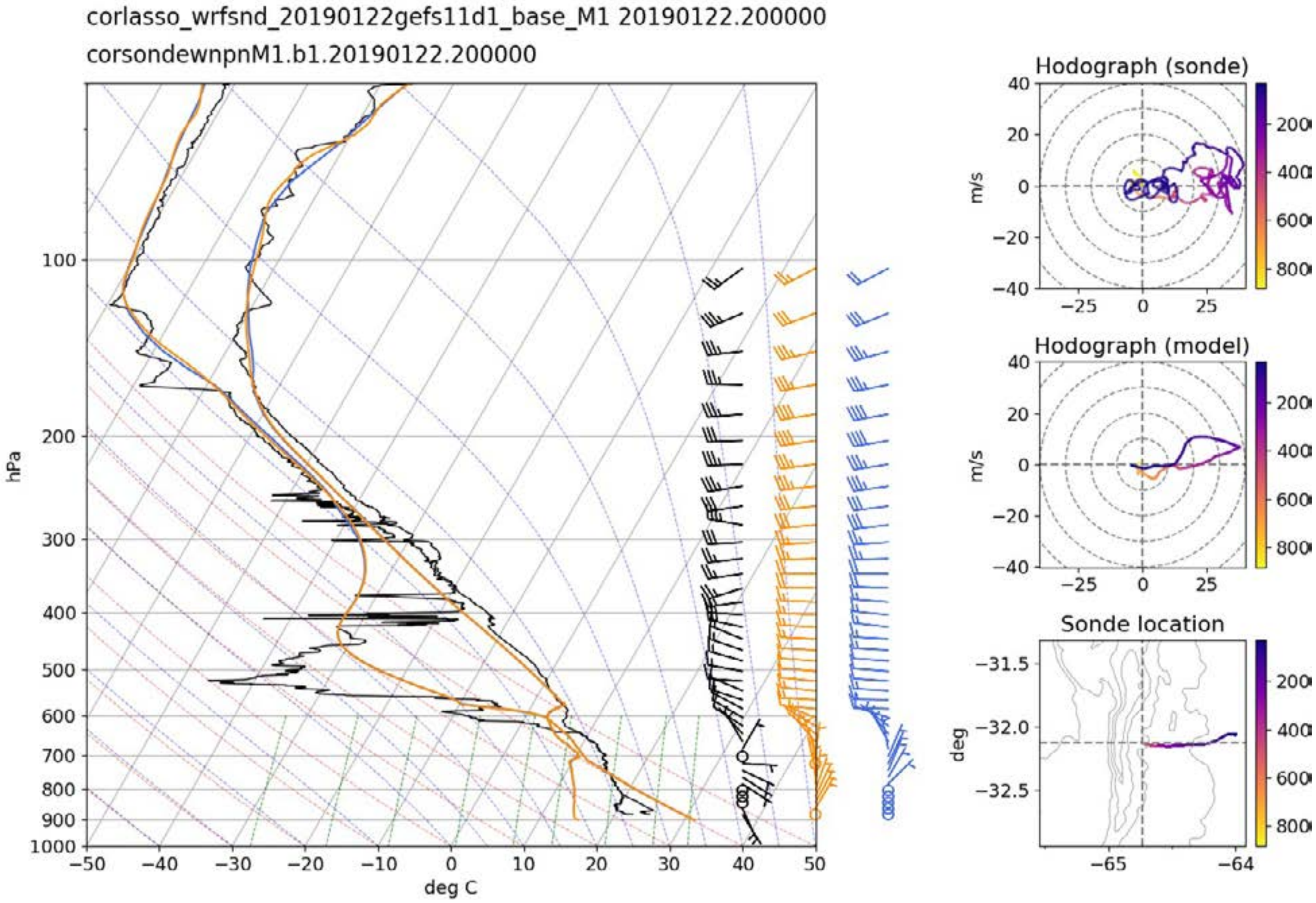


(1,1) is perfect agreement





Sounding and Hodograph Diagnostic Plots



User Highlight

Probing processes for deep convective cloud growth using LASSO-CACTI

Zhe Feng, Enoch Jo, & James Marquis
Pacific Northwest National Laboratory

(See additional file for these slides.)

Availability and Working with LASSO-CACTI

Status of the LASSO-CACTI scenario

- **Beta release,** announced May 2022
  - Contained mesoscale ensembles and a few LES runs
  - Preliminary file format and filename convention
  - Simulations accessed via ARM's Cumulus cluster
  - Skill scores accessed via web links
- **Evolved beta,** today
  - All available simulations are in final release form on Cumulus
  - Had to take down web content – content will be in the new Bundle Browser
  - Contact lasso@arm.gov for accessing the data
- **Production release,** imminent
  - ARM Data Center is uploading the files to the tape drives for distribution
  - Fine tuning the updated Bundle Browser
  - Working on the documentation and web pages
  - Cleaning up loose ends…

Simulation data types available in the release

wrfout: WRF output files in (mostly) raw form

(4 domains: 59 GB, 264 GB, 1.4 TB, 25 TB)

Variable subsets: subsetted output by variable category

(4 domains: 28 GB, 117 GB, 628 GB, 11 TB)

wrfin: tar file with input data, configuration files, etc. to reproduce simulations (D1+D2: 1.5 GB; D3+D4:17 GB)

wrfrst: WRF restart files for LES to reproduce portions of simulations (LES: 10 TB)

Intent is for most users to work with subset files to reduce data volume

Subset files: categories and interpolated level options

- Aerosol
- Cloud (on various level options)
- Meteorological (on various level options)
- Meteorological for staggered
- Planetary boundary layer
- Radiation
- Surface
- Static
- Tendencies
- Tracers

- Interpolation options for met. and cloud
  - **Raw:** all 149 model levels
  - **HAGL:** 33 levels, dz=100 m near surface, top at 5 km
  - **HAMSL**: 40 levels, dz=250 m near surface, top at 21 km
  - **Pressure:** 11 levels, mostly "standard" levs

Side product: Soil initial conditions for LASSO-CACTI

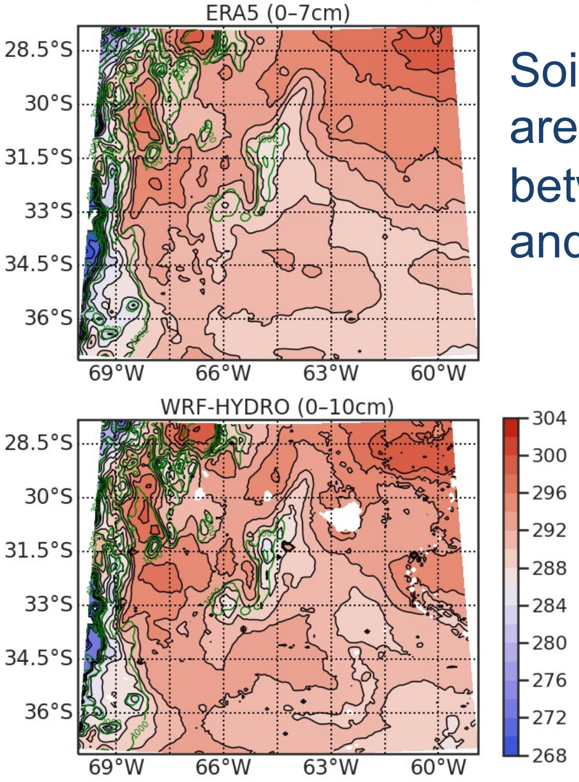
- Continuous WRF-Hydro simulation was to establish a spun-up soil state consistent with WRF physics
  - Run from August 2018 to April 2019 using Δx=2.5 km
  - Driven by ERA5
  - Useful for anybody looking for a spatial soil information, e.g., to initialize days outside of LASSO

Soil comparison for 26-Oct-2018 0 UTC:

ERA5

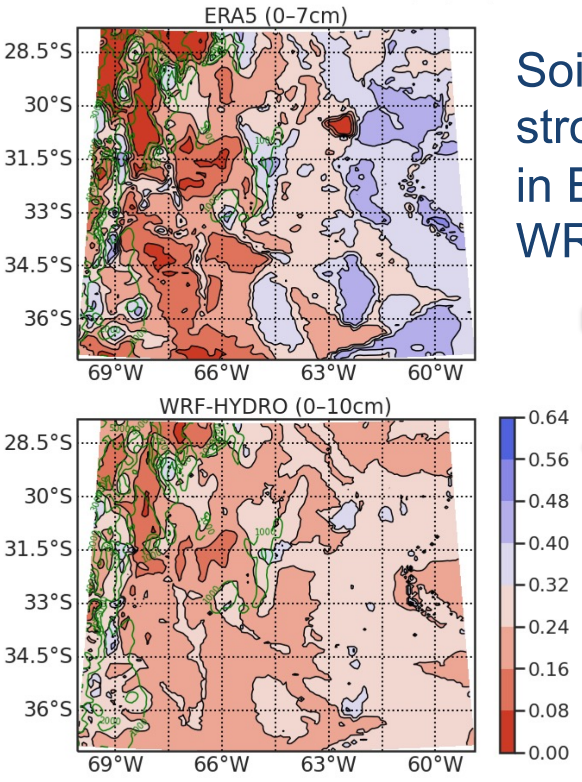
WRF-Hydro

Topmost Soil Layer Temperature [K]



Soil temperatures are similar between ERA5 and WRF-Hydro

Topmost Soil Layer Moisture [m^3/m^3]

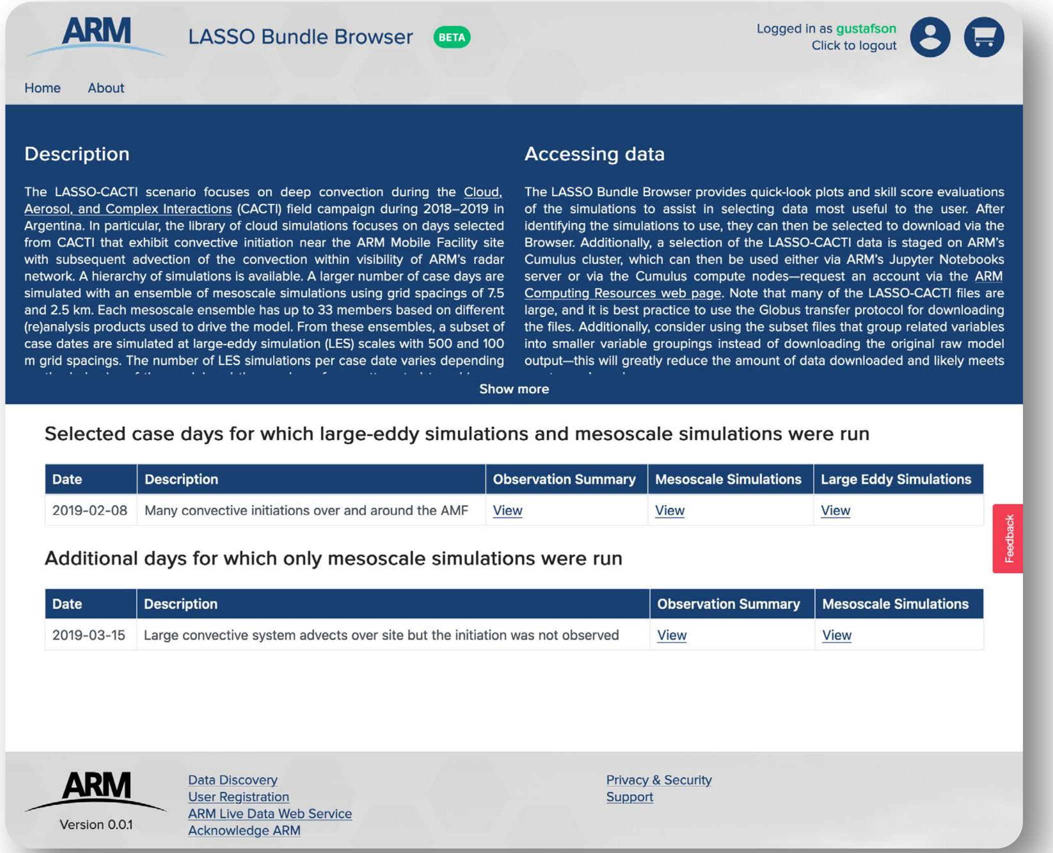


Soil moisture has stronger gradient in ERA5 versus WRF-Hydro

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

LASSO Bundle Browser updated for CACTI

- New LASSO-CACTI interface for the LASSO Bundle Browser
- A tool for viewing simulation behaviors
- This is the way to download LASSO-CACTI simulations
  - Data will not be visible in Data Discovery
  - New option to "order by YAML" for reproducing and automating orders

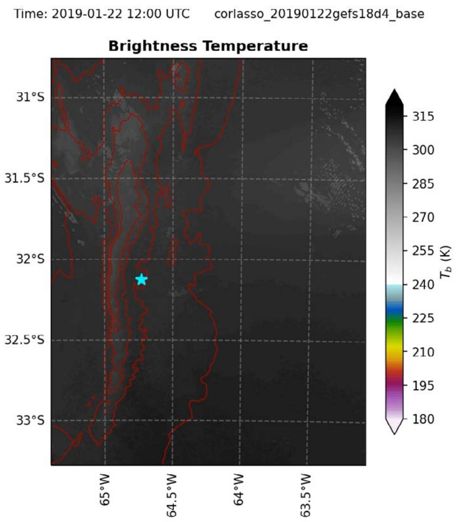


Supporting files available via Browser

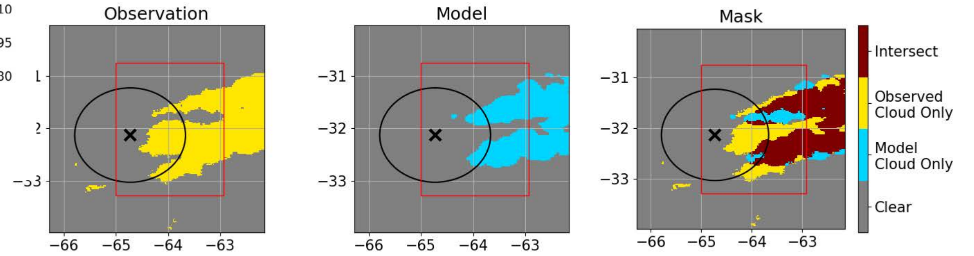
- Skill score plots and CSV files
  - Cloud masks for model vs. GOES16 brightness temperature
  - Regional echo-top heights vs. CSAPR2 / Taranis radar product
  - Rain rates vs. Taranis radar product

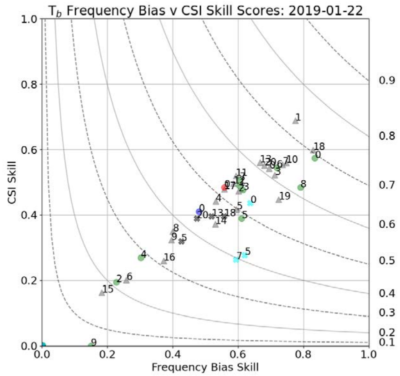
- Animations of brightness temperature

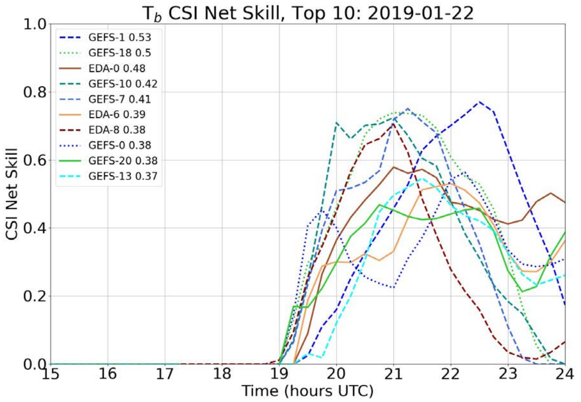
- Sounding & hodograph plots

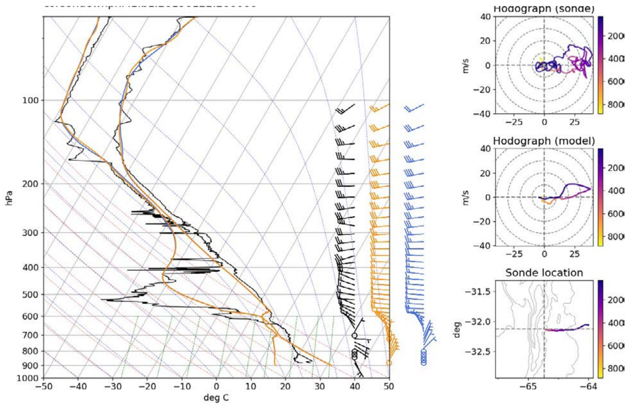


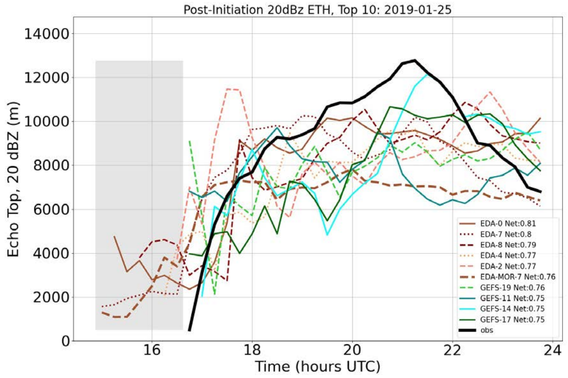
	A	B	C	D	E	F	G	H	I	J
1	Sim ID	CSI Skill	File	6	6.25	6.5	6.75	7	7.25	
2	ERA5	0.28	wrf-tb-thr_ta	0.03	0.01	0	0	0	0	
3	GEFS-3	0.26	wrf-tb-thr_ta	0	0	0	0	0	0	
4	GEFS-2	0.25	wrf-tb-thr_ta	0	0	0.01	0.02	0.01	0	
5	GEFS-0	0.25	wrf-tb-thr_ta	0.01	0	0	0	0	0	
6	GEFS-16	0.2	wrf-tb-thr_ta	0	0	0	0	0.01	0.01	
7	GEFS-18	0.19	wrf-tb-thr_ta	0	0	0	0.01	0.01	0	
8	GEFS-9	0.18	wrf-tb-thr_ta	0	0	0	0	0.01	0.03	
9	GEFS-20	0.17	wrf-tb-thr_ta	0	0	0	0	0	0	
10	EDA-3	0.17	wrf-tb-thr_ta	0	0	0	0	0	0	
11	FNL	0.17	wrf-tb-thr_ta	0	0	0	0	0	0	
12	GEFS-15	0.17	wrf-tb-thr_ta	0	0	0	0	0	0	
13	EDA-6	0.14	wrf-tb-thr_ta	0	0	0	0	0	0	
14	GEFS-4	0.13	wrf-tb-thr_ta	0	0	0	0	0	0	
15	GEFS-1	0.12	wrf-tb-thr_ta	0	0	0	0	0	0	
16	GEFS-11	0.12	wrf-tb-thr_ta	0	0	0	0	0	0	
17	GEFS-12	0.11	wrf-tb-thr_ta	0	0	0	0	0	0	





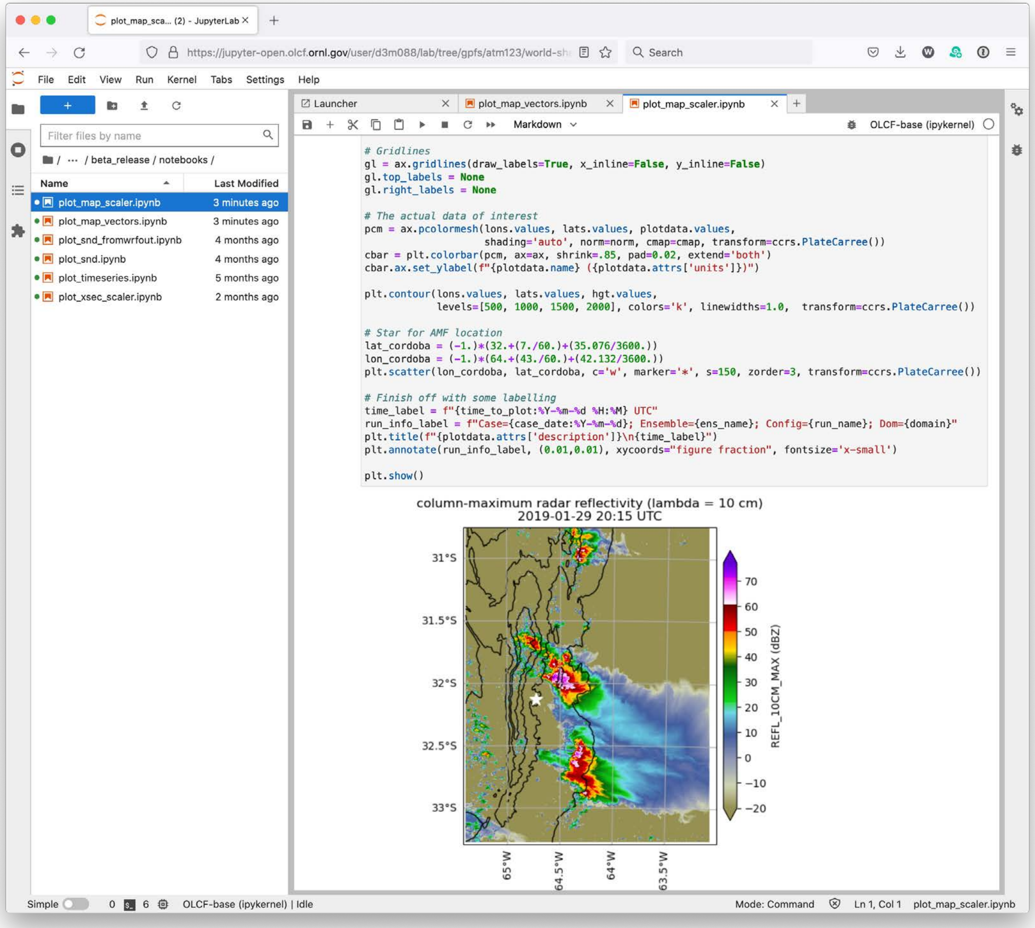






Accessing the beta release…

- Files currently reside on ARM's Cumulus cluster—email lasso@arm.gov for access details
- Two methods for access
  - ARM's Cumulus-based Jupyterlab server
  - Interactive logins and job submissions on Cumulus
- One account works for both methods
  - https://www.arm.gov/capabilities/computing-resources

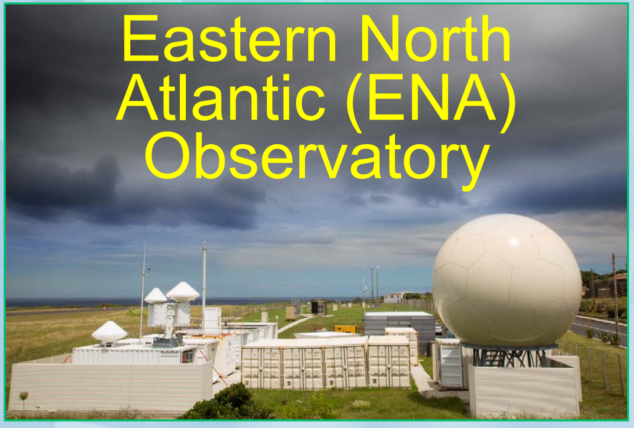


Q&A and Discussion for LASSO-CACTI

LASSO-CACTI related posters in Session 4, Wednesday, 9:15 a.m.

#40: Gustafson et al., 2023 LASSO Update: CACTI Release, Starting ENA, and Beyond

#42: Endo et al., Initial Insights into the LASSO-CACTI Simulation Library for Deep Convective Clouds



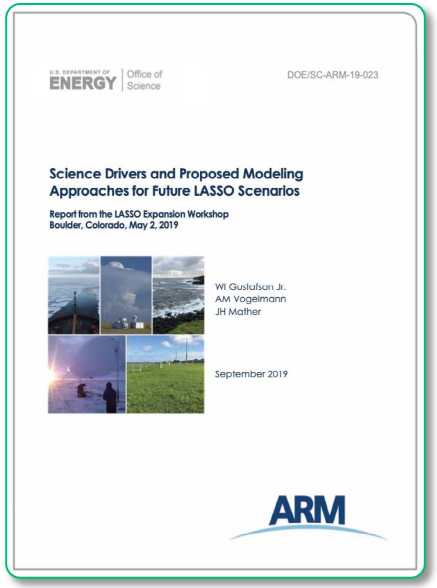
The LASSO-ENA Scenario

Building LASSO scenarios is a team effort

- Many thanks to all who help bring LASSO scenarios to fruition!
- Providing expertise and answering ENA questions
  - Virendra Ghate
  - Scott Giangrande
  - Karen Johnson
  - Alyssa Matthews
  - Mark Miller
  - Hugh Morrison
  - Kyle Pressel
  - Shuaiqi Tang
- LASSO staff currently focusing on ENA
  - Heng Xiao
  - Damao Zhang
- Submitters of the maritime theme to the LASSO Expansion Workshop in 2019
  - Graham Feingold
  - Richard Forbes
  - Pavlos Kollias
  - Robert Wood
- Attendees of the ENA planning workshop

Drivers for proposed ENA scenario from Expansion Workshop

- Produce LES of maritime shallow clouds with a primary focus on precipitation processes and a secondary focus on aerosol-induced impacts on clouds
- Focal science questions
  1. How do even relatively thin clouds at the ENA site produce detectable precipitation?
  2. Is low-cloud precipitation at the ENA site controlled primarily by the availability of condensate, and how sensitive is it to cloud droplet concentration?
  3. How do meteorological controls, such as wind speed and turbulent mixing in the planetary boundary layer, affect condensate and precipitation?
  4. How strongly are cloud droplet sizes and concentrations related to aerosol properties measured at the surface and what cloud processes are important for controlling the relationship?


U.S. DEPARTMENT OF ENERGY | Office of Science

DOE/SC-ARM-19-023

Science Drivers and Proposed Modeling Approaches for Future LASSO Scenarios

Report from the LASSO Expansion Workshop
Boulder, Colorado, May 2, 2019

WI Gustafson Jr.
AM Vogelmann
JH Mather

September 2019

ARM

Role of Observations in LASSO-ENA

- Select simulation periods based on phenomena and obs availability
- Guide specification of model input, particularly aerosol properties
- Quantitatively vet simulations with *discerning* cloud & meteorological data
  - Assess model setup/configuration from sensitivity tests
  - Identify ‘good’ bulk microphysics ensemble members, potential forcing for spectral bin run
  - Communicate simulation quality through skill scores and diagnostic plots using the obs
  - Provide ‘data bundles’ of the above curated data for users (e.g., an ‘LES CMBE’)
- Data restrictions (aka, LASSO is not conducting “PI science”)
  - Data should be readily available for use, not manually intensive
  - Tried and true methods – “bulletproof”, not experimental
  - Data available for all cases for consistency in vetting

Observational Vetting of Simulations

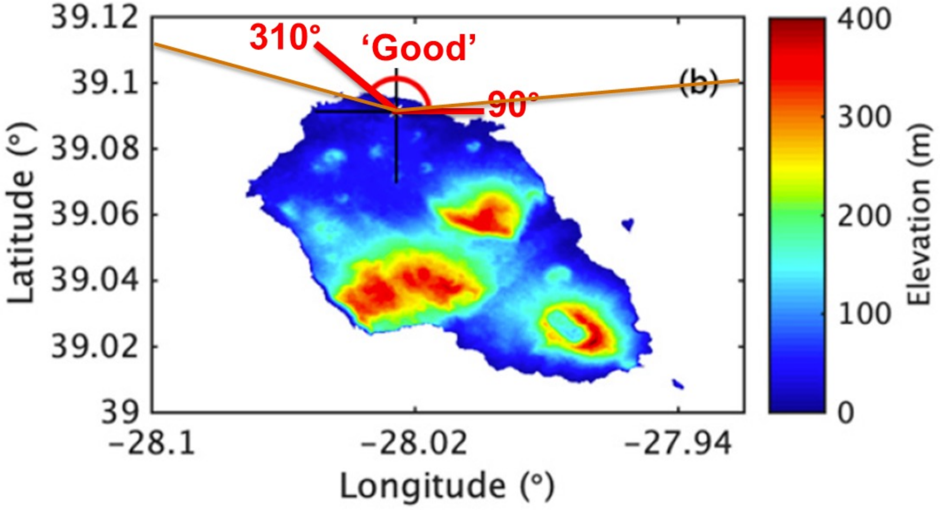
- 1st Order: ***Is the cloud something like observed, or is the simulation a bust?***
  - Cloud fraction: TSI, VISST/Satellite
  - Cloud boundaries: ARSCL
  - Lifting condensation level: Derived from surface met data

- 2nd Order: ***Are the simulated cloud microphysical & thermodynamic characteristics reasonable?***
  - Liquid-water path (LWP): MWR3C
  - Cloud droplet number concentrations (N_d): ARM lidar-based retrievals *(Zhang et al., Submitted to AMT)*
  - Cloud optical depth: VISST (regional), CSPOT retrievals (column), – *Both cannot have thick cloud aloft*
  - Thermodynamic properties (profiles, LTS, etc.): Sonde (discrete/limited temporal coverage)
  - Precipitation occurrence:
    - KAZR (column, for virga depth)
    - XSAPR2 and Ka/W-SACR2 (precipitation areal coverage)
  - Surface precipitation: Disdrometer (but only when reaches the surface)

Note: 'Point/Column retrievals' can be problematic for low cloud fractions (e.g., ARSCL, LWP, N_d, KAZR precip, Disdrometer)

Case Selection Considerations

- Avoiding island effects Preferred wind directions
  - Ghate et al. (2021)
  - Hunzinger et al. (2020), Zheng and Miller (2022)



- Scanning radar availability
  - X-band Scanning ARM Precipitation Radar 2 (X-SAPR2)
    - April 24, 2017 - April 25, 2018
  - Ka-/W-band scanning ARM cloud radar 2 (Ka/W-SACR2)
    - June 2017 – August 8, 2018
    - April 29, 2022 – Present

Potential Case Day Periods

- **Aerosol and Cloud Experiment in the Eastern North Atlantic (ACE-ENA) campaign**
  - Two IOPs: Summer, 21 June to 20 July 2017; Winter, 15 Jan to 18 Feb 2018
  - Assets
    - Aerosol characterization aloft from G-1 aircraft (39 flights)
    - XSAPR2 and Ka/W-SACR2 available (a1-level)
  - Challenges
    - Not a lot of long-duration open- or closed-cell cases w/out island effects
      - Jensen et al. (2021) find only 2 open- and 2 closed-cell cases with > 12 h duration; Of them, only 1 w/ G-1 flights
    - Case numbers can be dramatically increase by shortening to 6 h (Zheng and Miller, 2022)
- **Long-term ENA record**
  - Assets: Greater availability of cases
  - Challenges
    - Aerosol inputs would be approximated using surface obs and remote sensing of N_d
    - Precipitation information limited
      - XSAPR2 availability limited to ~ACE-ENA; Ka/W-SACR2 availability starts > 29 Apr 2022
      - KAZR available (column stats)

User Highlight

Using LASSO-ENA to fill data voids

Virendra Ghate
Argonne National Laboratory

(See additional file for these slides.)

LASSO-ENA Scenario Impressions

Slides and recording from *LASSO-ENA Planning Workshop:*

https://discourse.arm.gov/t/lasso-ena-planning-workshop-27-jul-2023/150

Case selection – Science foci

- From the *LASSO Expansion Workshop*: *"Produce LES for maritime shallow clouds with a primary focus on precipitation processes and a secondary focus on aerosol-induced impacts on clouds."*
  - Need variability in precipitating cloud types, and…
  - Variability therein of the meteorology and aerosol loading

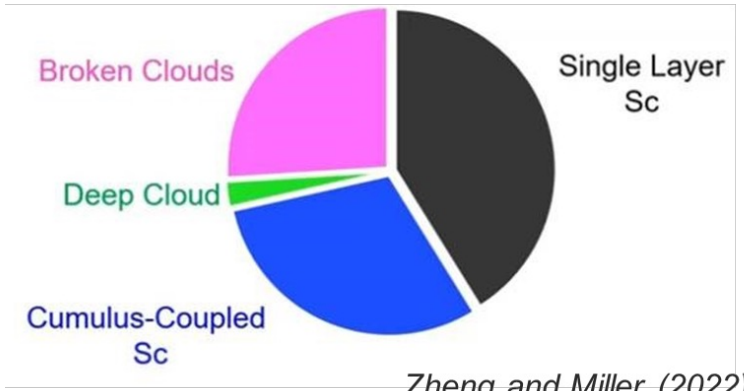
    → *How much of an ensemble is needed, and of what?*

    → *Observationally, how much of an ensemble do we have access to?*

- Candidate targets
  - Closed cell systems
  - Open cell systems, including cumulus-coupled sc
  - Nonprecipitating systems
  - Aerosol epochs, e.g., Dry-air intrusions (met conditions)
  - Other?

ENA Cloud Morphology

Based on 4 y of summertime data



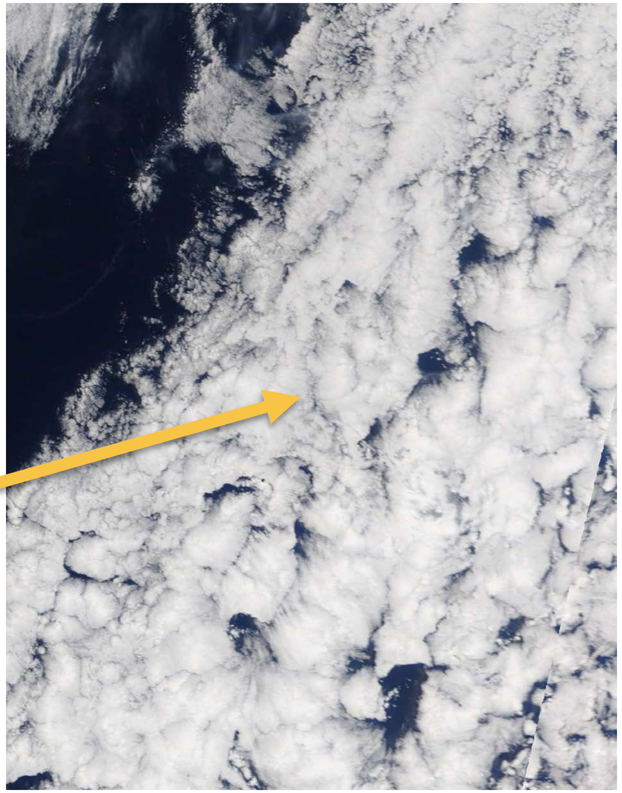
Zheng and Miller (2022)

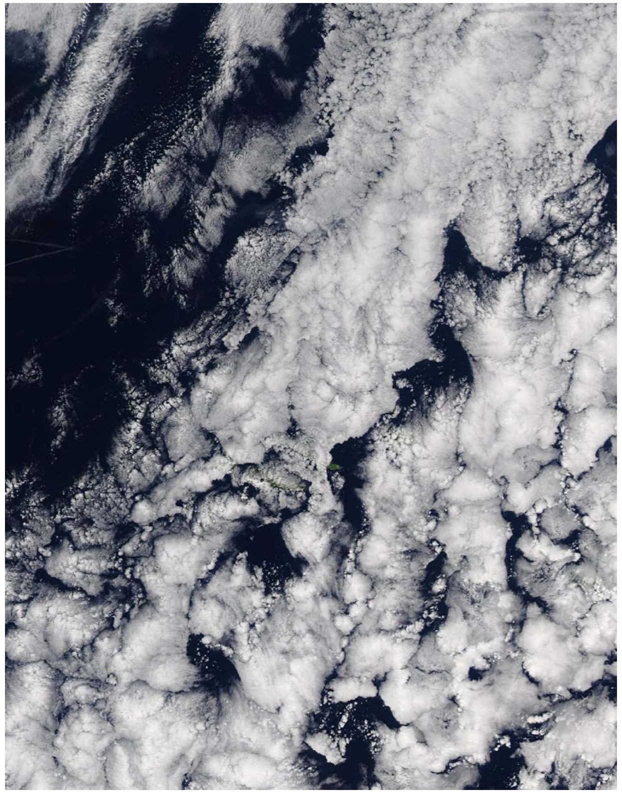
https://www.arm.gov/capabilities/modeling/lasso

Prototype case: closed cell, 7-Feb-2018

- Overcast at ENA with closed cells in vicinity

- Simulated initial tests using SAM model
  - Periodic domains
  - Δx=25 m, nx=256 (6.4 km)
  - Δz=25 m, nz=250 (6.25 km)
  - Forcings from MERRA2 and ERA5
  - Morrison and Spectral Bin microphysics

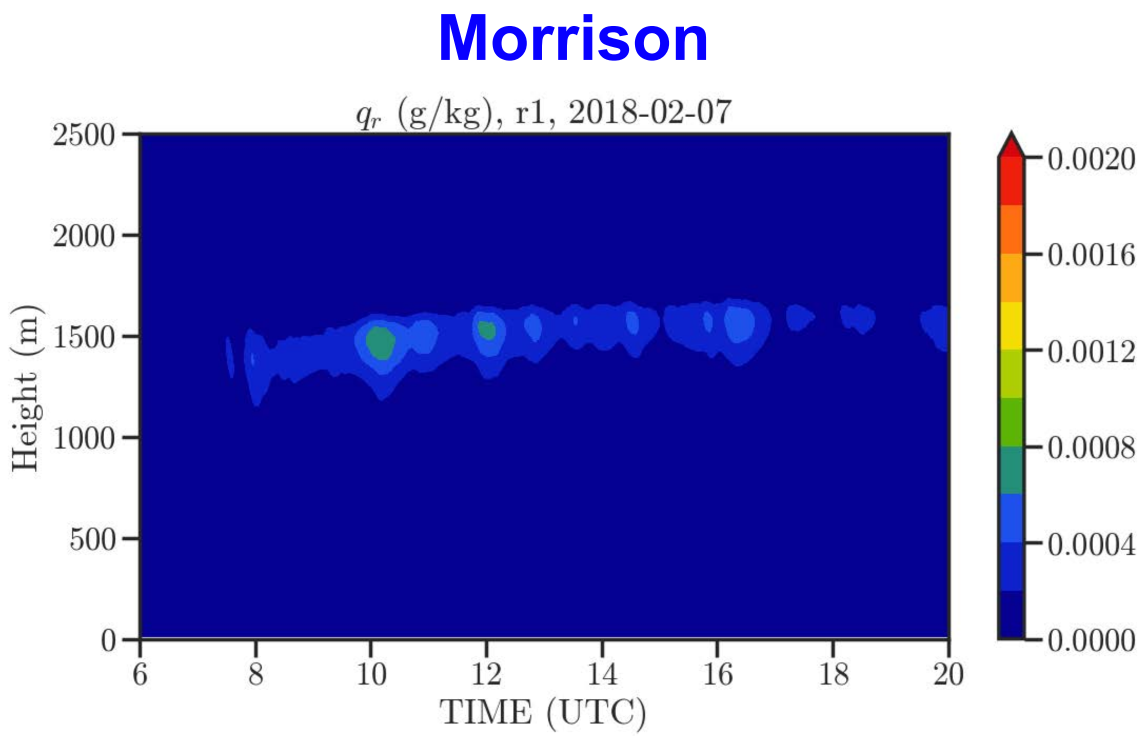


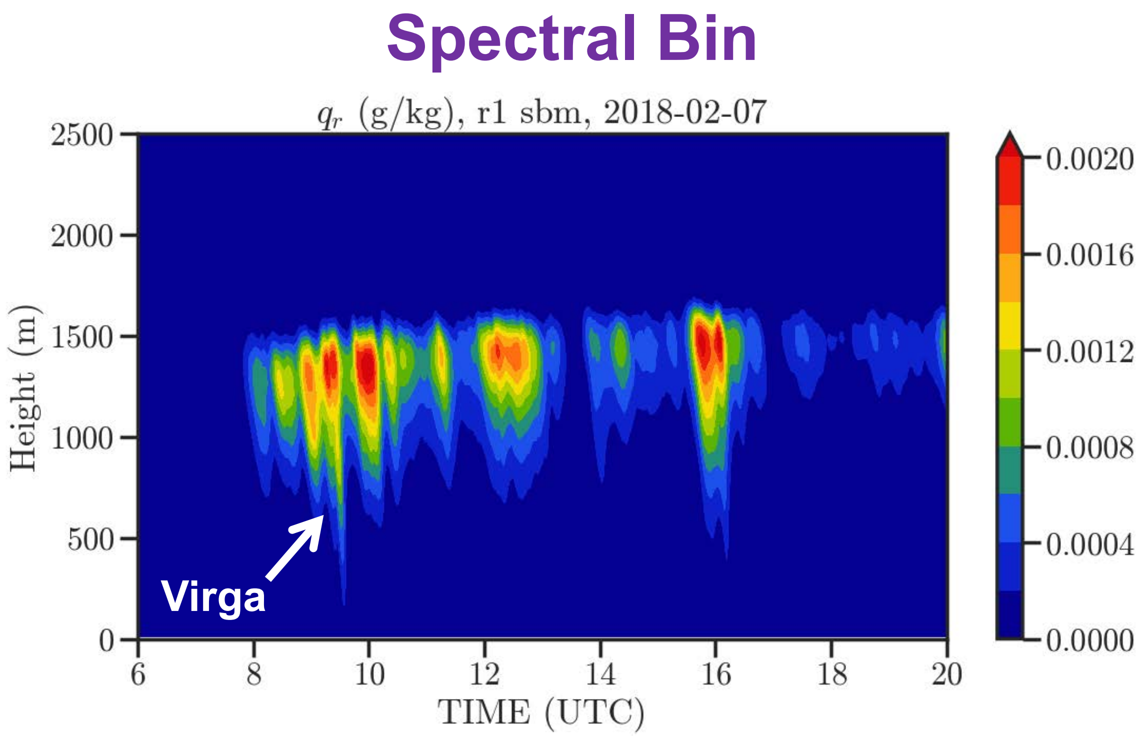


https://www.arm.gov/capabilities/modeling/lasso

Rainwater mixing ratio comparison for 7-Feb-2018

(domain average values)





- SBM raining more with virga below cloud (for current aerosol assumptions)

Proposed modeling approach from Expansion Workshop

- Domain configuration
  - Lagrangian oceanic domain – focus on over-water and not over-land conditions
    - Fetch from northern sector to avoid island influence
  - Choice of periodic or nested LES domain – left vague at earlier workshop
  - Forcing/boundary data from ERA5, MERRA2, etc., with specified SST for lower boundary
  - Δx = 50 m and Δz = 10–20 m in boundary layer (is that enough?)
  - Up to 60 km across to capture open cell mesoscale structure
- Aerosol-aware microphysics with spectral bin for selected cases
  - Aerosol inputs: In situ during ACE-ENA; else, approx.'d from surface obs and remote sensing
- Ensembles
  - Multiple forcing sources and scales
  - Microphysics parameterization and input parameters

What we heard from the *LASSO-ENA Planning Workshop*

- Strong interest in capturing the full precipitation distribution, which requires domains >100 km for rain rate extremes from open cells
  - Folks interested in mesoscale organization willing to compromise on grid spacing to 100–300 m
- Competing interests between cloud structures/organization and microphysical details
  - Bulk microphysics acceptable for foundational modeling?
  - Need spectral bin from ARM? Or, leave to researchers?
- Growing consensus for use of Lagrangian domains
  - Better captures scales of cloud organization
  - Improves spin-up and allows for smaller domains

Cloud history can be important

- Cloud field commonly evolves throughout the day
- Should we incorporate a Lagrangian approach to the modeling?
- If yes, what are the recommendations for boundary conditions (e.g., aerosol)?

FLEXPART Forward Trajectories

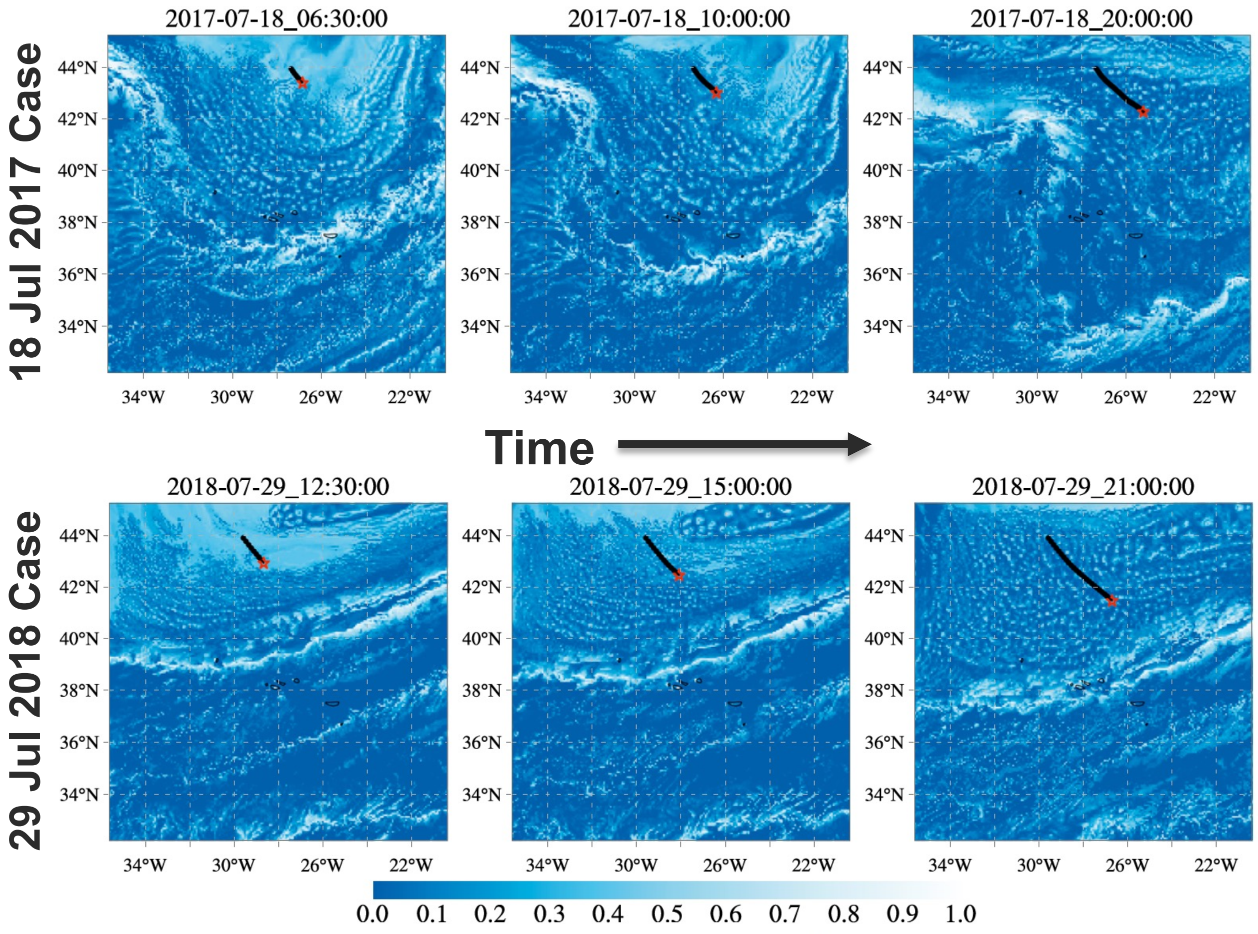


FIG. 5. Forward Lagrangian trajectories performed with FLEXPART-WRF on the (top) 2017 and (bottom) 2018 simulations. The starting point is the northernmost point, and the red star shows the location of the tracked parcel at time shown above each plot.

Kazemirad & Miller (2020)

Model options

- Weather Research and Forecast (WRF)
  - The industry standard -- it does it all and then some
  - Compressible and thus expensive to run
- System for Atmospheric Modeling (SAM)
  - Anelastic and thus ~5x faster than WRF
  - Designed for periodic boundaries
- Predicting INteractions of Aerosol and Clouds in Large Eddy Simulation (PINACLES)
  - New LES model developed at PNNL by Kyle Pressel
  - Anelastic with modern numerics combined with WRF-based physics (SBM is warm-phase only)
  - Easily runs nested inside of (re)analysis data with WRF-like nesting
  - Cost is similar to SAM

Cost considerations

- Computational cost increases compared to prior scenarios if we use same width domain
  - Maritime clouds require finer grid spacing, Δx=25–50 m instead of 100 m – adds 1–2 orders of magnitude in computational cost
  - Consideration of bin microphysics adds another order of magnitude
- Ultimately, storage is the limiting factor—max of 2 PB
- Mitigation options
  - Only run bin microphysics for a smaller, inner domain (and maybe only some cases)
  - Short model top to reduce levels – limits to warm-phase clouds
  - Turn off ice phase – roughly cuts SBM output by 1/3
  - Limit domain extent and coarsen grid spacing – would prefer Δx=25 m and width >60 km to capture mesoscale variability, but would be too much
  - Limit ensemble sizes – reduces odds of capturing good forcing and environment sensitivity
  - Limit number of case dates – how many days are needed to make the case library impactful?
  - Use a cheaper model

Q&A and Discussion for LASSO-ENA

Discussion…

- What applications would you do with LASSO-ENA? What do you need from ARM for this application?
- Are the science focus questions correct?
- How many case days needed? What sort of variety in conditions?
- How many ensemble members?
- What is a good modeling approach to address the science and balance cost?
  - 25 m, 50 m, 100 m, 300 m, 2 km grid spacing? What's your "limit" of acceptability?
  - Domain size(s), boundary style, and Lagrangian?
    - Multi-scale-domain approach, similar to LASSO-CACTI, but with Lagrangian inner domain?
  - Is spectral bin microphysics necessary?
    - Can we turn off ice-phase cloud physics?
  - Models we should consider and/or prioritize?



Future of LASSO Workshop
2–3 November 2023 at NCAR

Workshop format

- In-person at NCAR for ~20 attendees
  - Attendance by invite: contact Bill if you are interested in being invited, lasso@arm.gov
  - Virtual attendance open to everybody
- 1.5 days with full first day and half second day, 2–3 November 2023
- Will use community white papers to guide the agenda

Attendees of the prior *LASSO Expansion Workshop* in 2019

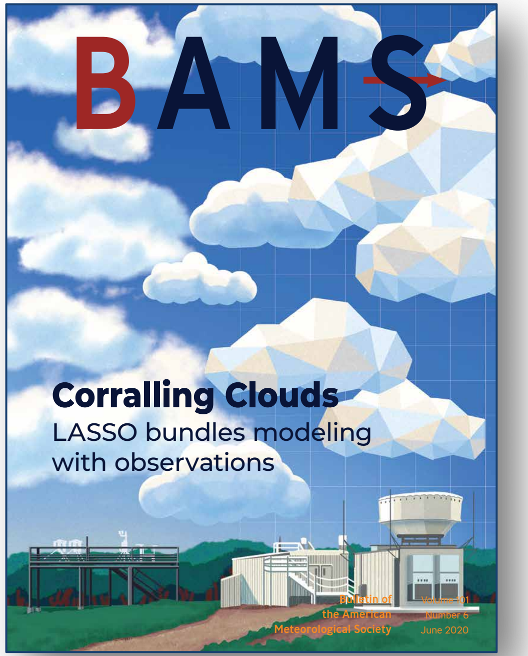
Topics to be discussed at the *Future of LASSO Workshop*

- What have been the most valuable aspects of the LASSO datasets?
- How can the LASSO approach be modified for greater scientific impact?
  - Should LASSO use a different modeling approach?
  - Should the approach to the use of observations be modified? Newly available datasets?
- What new science drivers should LASSO pursue?
- How can LASSO integrate with other modeling activities?

White paper submission process

- Keep an eye out for the formal white paper announcement
  - Contact lasso@arm.gov to be notified when the call is announced
  - Will be announced via ARM's e-mail channels
- We encourage folks to collaborate on submissions
  - Reduces duplication
  - Increases impact

Ways to continue the discussion



- Email to Bill and Andy: lasso@arm.gov
- Community discussion: https://discourse.arm.gov/c/lasso
- LASSO email list:
  http://us11.campaign-archive1.com/home/?u=74cd5b8a5435b8eca383fc18c&id=38f02e1568
- Thank you for your contributions to help guide LASSO!