2019 Update on LASSO Activities

LASSO Posters on Wed. 3:30 p.m.:
#1 LASSO-O by Toto et al.
#2 LASSO Update by Vogelmann et al.

PNNL: William Gustafson (PI), Heng Xiao
BNL: Andrew M. Vogelmann (Co-PI), Satoshi Endo, Karen Johnson, Tami Toto
UCLA/JPL: Zhijin Li
National U. of Defense Tech.: Xiaoping Cheng
ORNL: Bhargavi Krishna, Kyle Dumas

Joint ARM/ASR Principal Investigator Meeting, 11-June-2019, Bethesda, MD

Science drivers

Understand drivers of variability of continental shallow convection

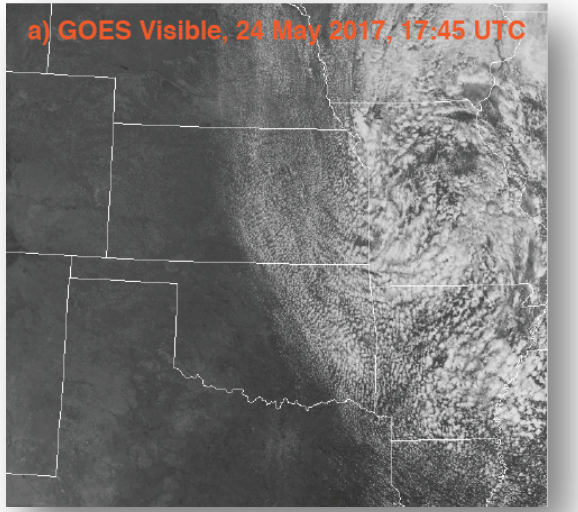
- How are shallow cumuli impacted by different sensible and latent heat fluxes?
- How do different morning boundary layer states impact shallow convection development?
- What is the relative impact of large-scale vs. local forcings on shallow cumulus?

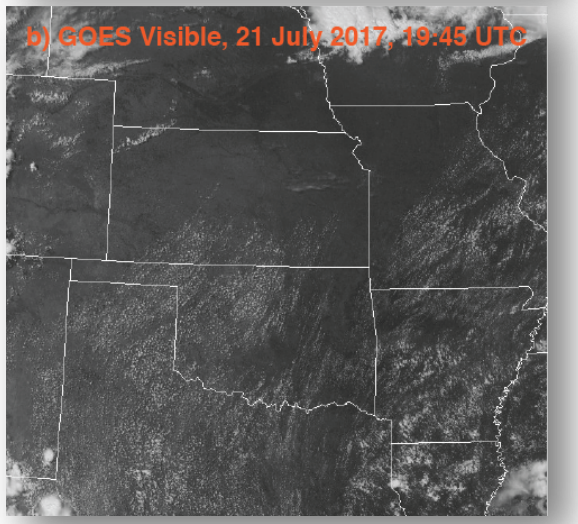
Improve climate model simulation of continental shallow convection

- Provide highly detailed spatial and temporal detail necessary for parameterization development
- Provide forcings and benchmark simulations for parameterization development
- Provide an observational and LES data suite for evaluating coarser model behavior

Provide virtual cloud fields for retrieval development

- Use high-resolution modeling as a proxy for realistic cloudy conditions





Overview of the shallow-cumulus scenario

- **Case selection:** target surface-driven shallow cumulus at SGP
- **Model configuration using WRF**
  - Traditional, periodic LES with lid at 14.7 km
  - Grid spacing = 100 m; domain width = 25 km; 226 levels with dz=30 m up to 5 km, stretching to 300 m at top
  - Physics uses Thompson microphysics, RRTMG radiation, and 1.5-order TKE SGS (Deardorff)
  - Simulations last 18 h, beginning at sunrise and lasting until shortly after sunset
- **Model input data**
  - Initial conditions from 12 UTC radiosonde
  - Prescribed surface fluxes based on VARANAL's regionally averaged flux measurements
  - Large-scale forcings provide subsidence and large-scale advection of T and Q (no nudging)
    - Multiscale Data Assimilation (MSDA) for scales of 75, 150, and 300 km
    - ECMWF IFS for scales of 9, 113, and 413 km (likely ERA-5 starting next year)
    - Variational Analysis (VARANAL) for scale of 300 km
    - No large-scale forcing (only time-varying surface fluxes after initialization)

Observations used and/or included in the data bundles

- Observation suite focuses on cloud macro statistics as well as the state of the boundary layer
- Items in green are those deemed necessary for a case to proceed

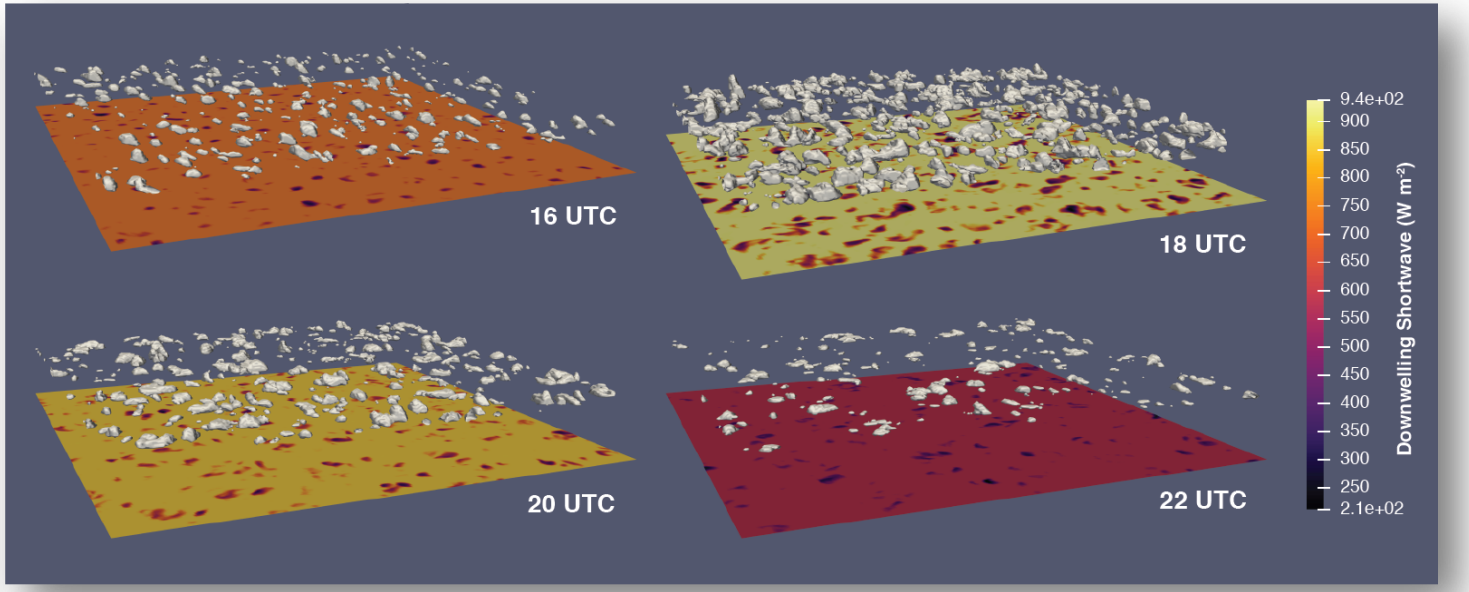
Instrument / VAP	Variable Measured or Retrieved
AERIoe, MWRRet	In-cloud liquid water path
ARSCL	Boundary-layer cloud fraction and time-height cloud mask
TSI	Opaque cloud fraction
MET & Mesonet w/n 60 km	Surface temperature and moisture conditions plus regional lifting condensation level
Radiosonde	Thermodynamic profiles, typically 4x per day
Raman lidar	Mid-boundary-layer temperature and moisture
Doppler lidars at Central and boundary facilities	Boundary-layer cloud-base height
Radar wind profiler	Wind profiles (used with MSDA)
GOES	Visible imagery

Available cases

Find out more at the LASSO poster (#2, A. Vogelmann et al., Wed. 3:30)

- Settled into one annual release per year
- Number of shallow cumulus days varies by year due to interannual variability (criteria was the same)

Year	Number	Release Date
2015	5	July 2018
2016	13	Sept. 2017
2017	30	Sept. 2018
2018	30	Anticipated June 2019
Total	78	



2018 development efforts

Full details at the LASSO-O poster (#1, Tami Toto et al., Wed. 3:30)

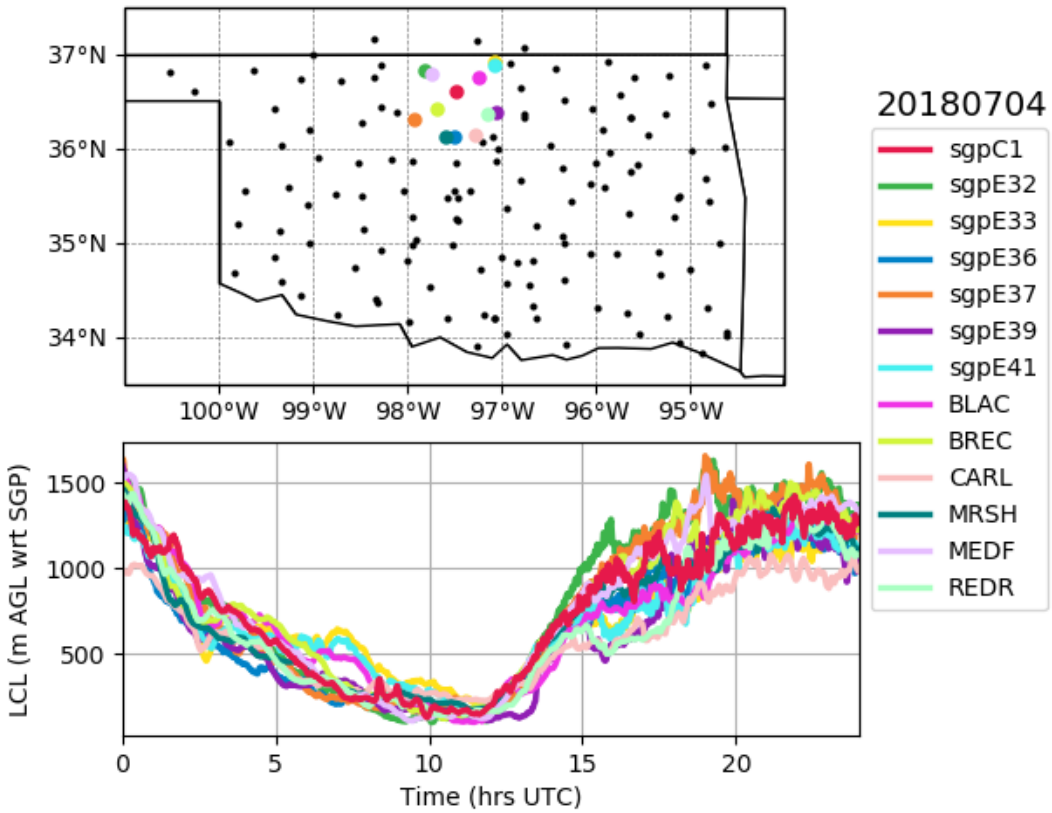
- Two new data sets for users
  - New regional lifting condensation level VAP for Oklahoma
  - New high-frequency LASSO observation VAP
- Significant effort to automate model post-processing, observation–model comparisons, and bundling process
- Proposal accepted by BAMS for an overview paper
- Had an open community call for expansion scenarios and held a workshop in May to discuss expansion options

Attendees of the LASSO Expansion Workshop, May 2019

Oklahoma lifting condensation level (LCL) VAP

- Dataset details: lcl.c1
  - Calculates the LCL for each ARM and OK Mesonet surface met. stations (149 of them)
  - 1 min. frequency
  - Currently processed 2017–2018 and will process historical data
  - Monthly processing schedule for every day
  - Available for download via ARM's Data Discovery web page
- Use within LASSO
  - Identify whether clouds are coupled to the surface
  - Evaluate LES model's LCL height in context of regional variability

Regional LCL Variability from LCL VAP

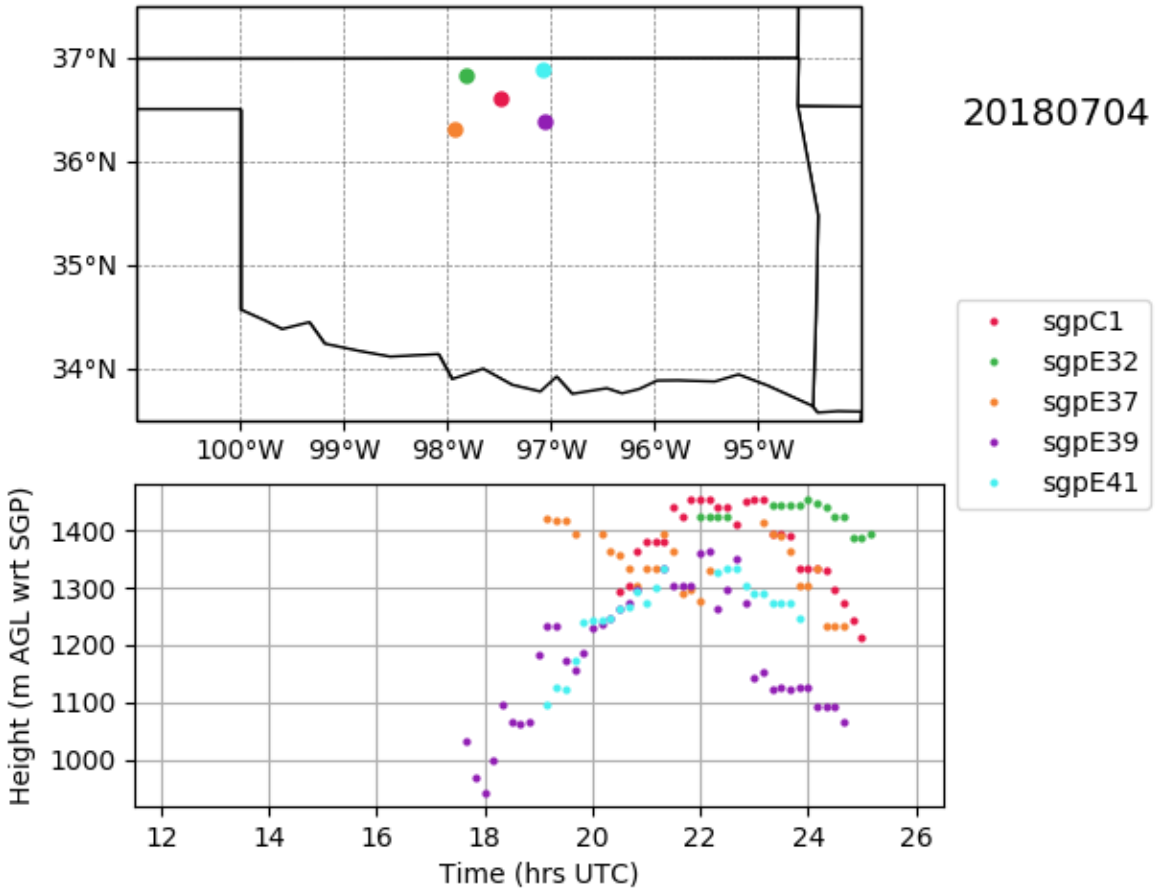


Non-black stations used for LASSO analysis

Doppler lidar shallow-cumulus cloud-base height (CBH) dataset

- Dataset details: lassodlcbhshcu.c1
  - Retrievals of cloud-base height for 5 locations around SGP
  - 10 min. frequency
  - Uses Doppler lidars at Central and boundary facilities
  - Included in the new high-frequency LASSO observations VAP
  - Produced only for days simulated by LASSO
  - To be released this summer
- Use with LASSO
  - Evaluate simulated cloud-base height in context of regional variability

Regional CBH Variability from Doppler Lidars



Looking toward the future

- We continue to receive strong support for LASSO from the ARM management.

- We are asking the question “What should LASSO look like over time?”
  - Are we starting to reach saturation where additional cases provide smaller returns on effort?
  - Would having a larger variety of cloud type and/or conditions be more valuable than producing more of the same type of classic shallow convection?

- Spent the past year seeking community input and discerning the route forward.
  - Started the discussion at the 2017 AGU Fall Meeting and last year’s PI Meeting
  - Produced a blog series and invited community interaction/feedback
  - Lots of presentations at meetings
  - Had a call for white papers from the community to propose new LASSO scenarios
  - Held the LASSO Expansion Workshop in May 2019

Expansion decision criteria

1. Scenario must be science driven, aligned with ARM's mission, and serve a broad community need
2. Scenario must effectively integrate observations and simulations
3. Scenario should clearly add value to observations through the addition of the modeling
4. The scenario cannot start unless necessary observation datasets are available
5. The computational cost must be within constraints, but this is not the primary criterion

Known usage statistics

Citations

- 4 research papers using LASSO data
- 7 research papers noting LASSO without data use
- 1 meeting summary highlighting use of LASSO for teaching
- Called out at international conferences

Usage topics

- Radar scan strategies (LES output)
- BL and ShCu parameterization (LES output and forcings)
- Spatial structure and organization of ShCu (used LASSO forcings)
- Field campaign supplement
- Inquiries about 3D radiation

Category	Usage
Number of unique users	40
Minimum and maximum number of data bundles downloaded by a user	1 / 160
Mean number of data bundles downloaded per user ± 1 standard deviation	25.9 ± 40.5
Number of users downloading ≥ 5 data bundles	16

Collaboration Discussions

- Ruisdael project in Netherlands
- NOAA for NWP model development
- Each ASR call results in 3–5 requests