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LASSO modeling & measurements update

LES ARM Symbiotic Simulation & Observation Workflow

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LASSO Webpage: http://www.arm.gov/science/themes/lasso

LASSO e-mail list sign up: http://eepurl.com/bCS8s5

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The LASSO Vision

- Bridging the scale gap between ARM observations and models
- Use LES to add value to ARM observations
  - Self-consistent representation of the atmosphere
  - Provide a dynamical context for the observations
  - Elucidate unobservable processes & properties
- Generate a simulation library for researchers
  - Enable statistical approaches beyond single-case mentality
  - Provide tools necessary for modelers to reproduce the LES

What can you do with an Obs+LES library?

- As an observationalist
  - Inform instrument remote sensing retrievals
  - Conduct Observation System Simulation Experiments (OSSEs)
  - Test implications of radar scan strategies or flight paths
- As a theoretician
  - Get estimates of fluxes & co-variability of values
  - Test relationships w/o having to run the model yourself
- As a modeler
  - Know ahead of time which days have good forcing
  - Have co-registered observations at high-resolution scales
  - Have inputs and corresponding outputs to test parameterizations

Learning to walk before we run

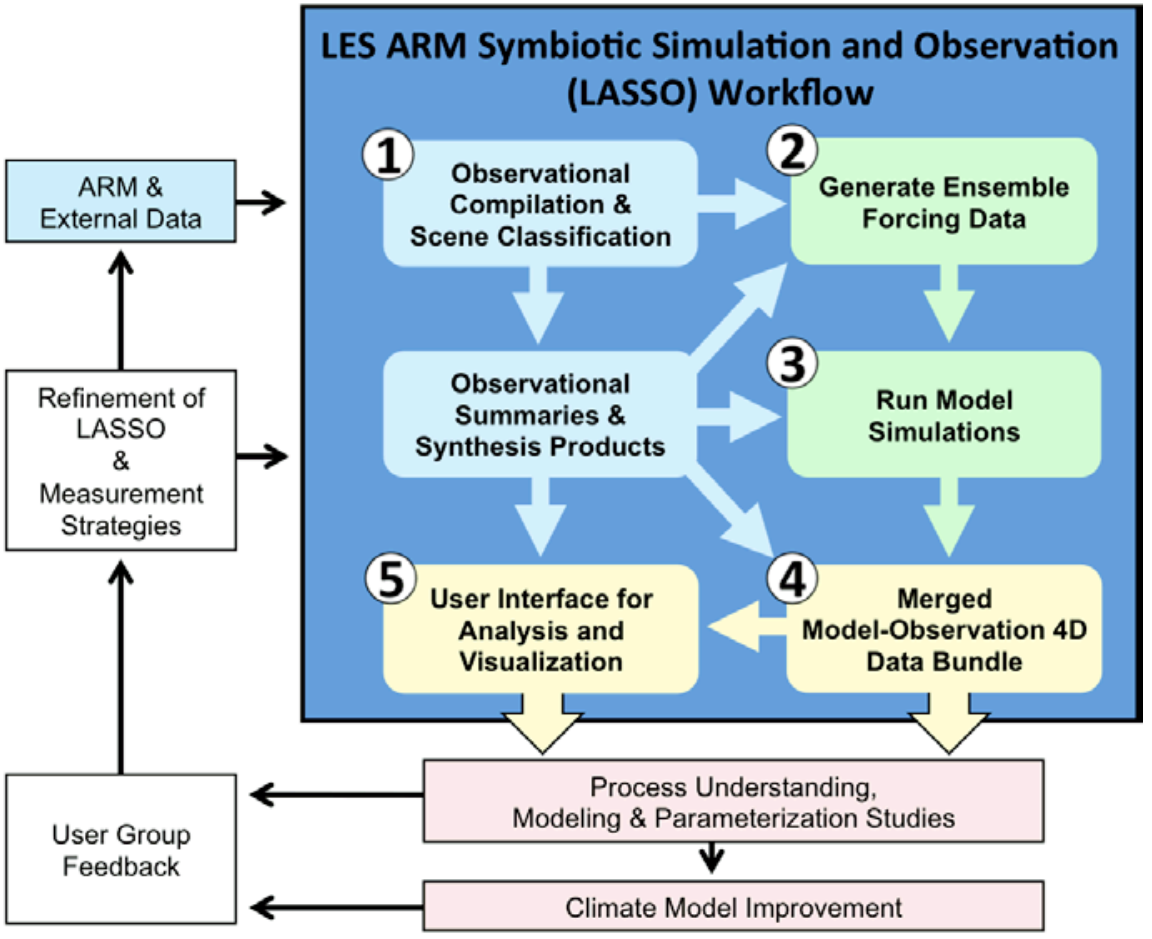
- Initial implementation is a proof-of-concept and targets shallow convection at SGP
  - Develop the ARM infrastructure for doing routine LES
  - Test interfaces and visualization methodologies for accessing the LASSO library
- Long-range vision is to later expand to multiple ARM locations and additional cloud regimes

The road to LES at SGP

Goal of running routine LES for shallow convection in 2017

The 2-yr LASSO pilot project

- Modular structure for flexibility and future growth
- Major focus on getting functionality in place and improving it over time
  - Implementing methods that already work
  - No time to experiment with untested methodologies



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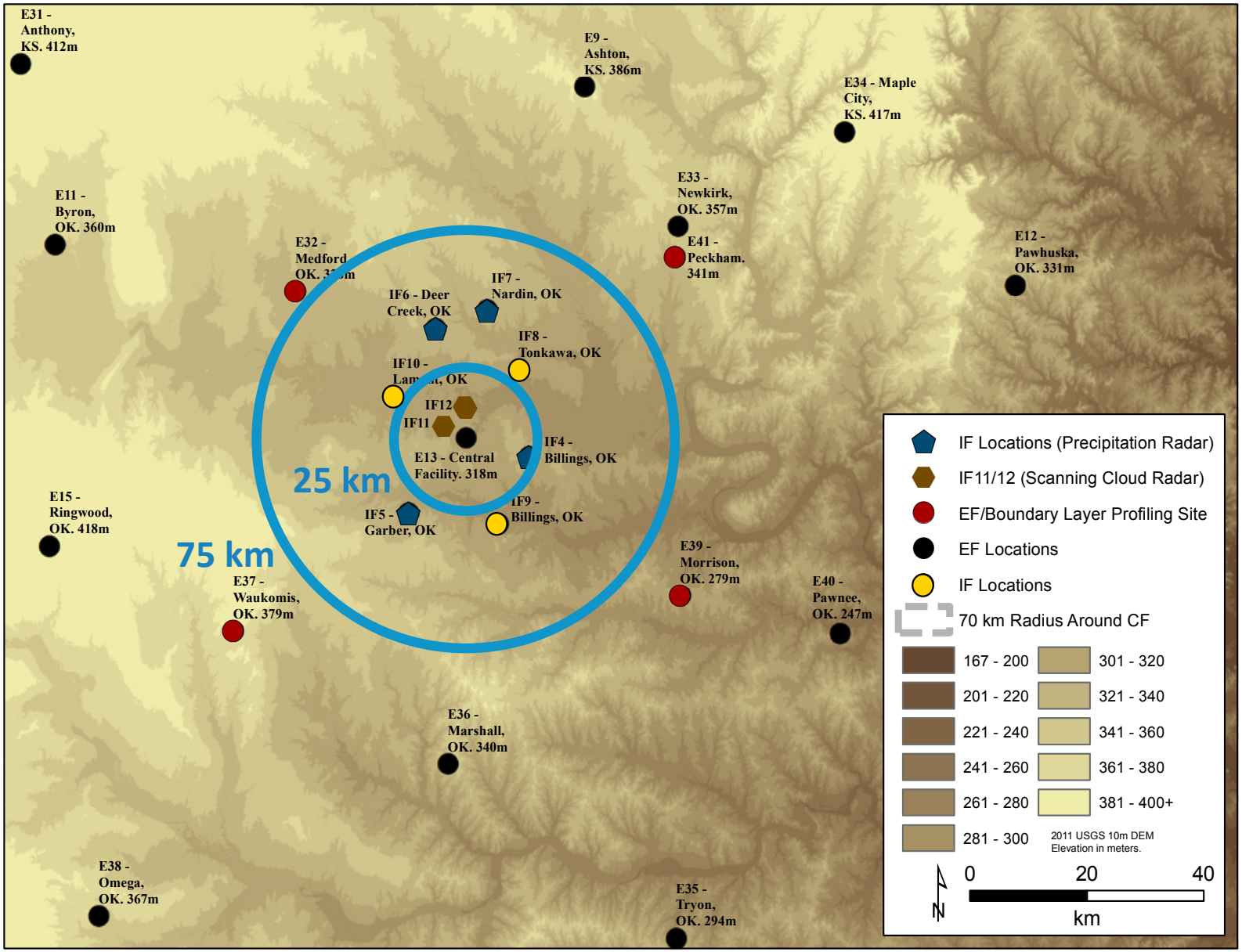
SGP Megasite Supports Integrated Measurements-Model Strategy

SGP Megasite Concept: a network of spatially distributed facilities designed to characterize the heterogeneity in atmospheric and land properties around the SGP site. This network addresses a range of science themes using an observations and modeling strategy.

Measurement Enhancements:

- Boundary Layer Profiling Modules (4 locations)
- Upgrades to AOS and Raman Lidar Instruments
- Improved soil moisture network (17 locations)
- Plans to deploy multiple scanning cloud radars

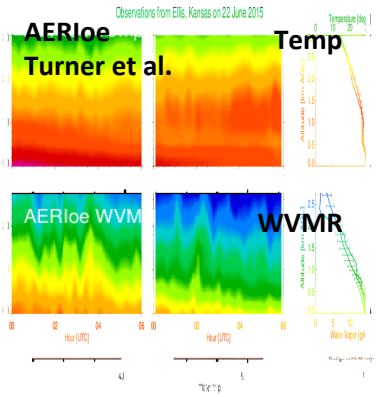
The Southern Great Plains Megasite

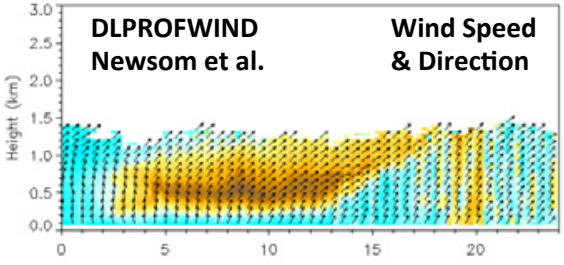


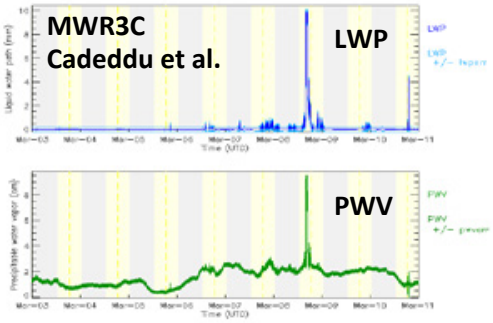
Boundary layer profiling sites

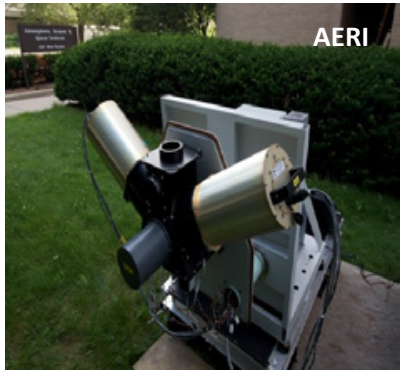
Enhance knowledge of spatial heterogeneity of state variables, fluxes, and soil properties.

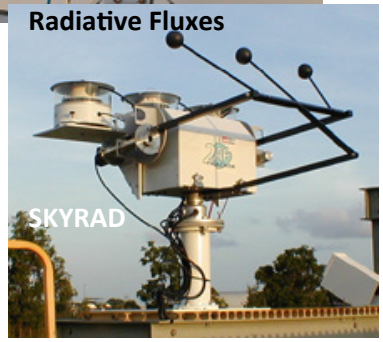
Improved Retrievals with Uncertainty Estimates





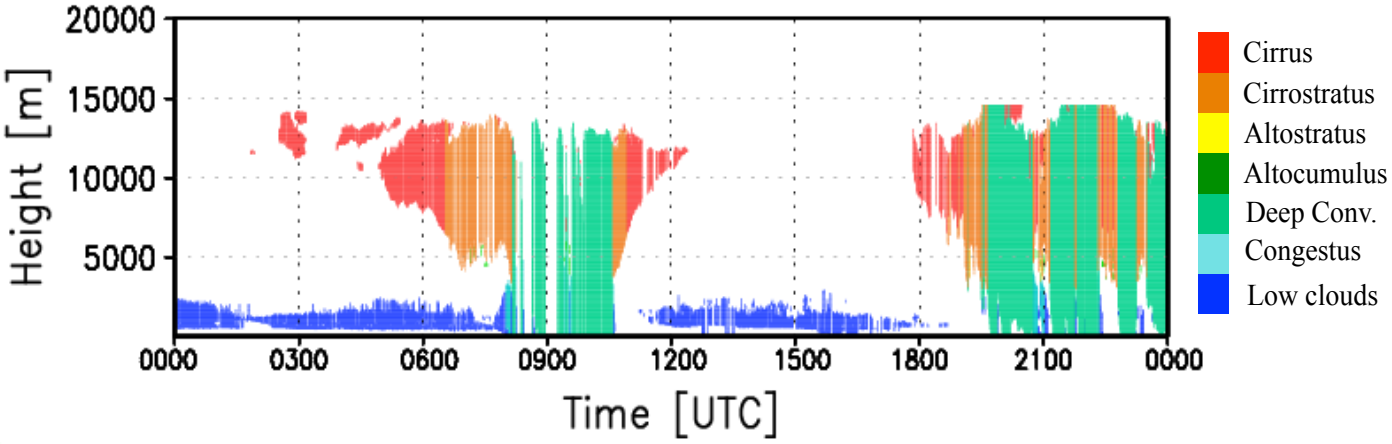






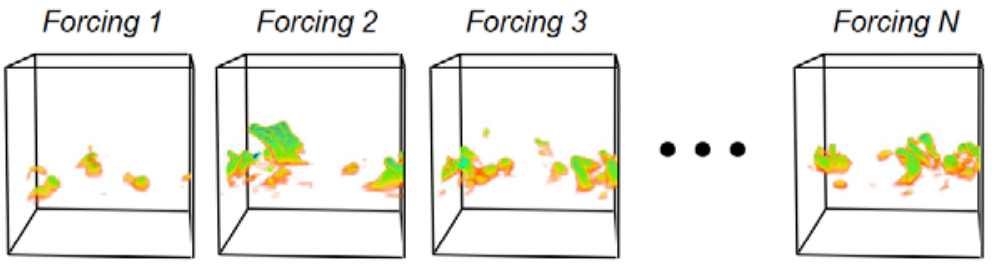
Situationally-dependent LES–not 24/7

- Simulations done when conditions are met
  - "Routine" instead of "operational"
  - 1–2 month lag time to account for needed VAPs and compute time
  - Contingent on available observations & presence of ShCu
- New cloud classification scheme by Sunny Lim



Ensemble of forcing datasets

- Employ forcing ensembles to address forcing uncertainty



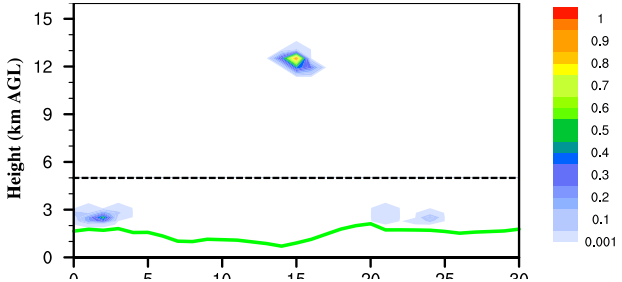
- Testing 3 forcing methods during pilot phase
  - ARM constrained variational analysis (VARANAL)
  - ECMWF-analysis–based forcing
  - Multi-scale data assimilation (MS-DA)
    - Based on WRF with GSI using two different error covariance scales
    - Initially using 3D-Var DA and plan to test hybrid EnKF DA

Multi-scale data assimilation

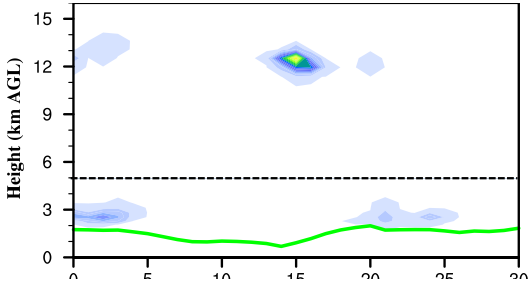
- Start with a gridded background field, e.g. FNL
- Incorporate ARM T, q, and wind profiles from boundary/intermediate facilities
- Provides a 3-D volume every 3 hours for generating LES forcing

Cloud Fraction from Δx=2 km MS-DA

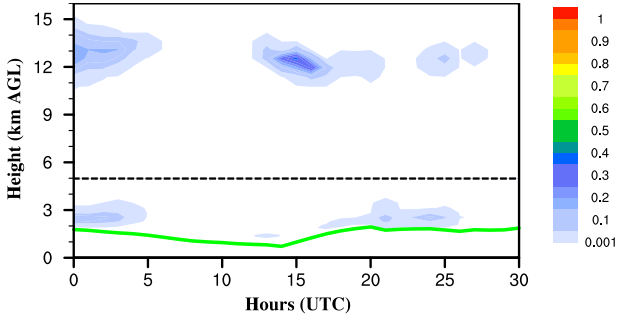
Averaged over 25 km



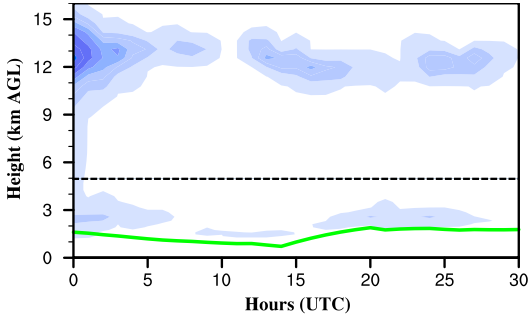
Averaged over 75 km



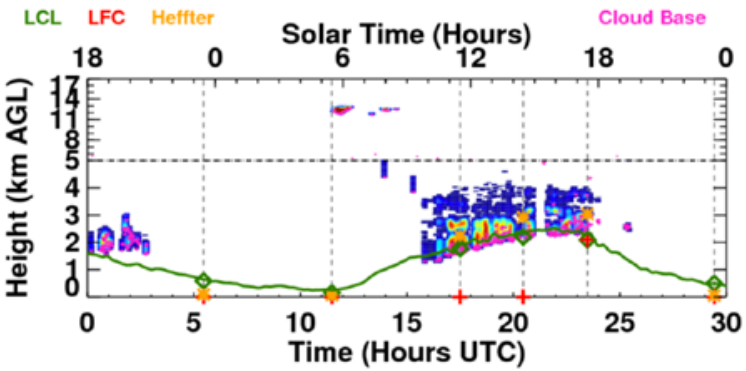
Averaged over 150 km



Averaged over 300 km

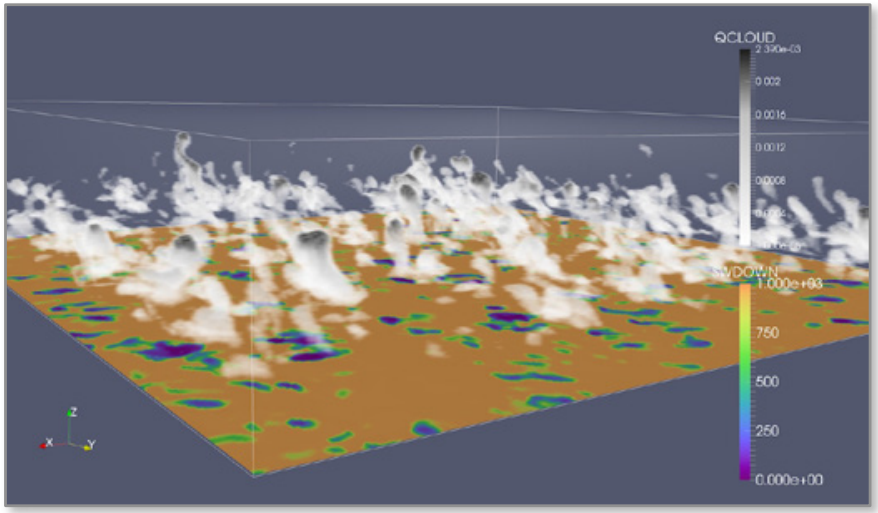


ARSCL Cloud Fraction

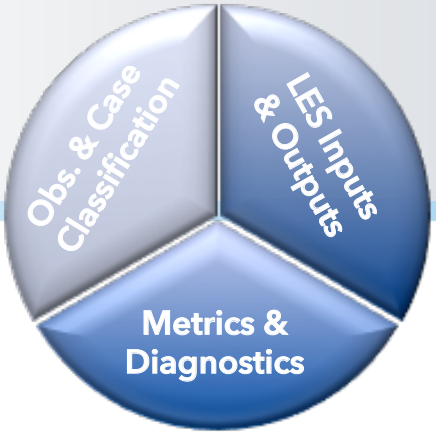


Model selection & configuration

- Evaluating both SAM & WRF during pilot phase
- Testing doubly-periodic & nested LES domains
- Initially targeting 25-km domain, Δx=100 m
- Current tests with model top near tropopause

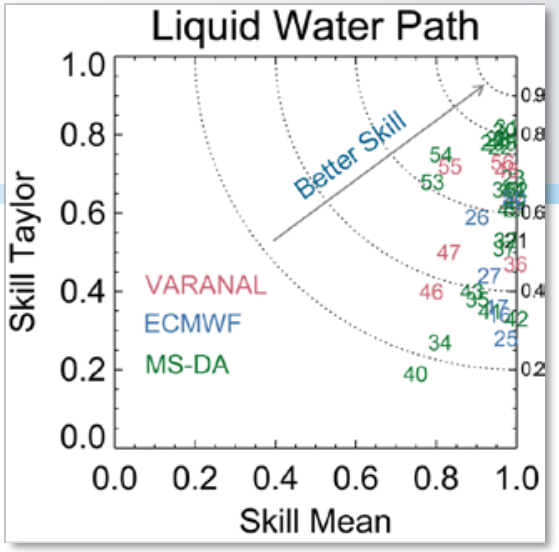


Data bundles



- Data bundles will provide the primary interface for LASSO data
- Contain observation & model output in comparable forms
  - Appropriate time sampling
  - Instrument simulators
- Include pre-computed quick-looks, metrics, and diagnostics to assist data discovery and quicken user analysis
- Include 3-D model fields, profile statistics, model-based budget terms, and GCM parameterization terms.
- Forcings and initial conditions provided for users to conduct their own sensitivity studies.

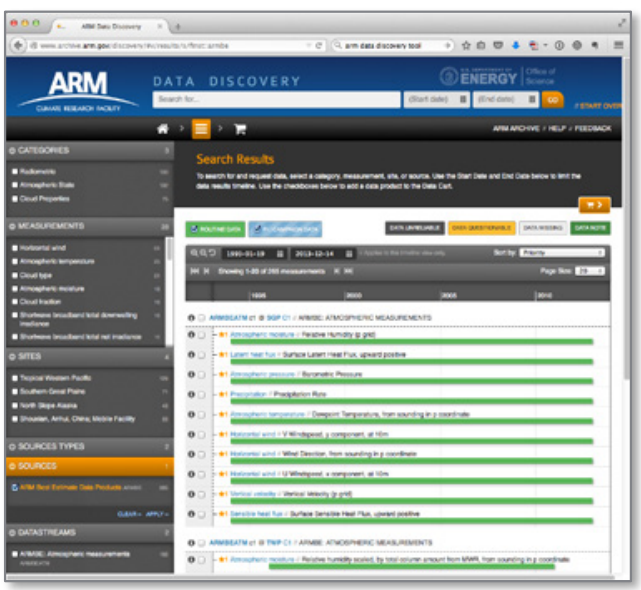
Data bundle metrics

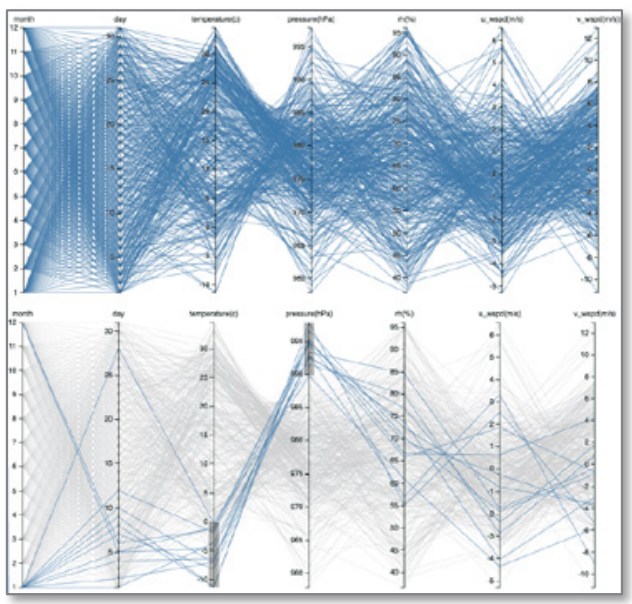


- LES simulations assessed using diagnostics based on ARM observations of cloud and environmental properties
  - E.g., Time series, Regression analyses, Taylor diagrams, Heat maps, and Phase space relationships
- Skills scores based on the diagnostics will quantify the quality of the simulations
  - e.g., LWP, cloud fraction, temperature, water vapor concentration, relative cloud forcing, vertical velocity, etc.
- Searchable metrics will assist users in finding cases of interest.

Data discovery

- Search on metric values and selected conditions
  - Evaluating ways to search based on model-observation agreement and case descriptors
- Testing methods to permit robust search capabilities and on-the-fly event comparison
  - E.g., Cassandra NoSQL database
  - Tiered levels of complexity with user needs and sophistication





Data access & software tools

- Reproducibility is paramount
  - Will provide all workflow software, model code, and configurations to enable others to reproduce the runs
  - Designing workflow to run on both ARM and other DOE computing facilities
- Goal of enabling easier data access/transfer from the ARM Archive via Globus

LASSO Timeline

May 2015	Pilot project began
June 2016	Initial ShCu simulations from spring-summer 2015 made available • Ensemble of forcings • LES simulations from SAM and WRF (bulk microphysics) • Observations in comparable form • First cut at metrics and diagnostics
January 2017	2nd batch of ShCu simulations from spring-summer 2016 • Will include influence of boundary facility profiles • Both bulk and spectral-bin microphysics versions
April 2017	Additional test cases for year-round shallow cloud conditions Beta software suite Recommended configurations for ongoing simulations
May 2017	Pilot project over and transition to routine simulation mode

Learn more about LASSO

- Breakout session, Wed. 7:30–9:30 p.m.
- Posters
  - 145: Gustafson, The LASSO Workflow Pilot Project
  - 147: Endo, LASSO Workflow: Ensemble forcings and LES sensitivity
  - 146: Vogelmann, LASSO Workflow: model-observation "data cubes"
  - 148: Comstock, Boundary layer profiling modules…
  - 137: Lim, Development of cloud-type classification algorithms…
  - 139: Kollias, Radar network approach to characterize ShCu at SGP
  - 138: Krishna, Large-scale data analysis and vis. for ARM using NoSQL
- Website:

  http://www.arm.gov/science/themes/lasso
- E-mail list: http://eepurl.com/bCS8s5