

Ensemble large-eddy simulation for the DOE Atmospheric Radiation Measurement Facility's

LES ARM Symbiotic Simulation and Observation (LASSO) project

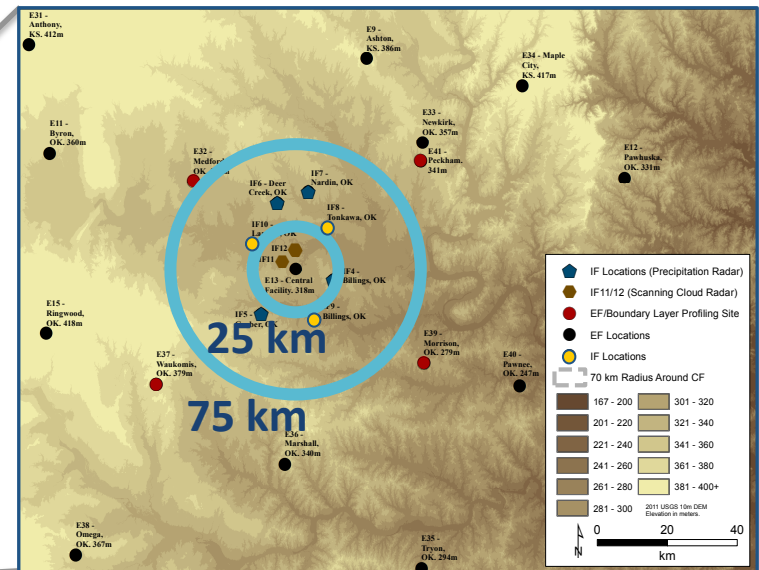
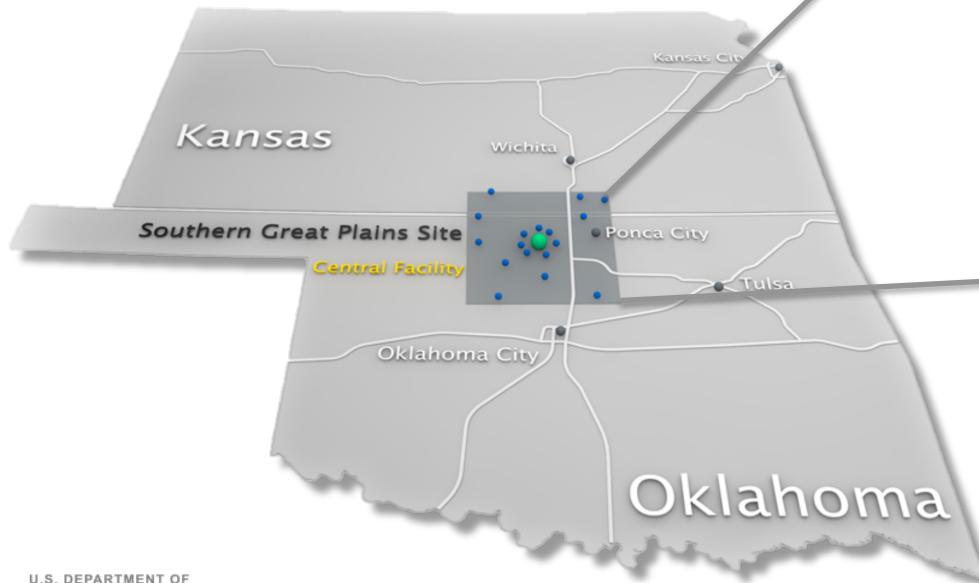
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UCLA: Zhijin Li, Xiaoping Cheng, Jinwon Kim

WRF Users' Workshop, Boulder, CO; 13-Jun-2017

ARM's Southern Great Plains (SGP) megasite

- **ARM** = DOE Atmospheric Radiation Measurement Climate Research Facility
- The SGP site is highly instrumented specifically for observing long-term meteorology, radiation, cloud, and surface conditions

ARM's Southern Great Plains Site in Oklahoma

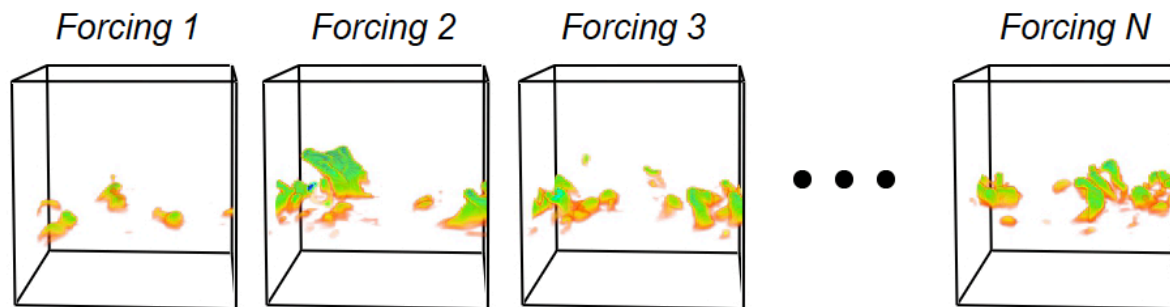


What is LASSO?

- **LASSO:** LES ARM Symbiotic Simulation and Observation Workflow
- **Goal:** The LASSO Workflow is designed to complement ARM megasite observations with LES output to support the study of atmospheric processes and the improved parameterization of these processes in atmospheric models
- **Approach:** Use an ensemble of LES combined with observations to simplify data discovery and bridge the gap from point observations to model grid cells; ARM will routinely run the LES for shallow convection days at SGP, building up a library of cases for researchers
- **Status:** In soft transition between pilot phase and routine operations

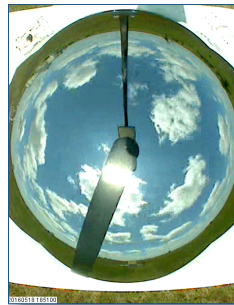
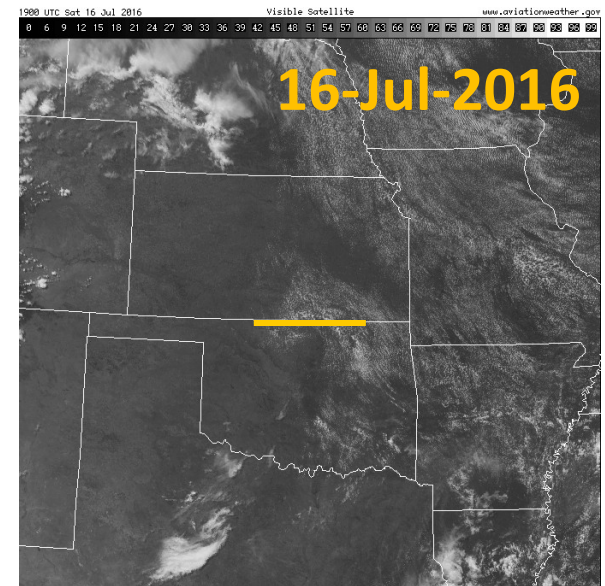
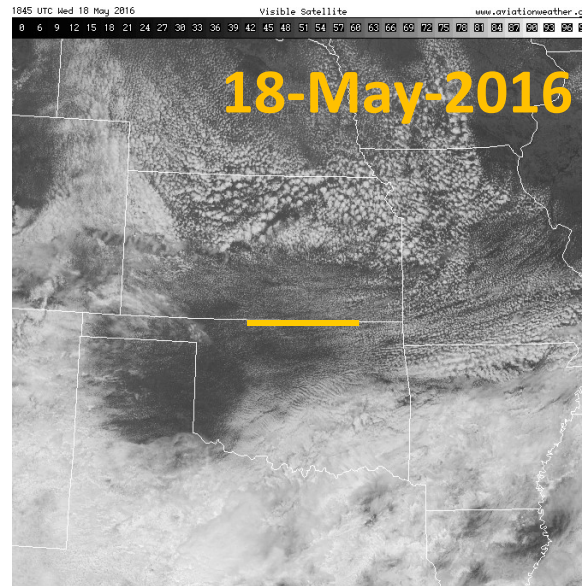
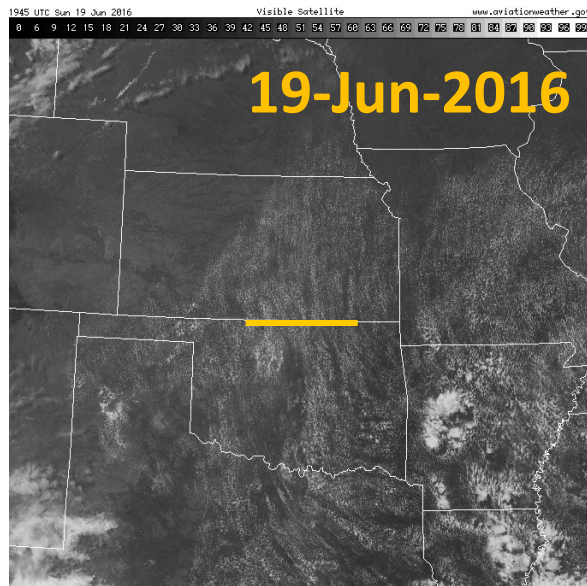
Why ensembles for hindcasting LES?

- Conceptually, a periodic LES domain generates a statistical representation of the clouds that would form given a specified forcing (surface fluxes & large-scale meteorological conditions)



- LES is a troublesome beast! Forcing uncertainty determines model results to zeroth order
 - ▶ Routine simulations cannot afford fine tuning of forcings as is done for case studies
 - ▶ A forcing ensemble increases the odds of getting things correct, combined with detailed metrics to identify "correct"

Shallow convection can occur in the midst of widely varying conditions



Yellow bar is approximately 300 km long, a commonly used forcing scale.

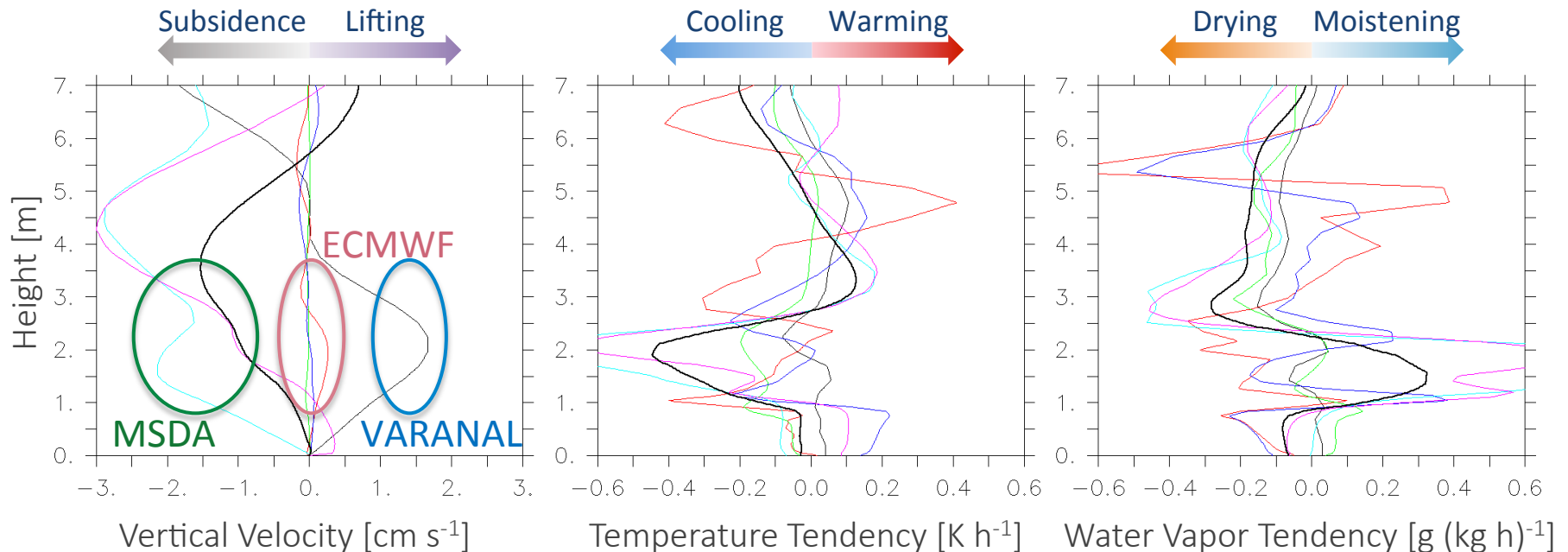
LASSO employs an ensemble of forcings to capture the range of possible conditions

- Large-scale forcing datasets generated from 3 sources
 - ▶ Variational Analysis: ARM product, 300 km spatial scale
 - ▶ ECMWF IFS model: ~16, 115, & 400 km spatial scales
 - ▶ Multiscale Data Assimilation (MSDA): 75, 150, & 300 km scales; can directly incorporate ARM observations into the analysis
 - Hybrid AERI+Raman Lidar T profiles
 - Raman Lidar Qv profiles
 - RWP wind profiles
 - Surface meteorology

Typical forcing ensemble displays significant differences

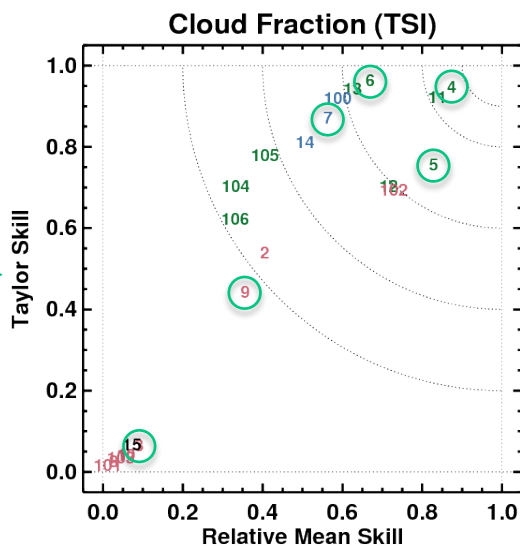
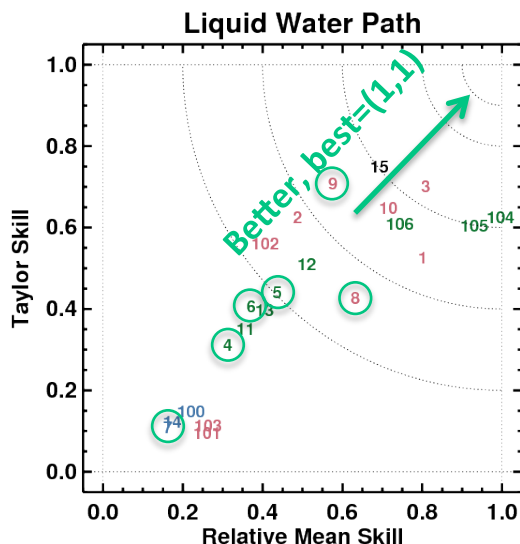
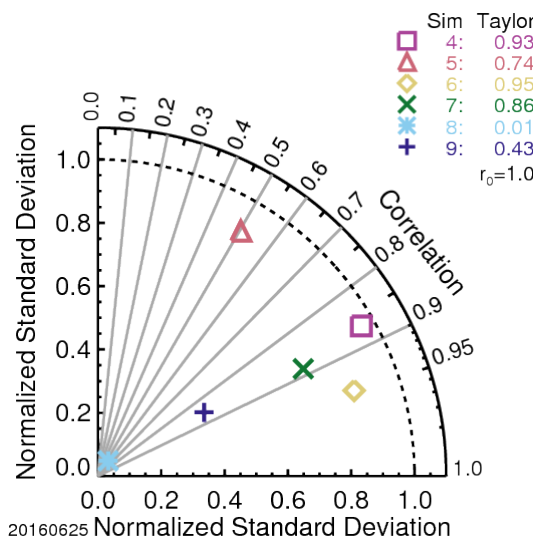
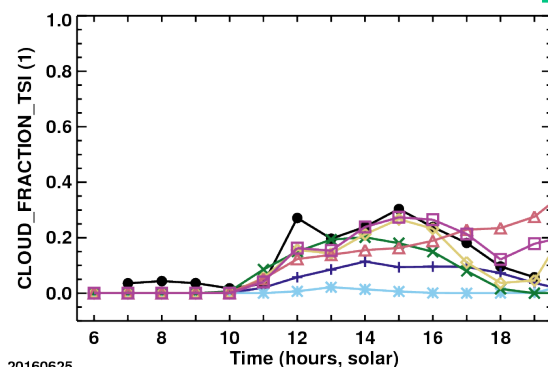
- Even the sign of the forcing differs between different forcing datasets...

Large-Scale Advective Tendencies, Ensemble from 25-Jun-2016 17 UTC



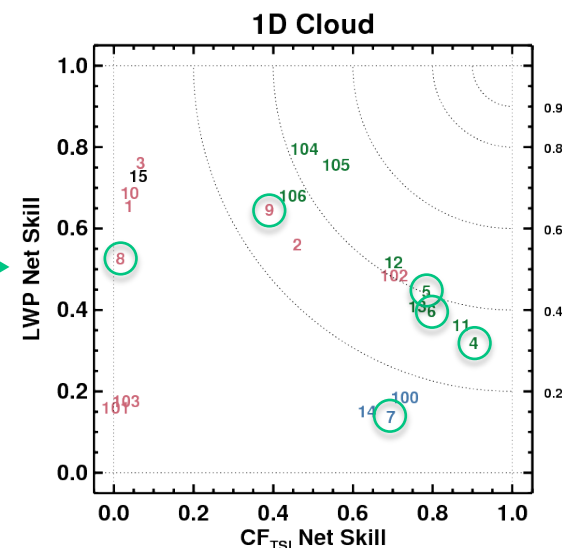
Metrics quantify the range of results to determine which forcing(s) is better

Case = 25-Jun-2016



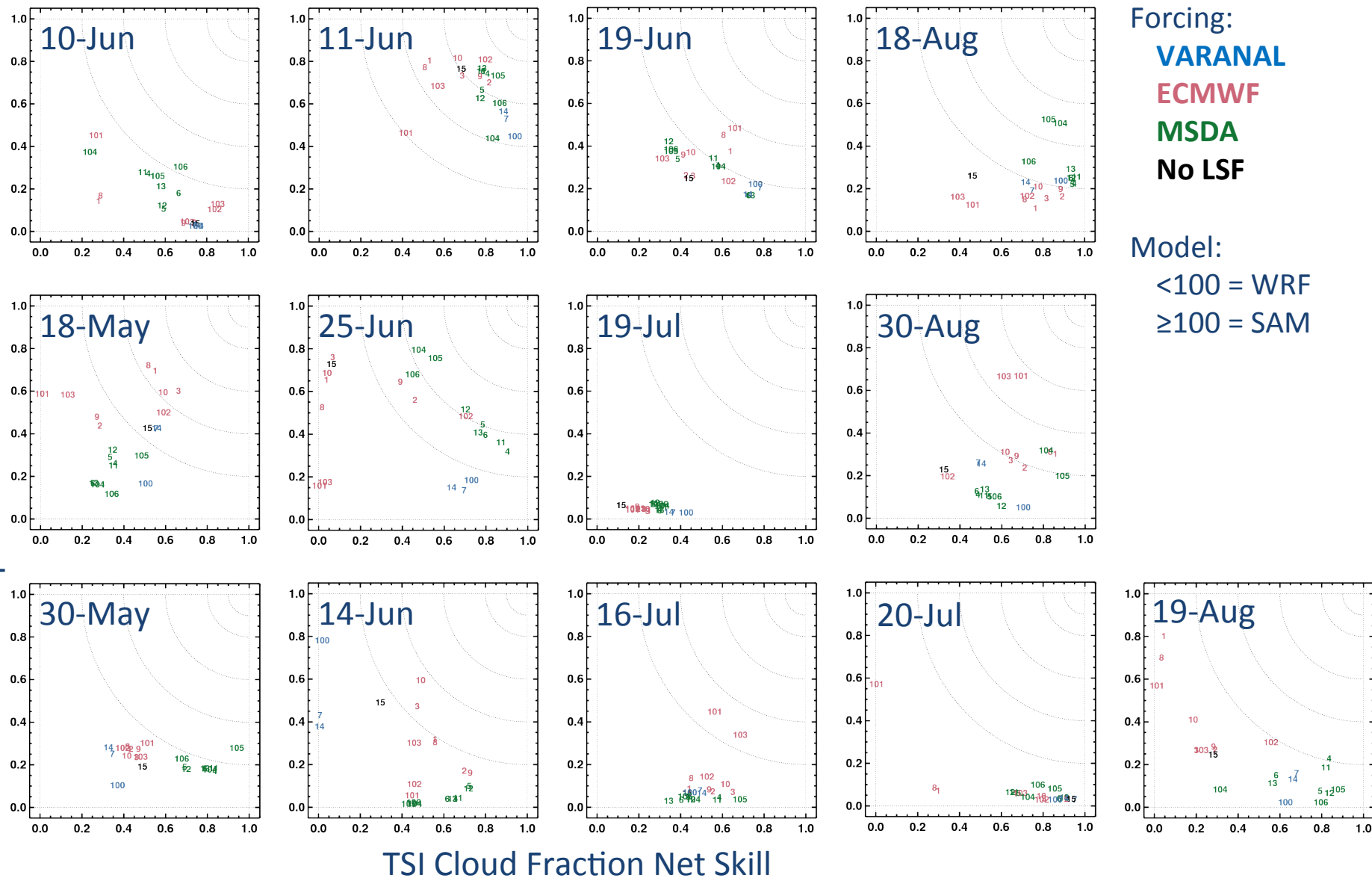
Forcing: **VARANAL**
ECMWF
MSDA
No LSF

Model: $<100 = \text{WRF}$
 $\geq 100 = \text{SAM}$



1-D cloud metric results for 2016 cases

Liquid Water Path Net Skill



NOTE: MSDA does not yet include ARM profile data.

Discover LASSO



- Top-level webpage: <https://www.arm.gov/capabilities/modeling>
- Bundle Browser interface: <http://www.archive.arm.gov/lassobrowser>
- E-mail list: <http://eepurl.com/bCS8s5>
- Contact: William.Gustafson@pnnl.gov or lasso@arm.gov

- Alpha 1 release currently available with 2015 cases (5 cases)
- Alpha 2 release available later this summer for 2016 cases (13 cases)

- Looking for feedback as we begin formal implementation later this summer
 - ▶ Still time to make adjustments, so check out LASSO and let us know what you think!

Extra...

http://archive.arm.gov/lassobrowser



DATA DISCOVERY LASSO BUNDLE BROWSER - VISUALIZATION & ACCESS

DATA DISCOVERY // LASSO HOME // ARM ARCHIVE // HELP // FEEDBACK

Introduction

Welcome to the LASSO Bundle Browser that is designed to assist users with identifying LASSO large-eddy simulations (LES) of interest for their research. The plots and associated data table update dynamically based on user search criteria, and links within the table enable direct access to order the data bundles of the displayed simulations. More information on LASSO and the data bundles can be found at the [LASSO home page](#) and on the [Alpha 1 Release web page](#). Note that this is an initial evaluation version of the browser that specifically queries and displays observed and simulated cloud properties for the five days worth of simulations released in the LASSO Alpha 1 release. There are 192 simulations between the five days that differ in terms of the LES model, forcing dataset, domain size, and model physics.

Select All

- Date
- Measurements
- Model Type
- Output Domain Size
- Number of Levels
- Large Scale Forcing
- Large Scale Forcing Scale
- Initial Condition
- Surface Treatment
- Microphysics

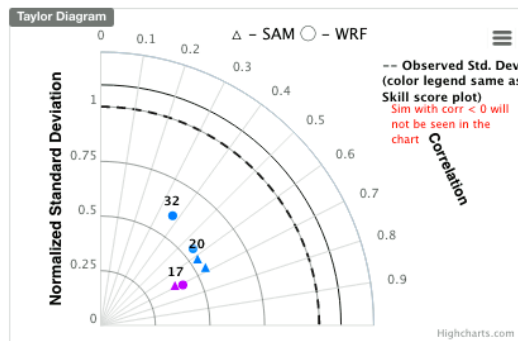
Submit

Overview Plots

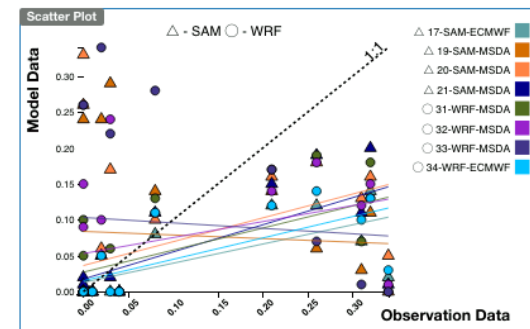
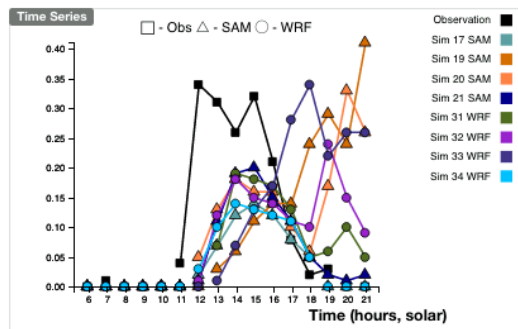
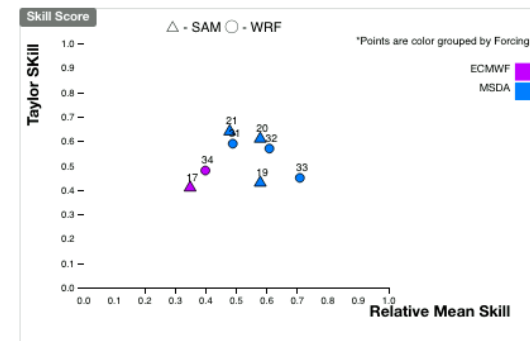
Heat Maps

Metrics

Date: June 9, 2015

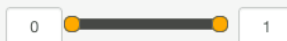


Measurement: Cloud Fraction TSI

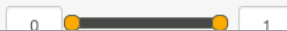


Skill Scores on June 9, 2015

Measurement Skill



1D Cloud Skill

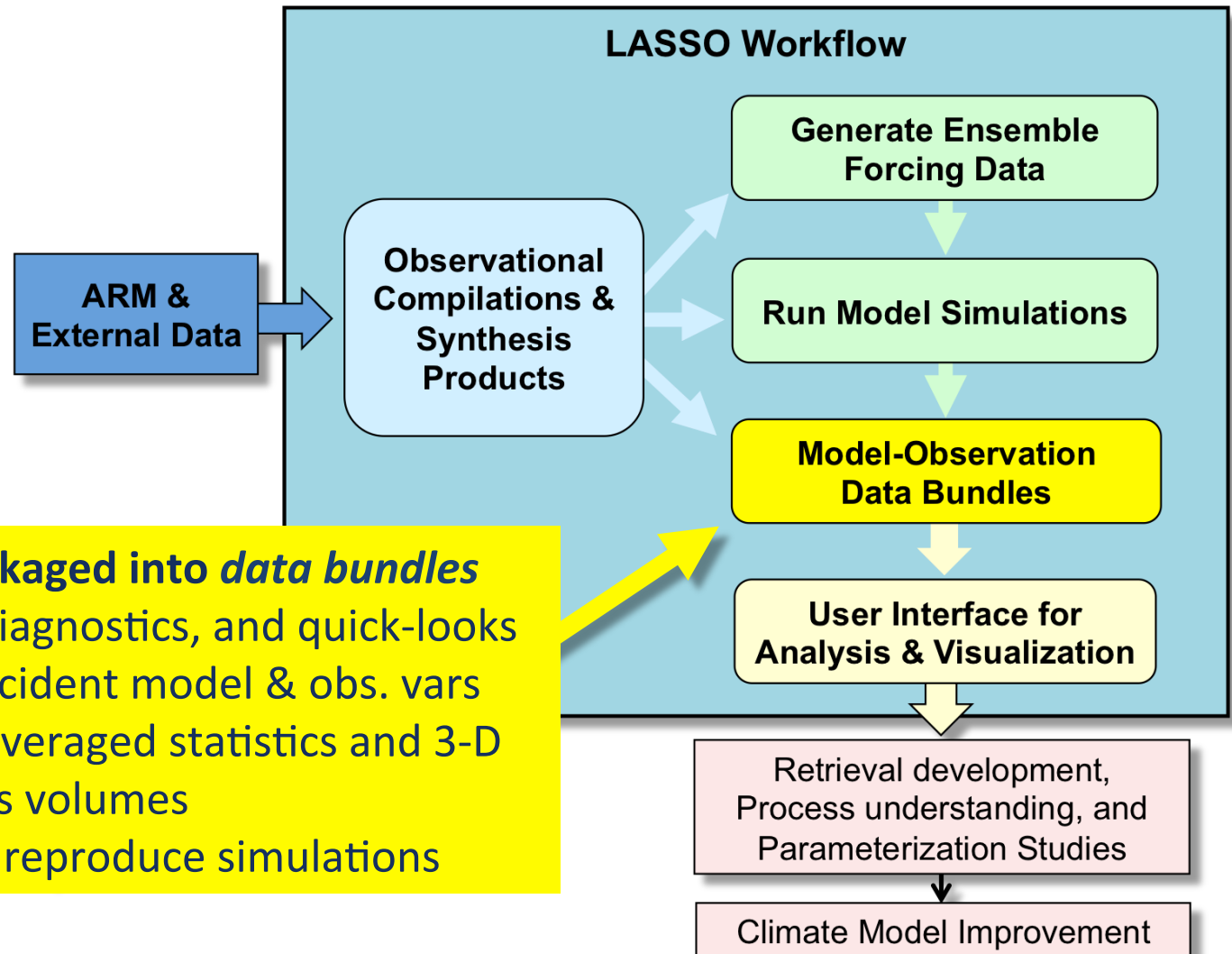


Copy CSV Print PDF

Search:

	Simulation ID	Measurement Skill (Cloud Fraction TSI)	1D Cloud Skill	2D Cloud Mask Skill	Total Cloud Skill
17	(Diagnostics) (Data)	0.38	0.5	0.23	0.34
19	(Diagnostics) (Data)	0.5	0.47	0.26	0.35
20	(Diagnostics) (Data)	0.6	0.67	0.28	0.43

LASSO's workflow for aiding research



Simulations packaged into *data bundles*

- Skill scores, diagnostics, and quick-looks
- Selected coincident model & obs. vars
- LES domain-averaged statistics and 3-D instantaneous volumes
- Input data to reproduce simulations