Routine Large-Eddy Simulations of Continental Shallow Convection and Megasite Observations at the ARM Southern Great Plains Facility
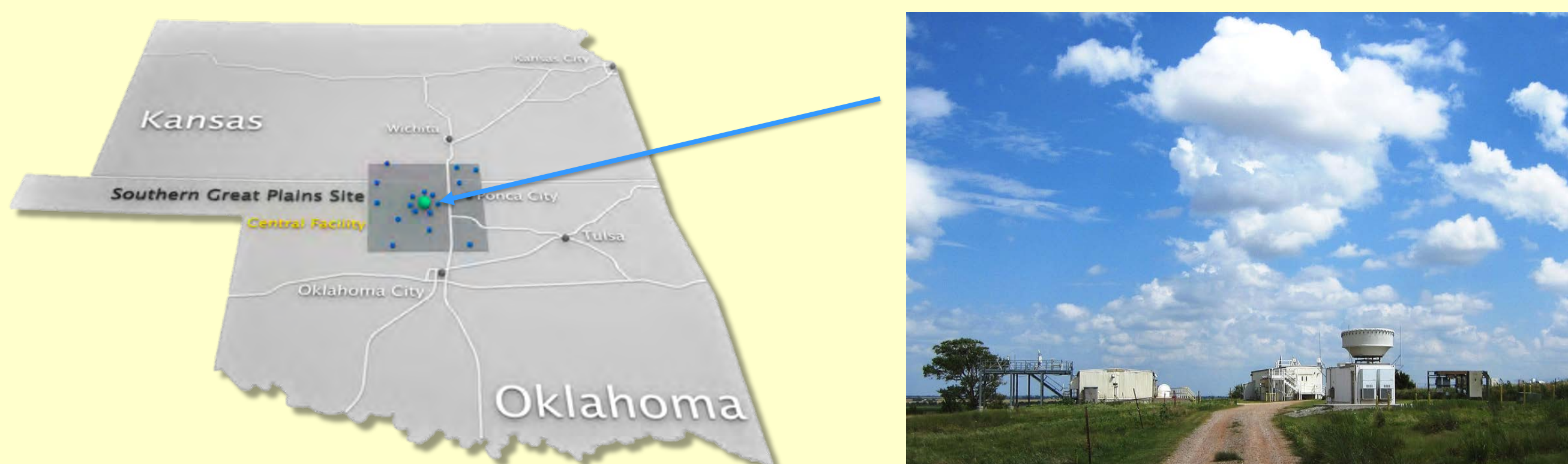
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ARM CLIMATE RESEARCH FACILITY

Summary

- Routine large-eddy simulations will be run at the U.S. Atmospheric Radiation Measurement (ARM) Facilities to complement its observations to support study of atmospheric processes and model parameterization improvement.

- ARM megasite observations will be used to drive and evaluate the simulations.

- The resulting library of "data bundles" will be freely available to the community, containing simulation output, inputs, evaluation data, and simulation skill scores.

- The effort called LASSO (LES ARM Symbiotic Simulation and Observation Workflow) begins with shallow convection at the ARM Southern Great Plains Site.

1. Objectives for LASSO Routine LES

- Help bridge the scale gap between ARM observations and models
- Add value to the observations
  - Provide self-consistent representation of the atmosphere (e.g., for covariances)
  - Provide *unobservable* processes and properties (e.g., budget terms)
- Generate a simulation library for statistical studies that go beyond single-cases
  - Provide information needed by modelers to run their own simulations

2. Ensemble Simulation Configuration and Approach

- Model Configuration
  - Evaluating SAM and WRF
  - Configuration:
    - Doubly-periodic domains
    - Δx=100 m, Δz=30+ m to tropopause
    - Environmental specifications
      - 12Z radiosonde, Surface fluxes (from obs or sim), Large-scale tendencies

- Models run in hindcast mode using ensemble forcings
  - Routine LES cannot afford to tune forcings as is done in case studies
  - The ensemble aims to bound the realizations with metrics to evaluate

- About 30-40 simulations are run per case day varying:
  - (a) Model type, (b) Forcing type, (c) Surface flux source, (d) Microphysics

3. Ensemble Forcings from Three Sources

1. ARM constrained variational analysis (300 km scale)
2. ECMWF-analysis-based forcing (16, 114, 413 km)
3. Multi-scale data assimilation (MS-DA) (75, 150, 300 km)
   - WRF-based using Gridpoint Statistical Interpolation (GSI) system
   - Scale separation to combine observations at coarse & fine scales
   - Initially using GSI w/ 3D-Var DA and will test hybrid EnKF DA
   - Can directly incorporate ARM observations
     - Hybrid Raman Lidar+AERI-retrieved T profiles
     - Raman Lidar Qv profiles
     - RWP wind profiles
     - Surface meteorology network

Forcing 1   Forcing 2   Forcing 3   • • •   Forcing N

4. ARM Southern Great Plains Megasite Observations

- Routine LES is supported by new instruments and measurement sites.
- Measurements are used to drive and evaluate the simulations.
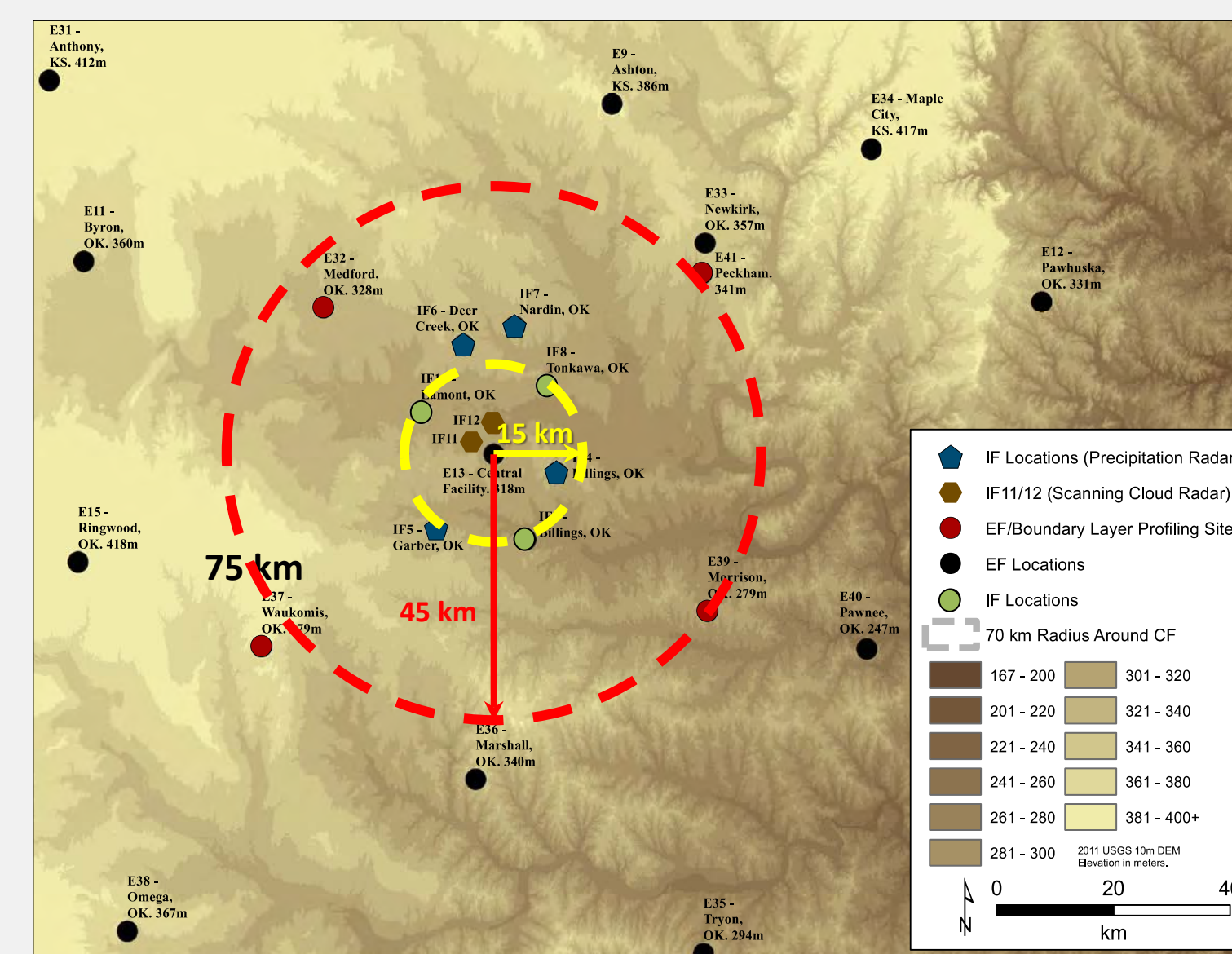
Central Facility (Primary site)
Extensive cloud, meteorology, radiation, surface flux, and aerosol obs including:
Raman lidar (T&Q profiles), Cloud radar and lidar and stereo cameras (vertical cloud boundaries)

15-km Ring (3 sites)
Includes Radar Wind Profilers (BL winds and PBL top)

45-km Ring (4 sites)
Includes Doppler Lidar (cloud-base height, cloud fraction, mass flux), IR Spectrometer & MWR (LWP), and surface fluxes
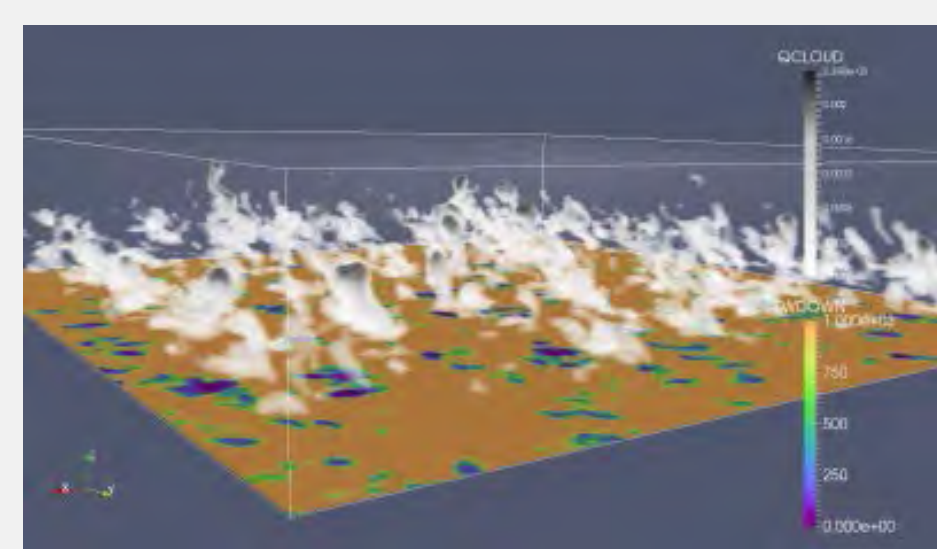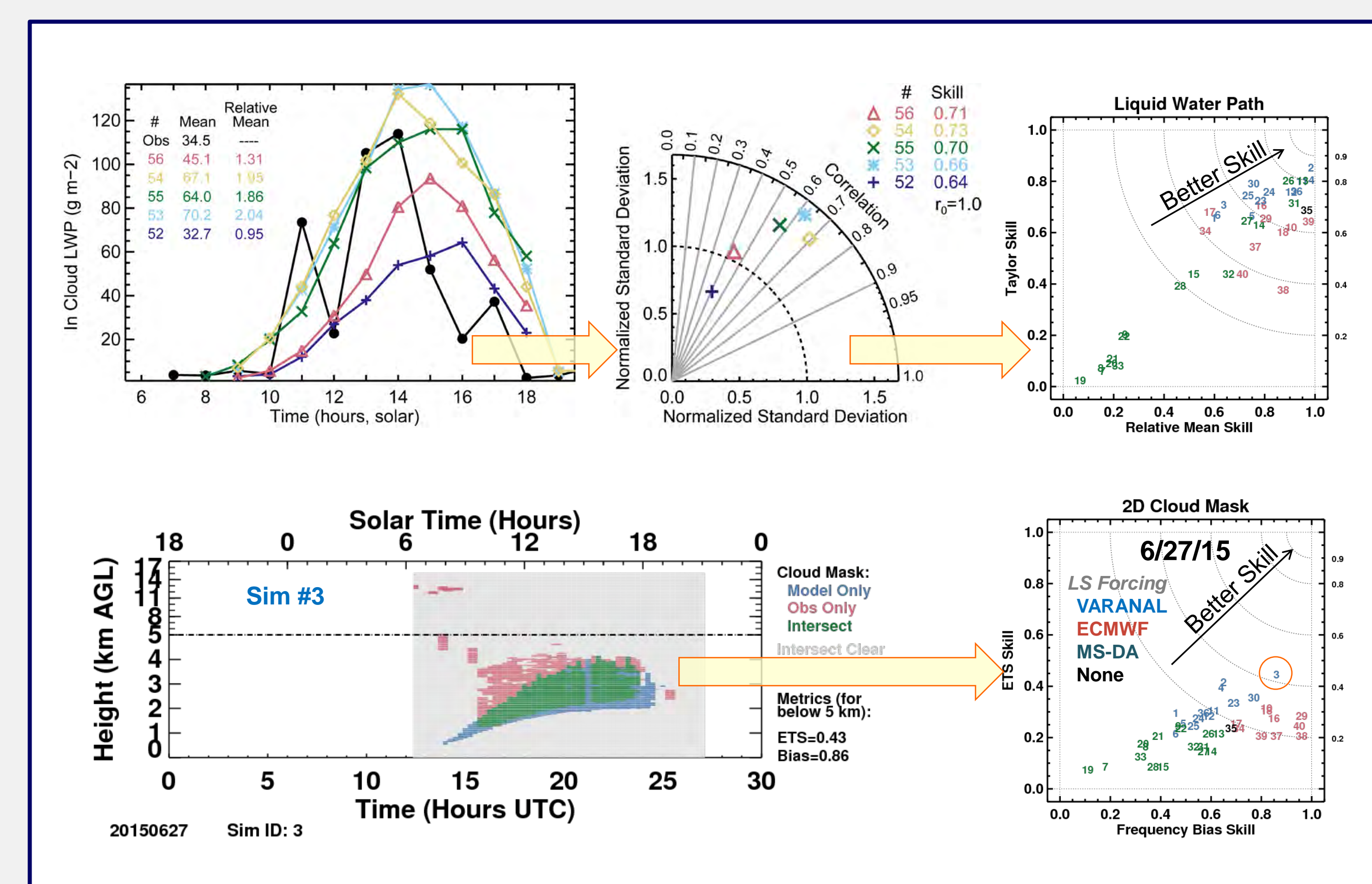
Met stations
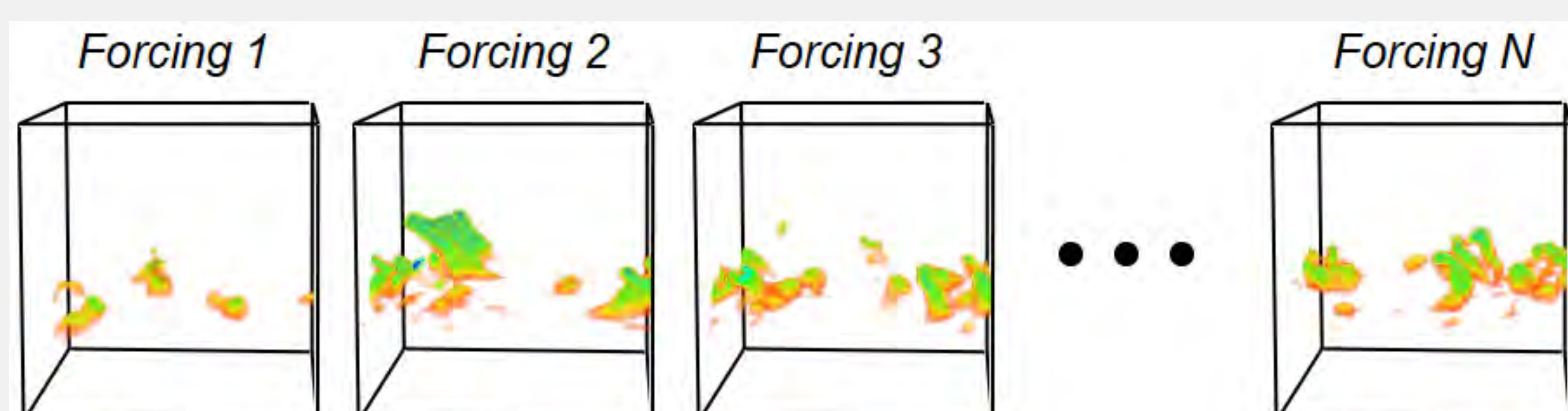Many scattered across the region

5. Simulation Skill Metrics

- Skill scores are used to rank the veracity of the simulations for many variables:
  - Horizontal cloud fraction, time-height cloud fraction profiles, LWP, Cloud-base height, LCL, surface and mid-BL thermodynamic (T, Q, RH)
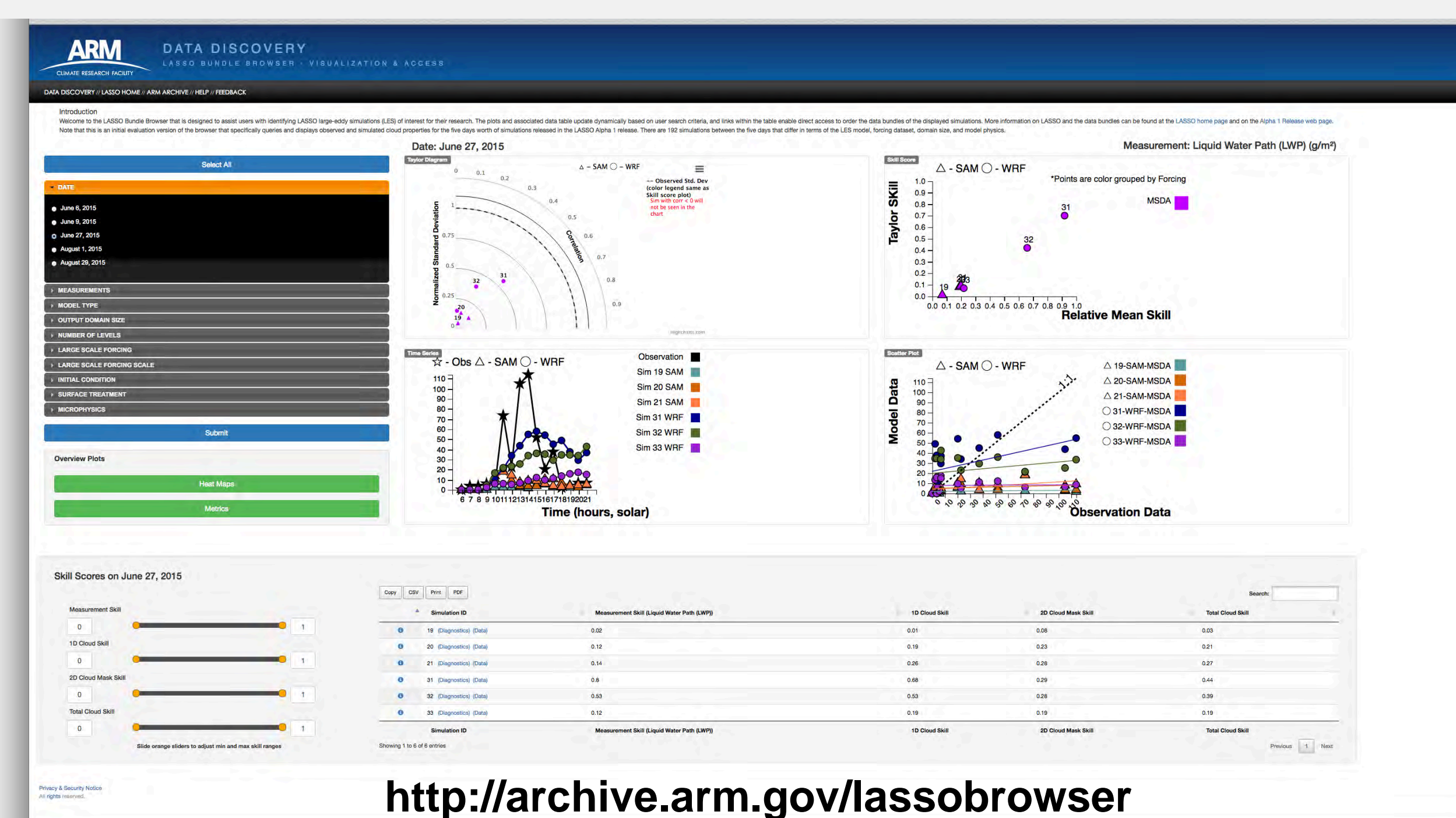- Diagnostic plots are also provided

6. Finding Cases You Want: The LASSO Bundle Browser

- Enables interactive plotting and sorting to find simulations of interest

http://archive.arm.gov/lassobrowser

7. Data Releases & Planning

- Alpha 1: 5 ShCu days in 2015 (~38 simulations each)
- Alpha 2: 13 ShCu days in 2016 (~32 simulations each)
- Summer 2017: Soft transition of LASSO to operations
- 2018: Determine next site/phenomena to be simulated