Shallow Cumulus Cloud-Base Vertical Velocity I: Difference Between Simulations and Observations

Poster #217

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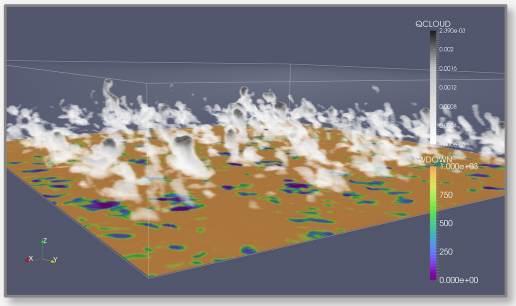


Coupling Mechanistically the Convective Motions and Cloud Macrophysics in a Climate Model (CM)[4]

A Climate Model Development and Validation (CMDV) Project

Single Stereo Camera View

Courtesy of Rusen Oktem

Objectives

- **Observe statistics of cloud-base vertical velocity at the SGP**
  - Based on network of 5 Doppler Lidars
- **Use observations to test large-eddy simulations**
  - Use newly available ARM routine large-eddy simulations

LASSO Large-Eddy Simulations

- **LASSO: LES ARM Symbiotic Simulation and Observation Workflow**
  - LASSO designed to complement ARM observations with routinely run LES
  - Currently run at the SGP for shallow convection

- **Key LASSO Features**
  - Ensemble forcings: 3 Sources plus different forcing scales
  - Routine simulations → Generate a simulation library for researchers
    - Enable statistical approaches beyond single-cases
    - Provide information needed by modelers to reproduce the LES

- **Further LASSO Information**
  - Poster #77 by Gustafson et al. [B1]
  - LASSO Breakout: Thursday, 10:45 am – 12:45 pm [Great Falls]

Methods

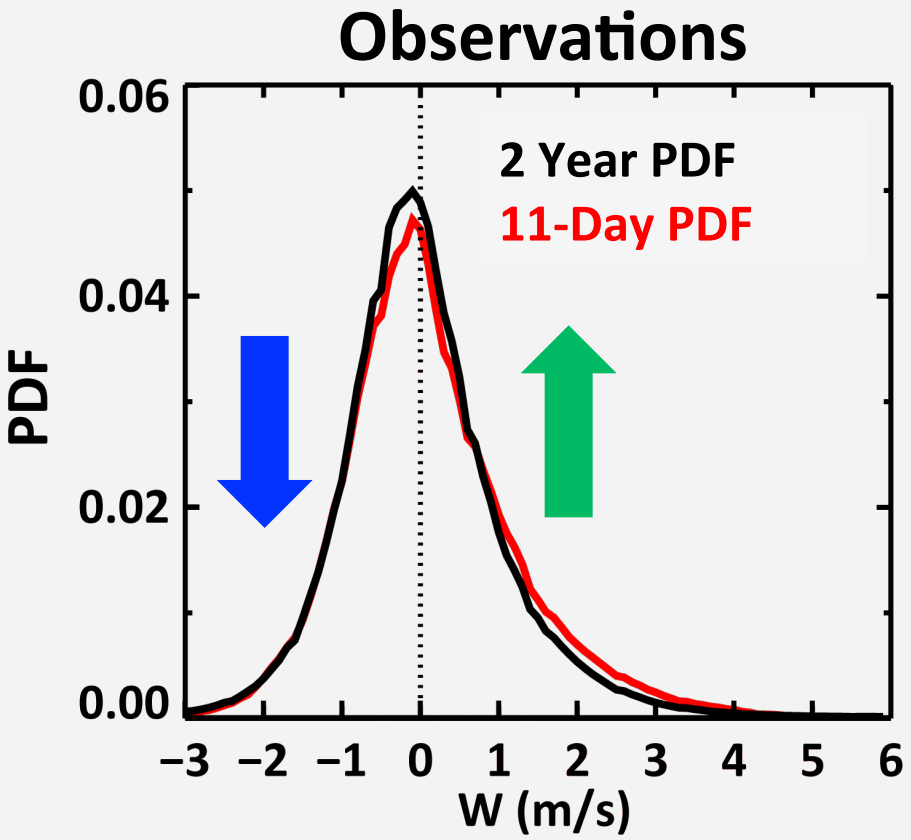
Observations

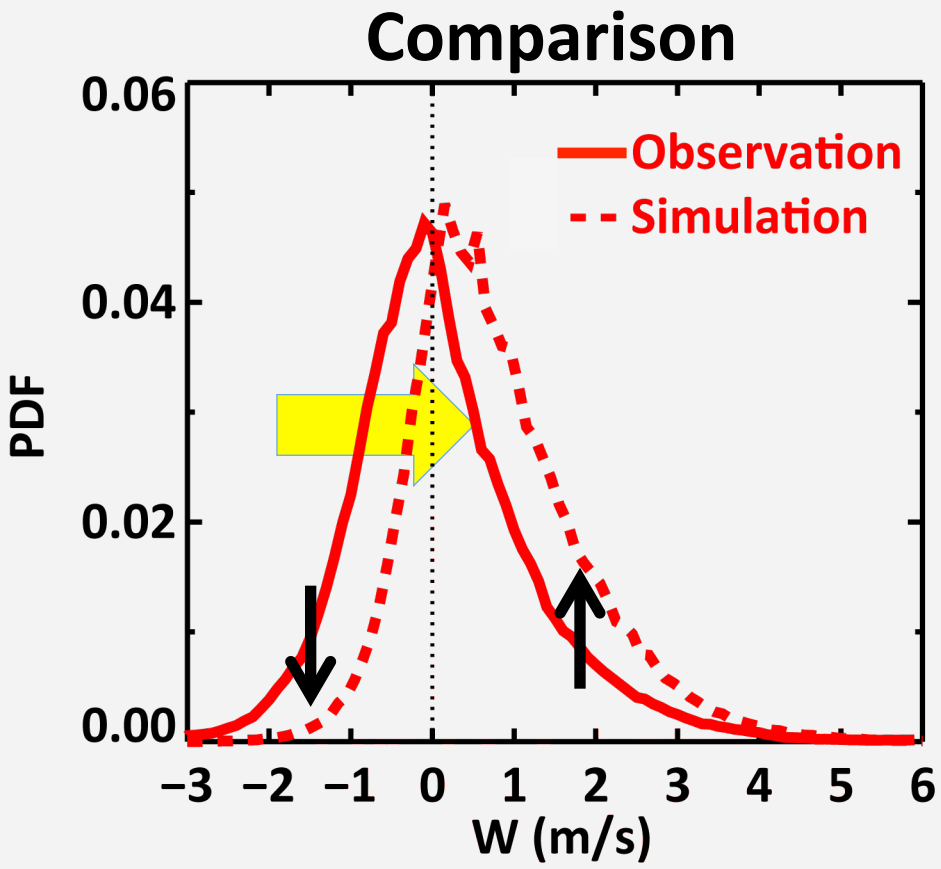
- Doppler Lidar data
  - 5 sites: May-September in 2016 and 2017
- Fair-weather shallow cumuli identification
  - Follows Lamer and Kollias (2015), similar to Zhang and Klein (2010, 2013)

LASSO Simulations

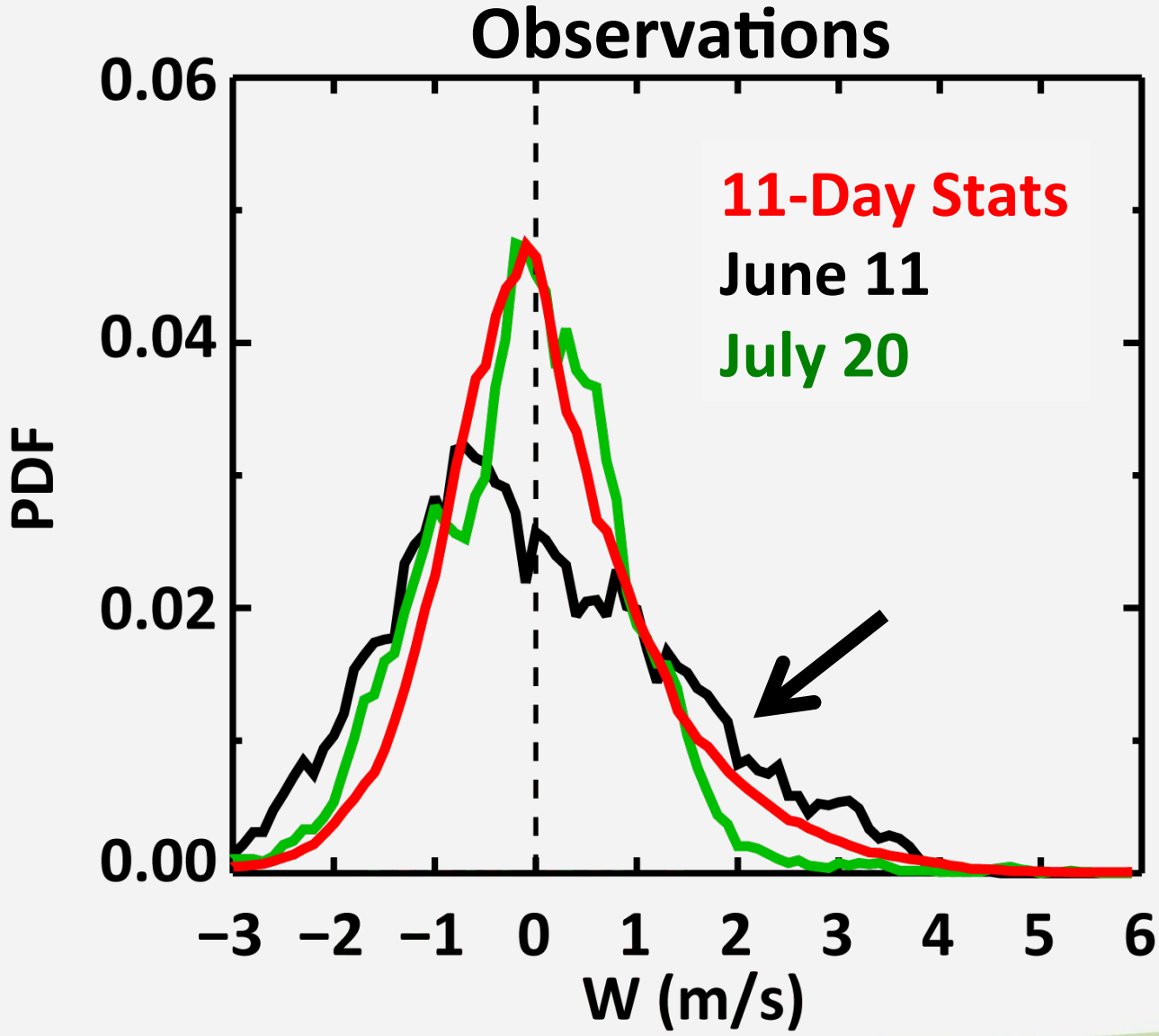
- Alpha 2 release for 2016 Cases
  - WRF simulations: 14.5 km domain, Doubly periodic lateral boundaries
  - Δx=100 m, Δz=30 m in the boundary layer
  - Forced with ARM VARANAL and observed surface fluxes

Observed and Simulated Cloud-Base Vertical Velocity

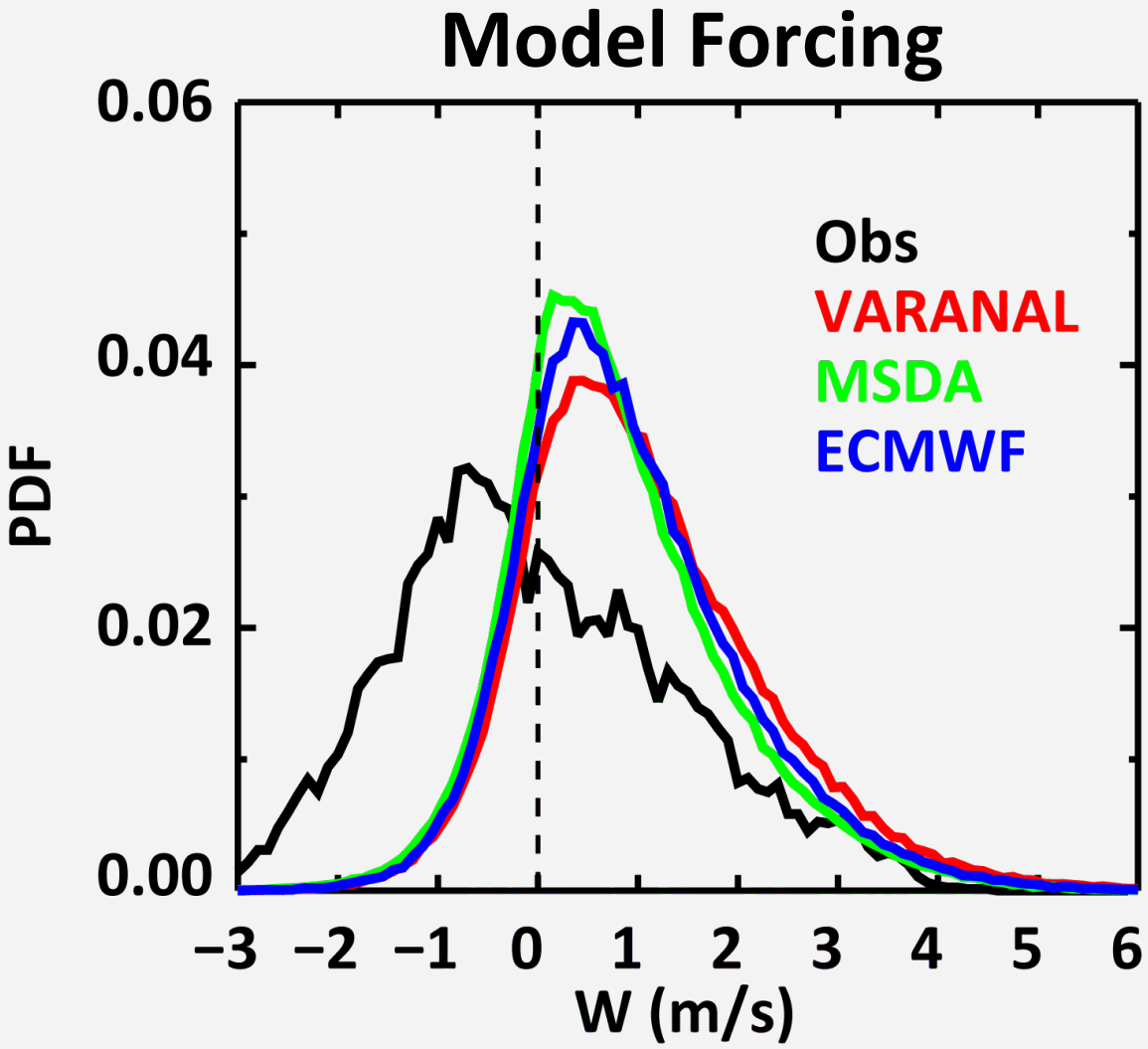




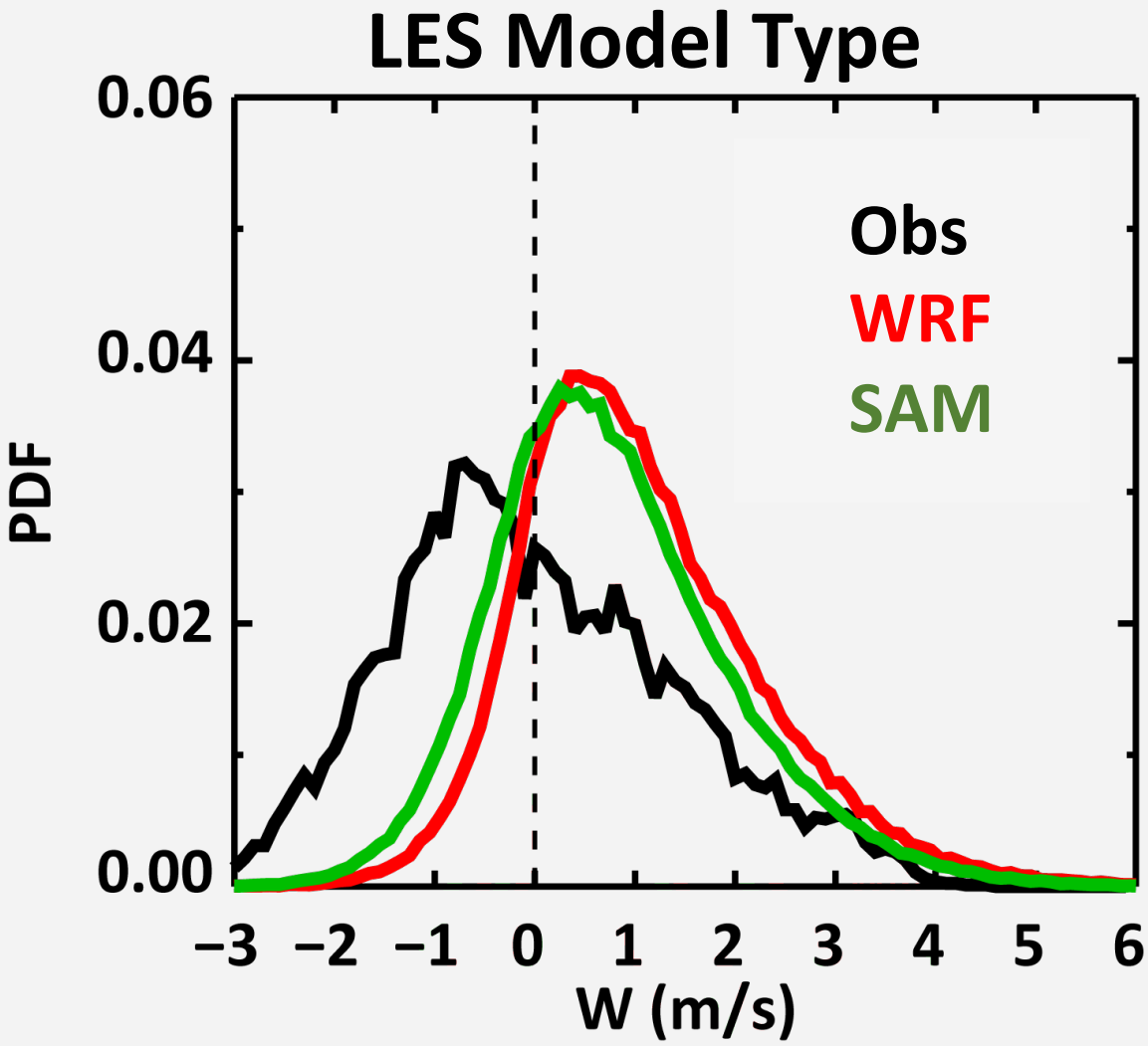
Daily Cases


Observations
11-Day Stats
June 11
July 20
PDF
0.06
0.04
0.02
0.00
−3 −2 −1 0 1 2 3 4 5 6
W (m/s)

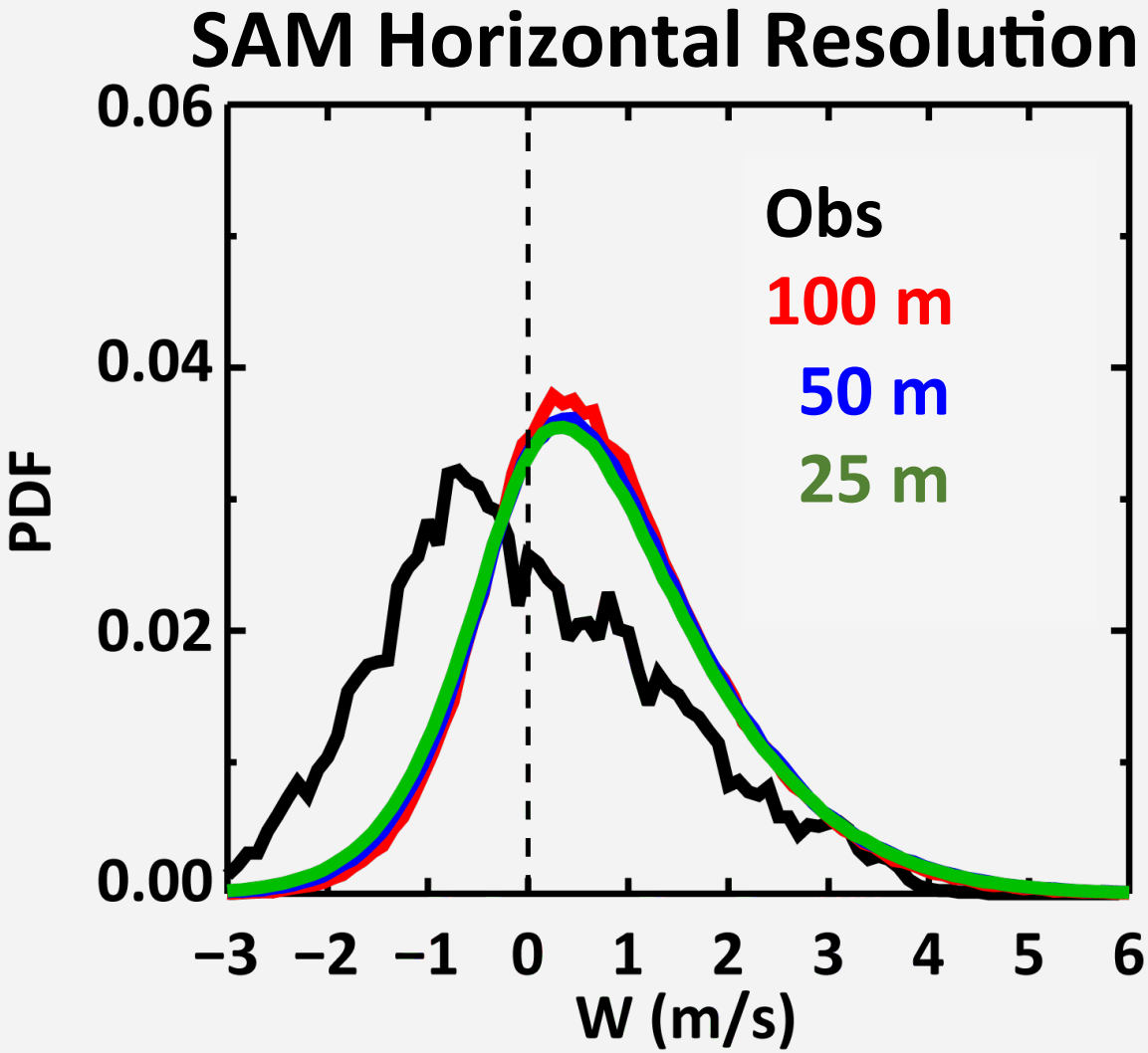
LASSO Sensitivity Tests for 11 June



LASSO Sensitivity Tests for 11 June



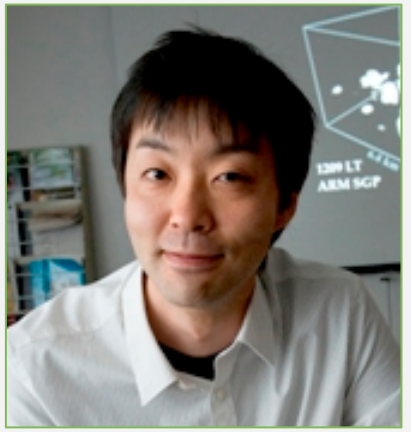
LASSO Sensitivity Tests for 11 June



WRF Sensitivity Tests

Variations on LASSO control configuration

- **Endo et al. Poster #218 [A2]**
- **Possible improvements from:**
  - Spectral bin microphysics
  - Include model drizzle/rain (if/when present)
- **Other tests did not alter the PDF**
  - WRF horizontal grid spacing
  - Horizontal wind/shear
  - Subgrid-scale turbulence representation
  - Positive-definite vs monotonic transport advection options
  - Aerosol number concentrations
  - Moist saturation adjustment process factor
  - Supersaturation factor
  - Cloud water removal threshold in subsaturated air
  - Radiation scheme
  - qc threshold values for sampling



Satoshi Endo

Summary

- **Current Results**
  - Observations suggest LES to be shifted towards more updrafts
  - Not a clear smoking gun:
    - Use spectral bin microphysics
    - Maybe inclusion of model drizzle (if/when present)
- **Further Work**
  - Additional checks on apples-to-apples model-observation comparison
  - Check aircraft vertical velocity observations (RACORO, HI-SCALE)
  - Modeling tests: Interactive land-surface model, Nested simulations
- **Related posters and sessions**
  - Vogelmann et al.: #217, A2
  - Endo et al.: #218, A2
  - Gustafson et al.: #77, B1
  - LASSO Breakout: Thursday, 10:45 am – 12:45 pm [Great Falls]