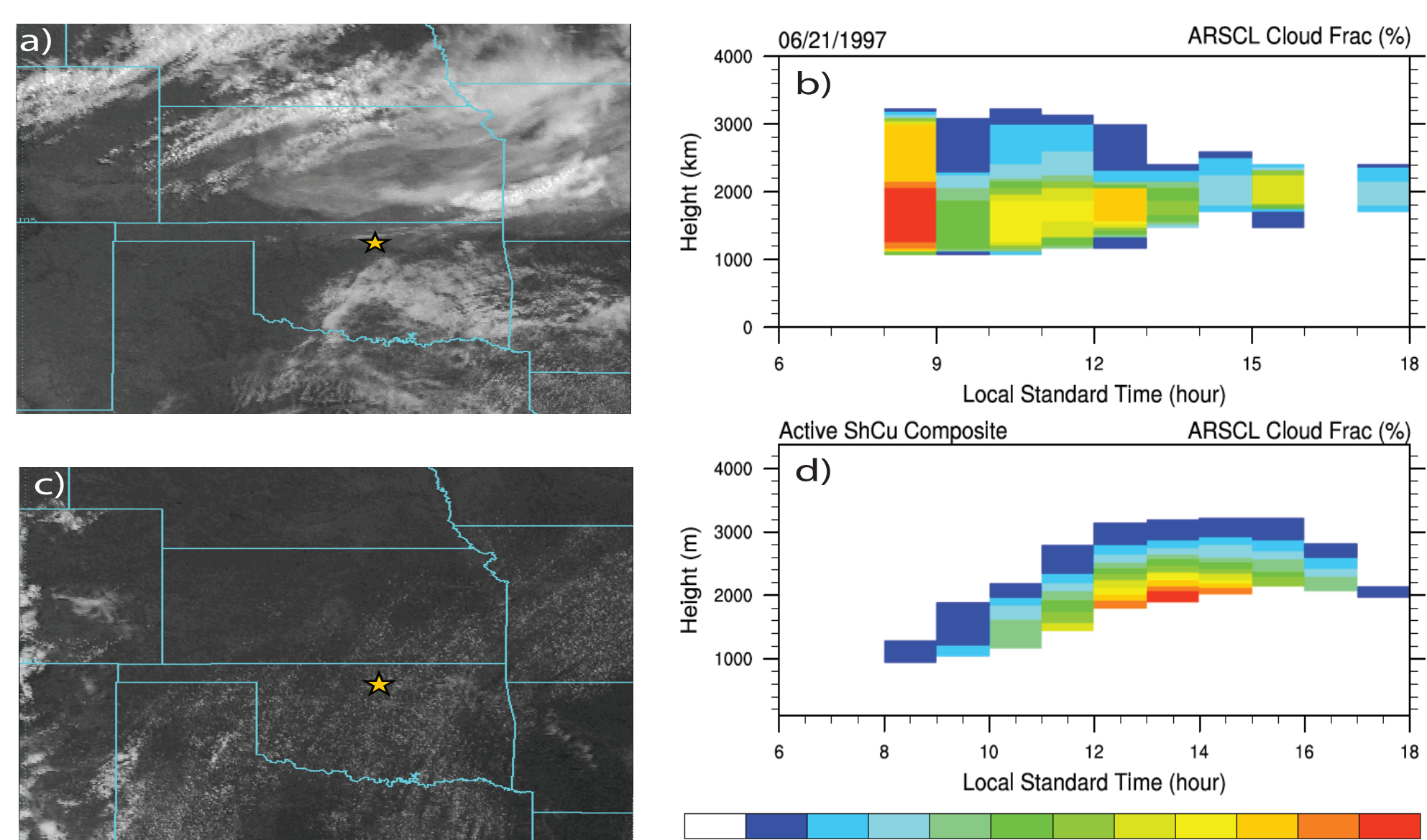


Why do we need CASS?

GCSS-ARM97 case (Brown et al, 2002) may not be representative of a typical land-surface-forced shallow convection. Based on 76 SGP active shallow cumulus golden days (Zhang and Klein 2013), a new composite case, CASS is built as a robust testbed for LES and single-column models to assess parameterizations' performance in simulating the diurnal cycle over land.

Benefits of a composite case:

- Reduce initial condition uncertainty due to synoptic variability
- Capture major characteristics in large scale forcing
- Reduce cld sampling uncertainty by vertical profiling ra/lidar

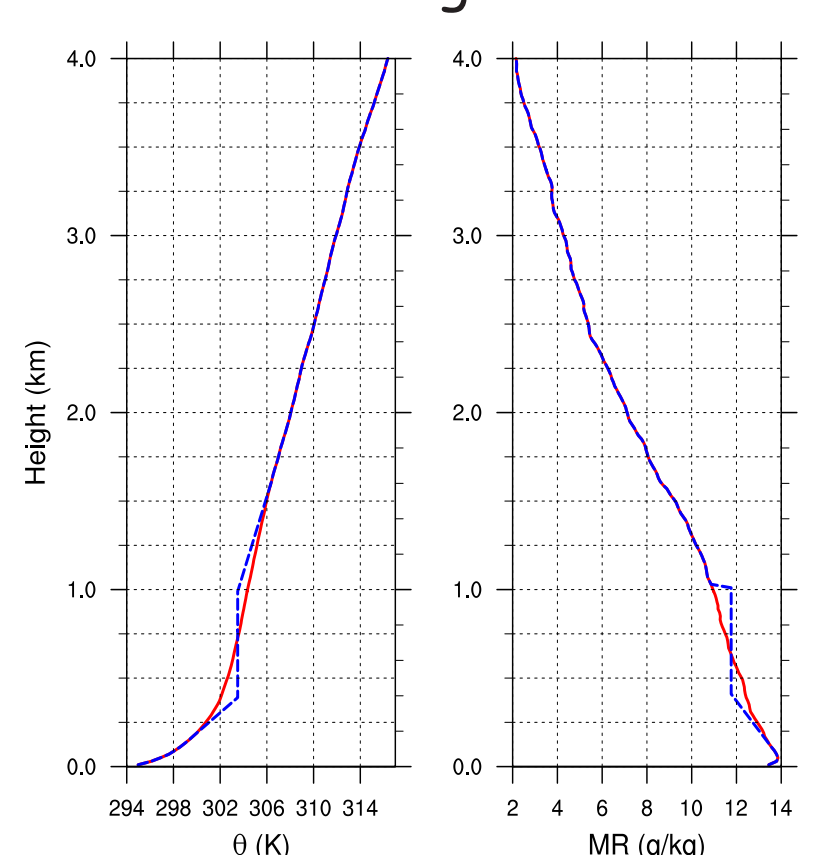


Top left (a): reflectance by GOES-8 at 08:15 Local Standard Time (LST) on 6/21/1997 over ARM SGP site (b): Diurnal cycle of vertical cloud fraction (%) based on ARSCL. X-axis is the Local Time. (c): same image but for 2001/05/14 at 13:15 LST, one of the shallow cumulus days. (d): observed ARSCL cloud fraction for our new composite case.

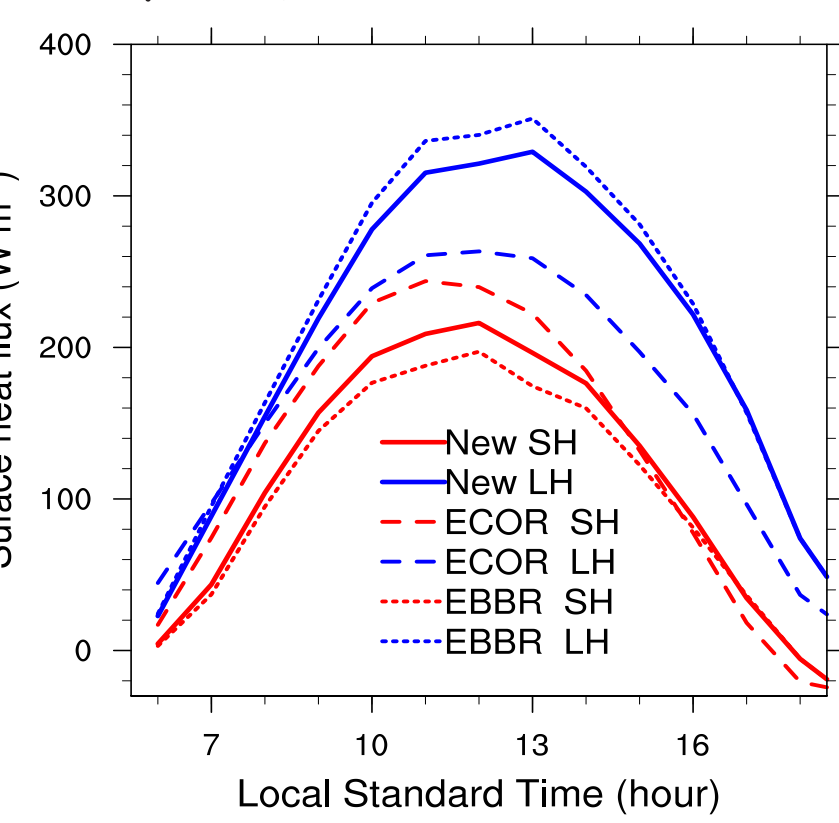
What does CASS include?

Forcing Dataset
<http://portal.nersc.gov/project/capt/CASS/>

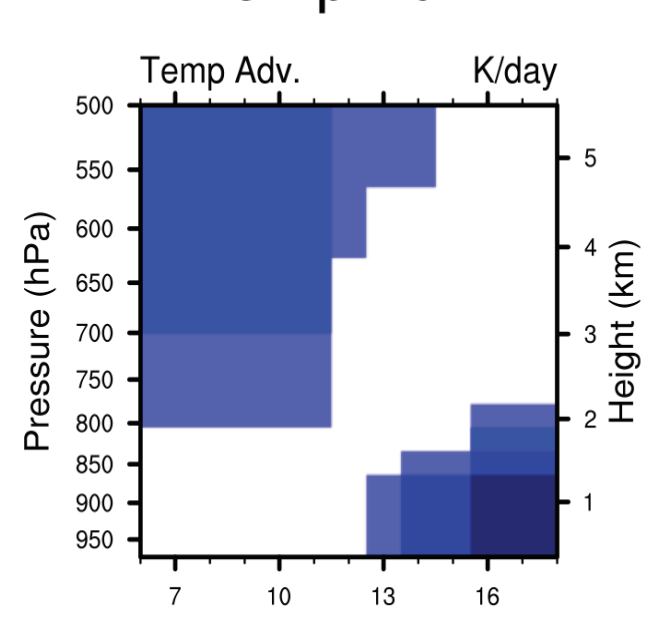
Initial Sounding in Blue lines



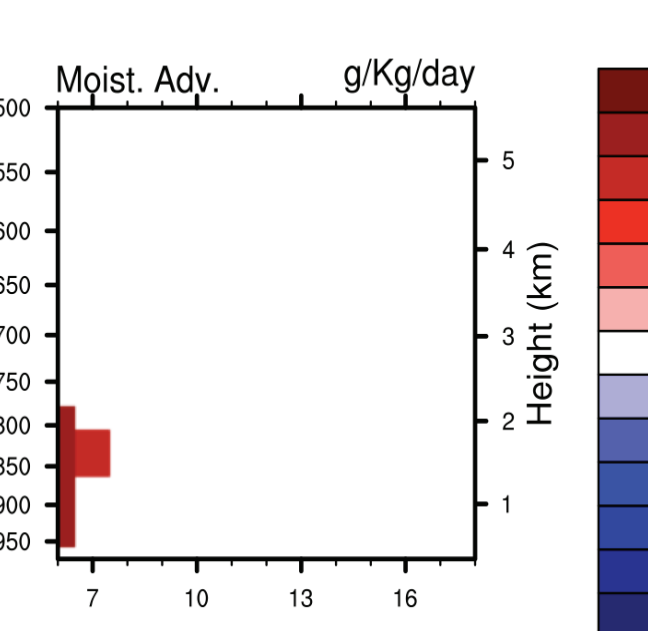
Surface Fluxes in Solid Lines



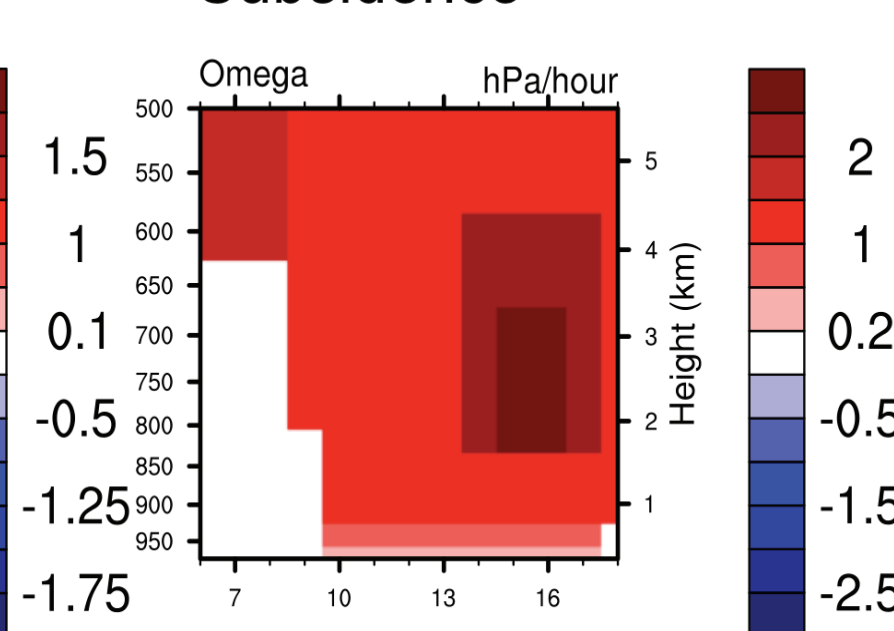
Temp Adv.



Moisture Adv.

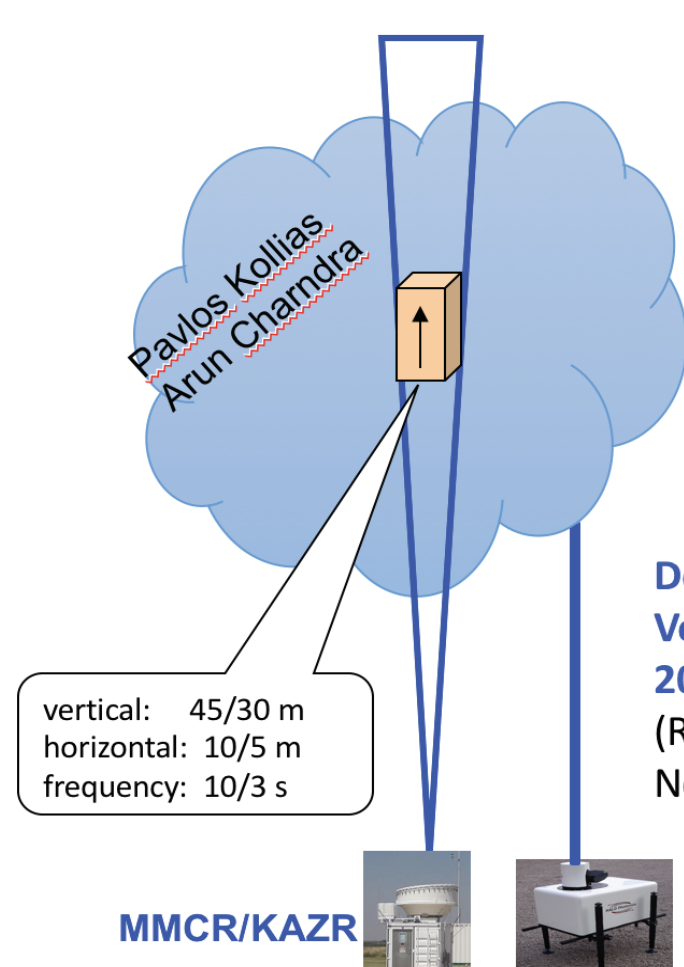


Subsidence



Based on ARM continuous forcing (Shuaiqi Tang and Shaocheng Xie)

Dataset for model evaluation and diagnosis



Diurnal cycle of

1. Cloud fraction
2. Cloud Base
3. Cloud size
4. Cloud physical depth
5. In-cloud velocity
6. Winds
7. Cloud LWP
8. Sub-cloud turbulence
9. Radiative fluxes at surface
10. And etc...

LES and Single Column Model

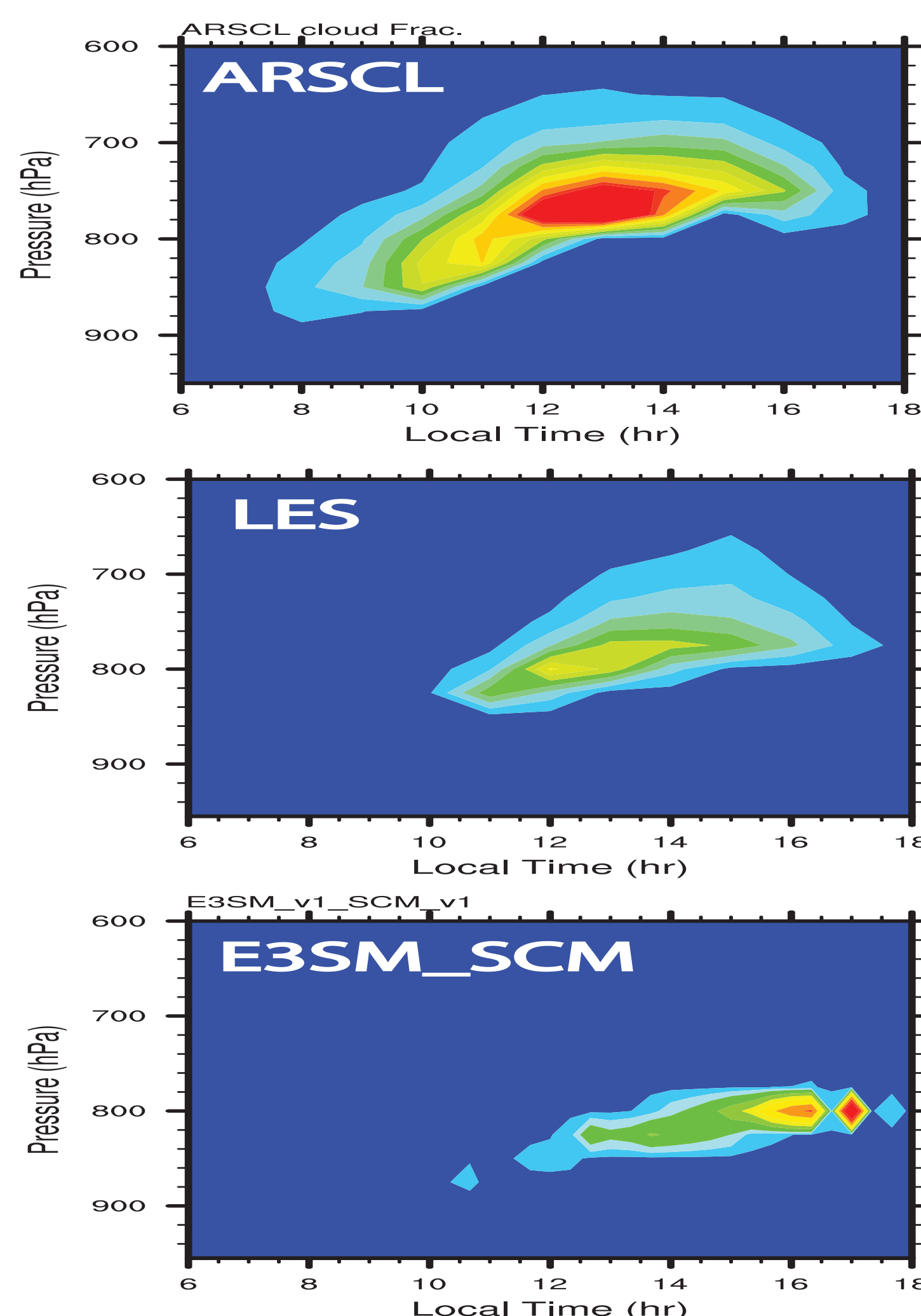
Large Eddy Simulation details

- System of Atmospheric Modeling (SAM6.9) (Khairoutdinov and Randall, 2003)
- Two microphysics packages: one-moment Bulk SAM default; Spectral Bin microphysics (Khain et al, 2004, Fan et al, 2009)
- Subgrid scale TKE with 1.5 order closure
- Coupled RRTM, lw/sw radiation calculation every 60s
- 28 km by 28 km domain, 1-s time step, 12-hr run from sunrise
- 50 m horizontal and 20 m vertical resolution. Stretching vertical grids above 6 km for radiation.

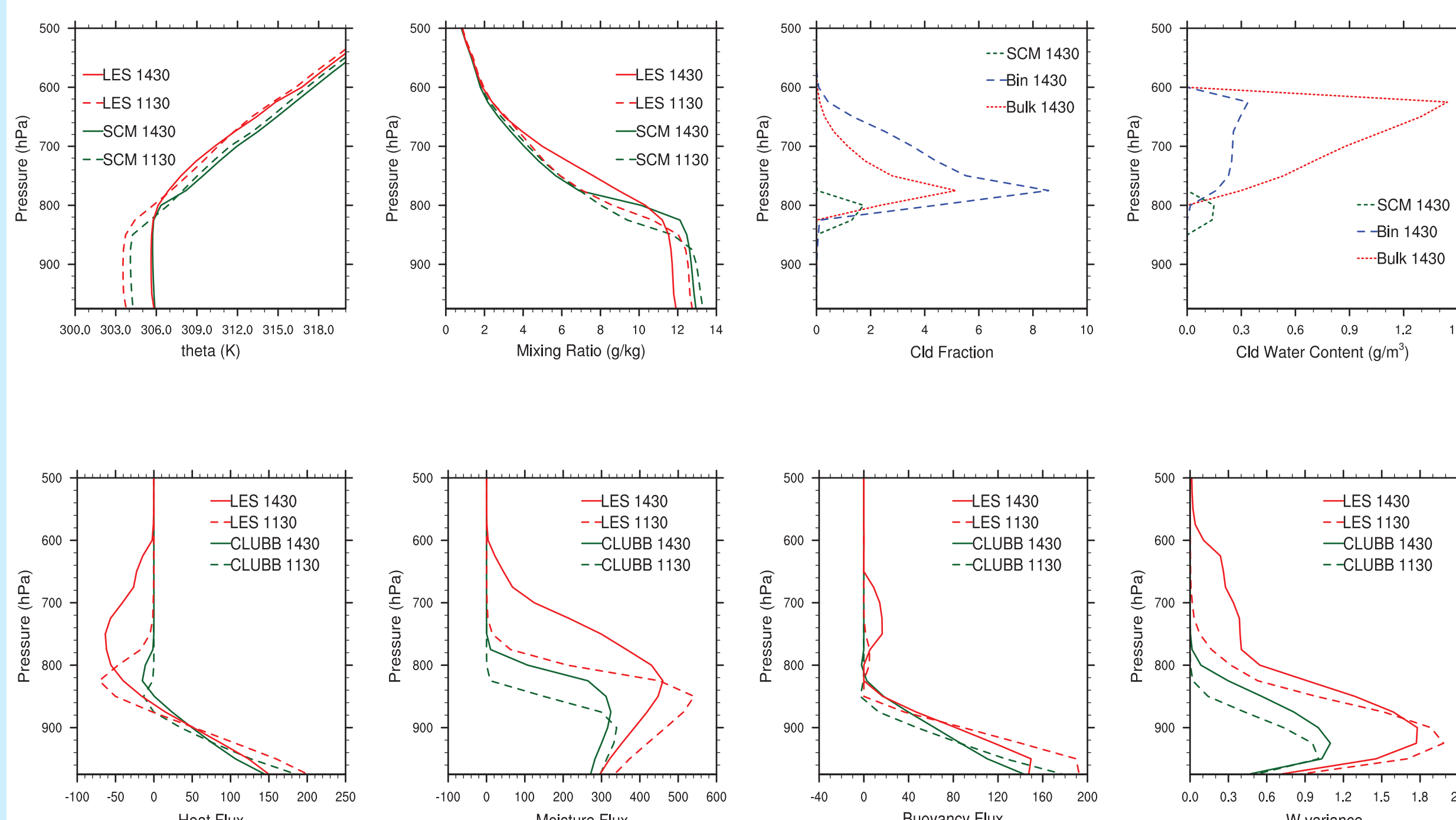
Single Column Model details

- Energy Exascale Earth System model (E3SM_v1_SCM_v1)
- CLUBB for Shallow convection/PBL
- Zhang and McFarlane for Deep convection
- MG2 for microphysics
- 20-minutes time step and 72 levels

Shallow Cumulus Cloud Fraction



PBL and Turbulent fluxes

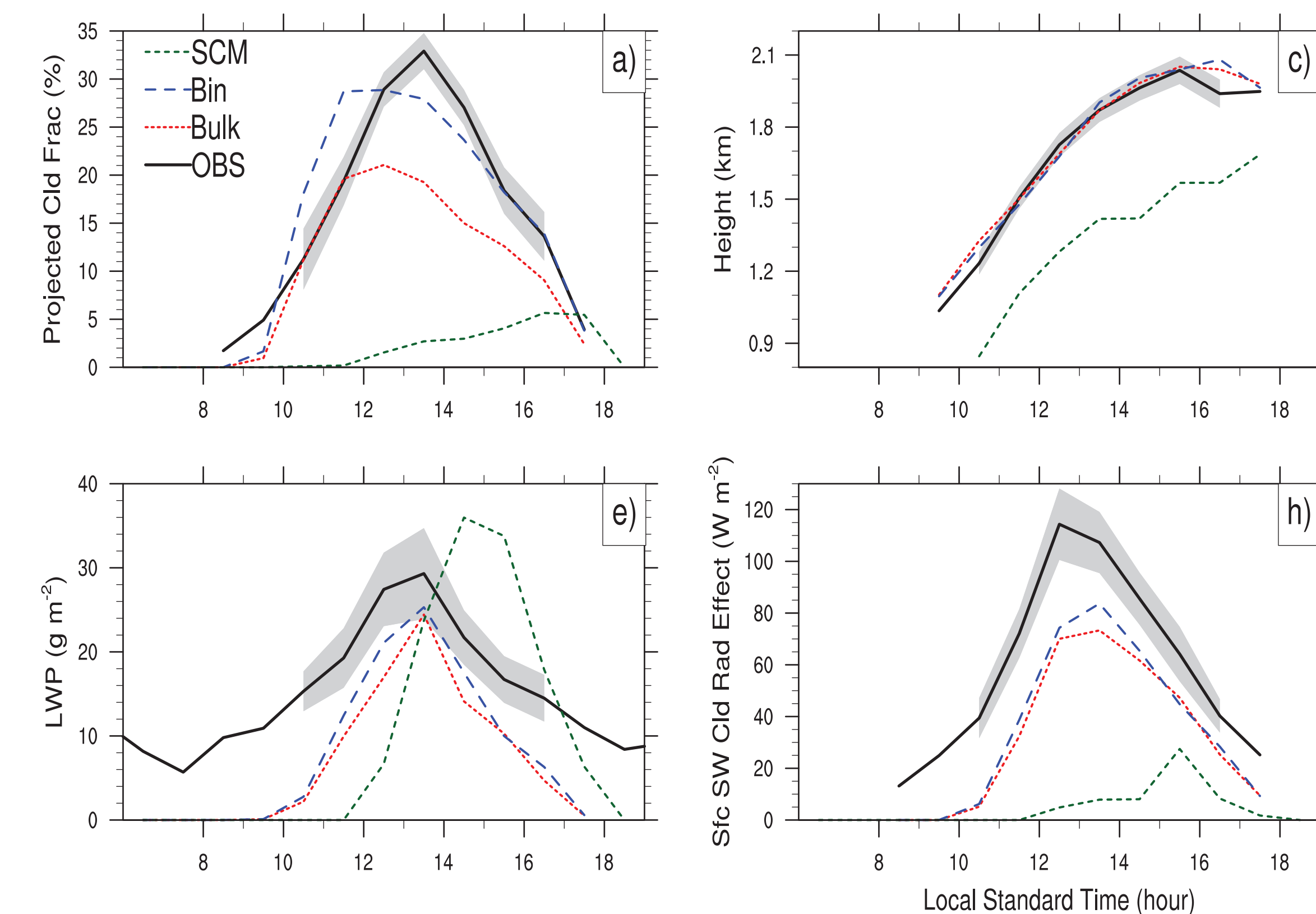


Summary

- CASS is a new composite test case typical of "land-surface forced" fair-weather non-precipitating Shallow Cumulus
- CASS includes observation-constrained forcing datasets as well as observed cloud statistics and in-cloud vertical velocity data for model evaluation and diagnosis
- CASS will provide new perspectives in both LES and SCM of parameterization in comparison with observations
- CASS composite case LES results based on average forcing and initial condition well represent the average behavior of LES ensemble in which LES is run for each of the golden ShCu days.
- Preliminary tests of CASS show that compared with observation and LES, the E3SM single-column model produces a slower PBL development and a late onset, less but thicker clouds which requires further investigation.

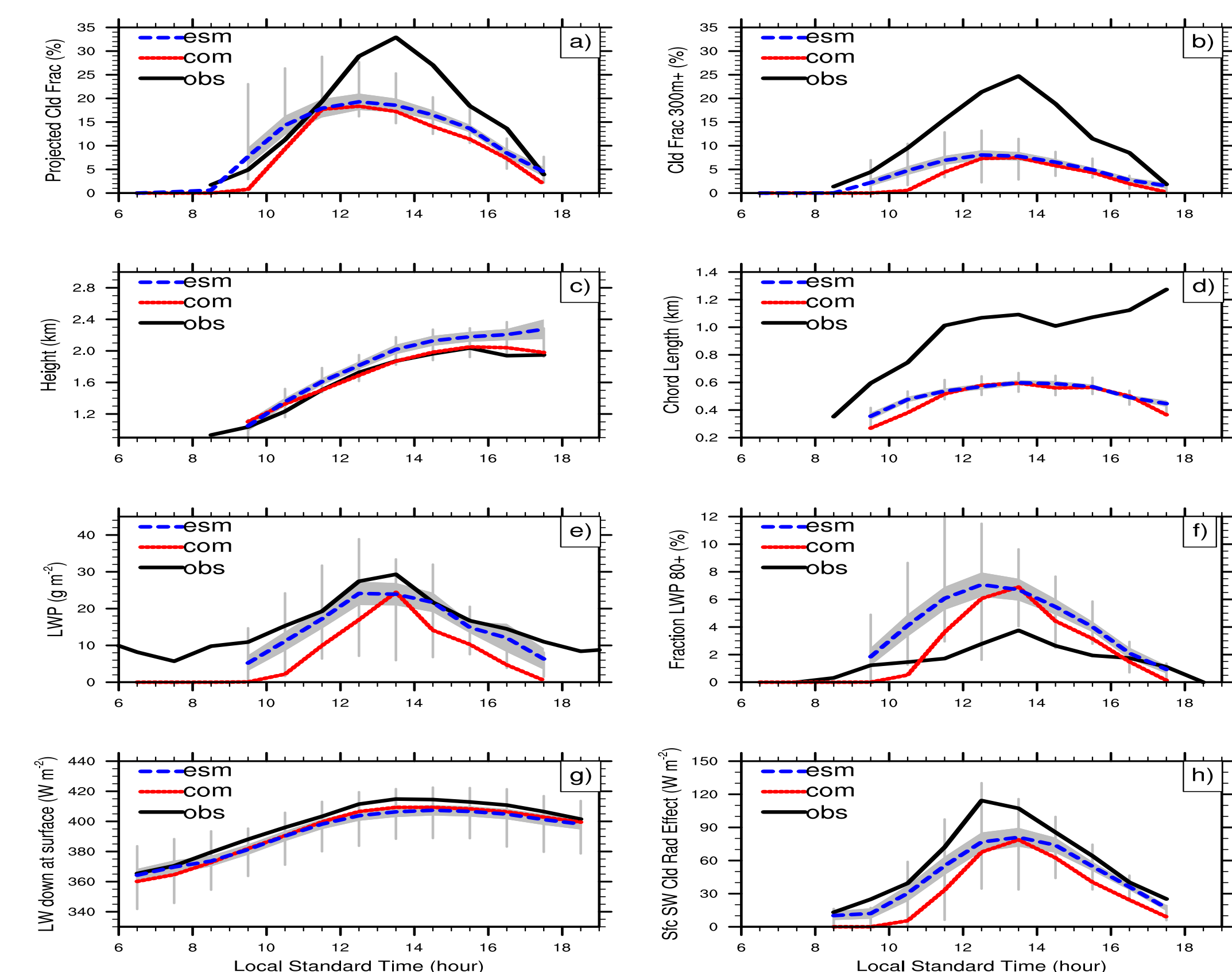
Reference: Zhang et al, 2017, Large-eddy simulation of shallow cumulus over land: A composite case based on ARM long-term observations at its Southern Great Plains site. JAS.

Daytime Evolution



Comparison of daytime evolution of a) projected cloud fraction at surface, c) cloud base height, e) in-cloud liquid water path and h) downwelling shortwave cloud radiative effect at surface (clear sky minus whole sky)

Composite case vs. LES Ensemble



The shaded area denotes the one standard error spread of the 40 ensemble runs which produce shallow cumulus clouds. Vertical gray lines denotes interquartile range.