What controls the vertical extent of non-precipitating fair-weather shallow cumulus over land?

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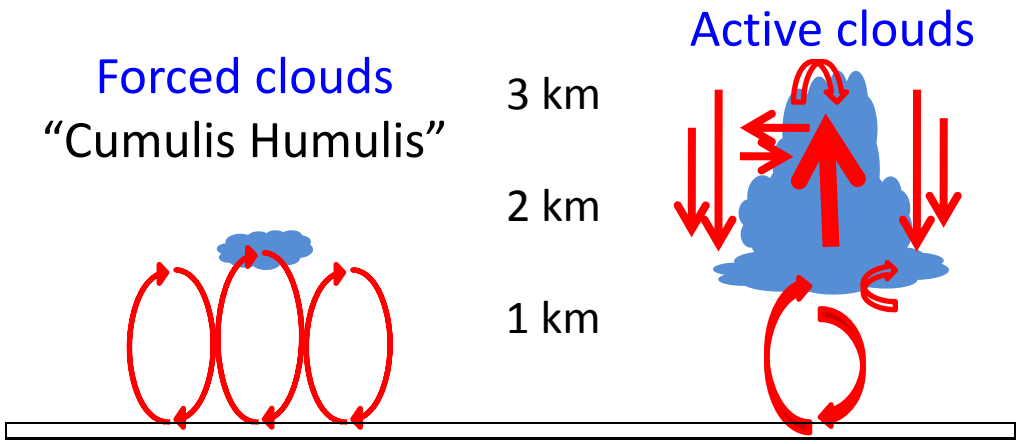
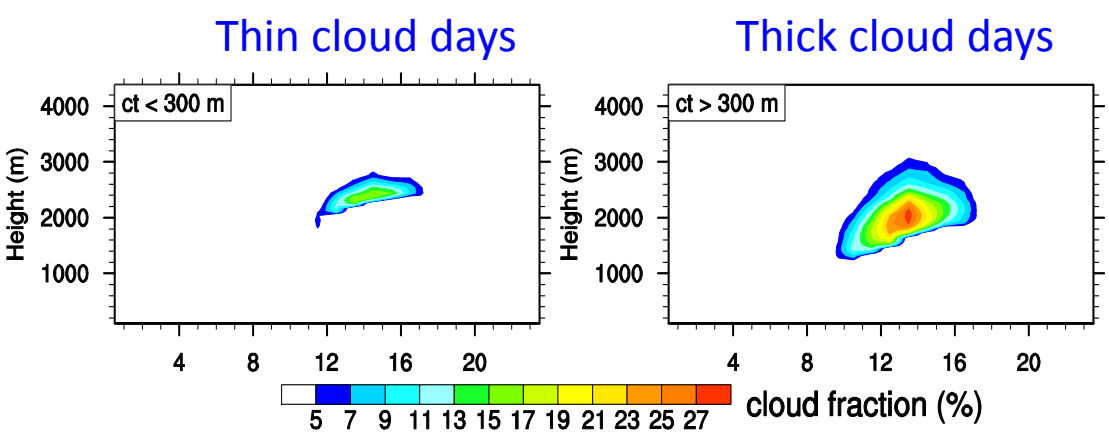
PCMDI

Program for Climate Model Diagnosis and Intercomparison

Motivation



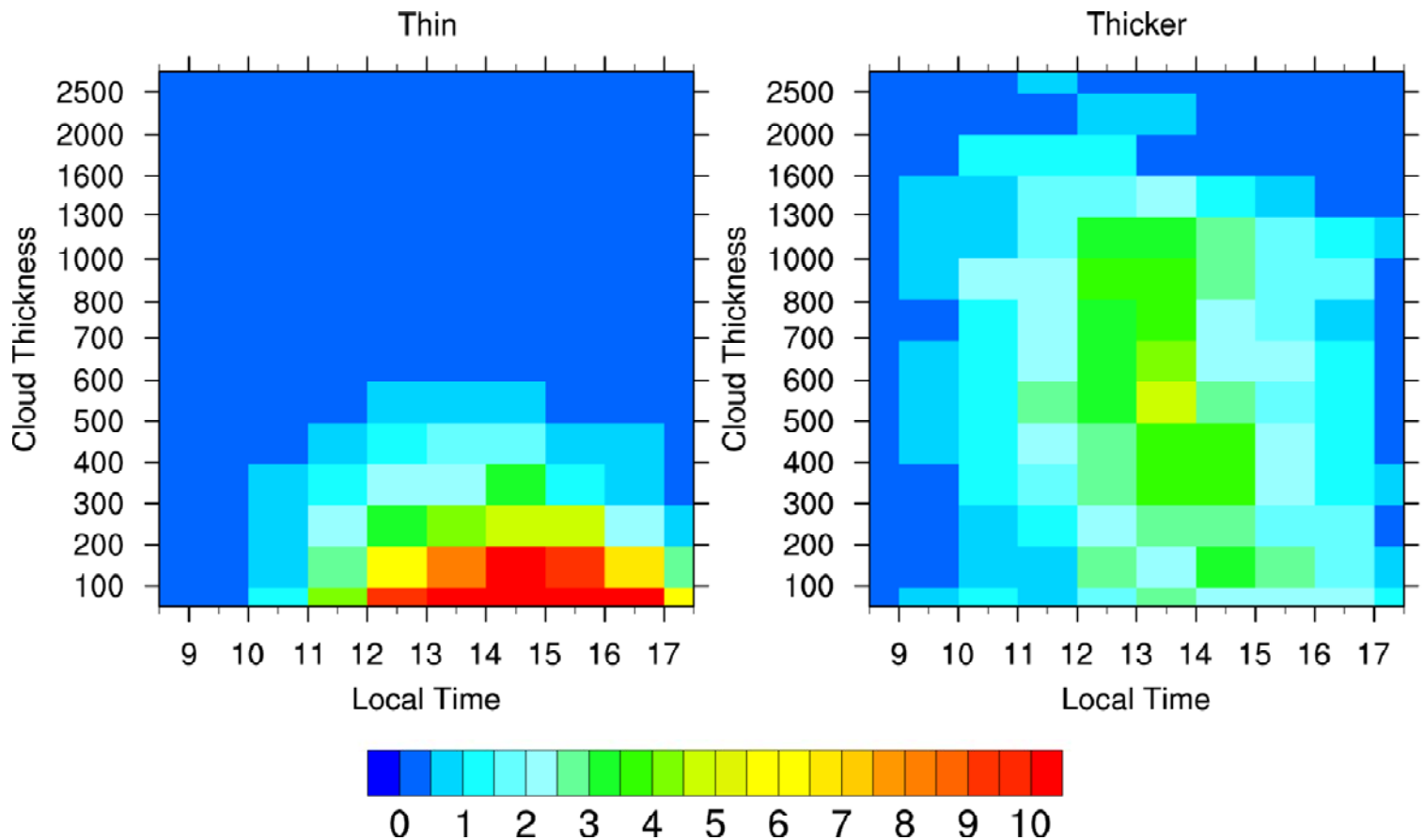


13 summers of observations at SGP are studied for the following questions:

1. How different are cloud properties and their radiative impacts between days with "thin" versus "thick" clouds?

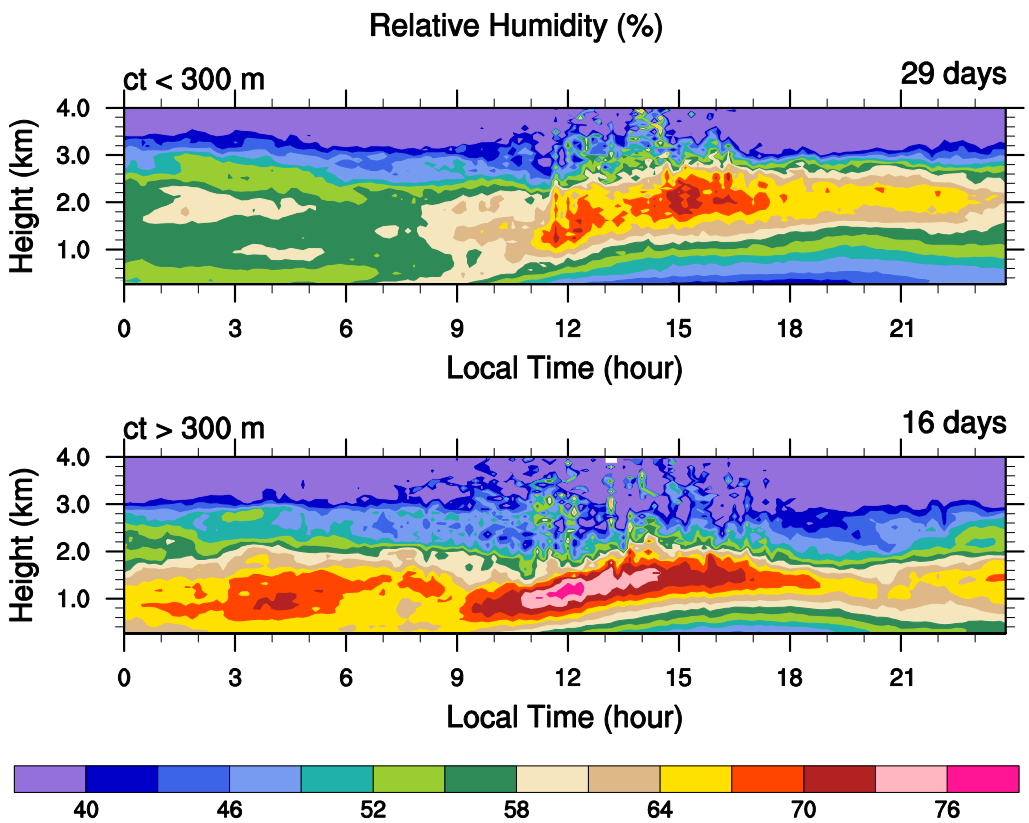
2. How do environmental conditions differ between days with thin and thick clouds and do the differences provide any clues as to what controls the vertical extent of shallow cumuli?

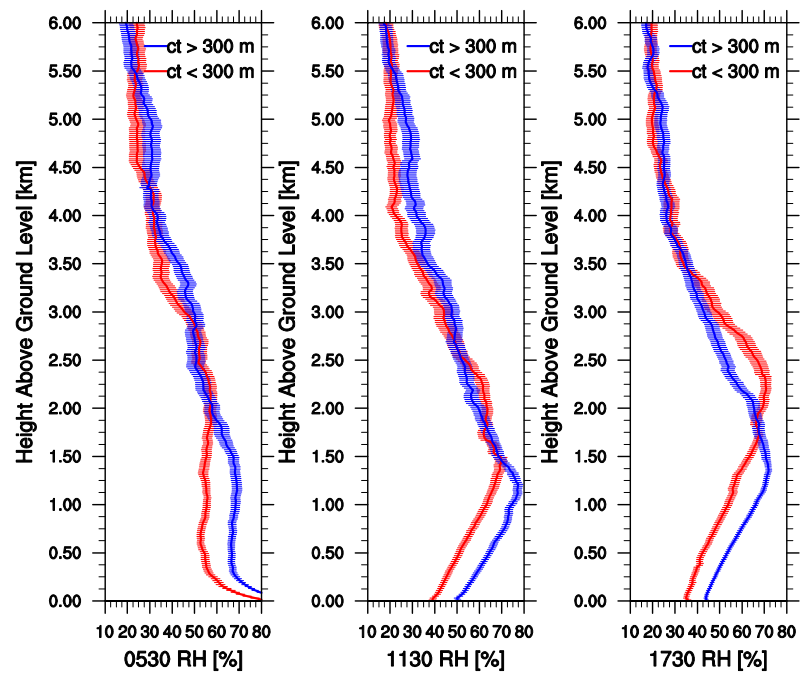
Diurnal frequency of cloud thickness



Data: 10s-ARSCL

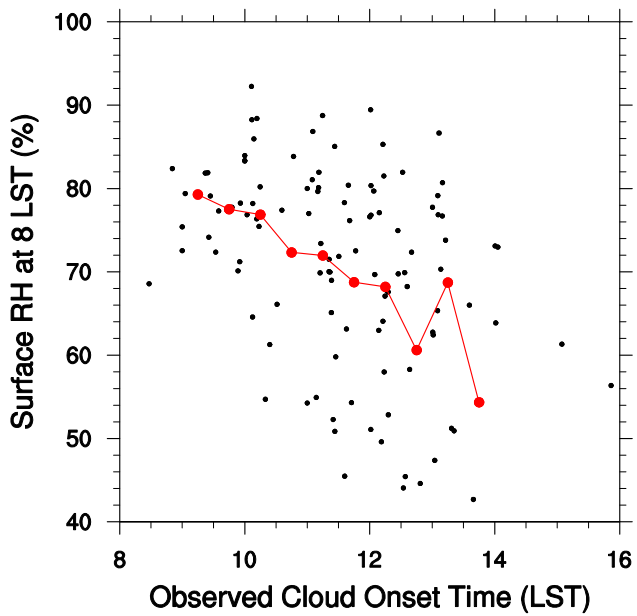
RH difference

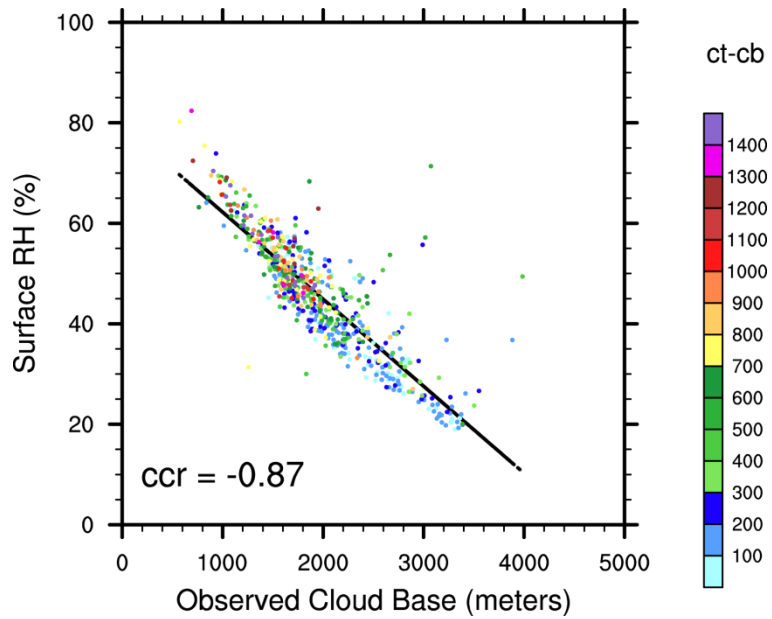




Data : Raman Lidar and LSSONDE

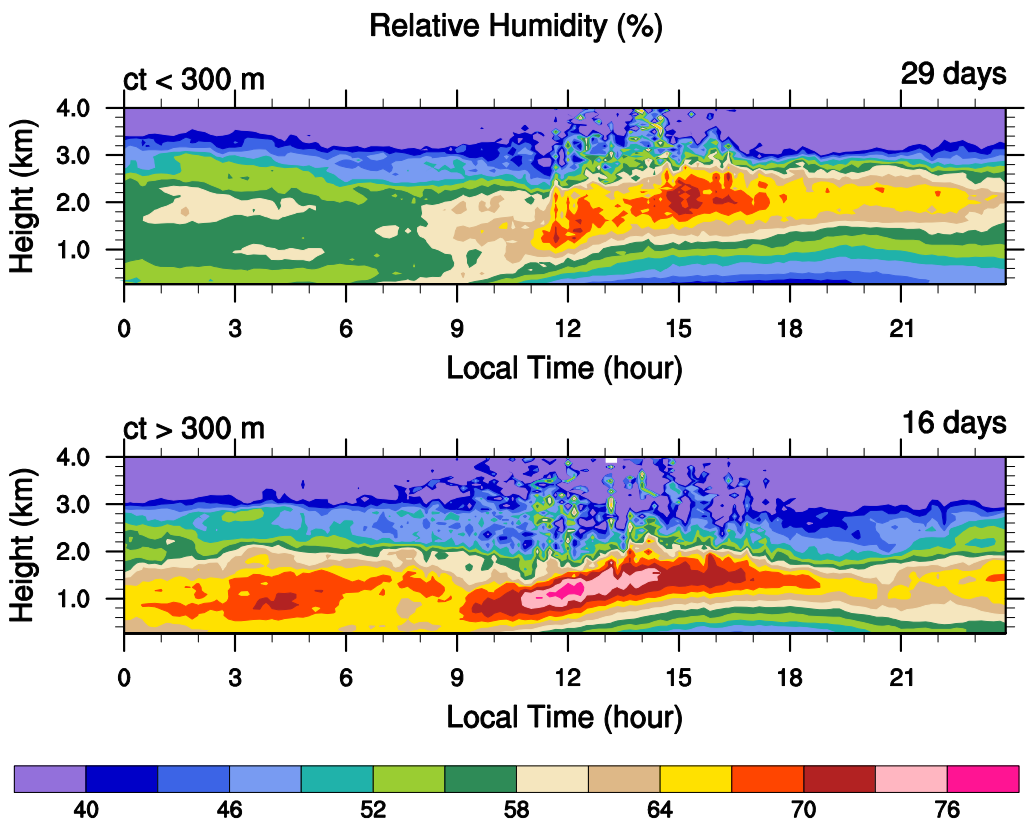
RH control on cloud base and onset time

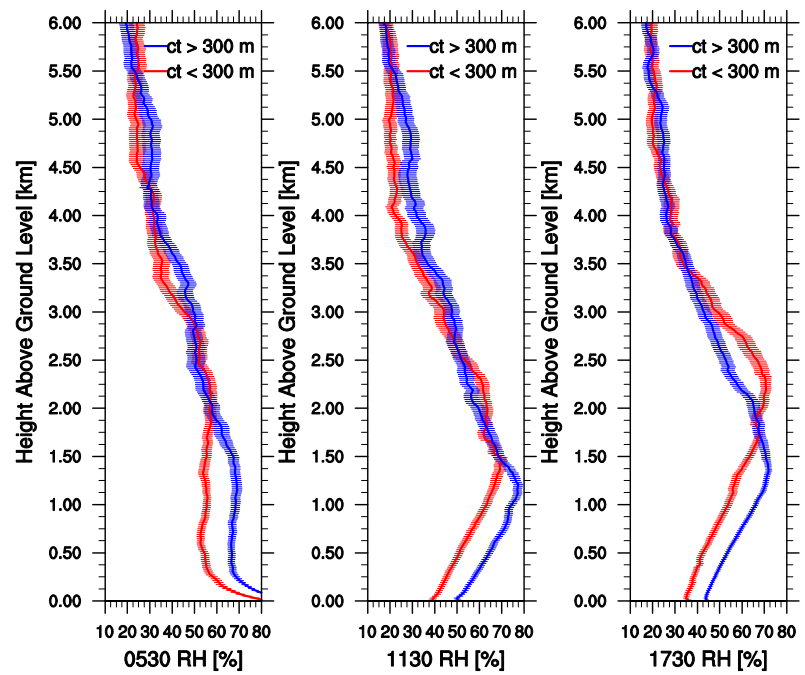




Data : 10s-ARSCL, SMOS

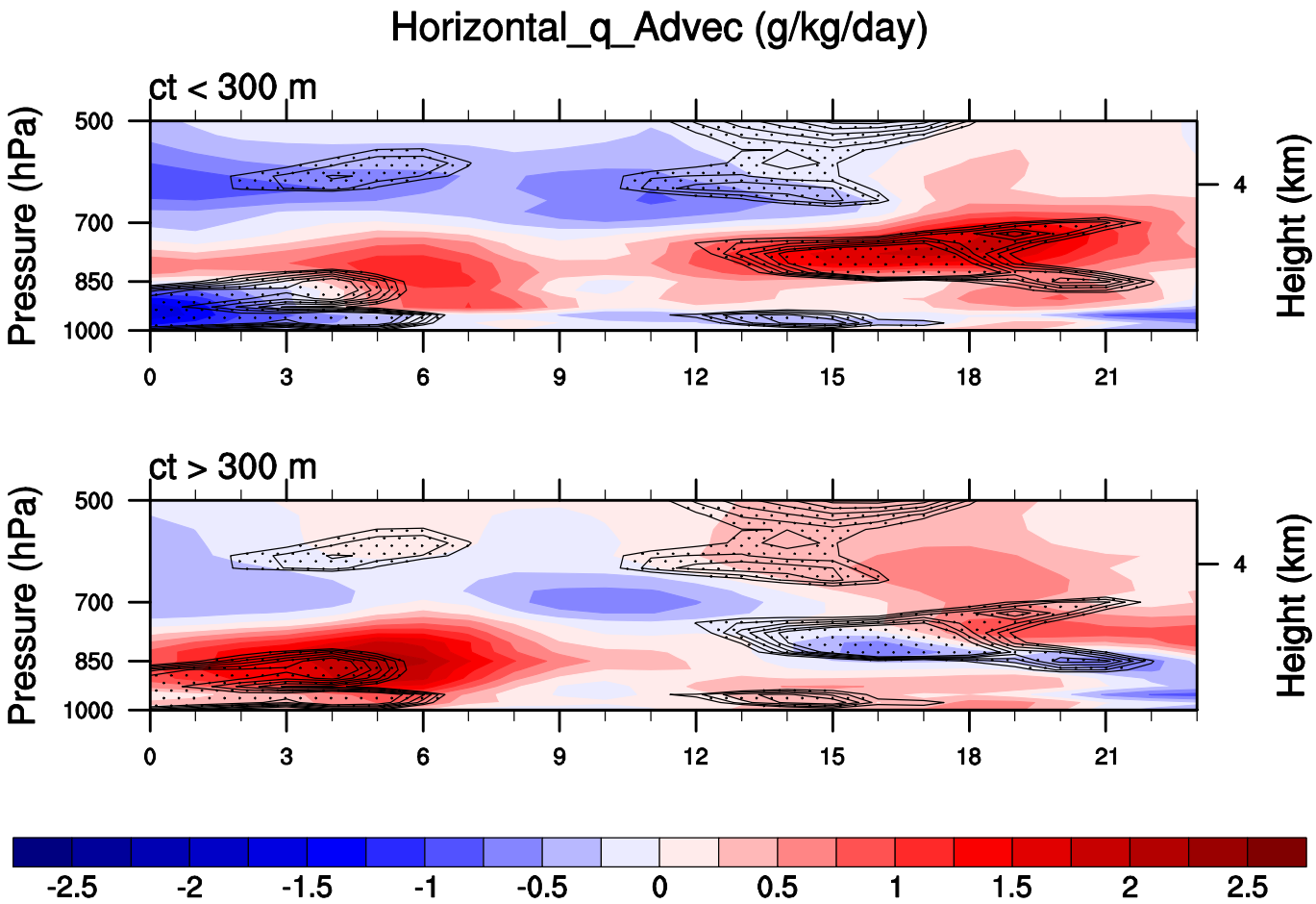
RH difference





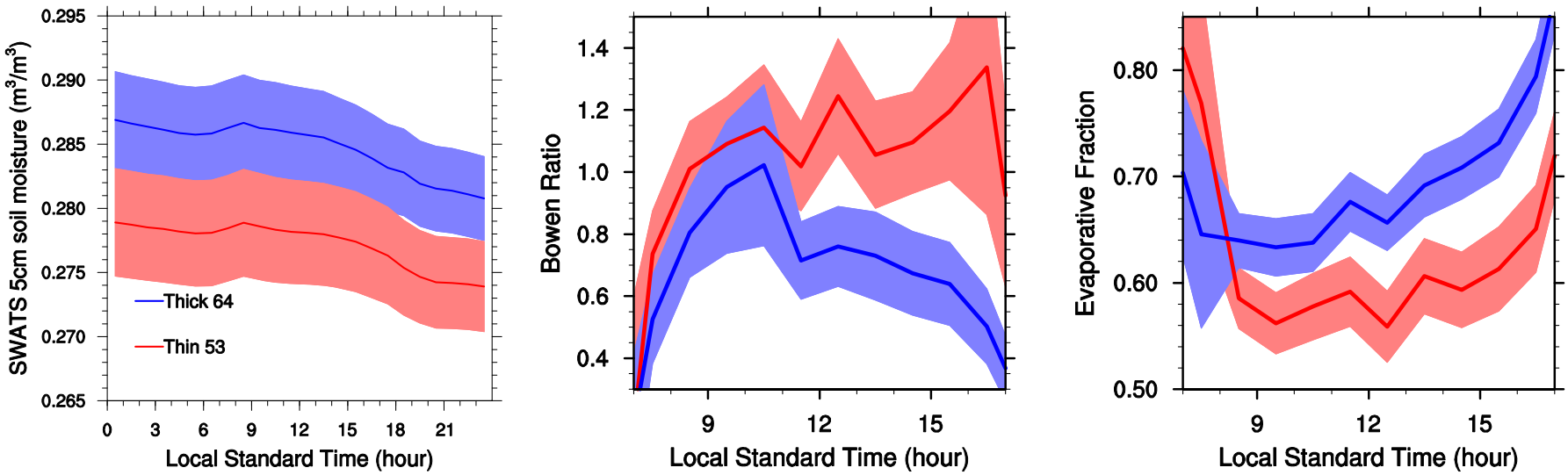
Data : Raman Lidar and LSSONDE

Moisture source : Early-Morning advection



Data : long-term continuous forcing

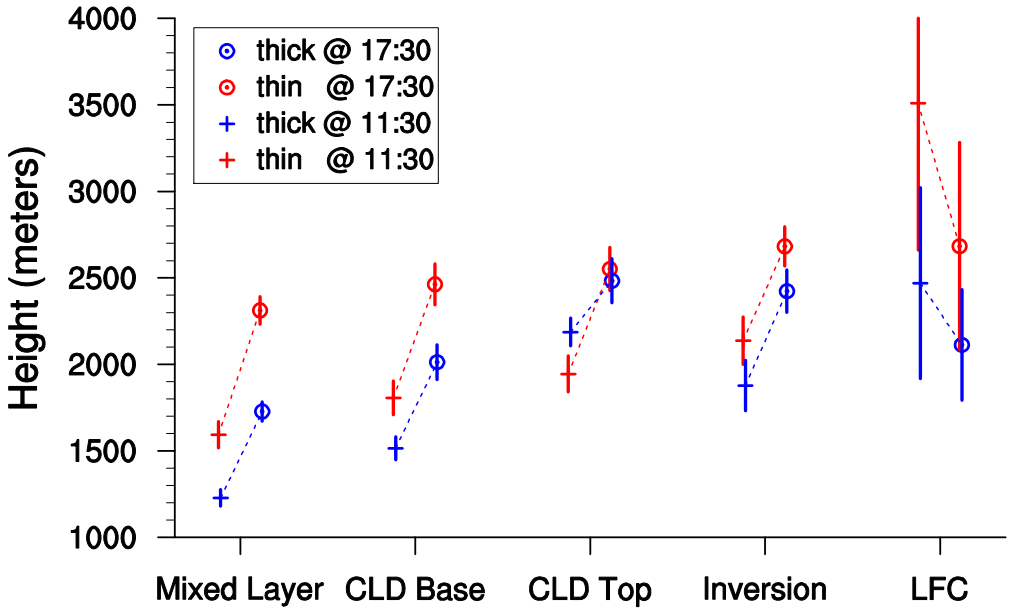
Soil moisture and surface fluxes



more soil moisture -> less sensible, more latent heat ->
weaker entrainment, shallower boundary layer growth -> larger RH in BL

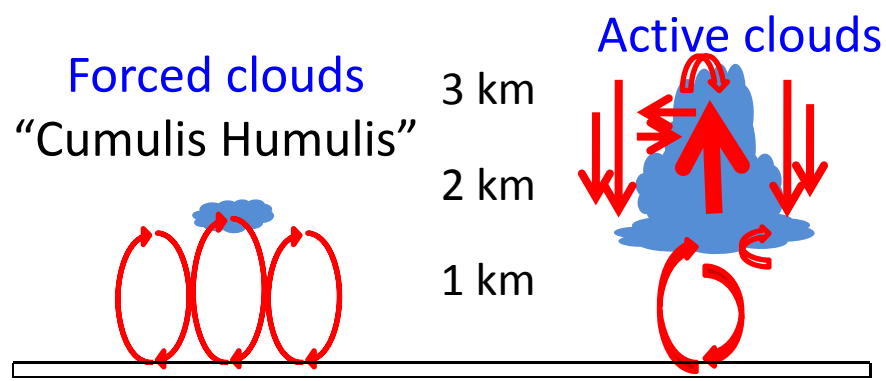
Data : SWATS, BAEBBR

Forced versus Active clouds



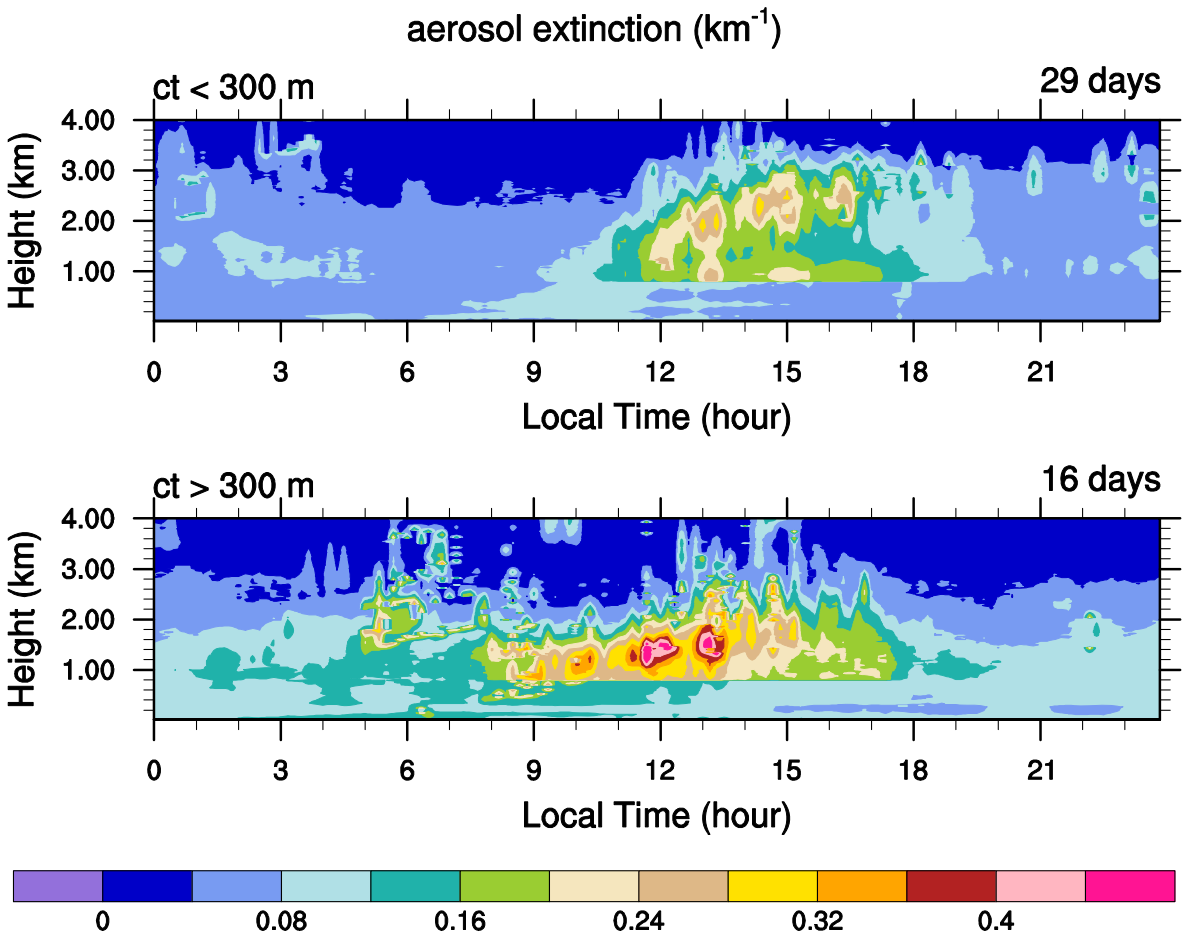
Mixed-layer growth rate:
3.3±0.4 vs 2.3±0.3 cm/s

Cloud base growth rate:
3.0±1.0 vs 2.3±0.5 cm/s



Data : LSSONDE, 10s ARSCL

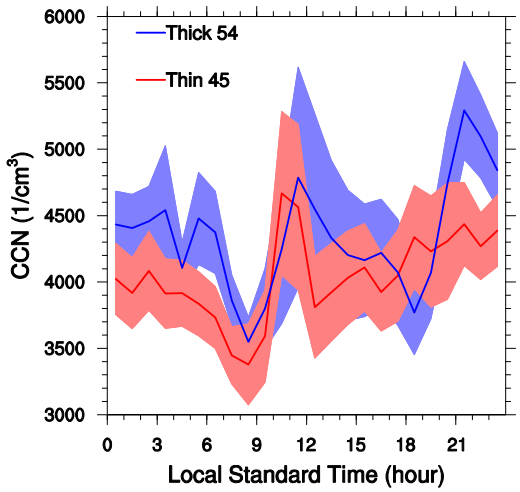
Is aerosol a player?

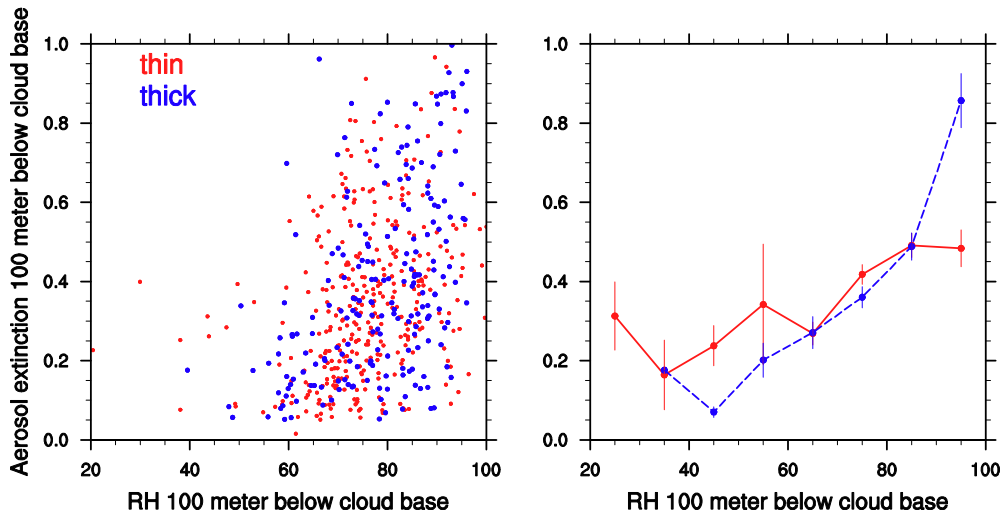


Concentration?
Size distribution?
Composition?
Humidity?

Data : Raman Lidar aerosol extinction

Hygroscopic growth?





Data : TSI CN counter, Raman Lidar RH

Remarks

- There is significant higher BL RH on the days with thicker (or active) fair-weather shallow cumulus
- The higher value of RH in the morning is likely attributed to larger early morning horizontal moisture advection, while during daytime the surface evaporation feedback may contribute too.
- The higher aerosol extinction observed is highly possible due to hygroscopic growth of higher RH.