Impact of middle atmospheric humidity on boundary layer turbulence and clouds

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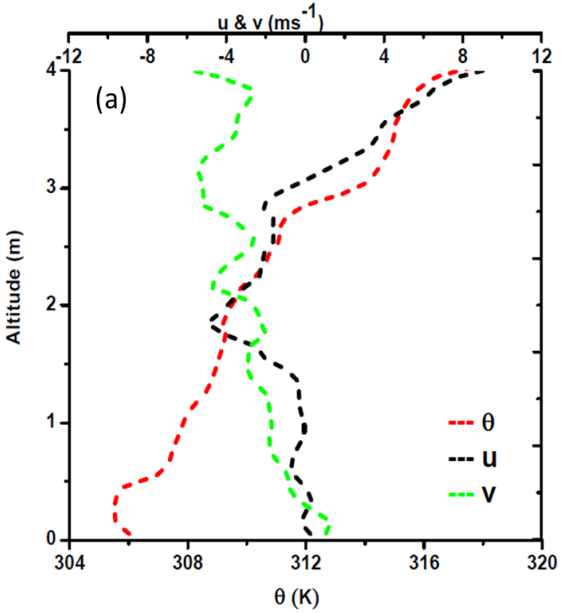
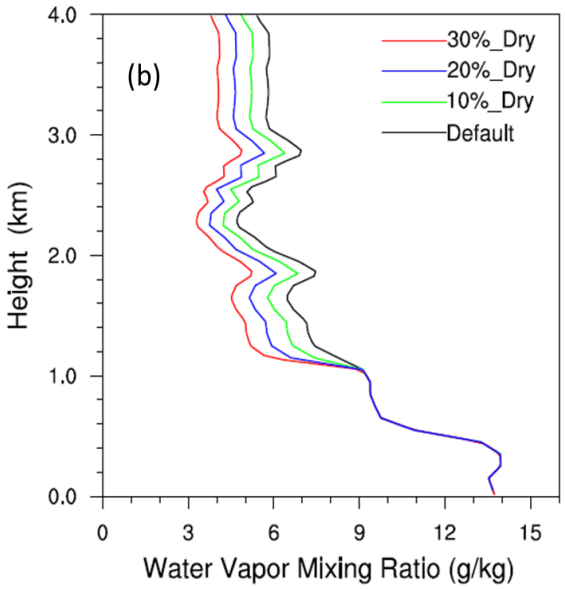
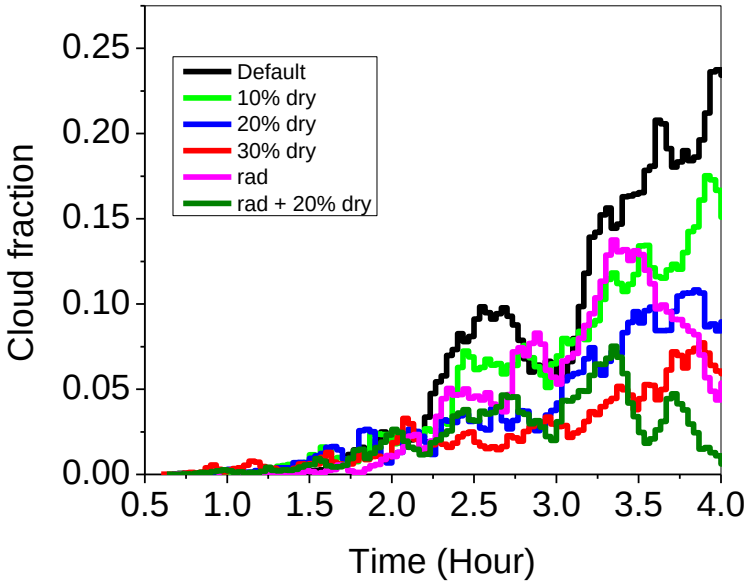
Case: Continental Shallow cloud regime during the Indian monsoon

Focus: Sensitivity to middle atmospheric drying and interactive radiation using LES



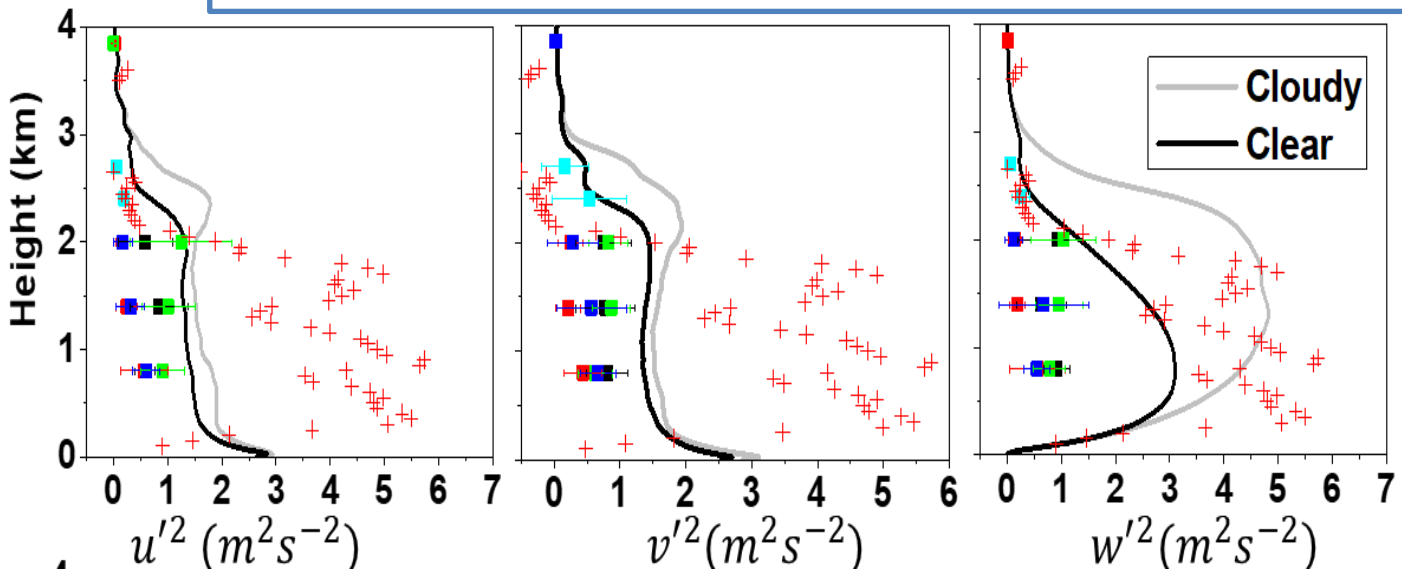




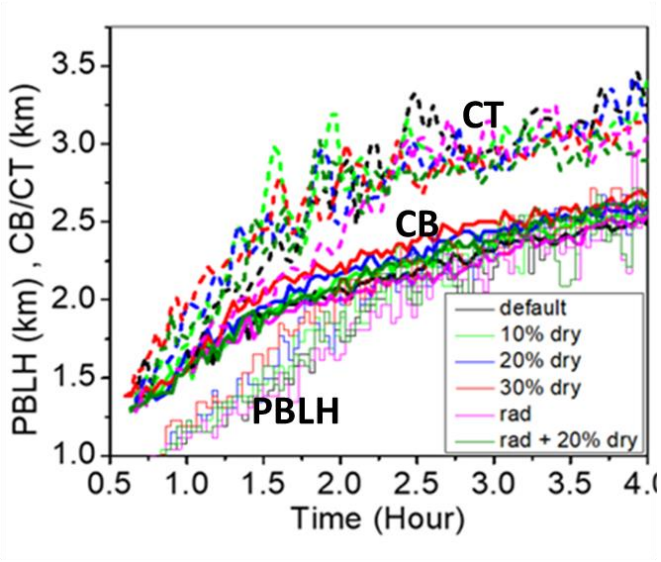
Model domain is 10km X 10km X 4km, with grid dx=dy=100m and dz=30m

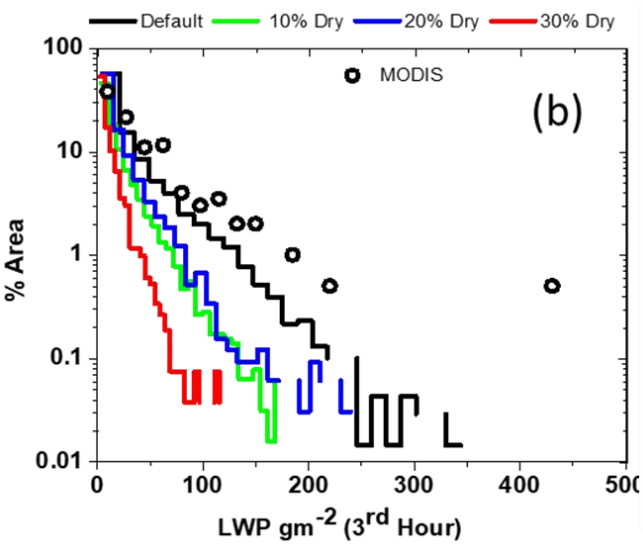
Microphysics : WDM, Radiation : RRTM LW/SW,

LES variances compared with aircraft observations



LES derived fluxes (solid Line) compared with Fluxes observed from aircraft (square) and wind lidar (plus)

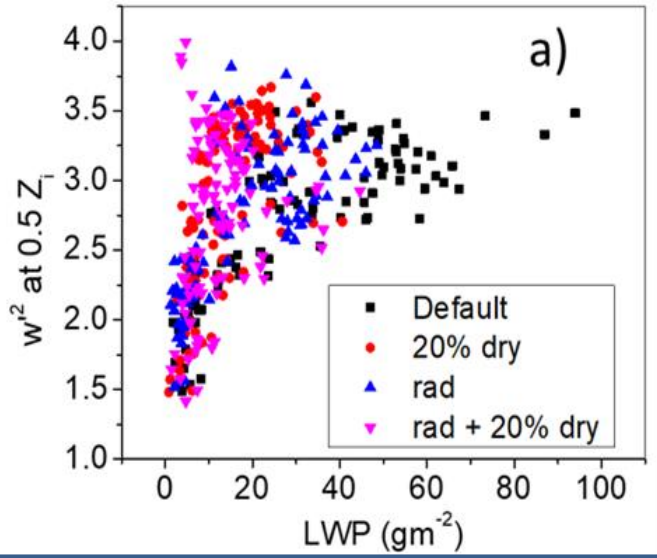




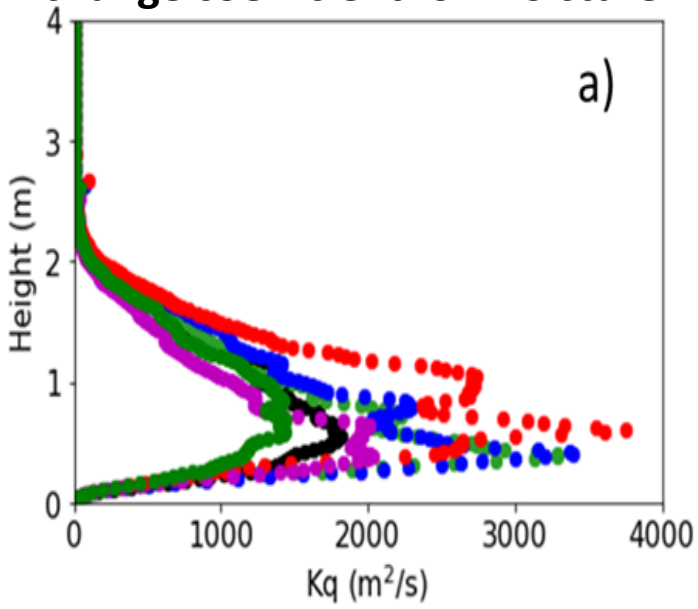
Drying above the boundary layer has

- Elevated cloud base height
- Elevated boundary layer height
- Reduced population of deep cumulus clouds
- Reduced cloud albedo

Vertical velocity variance and LWP



Exchange coefficient for moisture



Summary

- Drier conditions above BL resulted in deeper, warmer and drier BL and with an enhanced BL TKE.
- A dynamic feedback from dry air intrusion into the BL resulted in energetic BL eddies in the dry conditions and a doubling of moisture exchange coefficients.
- The liquid water content in cloud updrafts rather than in downdrafts were depleted significantly in dry conditions.
- LES sensitivity study indicated that the middle atmospheric water vapor alone could influence the shallow to deep cumulus cloud transitions in the monsoon regime
- A 30 % drying above the BL could drastically reduce the liquid water path and cloud albedo by 10-15 %.