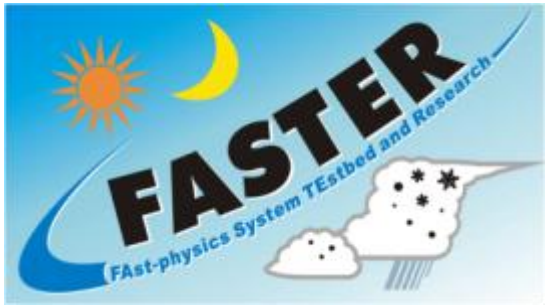
Large Eddy Simulations of RACORO Boundary Layer Cumulus Clouds



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LES of the RACORO Case 1 (Cumulus Clouds)

LES Models & Setup

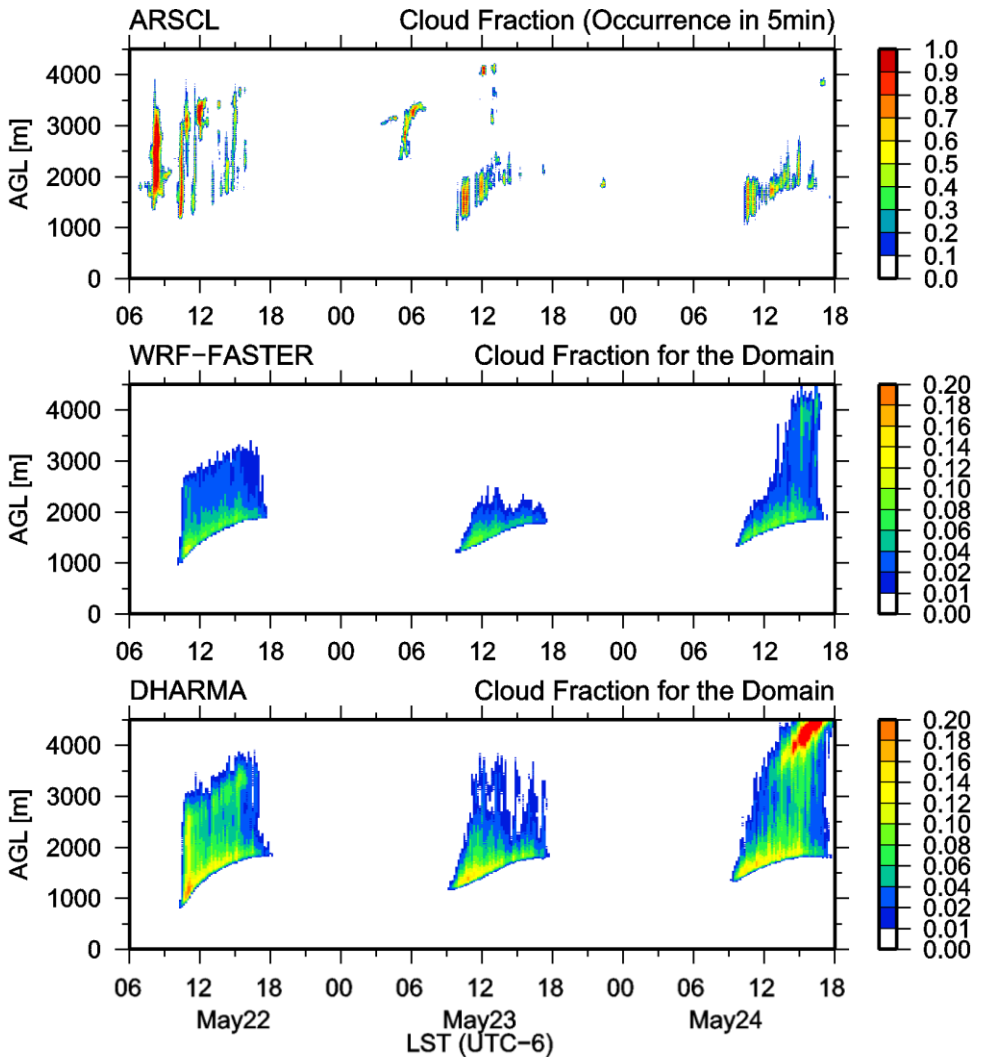
- GISS **DHARMA** and **WRF-FASTER**
- Using the **same grid spacing** in low levels
- Morrison Two-moment microphysics
- Use **diurnally varying** TOA radiation

Aerosol Input & LS Forcing

- Idealized, observation-based, **time-varying aerosol number size distribution profile & hygroscopicity**
- ARM VARANAL **continuous forcing**
- 12-h **relaxation** for temperature/water vapor, 3-h relaxation for horizontal winds

Evaluation

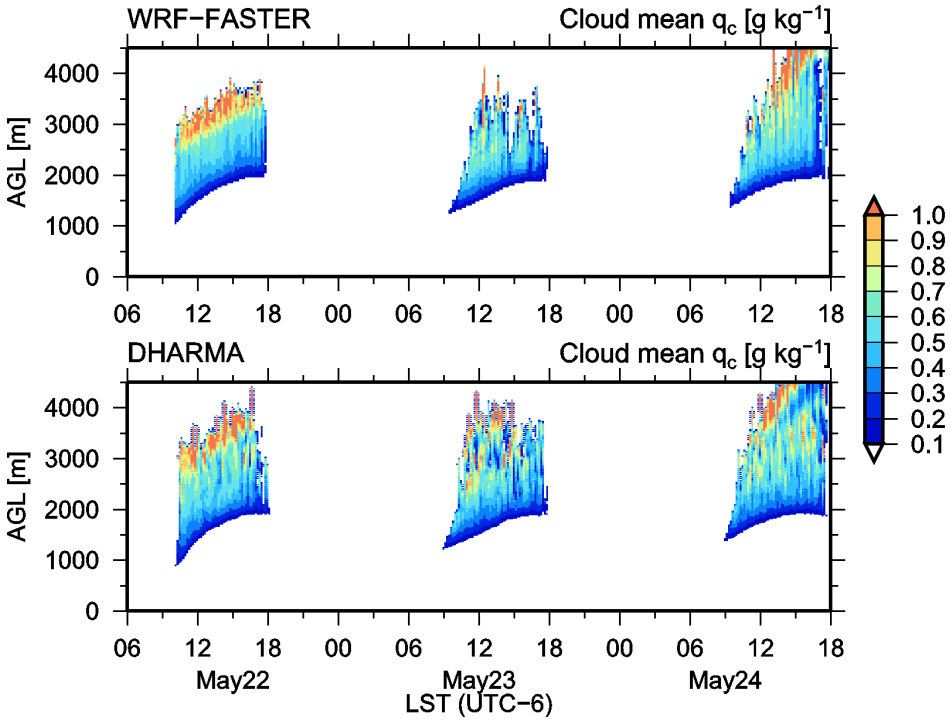
- Use ARM ground-based obs to evaluate **cloud macrophysical properties** and **boundary layer structure**
- Use **RACORO in-situ cloud obs** to evaluate cloud **microphysical** properties



WRF-FASTER and DHARMA both capture the daytime evolution of the cumulus clouds during the three days.

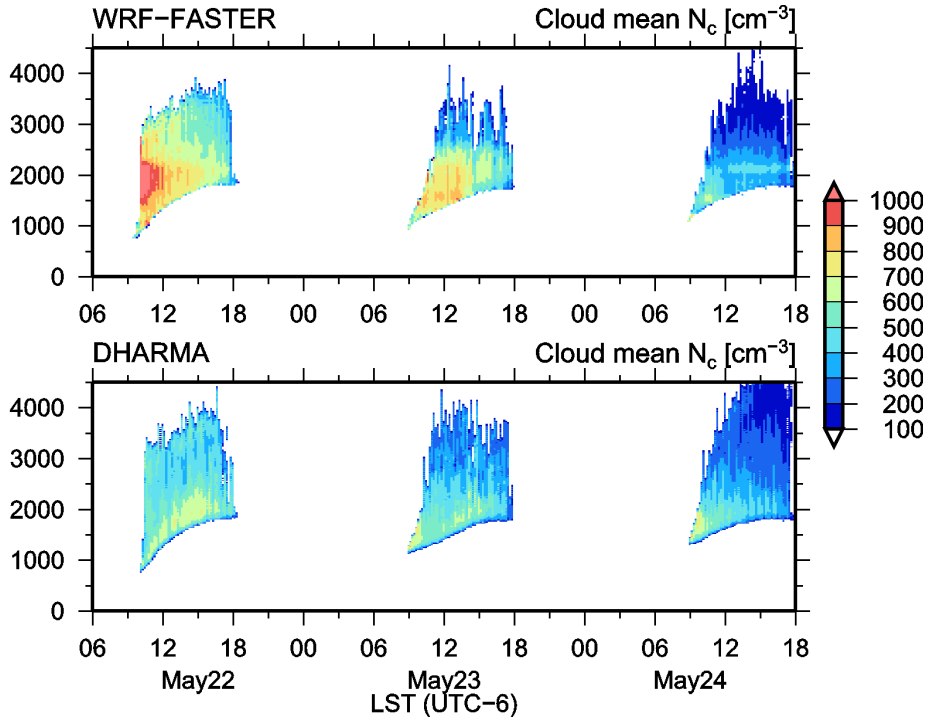
Aerosol - Dynamics - Microphysics Links

Cloud Water (cloud mean)



Cloud water increases with height, caused by the competition of **condensation from lifting** and dilution from entrainment.

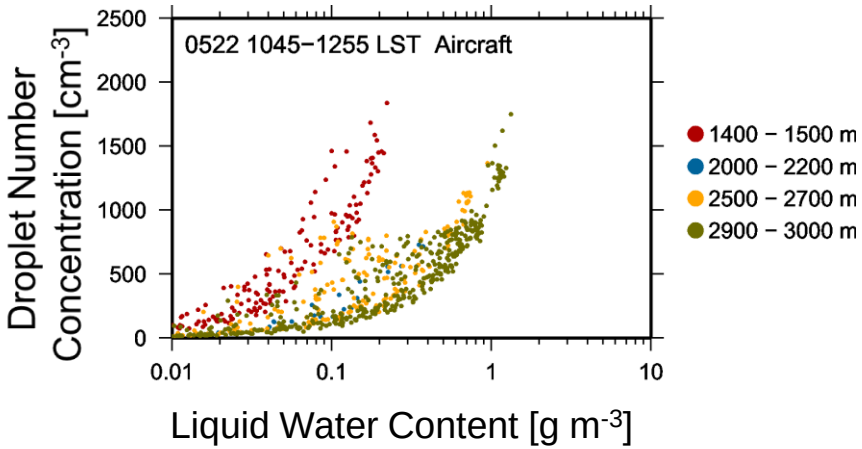
Droplet Number Conc. (cloud mean)



Droplet concentrations decrease with day, reflecting the change in the specified **time variation of aerosol concentration**.

The microphysical properties are constrained by the variations of cloud macrophysical properties, and the specified aerosol characteristics.

Evaluation of Microphysical Properties: In-situ Obs vs LES



Example from Day 1:

- The in-situ observations show a co-increase of droplet number (Nd) and liquid water content (LWC).
- Two curves are from horizontal legs near the cloud base and the higher levels.

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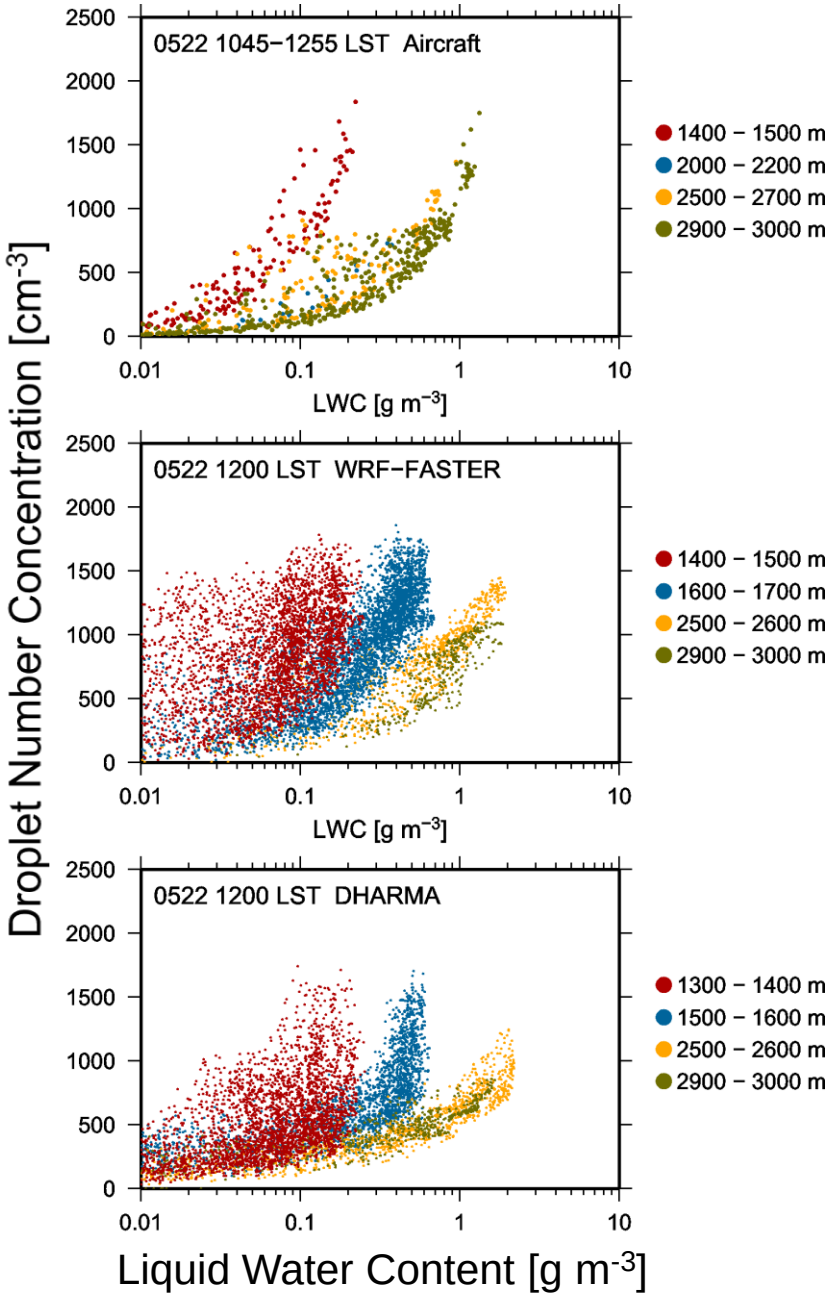

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Simulations capture the observed curves, and suggest an evolution of microphysical properties near cloud base.

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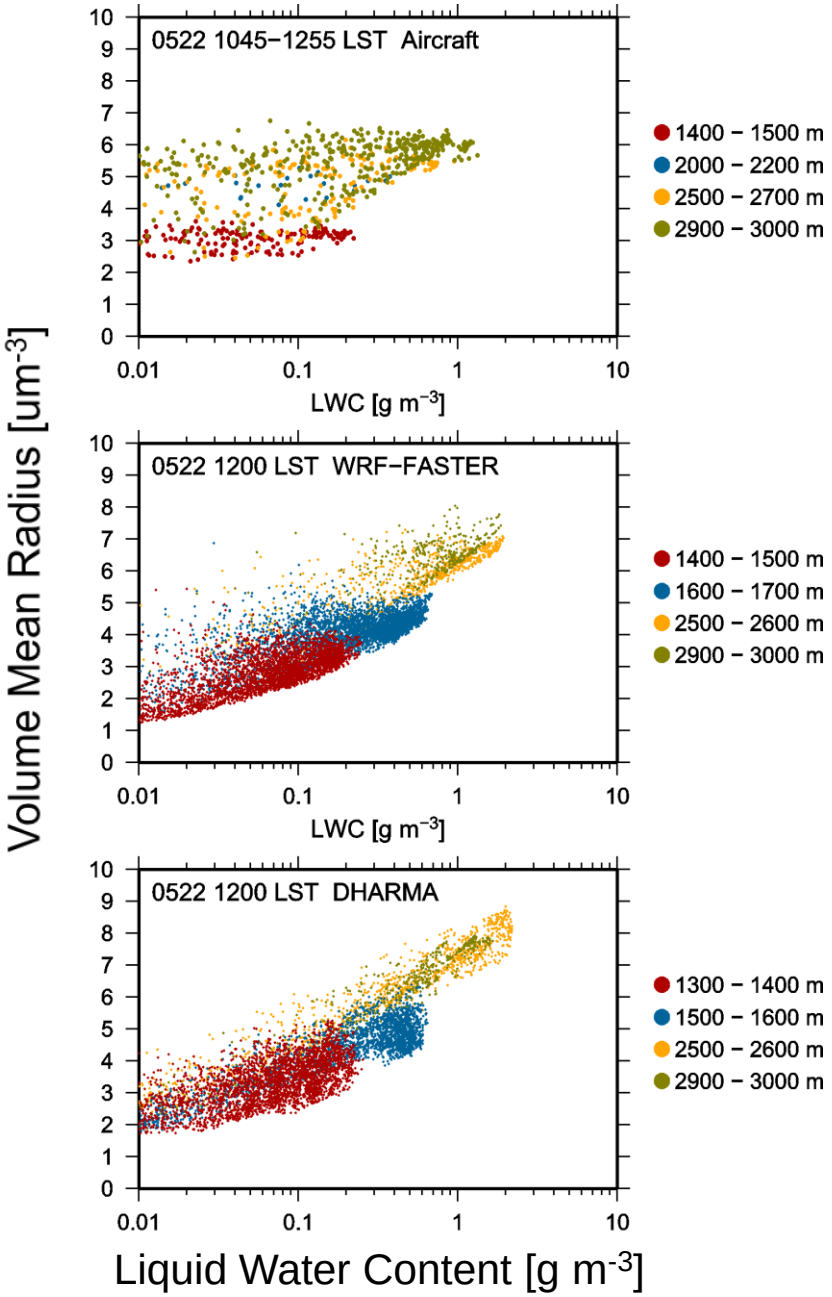

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The differences in the LWC-r_v curvatures suggest that the mixing process is more homogeneous in the simulations.

Next Steps

- Test a newly developed **mixing degree parameterization**
- Compare with the **bin microphysics** simulations