Some Preliminary Results from WRF-LES Simulations

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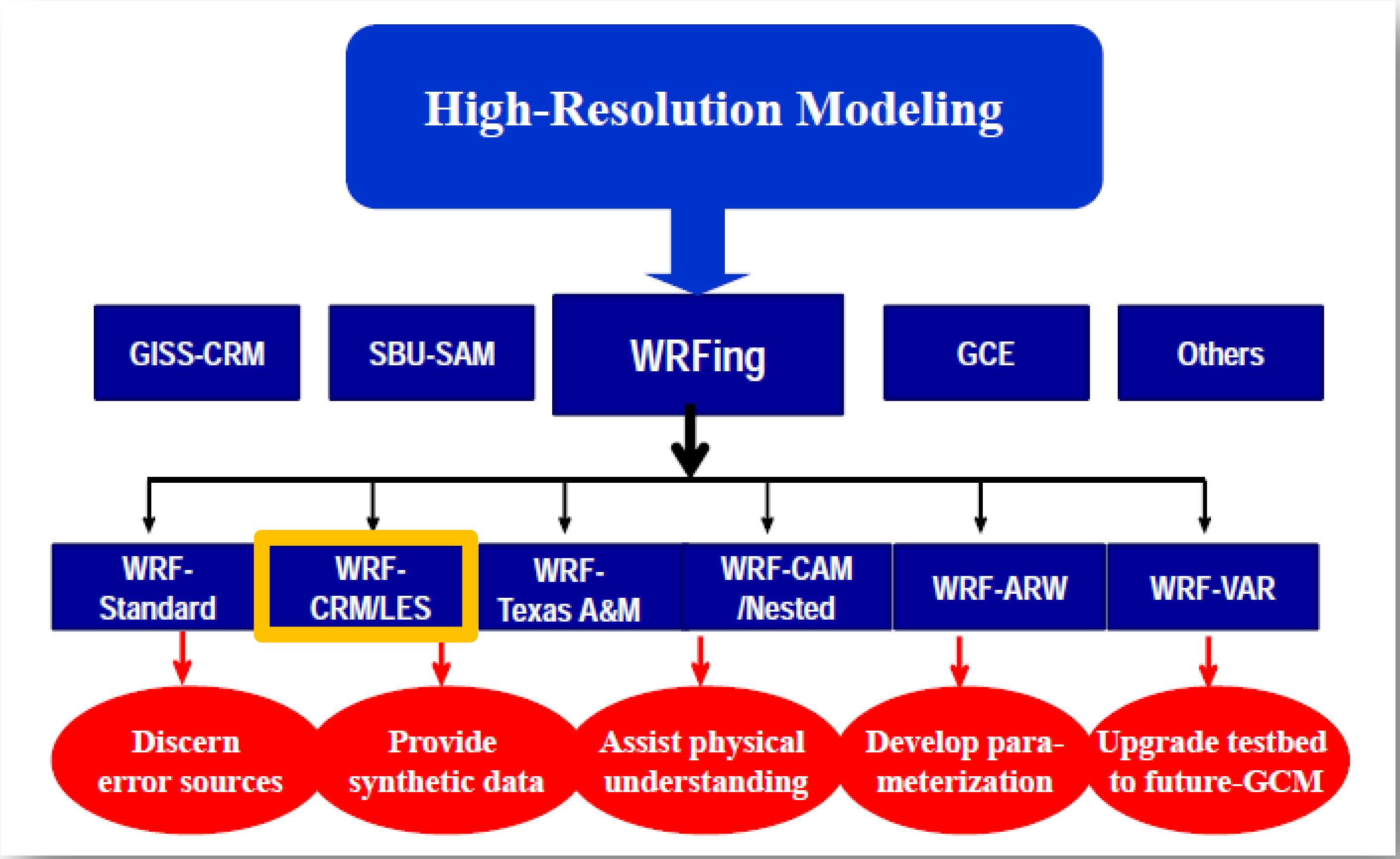
In the FASTER project …

- The WRF model is utilized in several ways in order to provide dataset for studies.



From the slide of Liu in the kick off meeting

Testing WRF

- The first warm-up case is March 2000 IOP at SGP

  Realistic/complicated external forcings

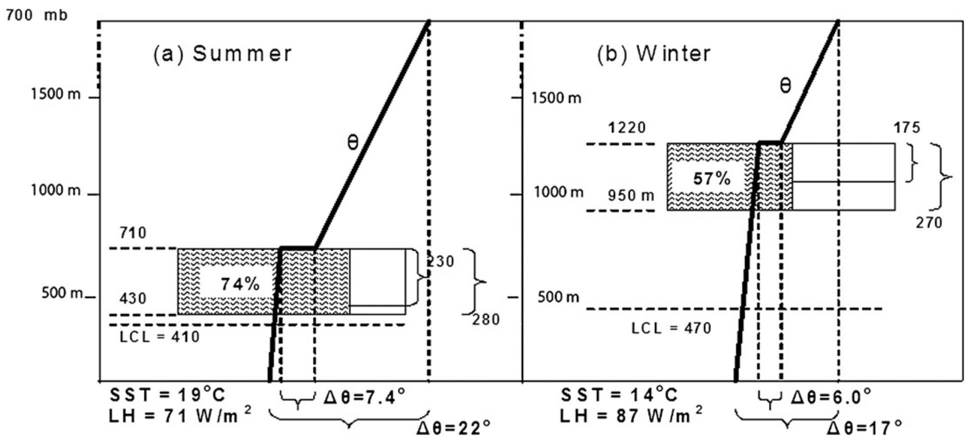
- Before the IOP case, it is better to test

  Idealized simple settings

- As one of the tests, an idealized simulation of marine boundary layer clouds off the California coast is performed.

Macrophysics vs Microphysics

- The wintertime clouds have a smaller cloud fraction and LWP, higher cloud-top, cloud-base and degree of decoupling, similar cloud thickness and inversion strength (Lin et al. 2009).



- The wintertime clouds have a smaller LWC and cloud droplet concentration but larger effective radius and drizzle rate (Liu, 2010).

	Summer	Winter
Cloud top	710 m	1220 m
Cloud base	430 m	950 m
LWP	70.12 g m^{-2}	40.06 g m^{-2}
LWC	0.26 g m^{-3}	0.15 g m^{-3}
Ncloud	53 cm^{-3}	15 cm^{-3}

and more …

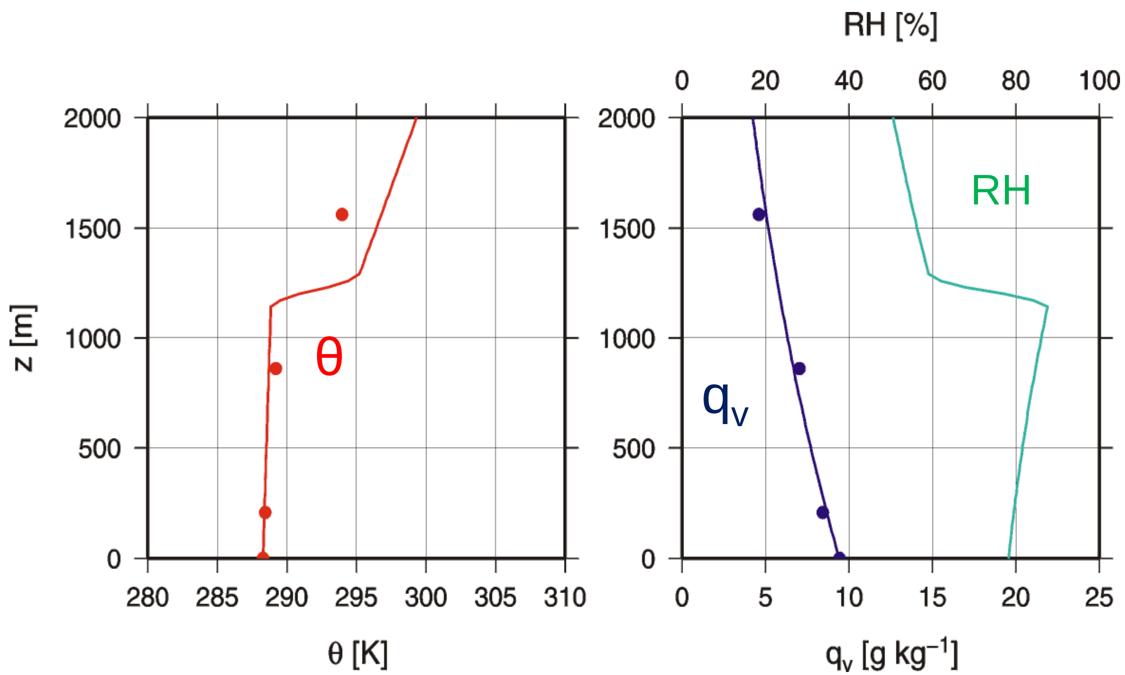
Goal of this study is to discern the relative roles of macro- and microphysics using WRF

Configuration of the Simulation

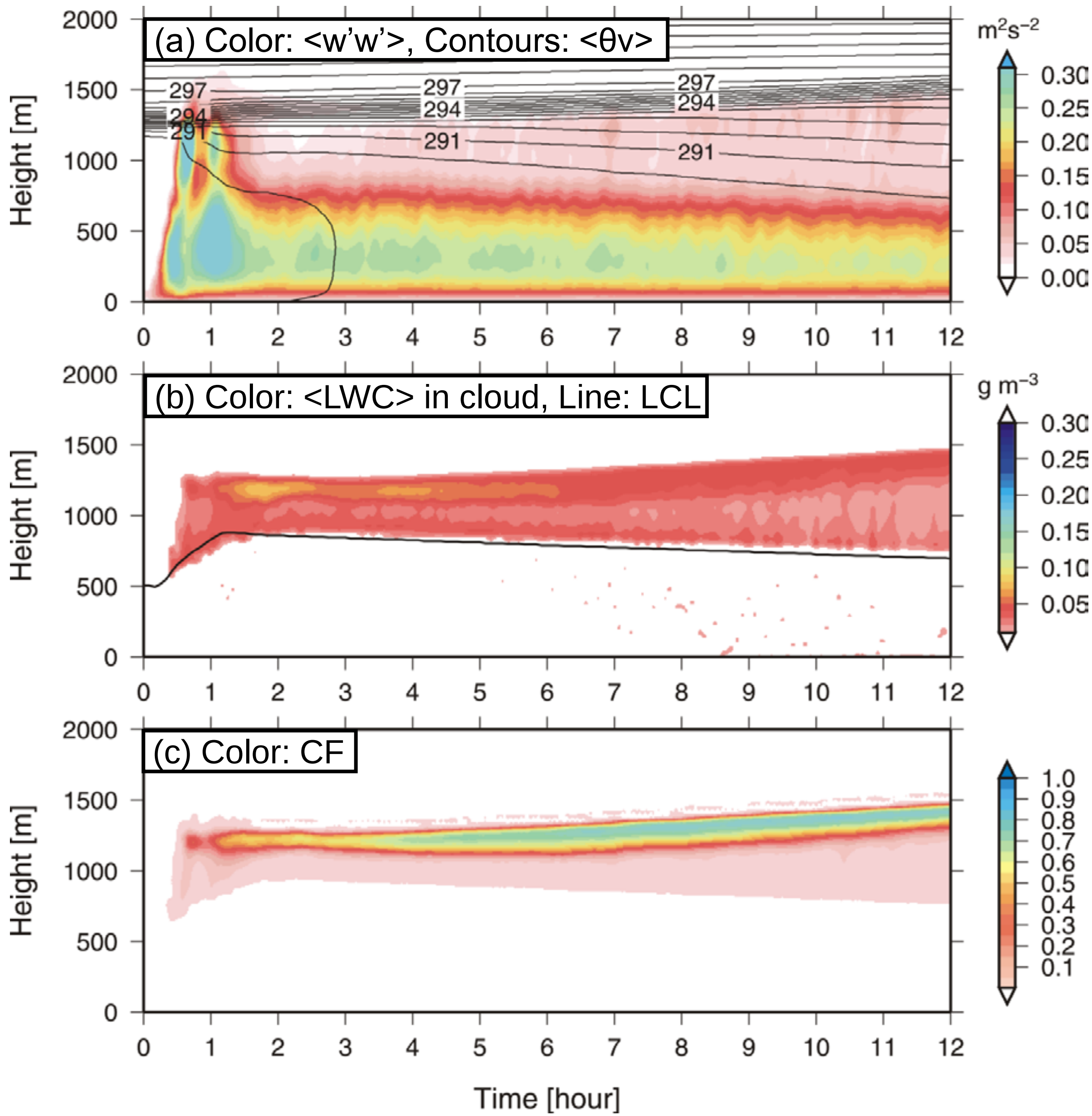
- As the first step, winter case simulation using a single moment cloud microphysics scheme is performed.

Model	WRF ARW v.3.1.1
Microphysics	Lin et al.
Radiation	RRTMG
Turbulence	1.5 order TKE
Grid size	$\Delta x, \Delta y$ = 50m Δz = 30m
Domain	6 km x 6 km x 2.7 km
Surface	Constant flux LHF = 87, SHF = 12.5 W m^{-2}
Lateral boundary	Periodic boundary conditions

- Initial condition is based on Lin et al. (2009) and monthly mean values of NCEP-Reanalysis 2 at 130W 27.5N for Jan. 2007(dots).



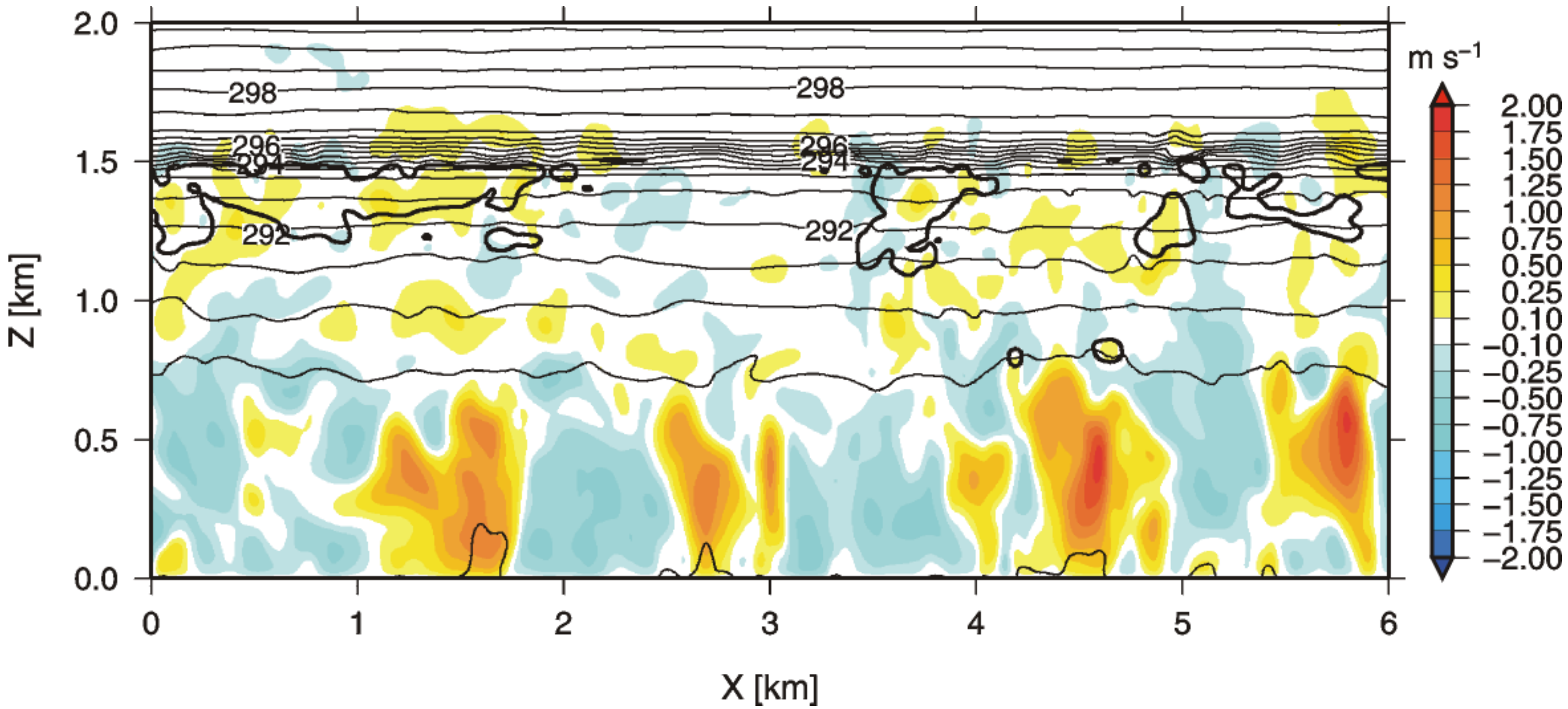
Time evolution



After 2 hours,
the boundary layer consisting of
dry convection,
intermittent cumulus,
stratocumulus is formed.

Structure

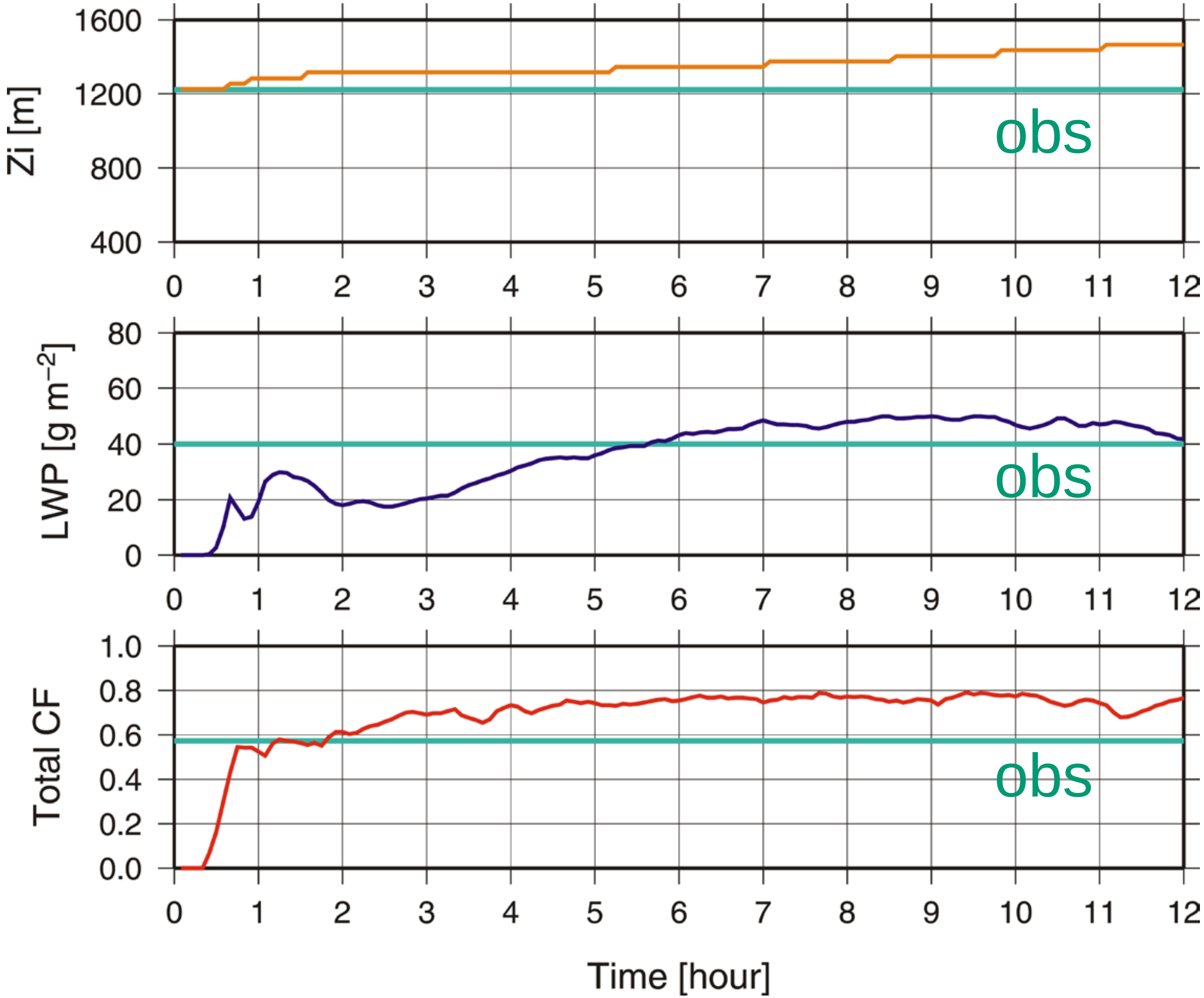
Color: w, Contours: θv, Thick line: qc = 0.01 g kg^{-1}



The stratocumulus layer just below the inversion layer almost decouples from the underlying dry convective boundary layer.

The structure is consistent with the obs.

Comparison with the observation



Summary & Next step

- Results of the simulation of wintertime boundary layer clouds off the California coast were examined as a preparation for the CRM simulation of the warm up case.

- Simulated structure is consistent with the results from the observation: the stratocumulus layer decoupled from dry convective boundary layer.

- Simulated values are reasonably close to the observation but some of them (e.g., CF) showed difference.

- Need to implement large-scale forcings for equilibrium (also for the March 2000 IOP case).

- Simulations using a double moment micro-physics scheme and the summer case are in progress.

Bench Warmers

Cloud Properties based on Observation

Season / Property	Summertime	Wintertime	Relative Diff (%)
Cloud fraction	Larger, 74.77%	Smaller, 57.34%	23
Liquid water path	Higher, 70.12	Lower, 40.06	43
Cloud thickness	Similar, 280 m	Similar, 270 m	4
Cloud-base height	Lower, 430 m	Higher, 950 m	-121
Cloud-top height	Lower, 710 m	Higher, 1220 m	-72
LTS*	Stronger, 22 ^{0}C	Weaker, 17 ^{0}C	23
Inversion strength	Stronger, 7.4 ^{0}C	Weaker, 6.0 ^{0}C	19
LCL*	Lower, 410 m	Higher, 470 m	-15
Surface-latent heat flux	Smaller, 71 Wm^{-2}	Larger, 87 Wm^{-2}	-23
SST*	Higher, 19 ^{0}C	Lower, , 14 ^{0}C	26
Liquid water Content	Larger, 0.26 g m^{-3}	Smaller, 0.15 g m^{-3}	42
Droplet Concentration	Larger, 53 cm^{-3}	Smaller, 15 cm^{-3}	72
Effective radius	Smaller, 11.4 μm	Larger, 14.6 μm	-28
Drizzle rate	Smaller, 0.67	Larger, 2.38	-255