

High resolution 3D simulations of stratiform clouds during the MASRAD and MASE Experiments



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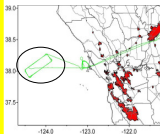


1. Introduction

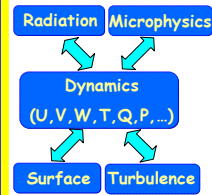
- Simulate MASRAD-MASE clouds using a large-eddy simulation (LES) model to examine cloud properties and convection strength.
- Examine the effects of resolution on a) cloud properties and their diurnal variations; b) convection strength

2. MASRAD (Marine Stratus Radiation Aerosol and Drizzle)/MASE (Marine Stratus Stratocumulus Experiment) (1)

- near Point Reyes, CA
- on 19 July, 2005, a stratus deck over Pacific Ocean
- comprehensive airborne observations available

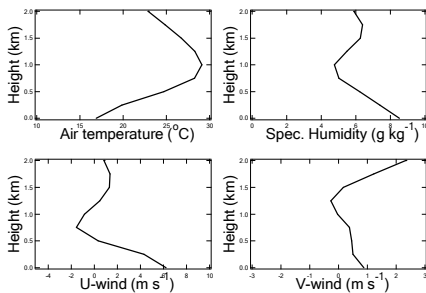


3. Model(2) & simulation set-up



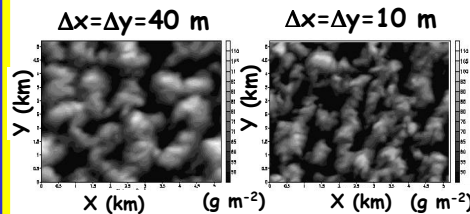
- 3D anelastic dynamics
- 1.5-order turbulence
- 1-moment micro-physics
- 2-stream radiation
- resolution:
dx=dy=40m, 20m, 10m
dz(min)=40m, 20m, 10m

4. Initial conditions



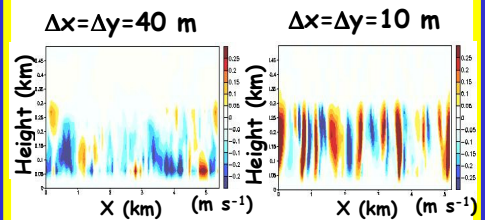
Strong inversion; Shallow boundary layer

5a. Snap shots: liquid water path



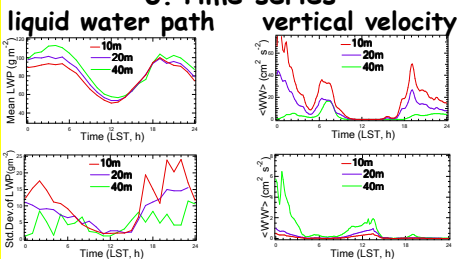
With a higher resolution:
domain mean LWP ($\langle \text{LWP} \rangle$) decreases,
variance of LWP increases

5b. Snap shots: vertical velocity



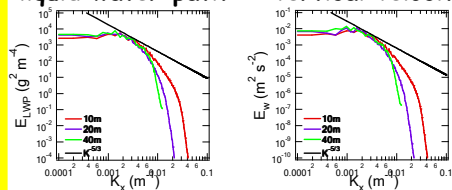
With a higher resolution:
domain mean vertical velocity ($\langle W \rangle$) remains 0,
variance of W increases

6. Time series



Significant diurnal variation:
larger LWP & stronger convection at night
For different Δx:
LWP & convection differ more at night

7. Power spectra



Δx ↓:
higher power @ high wavenumbers,
steep fall-off @ higher wavenumbers

8. Conclusions & future work

- Higher resolution could better resolve cloud variations and small-scale convection;
- Resolution effects are more significant at night when convection is stronger;
- Higher resolution could better represent power spectrum.
- Future work includes: multi-moments and size-bins cloud micro-physics, aerosol indirect effects, ...

References

- (1) Daum, P. et al., Microphysical properties of stratus/stratocumulus clouds during the 2005 Marine stratus/stratocumulus Experiment (MASE), revised, 2008
- (2) Tao, W. et al., Microphysics, radiation, and surface processes in the Goddard Cumulus Ensemble (GCE) model, *Meteorol. Atmos. Phys.*, 82, 97-137, 2003.



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