An assessment of MODIS marine boundary layer cloud property retrievals based on a Large-Eddy simulation.

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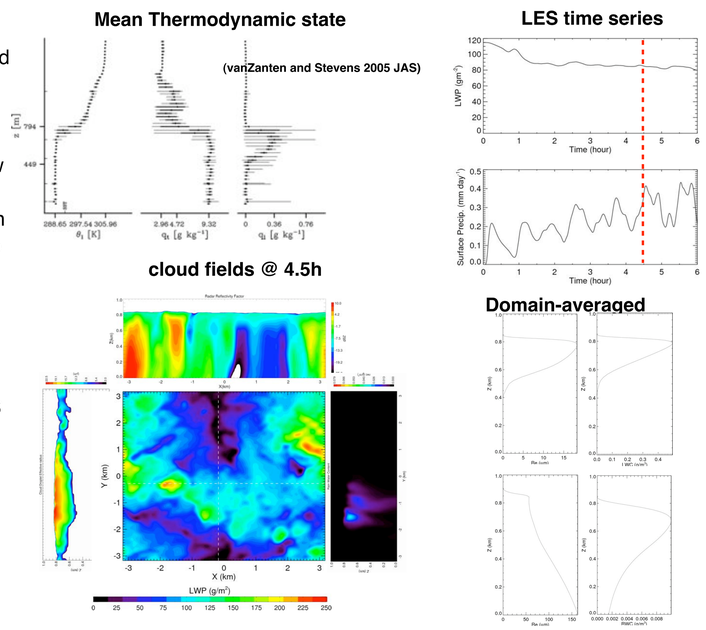
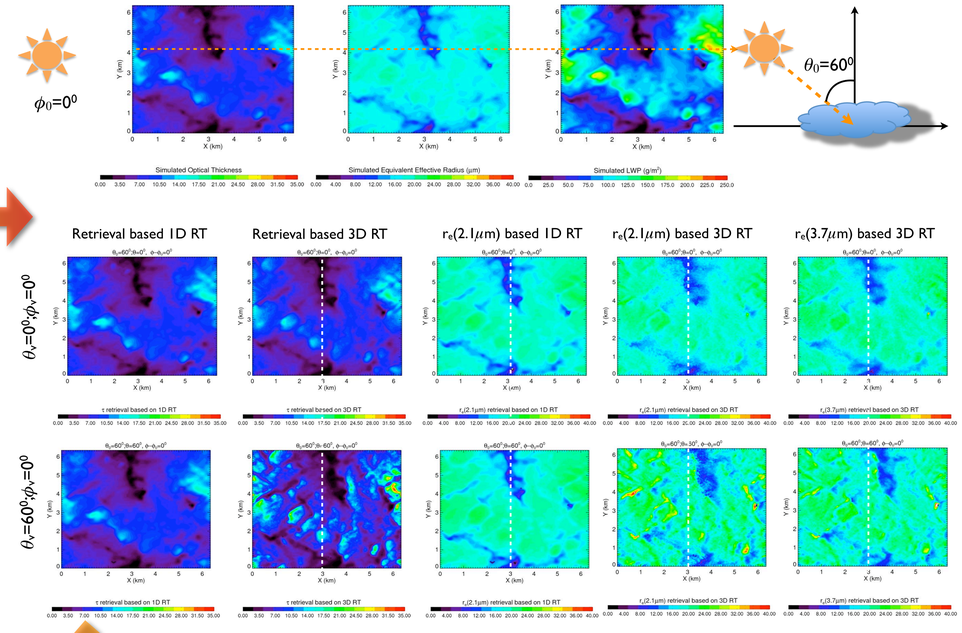
Abstract

The extensive and persistent marine boundary layer (MBL) clouds play a vital role in Earth's radiative energy budget and have been suggested to be at the heart of tropical cloud feedback uncertainties in current GCMs. Improving our understanding of MBL clouds requires long-term satellite-based observations of these clouds and correct interpretation of the observation. Some recent studies show evidence that some microphysical processes, such as the drizzling and cloud top entrainment, may have an impact on MODIS cloud property retrievals. To identity the importance of these impacts, we have recently developed a framework to simulate MODIS operational retrievals from cloud fields simulated by a Large-Eddy model. In this research, we explore the possibilities of using this framework to help us understand the impacts of 3D effects, sub-pixel cloud heterogeneity, drizzle and cloud top entrainment on MODIS cloud effective radius and optical thickness retrievals. We are investigating how the 3D effects depend on the combination of MODIS bands selected for the retrieval. We are also investigating the impacts of vertical droplet size variation and the presence of drizzle on MODIS cloud effective radius retrieval.

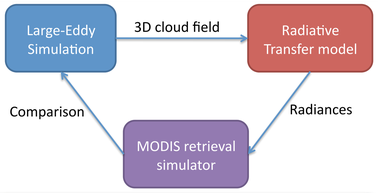
DYCOMS-II RF02 LES (N_c=25/cm^3)



MODIS retrieval simulation



Infrastructure



UCLA LES V2.0

Microphysics:	cloud droplet & drizzle
Two-moment scheme:	mass & # concentration
Particle size distribution:	Gamma distribution
Cloud droplet:	LWC_c & N_c (specified)
	r_c=/(LWC_c, N_c) 1~30μm
Drizzle:	LWC_d & N_d
	r_d=/(LWC_d, N_d) 50~400μm

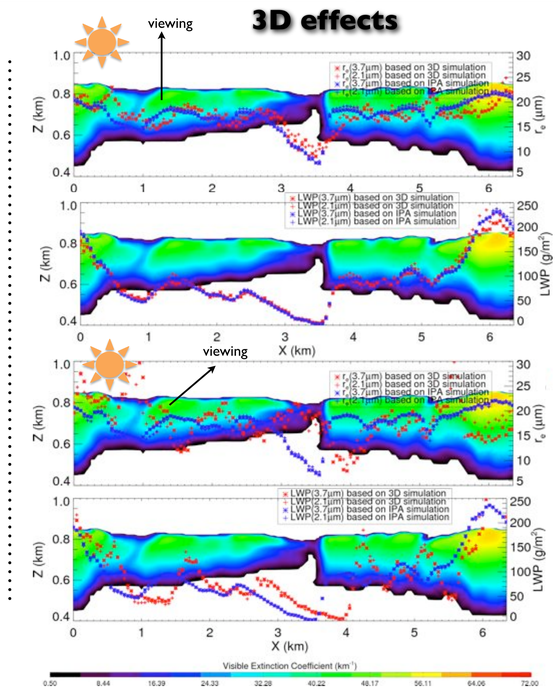
RT models:

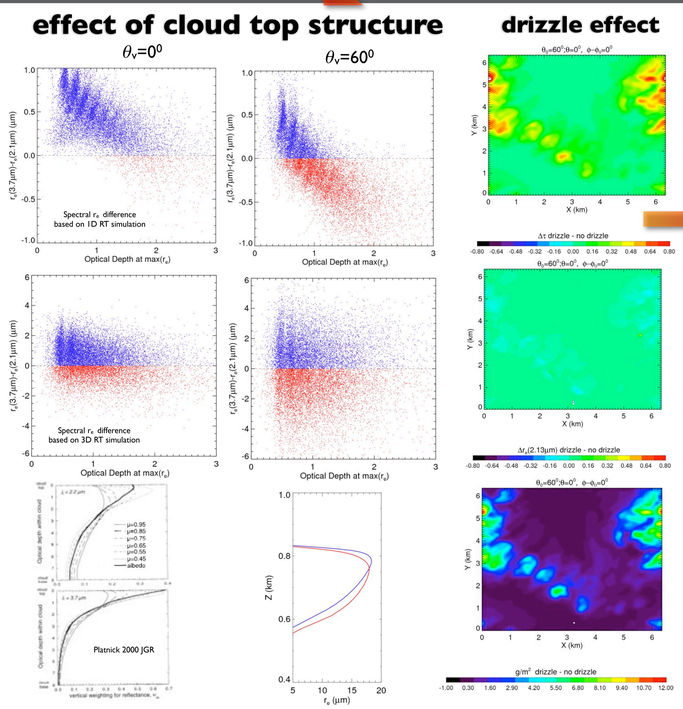
1D: DISORT (Stamnes et al. 1988 Appl. Optics)
3D: I3RC Community Monte Carlo model (Pincus, and Evans 2009 JAS)
Mie Code: Wiscombe MIEV0

MODIS retrieval simulator

Assumption: Plane-parallel, vertical homogeneous
Method: Nakajima-King Look-up-table
τ retrieval: 0.86μm
r_e retrieval: 1.63μm, 2.13μm
3.70μm(reflective component only)

Retrieval analysis





Conclusions

The effects of cloud 3D structure on passive remote sensing of MBL cloud properties are studied using a simulator package, which includes a LES model, 1D/3D radiative transfer models and a MODIS retrieval simulator. *Preliminary* results from the DYCOMSII-RF02 case suggest that:

- 3D radiative effects, i.e. illumination and shadowing, can substantially influence the optical thickness and effective radius retrievals.
- Cloud top structure, which is closely connected to the entrainment mixing, may have significant impact on cloud effective radius retrieval.
- *For the simulated case*, drizzle droplets do not show significant impact on either cloud optical thickness or effective radius retrievals

The simulator proved to be very helpful for understanding the underlying physics for passive remote sensing of MBL clouds. Plans for future work include:

- Further investigation of the effects of cloud top structure on passive cloud property retrievals.
- Study 3D effects on the differences between effective radius retrievals based on different SWIR bands
- Information content analysis for new retrieval algorithm development