Part I:
The Impact of the Vertical Variation of Cloud Droplet Size on the Estimation of Cloud Liquid Water Path

Ruiyue Chen(1), Fu-Lung Chang(2), Zhanqing Li(1), Ralph Ferraro(1)
1. Cooperative Institute for Climate Studies University of Maryland, College Park, MD 20742
2. National Institute for Aerospace, Hampton, VA 23666

Introduction

- Traditional Satellite estimation of LWP from SW observation

$$LWP = \frac{2}{3}\tau \; r_e$$

re: droplet effective radius (DER)

Problem : Assume vertically constant re. re is retrieved from single NIR channel and weighted toward cloud top.

- Overestimate LWP when DER increased with height (IDP)
- Underestimate LWP when DER decreased with height (DDP)

DER profile retrieval

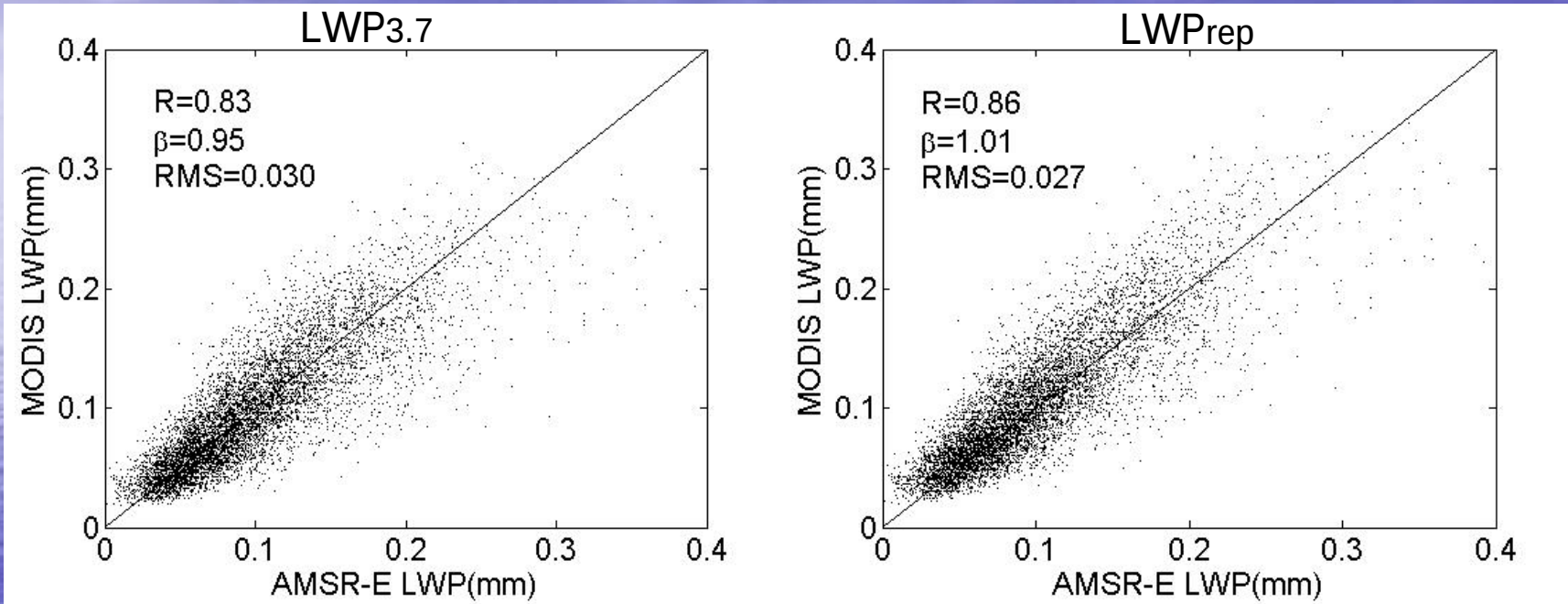
- Compare observed reflectance at 0.63μm, 1.6μm, 2.1μm, and 3.7μm with pre-calculated value. (Chang and Li, JGR, 2002, 2003)

- Catch the trend of DER vertical variation, improve LWP estimation.

Data

- AQUA MODIS 1km L1 B data (NSIDC DAAC)
- AMSR-E LWP estimation from Wentz's algorithm (NSIDC DAAC), 13x7km
- Overcast cloud (AMSR-E foot print) on 01/01/2003 , Latitude -30~30, warm top (>273K), optical depth 3.4~23, solar zenith angle < 60, satellite view angle < 30

Comparison between MODIS LWP estimation and AMSR-E LWP estimation



- re profile makes some changes, but not obvious.
- IDP and DDP has opposite impact on LWP

Comparison for cloud with IDP, NDP, and DDP

	IDP	NDP	DDP
$LWP_{3.7}$	1.126	1.026	0.888
LWP_{rep}	1.052	1.029	1.001

Linear regression coefficient between MODIS LWP and AMSR-E LWP

- re profile causes +10% bias for IDP cloud and -13.8% bias for DDP cloud on $LWP_{3.7}$
- LWP_{rep} corrects the bias

Conclusion

- Neglecting vertical variation of cloud DER causes bias in LWP estimation from satellite shortwave observation
- LWP calculation with DER profile corrects the bias and improve LWP estimation

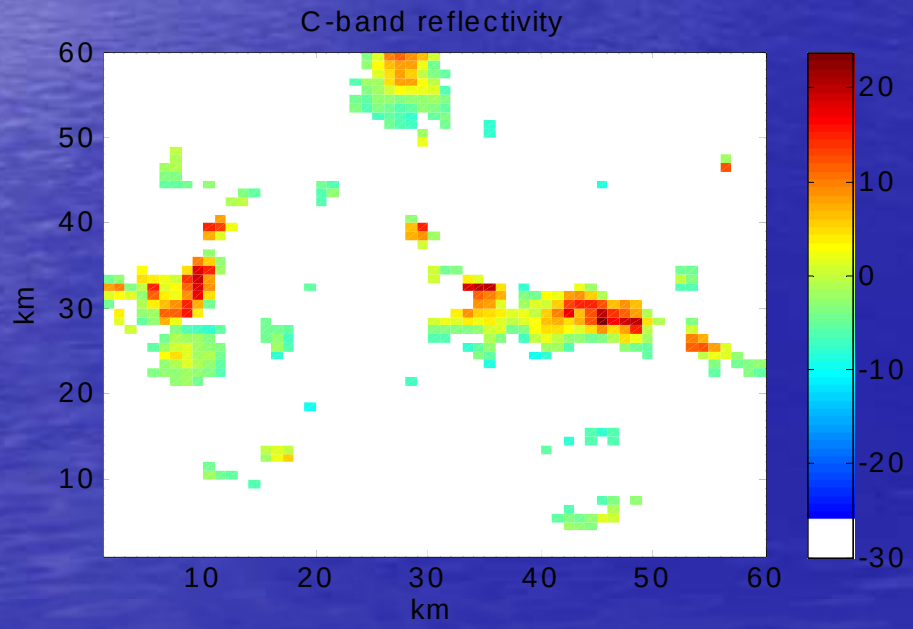
Part II:
Relationship between cloud droplet size profile and drizzle

Ruiyue Chen(1), Robert Wood(2), Fu-Lung Chang(3), Zhanqing Li(1), Ralph Ferraro(1)

1. Cooperative Institute for Climate Studies, University of Maryland, College Park, MD
2. Department of Atmospheric Sciences, University of Washington, Seattle, WA
3. National Institute for Aerospace, Hampton, VA 23666

Data

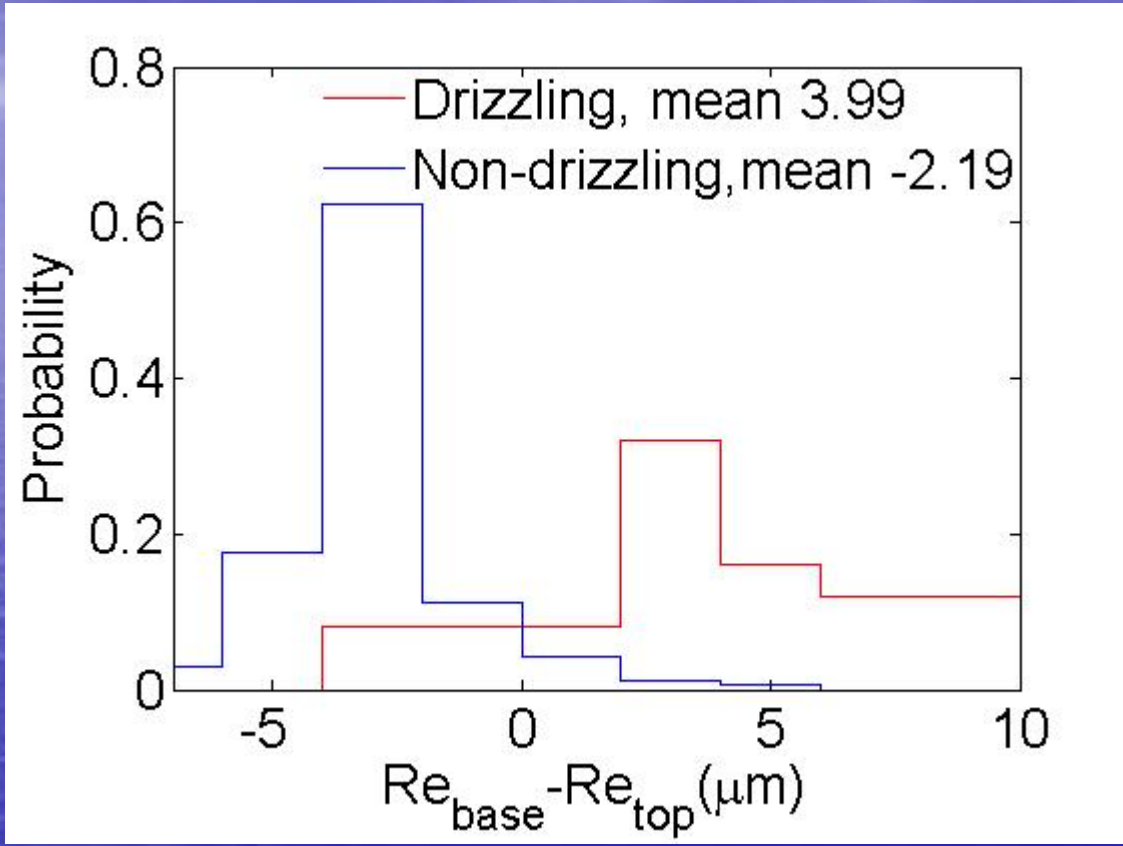
- Terra MODIS 1km L1B data, for retrieval of DER profile
- Rain estimation from C-band ship-based radar during EPIC 2001, 0.5x0.5 km, 5-min averaged



Data processing

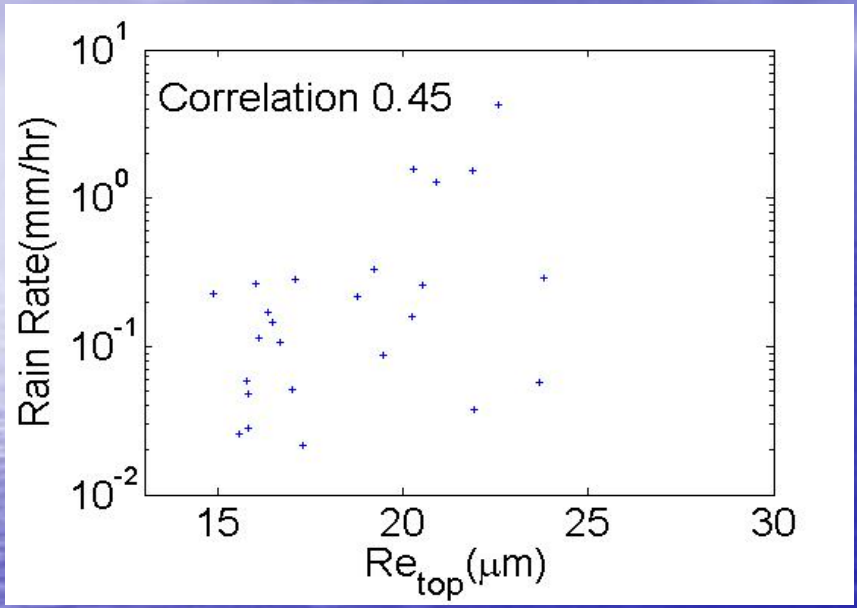
- MODIS measurements over EPIC location are selected to match the radar measurements
- Both MODIS and Radar measurements are averaged in 5x5km grid box
- Only overcast clouds cover whole 5x5 km pixels are included
- Drizzling threshold is -5dbz
- Z=12.4R^1.18 (Wood, JAS, 2005)

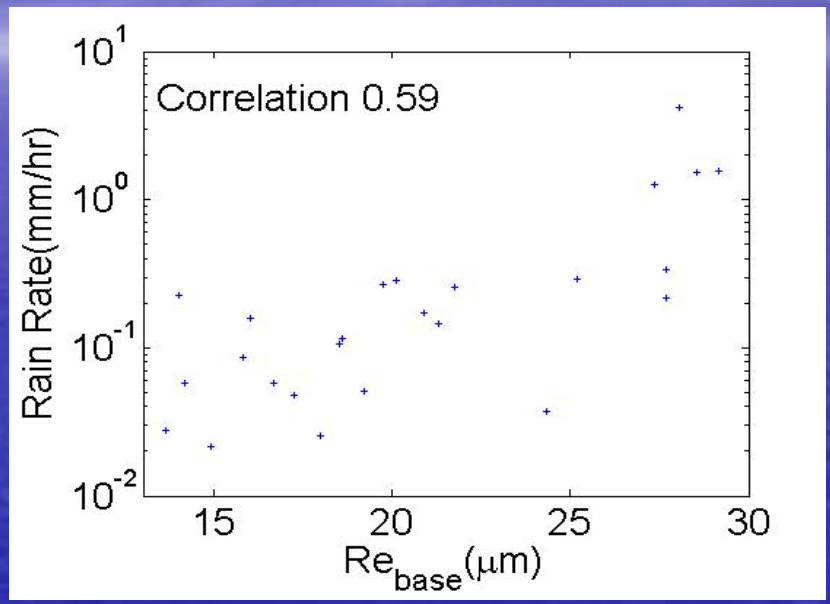
DER profile and Drizzle



- Drizzling cloud are more likely to have a decreasing DER profile with height

Cloud droplet size and rain rate





- The larger cloud droplets, the more rain
- DER at cloud base is more correlated with rain

Conclusion

- Drizzling cloud are more likely to have a decreasing DER profile with height
- The larger cloud droplets, the more rain
- DER at cloud base is more correlated with rain

Cloud DER profile and rain rate