On the Characterization of Precipitating and Not-Precipitating Shallow Clouds over Manus

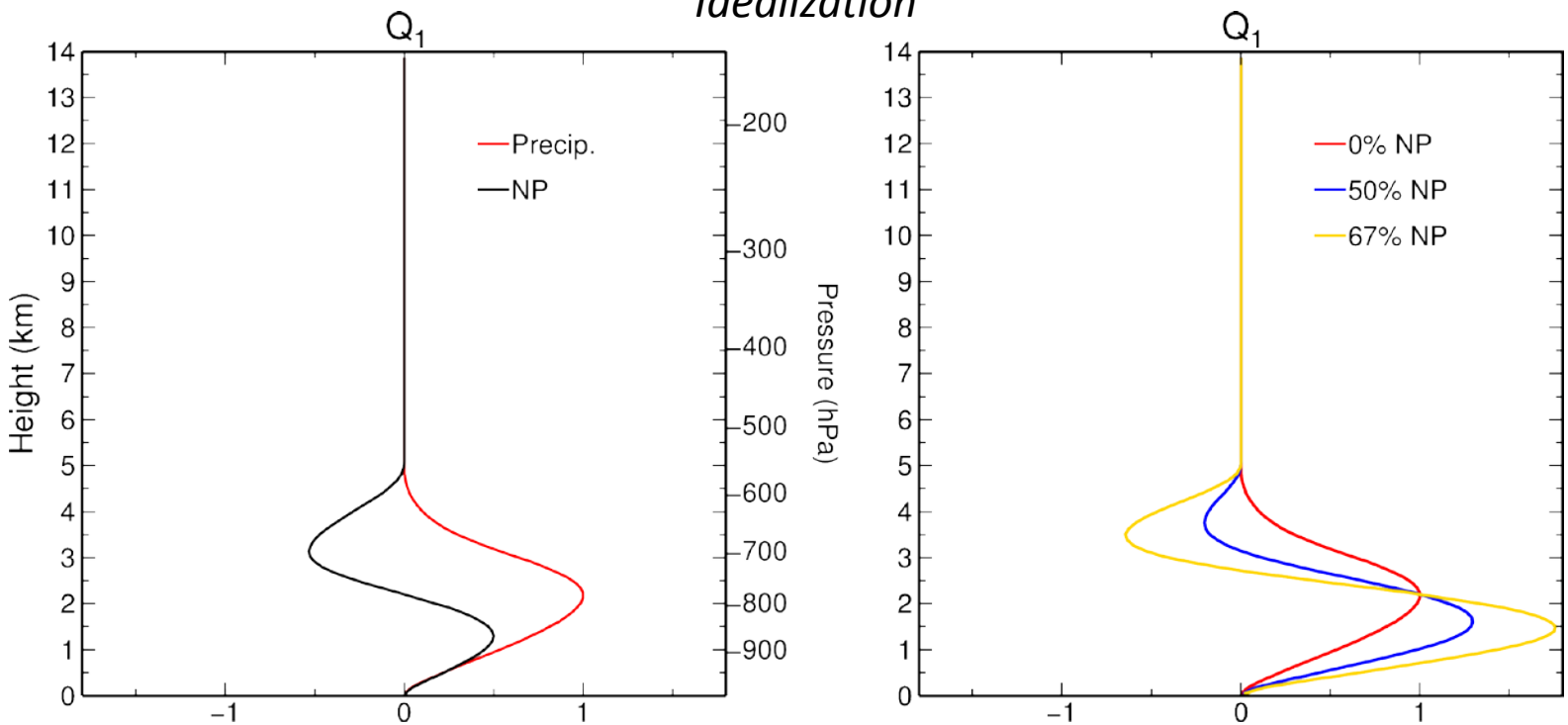
David Zermeno, Chidong Zhang
University of Miami
Pavlos Kollias and Heike Kalesse
McGill University

Introduction

- The role of shallow convection has been proved to be critical to improve model simulations (Zhang and Song 2008; DelGenio 2011)

- Not-precipitating clouds might also be critical to adequately simulate the role of shallow convection

Idealization



See also Schumacher 2007

Data

Observations collected over Gan and Manus Islands during DYNAMO (8th Oct 2011 to 8th Feb 2012)

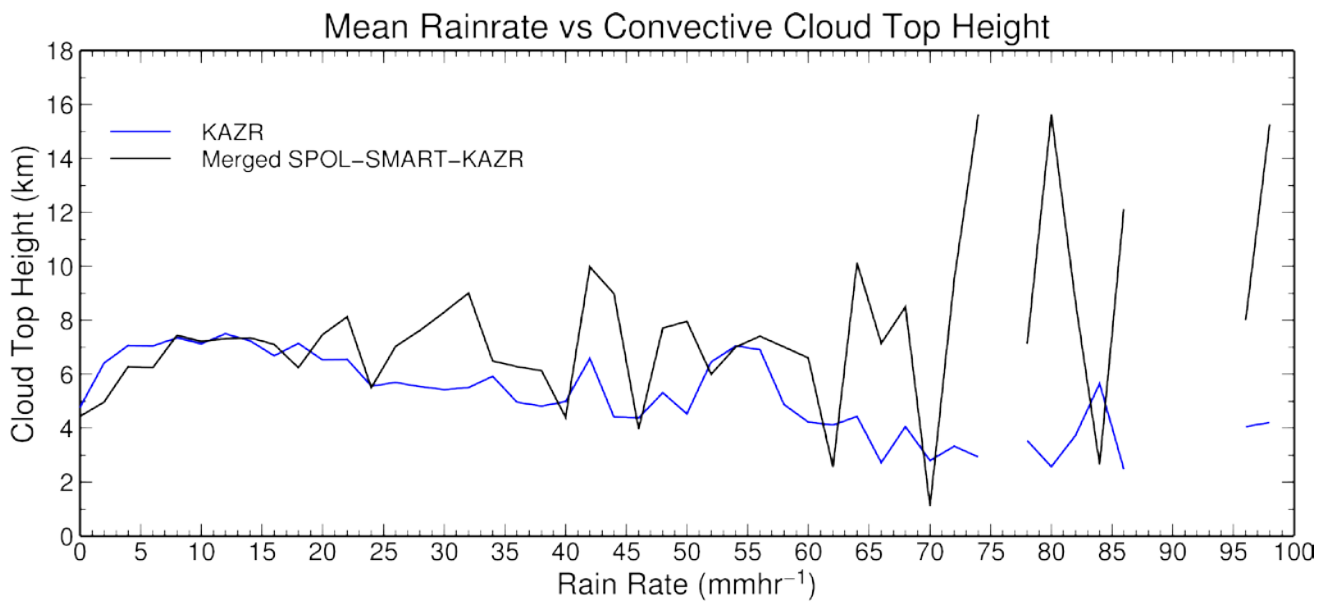
- Optical rain gauge
  - -60 sec resolution
- ARSCL KAZR over Gan
  - -4sec, 30m resolution
- KAZR over Manus (NO ARSCL, noise was filtered using 0dB threshold. Preliminary version.)
- Merged KAZR-SPOL-SMARTR (MKS, hereafter) reflectivity over Gan (http://www.arm.gov/data/pi/71).
  - - 30 sec, 90m resolution

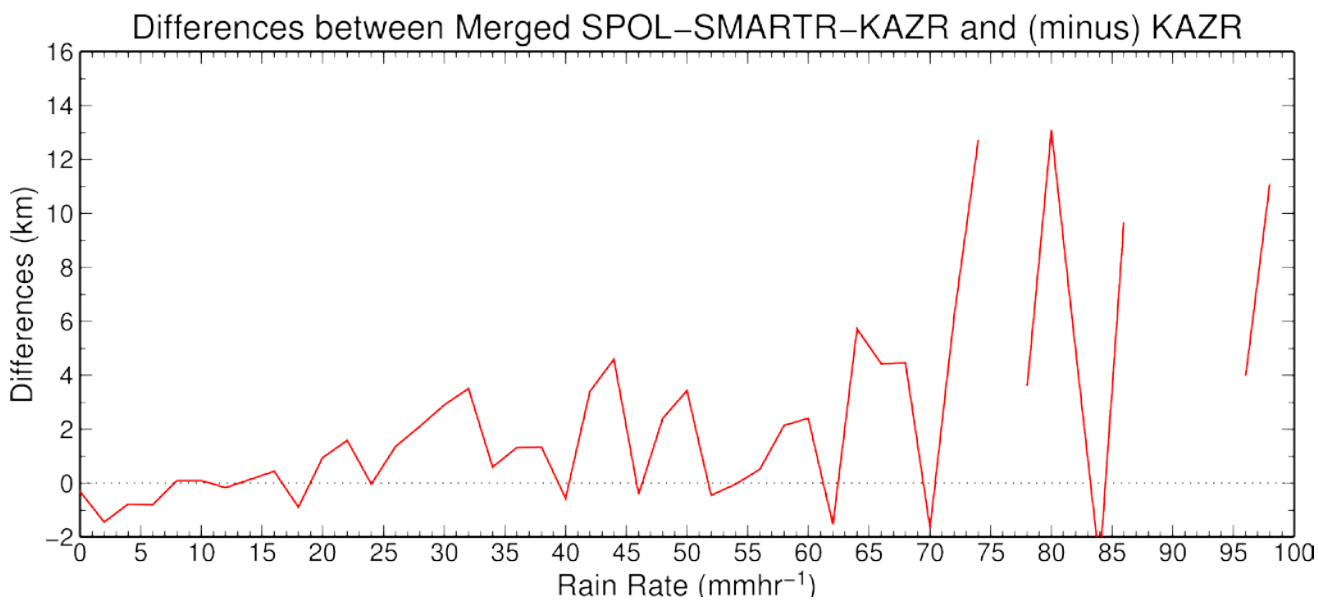
All data was binned to 60 sec temporal resolution

Merged KAZR-SPOL was interpolated to the vertical resolution of KAZR

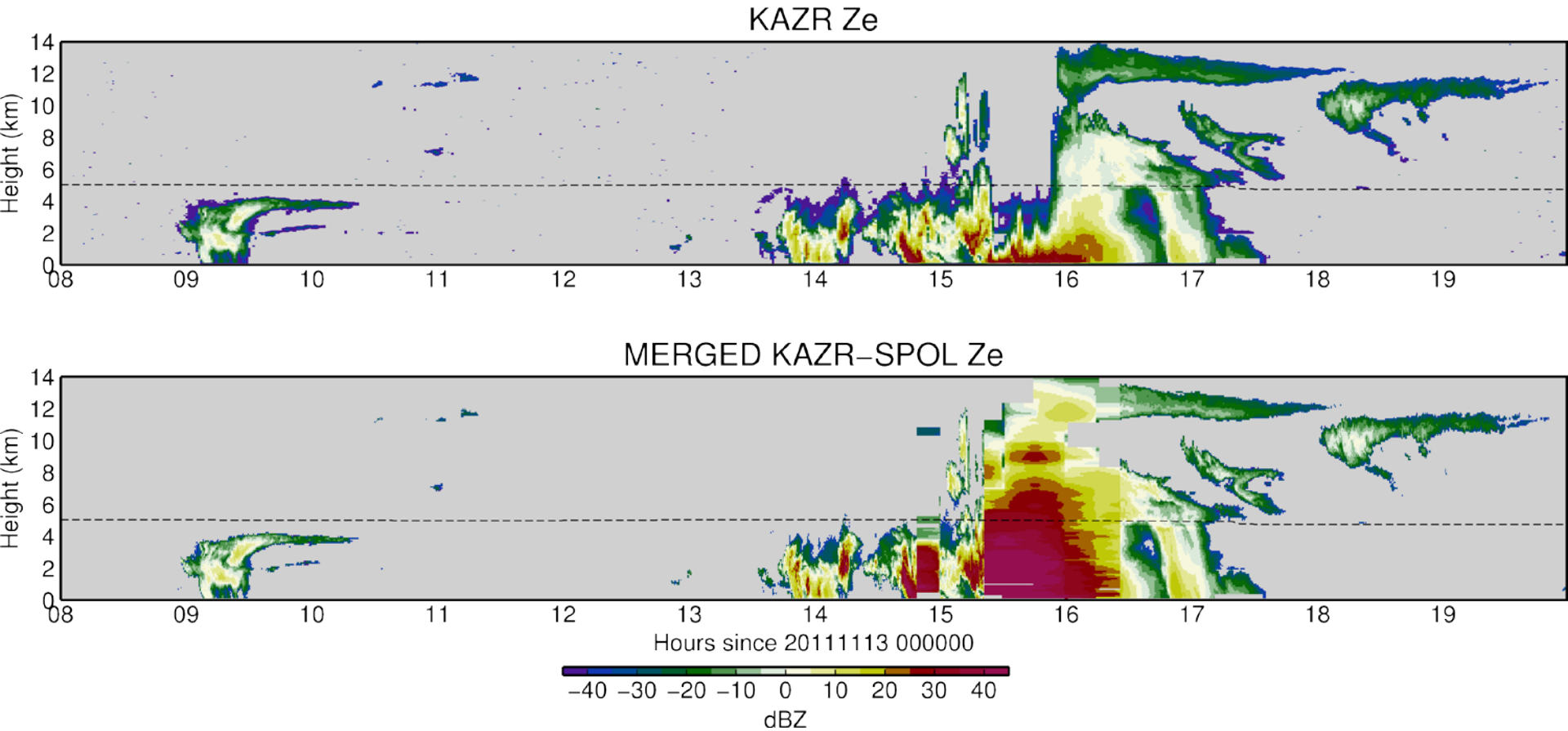
A Convective cloud: an echo starting at approximately the LCL without a bright band close to the 0C height

Bright Band: an absolute reflectivity maximum in Ze and/or DVG greater than 2m/s (Geerts et al 2004) close to the 0C height



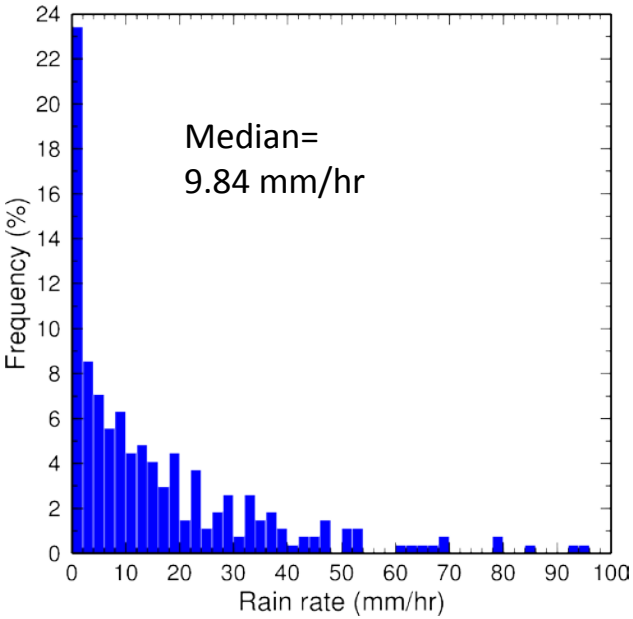


How to detect Shallow Clouds using KAZR as a sole reference?

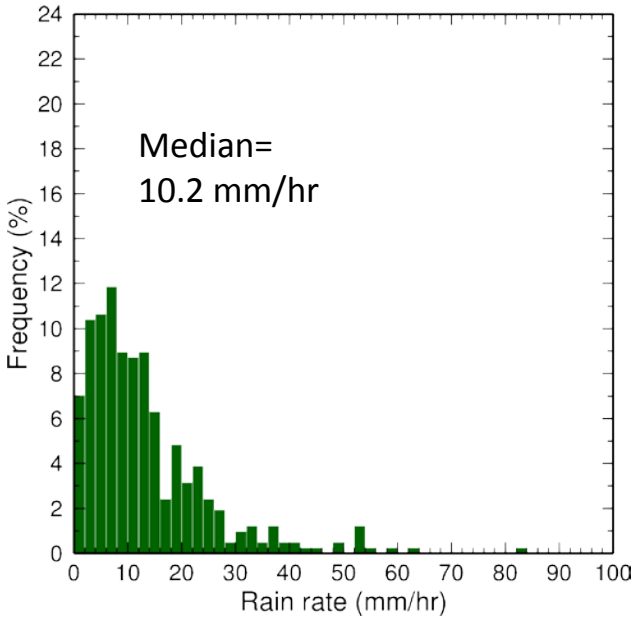


Rain Rate Frequency Distributions

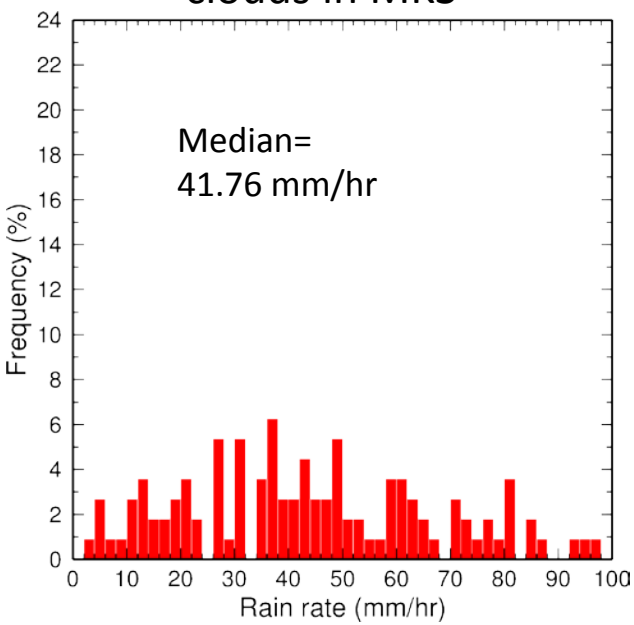
Shallow clouds
in KAZR and MKS



Deep clouds
in KAZR and MKS

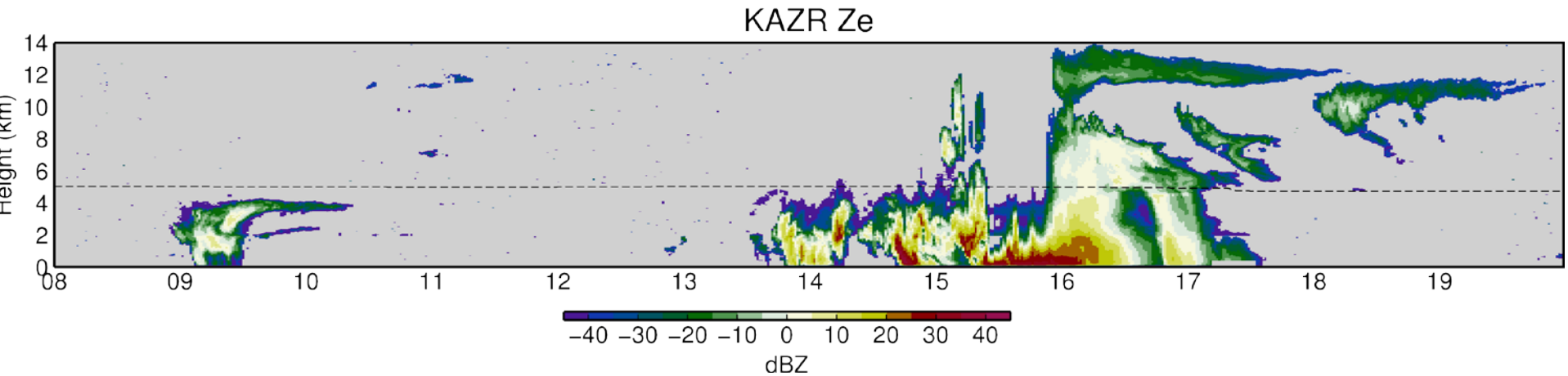


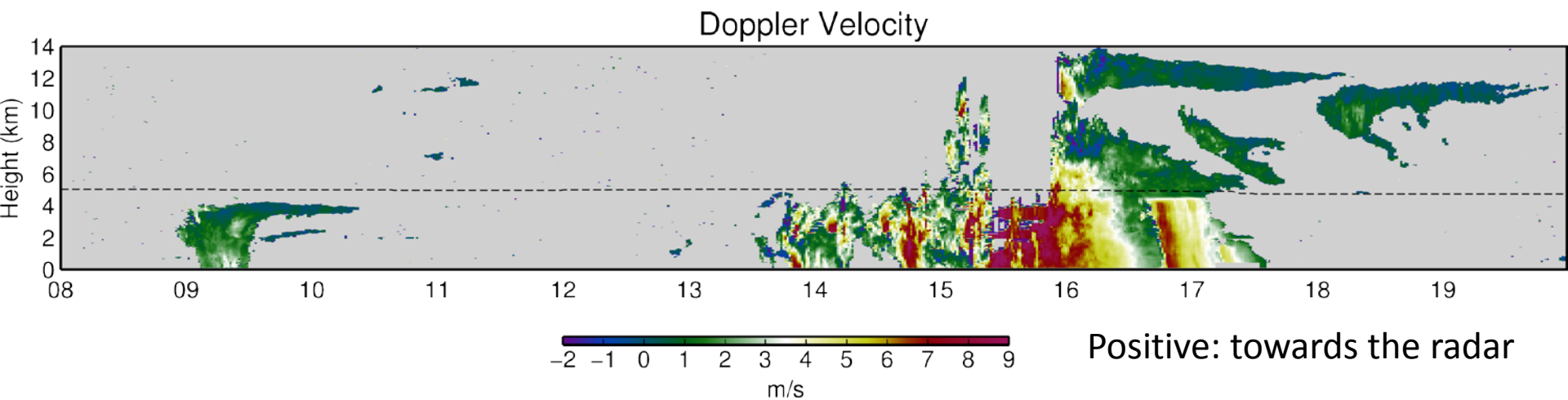
Shallow clouds
in KAZR and deep
clouds in MKS



Shallow cloud: a convective cloud having its top below the 0C height
Deep cloud: a convective cloud having its top above the 0C height

Possible Solution





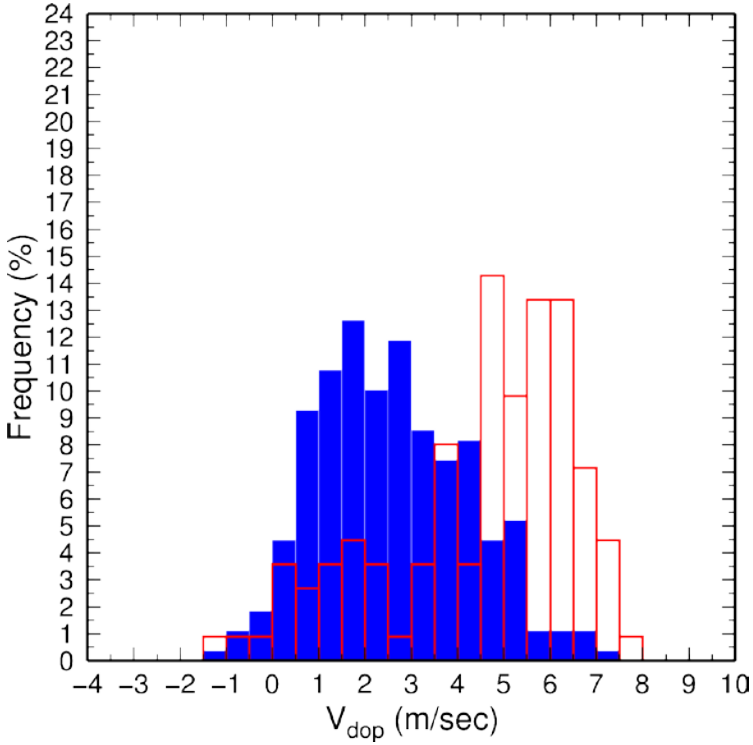
Positive: towards the radar

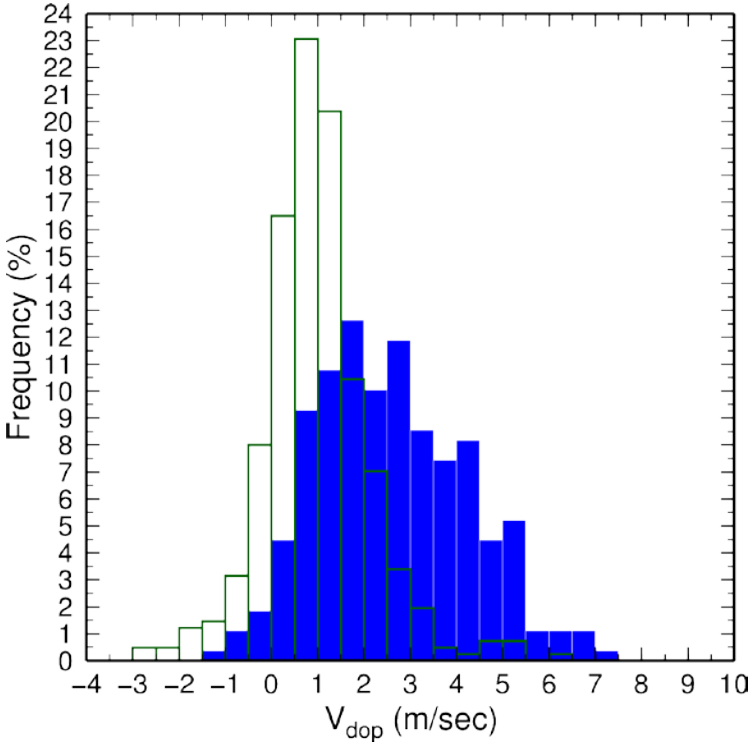
Doppler Velocity Frequency Distributions At the Cloud Top

Shallow clouds in KAZR and MKS

Deep clouds in KAZR and MKS

Shallow clouds in KAZR and deep clouds in MKS

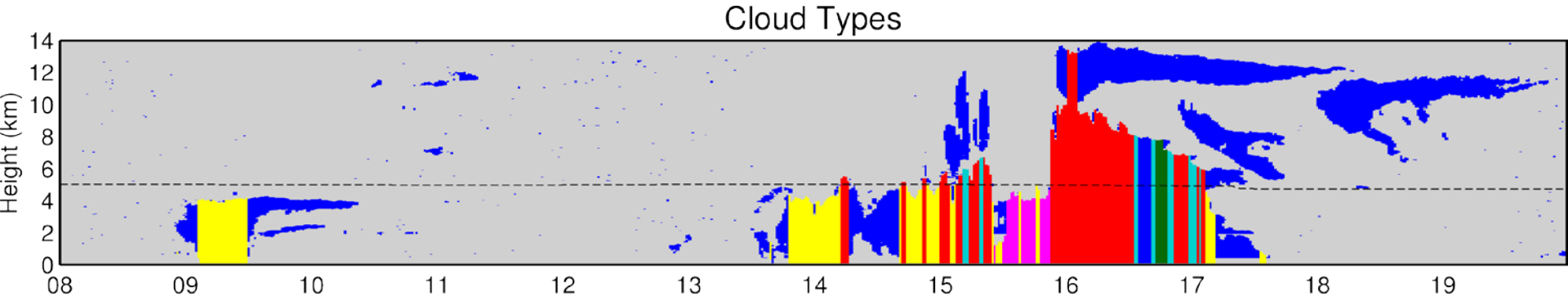




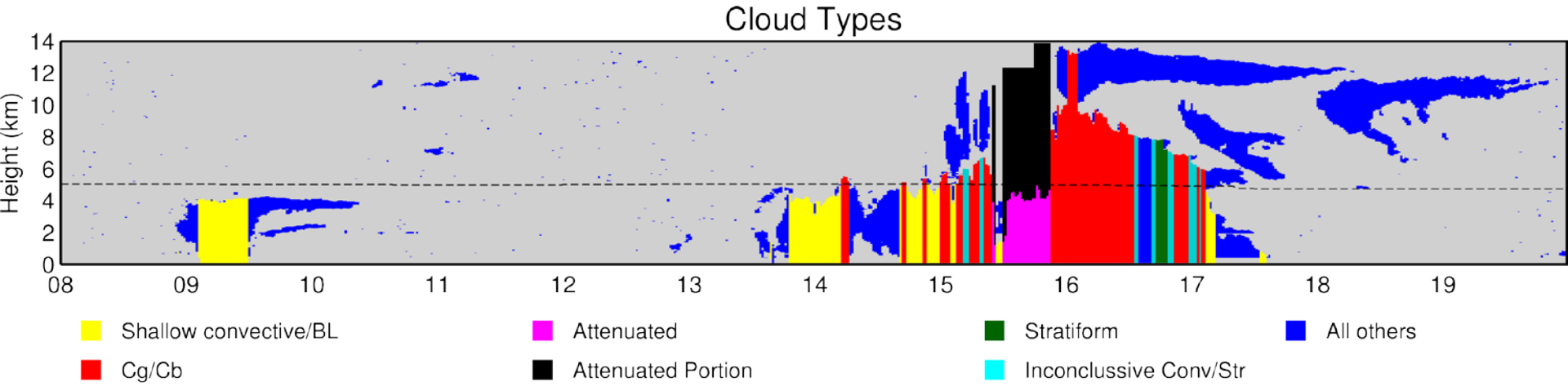
1km deep below the cloud top was averaged.
Similar results using different depths

Positive: towards the radar

Attenuated Profiles detected using a Vdop threshold of 3.5 m/s mean at the cloud top



Attenuated Profiles detected using the Merged Ze

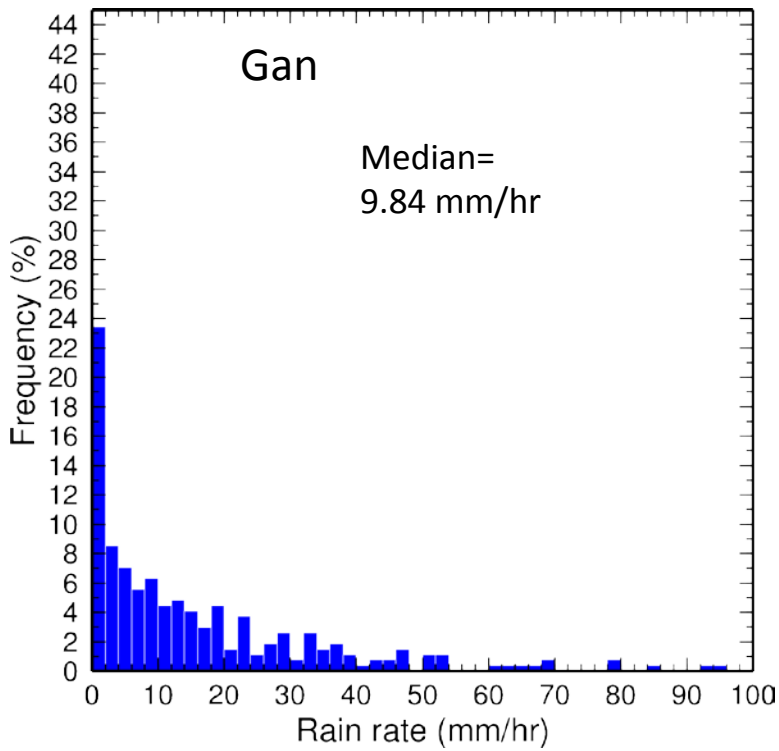


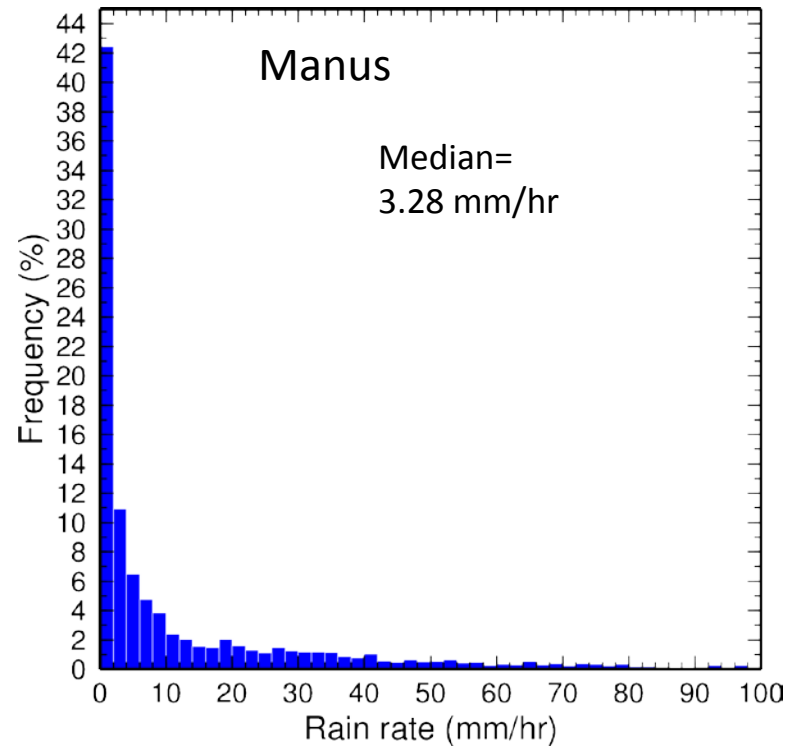
Shallow/Deep Attenuated Cloud Detection Metrics

	Using MKS	Using cloud top vel. (3.5m/s) and rain rate (10mm/hr)
Shallow	Med. = 9.84 mm/hr Total # of profiles = 269	Med.= 8.28 mm/hr Predicted profiles = 260 Hit Score (%) = 85.87
Deep Attenuated	Med. = 41.76 mm/hr Total # of profiles = 112	Med. = 37.5 mm/hr Predicted profiles = 121 Hit Score (%) = 74.11

Precipitation from shallow clouds identified using Vdop and rain rate are from the same distribution (95% KS test) as those detected using MKS

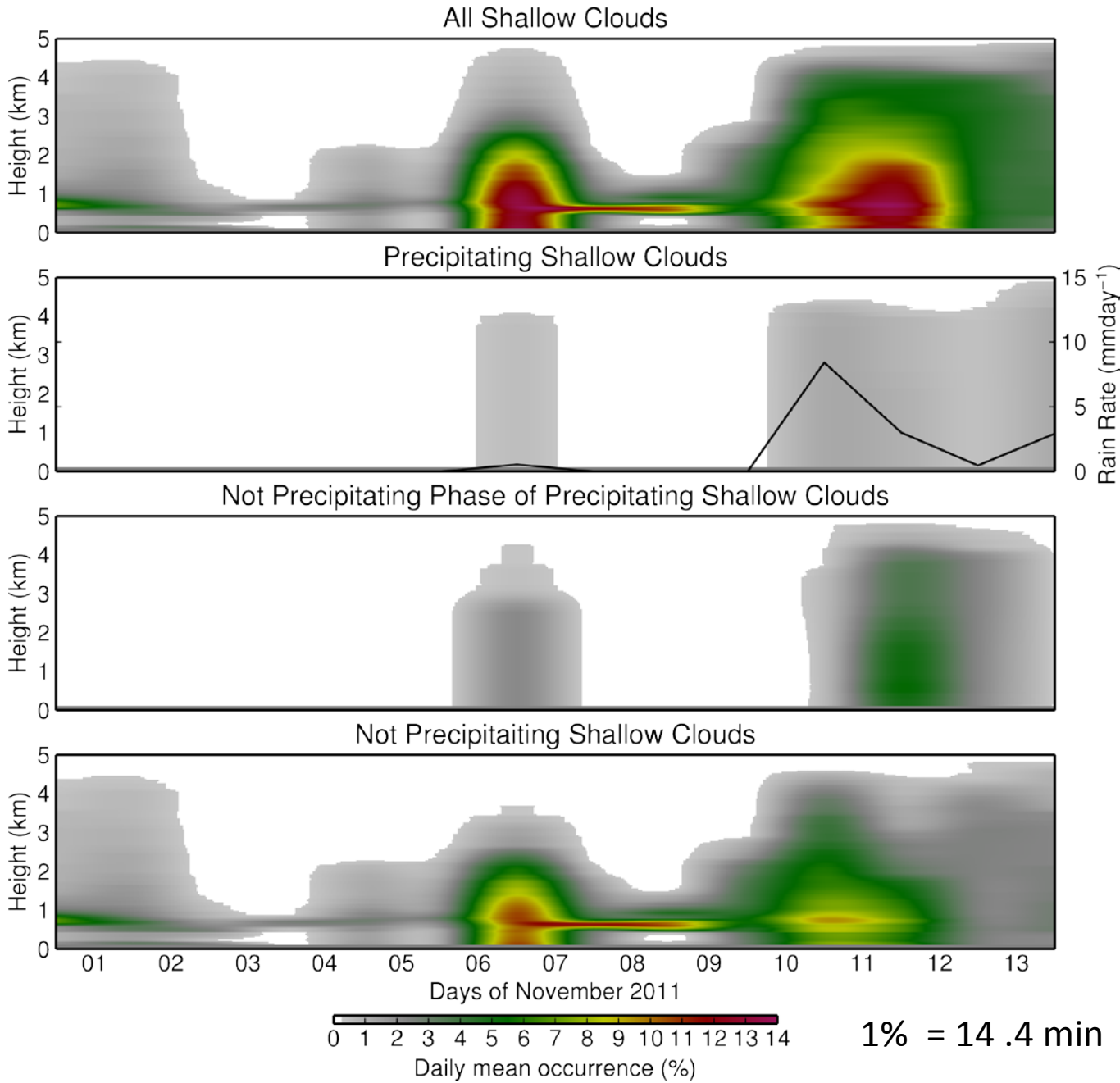
Rain Rate Frequency Distributions





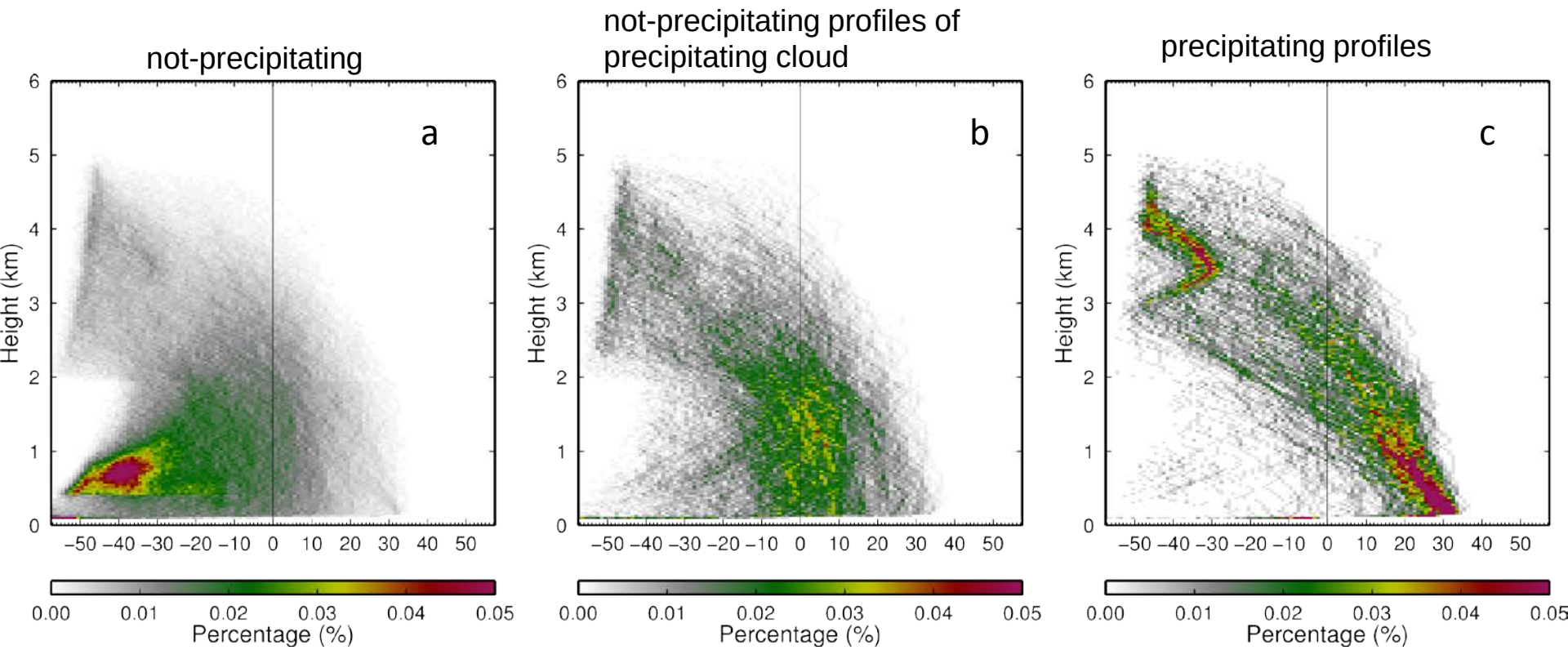
Mean Daily Cloud Occurrence and Rain Rate of Shallow Clouds from KAZR

Not-precipitating clouds when: rain rate <0.1 and dry MWR window



1% = 14 .4 min

Height frequency diagrams of reflectivity from shallow clouds over Gan



Height frequency diagrams of reflectivity from (a) not-precipitating clouds, (b) the not-precipitating profiles of precipitating clouds and (c) precipitating profiles of shallow clouds from KAZR over Gan.

Summary

- Doppler velocity at the cloud top is a good indicator of attenuated deep clouds. 74% hit rate in identifying attenuated clouds by means of conditions in Doppler velocity and collocated rain rate

- No evident rain rate threshold is evident to separate shallow and deep convective clouds. Shallow clouds can have very high rain rates.

- Not-precipitating shallow clouds represent the largest portion of cloud occurrence of shallow clouds.

References

- DelGenio Anthony D., Yonghua Chen, Daehyun Kim, Mao-Sung Yao, 2012: The MJO Transition from Shallow to Deep Convection in CloudSat/CALIPSO Data and GISS GCM Simulations. J. Climate, 25, 3755–3770.
- Geerts, Bart, Yu Dawei, 2004: Classification and Characterization of Tropical Precipitation Based on High-Resolution Airborne Vertical Incidence Radar. Part I: Classification. J. Appl. Meteor., 43, 1554–1566.
- Zhang, G., and X. Song, 2009: Interaction of deep and shallow convection is key to Madden–Julian oscillation simulation. Geophys. Res. Lett., 36, L09708, doi:10.1029/2009GL037340.