Investigating Simulated Convective and Stratiform Structures of Monsoonal Convection Using TWP-ICE Observations

Adam Varble[1], Ed Zipser[1], Ann Fridlind[2], Andrew Ackerman[2], Jean-Pierre Chaboureau[3], Scott Collis[4], Jiwen Fan[5], Adrian Hill[6], Jean-Pierre Pinty[3], Ben Shipway[6], and Christopher Williams[7]

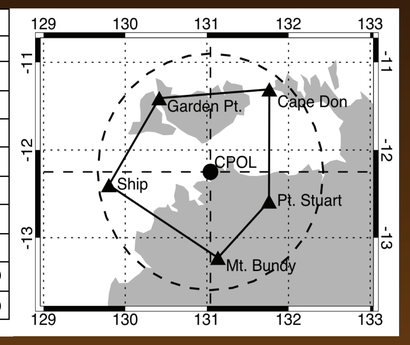
[1]University of Utah, [2]NASA GISS, [3]University of Toulouse/CNRS, [4]Argonne National Lab, [5]PNNL, [6]UKMO, [7]University of Colorado/NOAA ESRL

Atmospheric System Research

Overview and Motivation

Model Simulation Configurations

Simulation	Symbol	Domain	Δx	Δz	Microphysics
DHARMA-B	◆	(176 km)^2	917 m	100-250 m	1-moment
DHARMA-S	◇	(176 km)^2	917 m	100-250 m	1-moment
UKMO-1	▶	(177 km)^2	917 m	225-500 m	2-moment (i)
UKMO-2	◀	(177 km)^2	917 m	225-500 m	2-moment (i,g,s)
UKMO-2M	■	(177 km)^2	917 m	225-500 m	2-moment (i,r,g,s)
MESONH-1	▲	(192 km)^2	1000 m	100-250 m	1-moment
MESONH-2	▼	(192 km)^2	1000 m	100-250 m	2-moment (i,w)
SAM-B	●	(192 km)^2	1000 m	100-400 m	2-moment (i,w,r,g,s)
SAM-S	○	(192 km)^2	1000 m	100-400 m	2-moment (i,w,r,g,s)



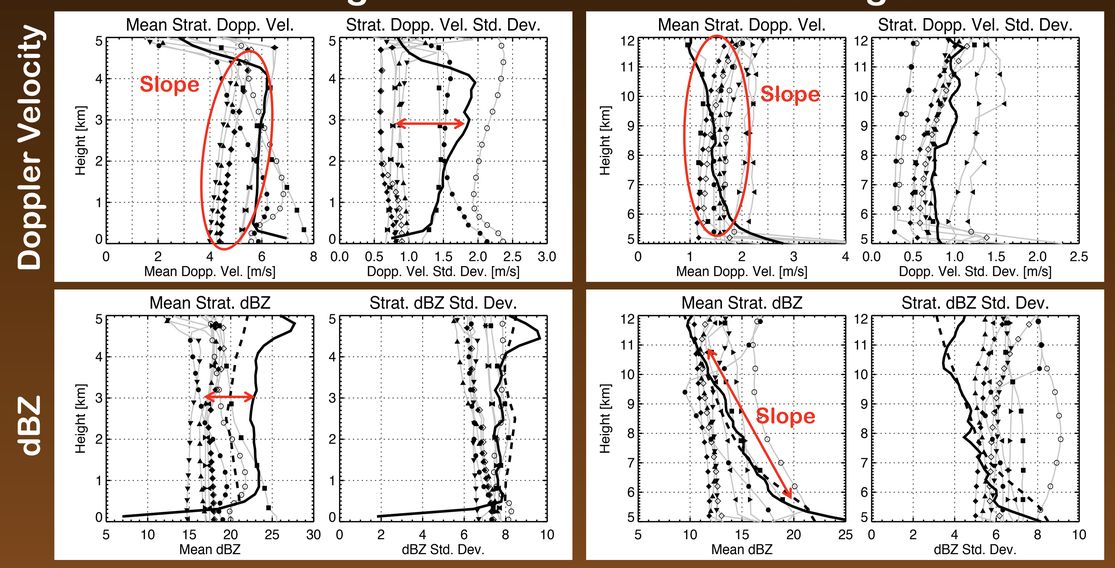
Our previous work comparing simulated TWP-ICE monsoonal convective systems to observations (Varble et al., 2011, in press) has shown that:

- simulated stratiform rain rates are too low while stratiform area is too high
- convective dBZ aloft is too high in most simulations
- differences among models' dBZ aloft is more highly correlated to differences in assumed size distribution properties than IWC

Q: What leads to over-predicted convective dBZ aloft and how do convective issues affect stratiform regions?

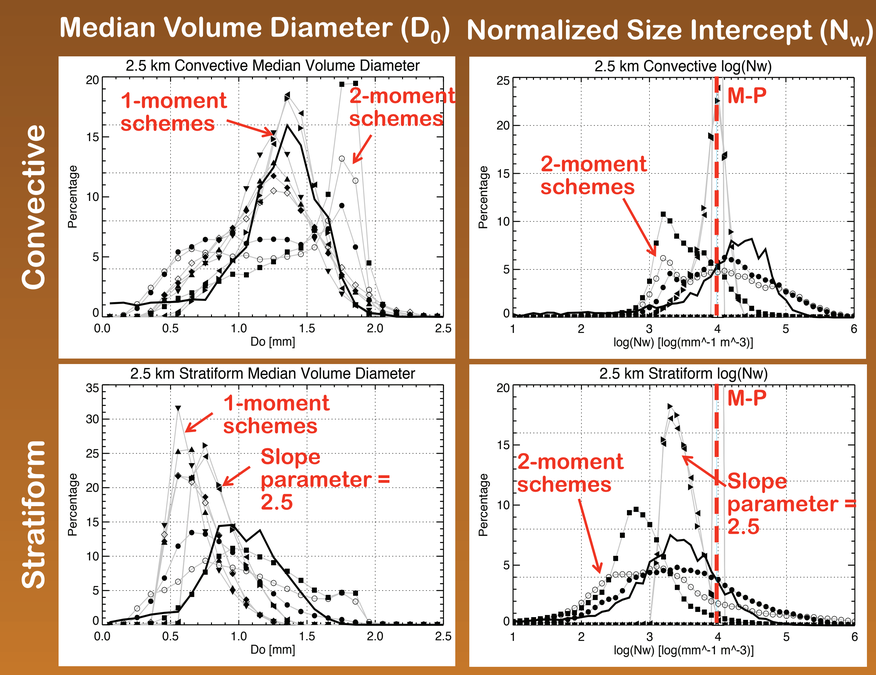
Q: What combination of factors leads to stratiform rain rates being under-predicted?

Stratiform Doppler Velocity



- Solid black is S-band profiler Rayleigh reflectivity weighted Doppler velocity
- Dashed is CPOL dBZ
- 2-moment rain schemes do not reproduce the slight increase in Doppler velocity with height, but are much closer to observed. variability than 1-moment schemes.
- Models fail to reproduce the observed decrease in Doppler velocity with height aloft . Schemes that have a shape parameter of 2.5 rather than 0 have Doppler velocities that are too high and too variable.

Raindrop Size Distributions

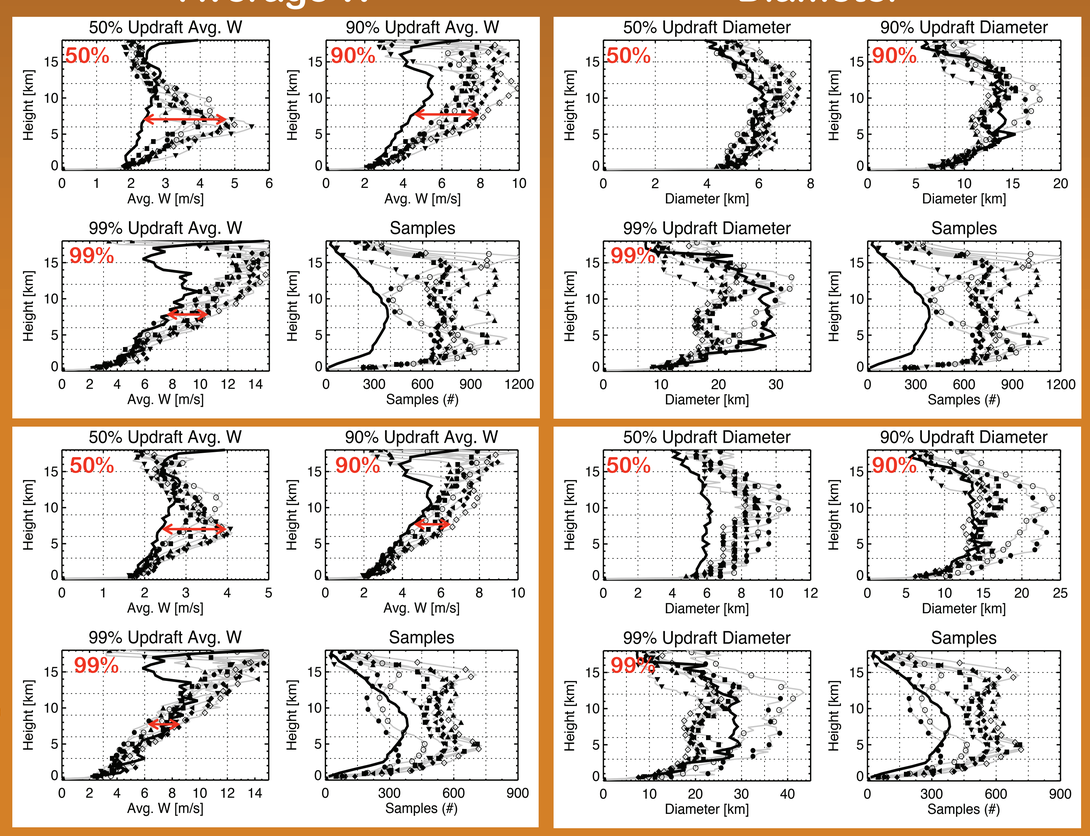


- CPOL-derived size distributions in solid black (Bringi et al., 2009)
- 1-moment rain schemes produce convective D_0 close to observed, whereas 2-moment distributions are too broad.
- Observed convective N_w values are generally higher than the Marshall-Palmer (M-P) intercept of 10^4 mm^{-1} m^{-3} used in 4 simulations.
- 1-moment schemes have stratiform D_0 that are too small, whereas 2-moment schemes have distributions that are too broad.
- Observed stratiform N_w are smaller than a Marshall-Palmer size intercept, but other schemes also fail to represent observations.

Updraft Property Percentiles

Comparison of dual Doppler updraft retrievals (solid black) with simulated updrafts

- Require avg. w of 1.5 m/s and diameter of 3.5 km
- Updraft diameters are similar in models and the dual Doppler retrieval.
- Degrading the model resolution from ~1 km to ~3 km brings models and dual Doppler retrievals in line in upper percentiles of average w.



Conclusions and Future Work

- Simulated **updrafts are of similar size and magnitude** to the dual Doppler retrieved updrafts
  - Despite this, convective dBZ is too high in most simulations
- **1-moment stratiform rain Doppler velocities are too low** by 1-2 m/s and not as variable as those observed
- Whereas **observed Doppler velocities decrease with height aloft, simulated Doppler velocities remain constant or increase with height**
- Simulated **2-moment D_0 and N_w distributions** that are **too broad**
- **1-moment schemes reproduce observed convective D_0 but under-predict stratiform D_0**
  - Observed convective N_w is higher and stratiform N_w lower than 1-moment schemes that use Marshall-Palmer distributions
  - A shape parameter of 2.5 rather than 0 brings models closer to observations
- Future work includes comparisons with disdrometer data, high temporal resolution case studies, and limited area model (LAM) simulations to further address the motivation questions