Introducing Ice Nuclei into Turbulence Parameterization in CRMs

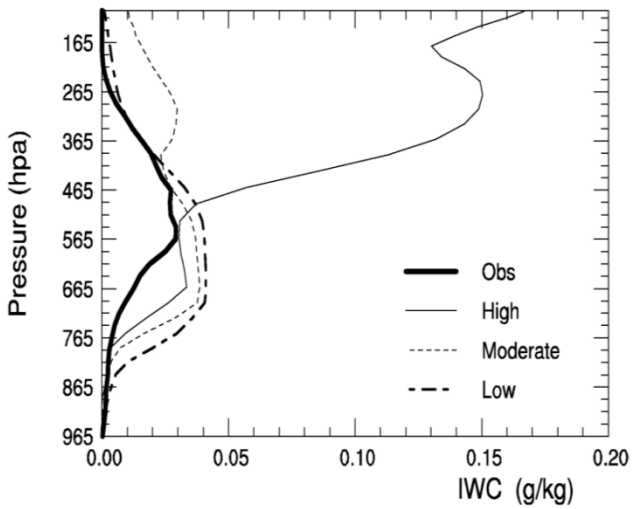
Xiping Zeng, NASA/GSFC

Recent CRM Simulations using

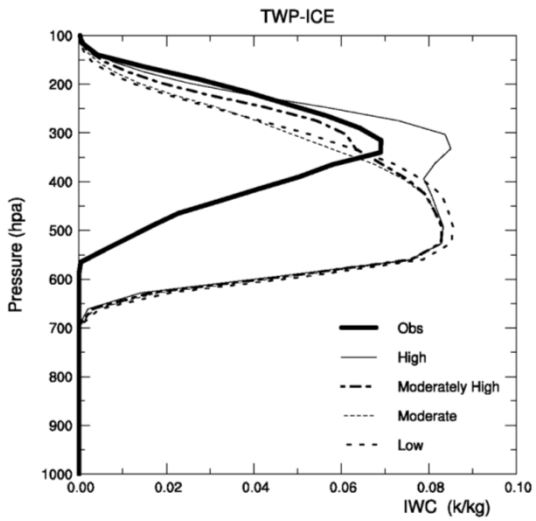
the Rutledge-Hobbs Scheme
+ Ice Crystal Concentration or
(or μN_i)

N_i : ice nuclei concentration
μ : ice crystal enhancement factor

Comparison in IWC between ARM-SGP and TWP-ICE



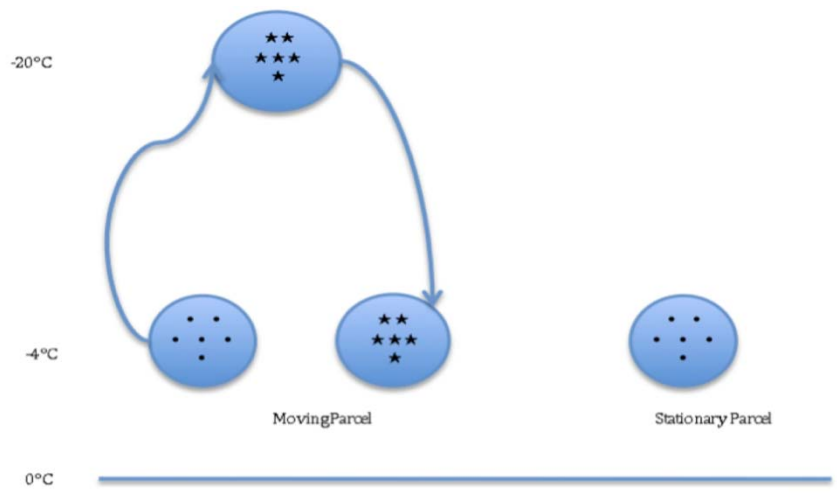
Over ARM-SGP



Over TWP-ICE

from Zeng et al. (2011, JAS)

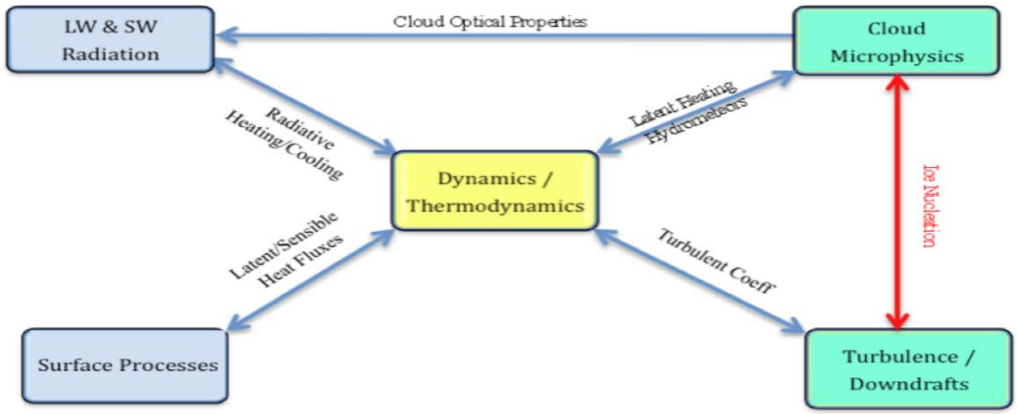
Effect of Vertical Circulations on Ice Crystal Concentration



Observations of Downdrafts and Entrainments

- Wei, D., A. M. Blyth, and D. J. Raymond, 1998: Buoyancy of convective clouds in TOGA COARE. *J. Atmos. Sci.*, **55**, 3381-3391.
- Igau, R. C., M. A. LeMone, and D. Wei, 1999: Updraft and downdraft cores in TOGA COARE: Why so many buoyant downdraft cores? *J. Atmos. Sci.*, **56**, 2232-2245.
- Heymsfield, G. M. et al, 2010: Characteristics of deep tropical and subtropical convection from nadir-viewing high-altitude airborne Doppler radar. *J. Atmos. Sci.*, **67**, 285-308.
- Zipser, E. J., 2003: Some view on “hot towers” after 50 years of tropical field programs and two years of TRMM data. Cloud systems, hurricanes, and the Tropical Rainfall Measuring Mission (TRMM). *Meteor. Monogr.*, **29**, 49-58.

Physical Process Connection in CRMs



Red line is proposed to represent the effect of (subgrid) downdrafts on ice crystal concentration.

Turbulence Parameterization for CRMs

Decomposition for parameterization

$$\phi = \overline{\phi} + \phi'$$

However,

$$\overline{\phi'} \neq 0$$

ϕ = IN concentration
ice crystal concentration
cloud water
equivalent potential temperature

Future Work

- Use high-resolution cloud models to simulate convective downdrafts and evaluate them with field campaign observations.
- Model the interaction between convective downdrafts and ice crystal concentration
- Develop a turbulence parameterization scheme on the interaction between convective downdrafts and ice crystal concentration