

**PARAMETERIZATION AND
SUPERPARAMETERIZATION: USING
SUPERPARAMETERIZATION TO DEVELOP
IMPROVED “CLASSICAL” PARAMETERIZATIONS**

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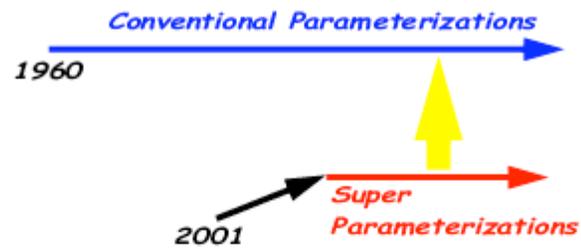


Figure 15: Starting now, parameterization development will proceed along two parallel paths: the conventional approach, and the super-parameterization approach. The yellow arrow represents the possibility that super-parameterizations can help us to learn how to make better conventional parameterizations.

from Randall et al. (2002, BAMS)

**PARAMETERIZATION AND
SUPERPARAMETERIZATION: USING
SUPERPARAMETERIZATION TO DEVELOP
IMPROVED “CLASSICAL” PARAMETERIZATIONS**

I. The Role of “Classical” Parameterizations in a “Super-Parameterized” World.

II. Learning About Parameterizations from Cloud-System Resolving Models: What Do We Gain by “Going Global”?

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THE ROLE OF “CLASSICAL” PARAMETERIZATIONS IN A “SUPER- PARAMETERIZED” WORLD

I. In simplified models for very long-time integrations, *e.g.*, paleoclimate problems.

II. In simplified models with computationally expensive representation of earth-system processes, *e.g.*, chemistry and biology.

III. As “theories” to interpret complex, “emergent” properties in GCMs with superparameterization. Useful for study of feedbacks, organizing principles (if any!) for scale interactions.

IV. For I and II, goal is accuracy under computational constraint. Statistical methods to capture behavior of superparameterization may be useful, analogous to fits to LBL in radiative transfer, FEOMs for radiative transfer and chemical kinetics (Wang *et al.*, 1999, *JGR*).

**LEARNING ABOUT PARAMETERIZATIONS FROM
CLOUD-SYSTEM RESOLVING MODELS: WHAT DO
WE GAIN BY “GOING GLOBAL”?**

I. Case studies vs. global advantage

A. Closure

B. Dimensionality

C. Sub-grid vertical velocity

D. Dynamic core, parameterized turbulence, microphysics, and “LES”-type cloud systems limit the extent to which super-parameterized GCM can be regarded as benchmark .

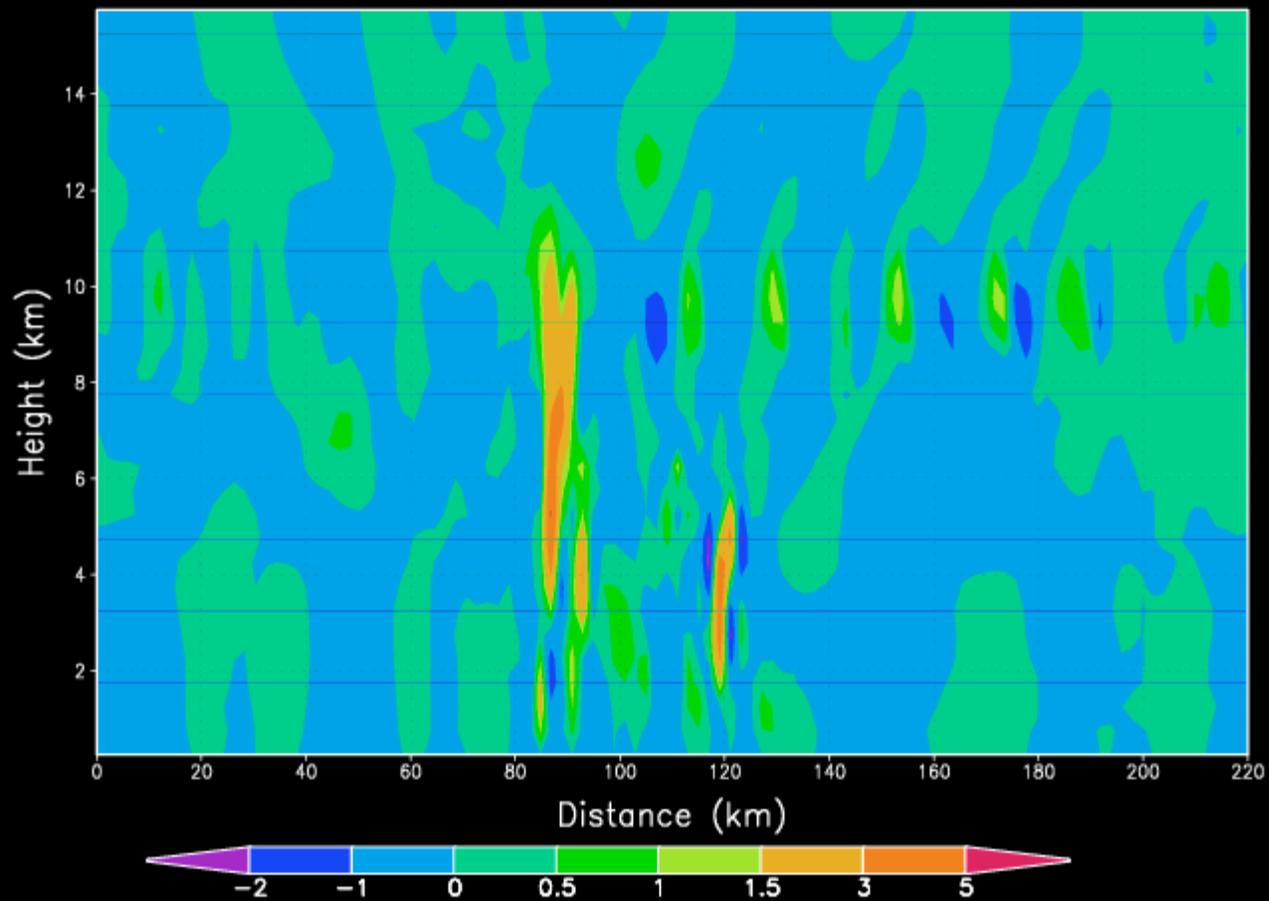
II. Global advantage-global integration

A. Identify regions where parameterization inadequate

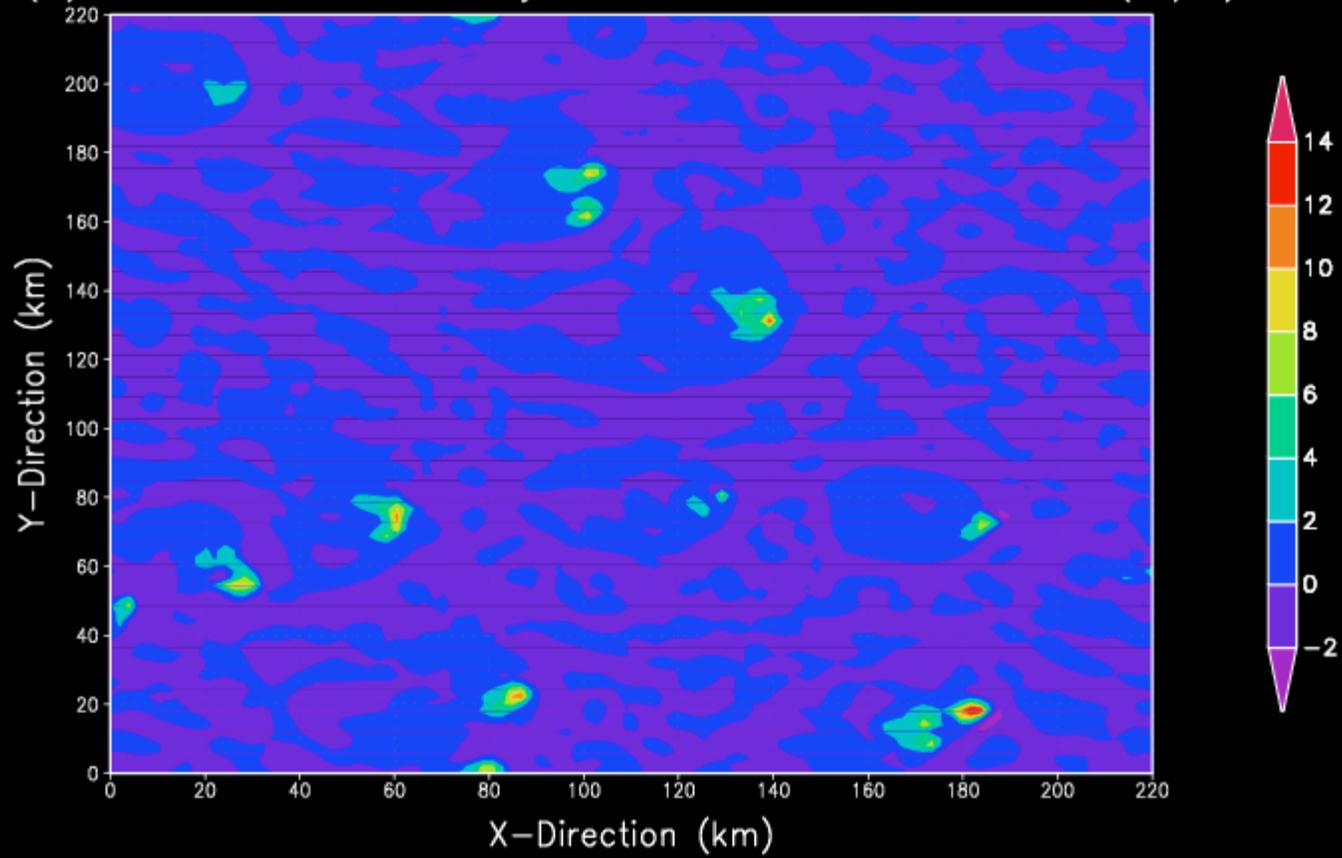
B. Global statistics on closure, PDFs of critical subgrid properties, mass fluxes, chemical transports, *etc.*

C. Systematic simplification of superparameterizations permits evaluation of parameterizations for particular GCM applications.

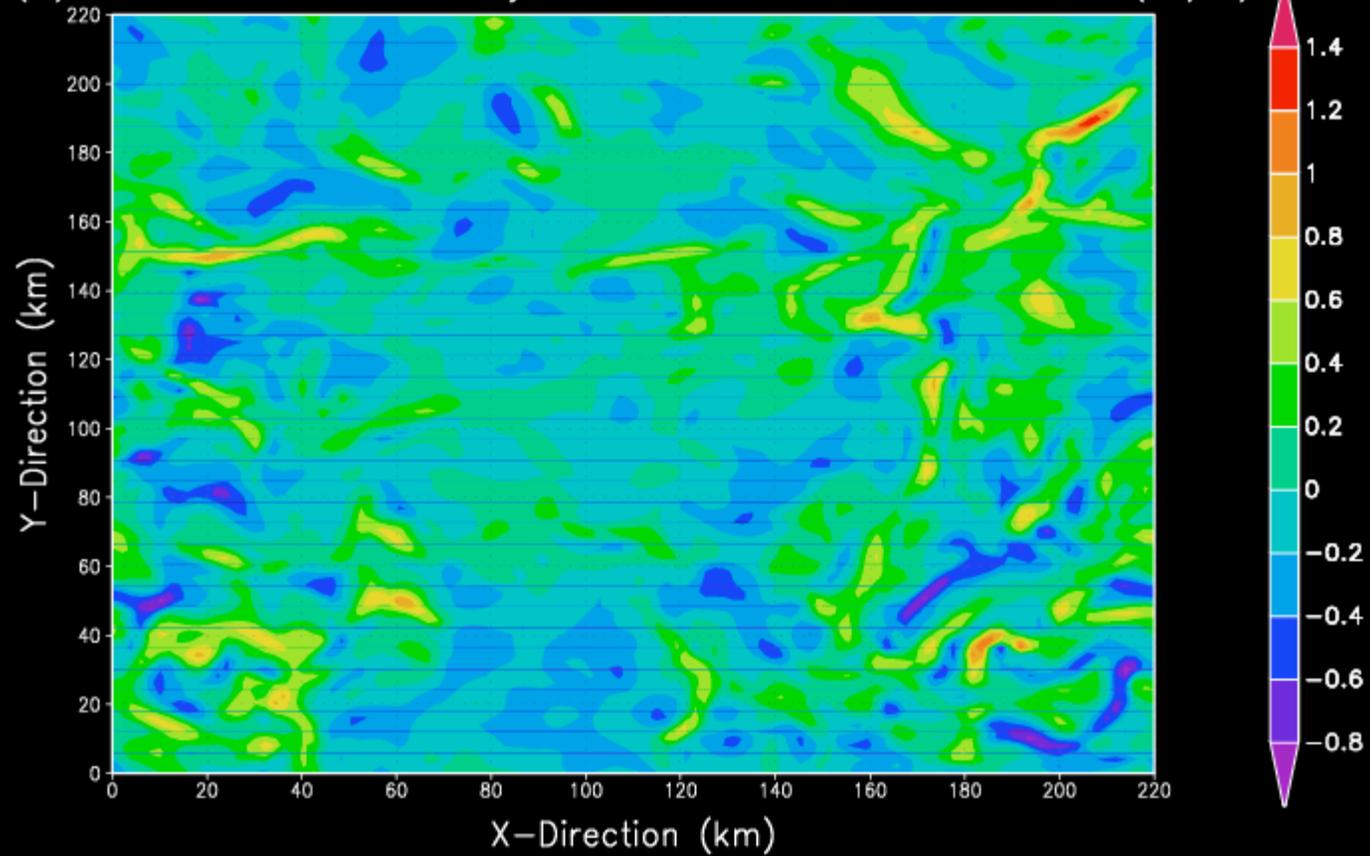
2-D Vertical Velocity at 11.25 hr (m/s)

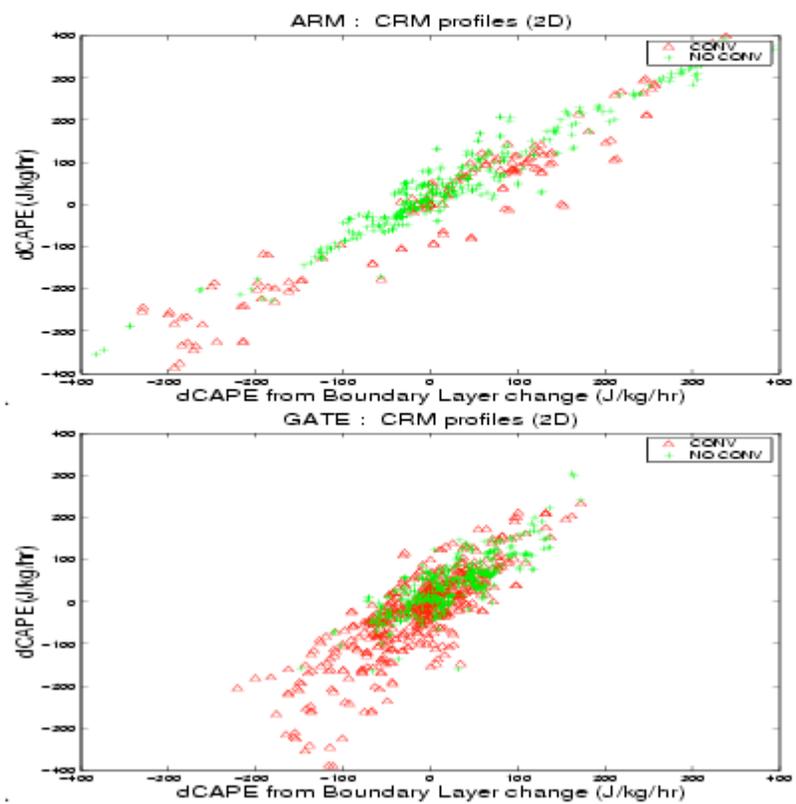


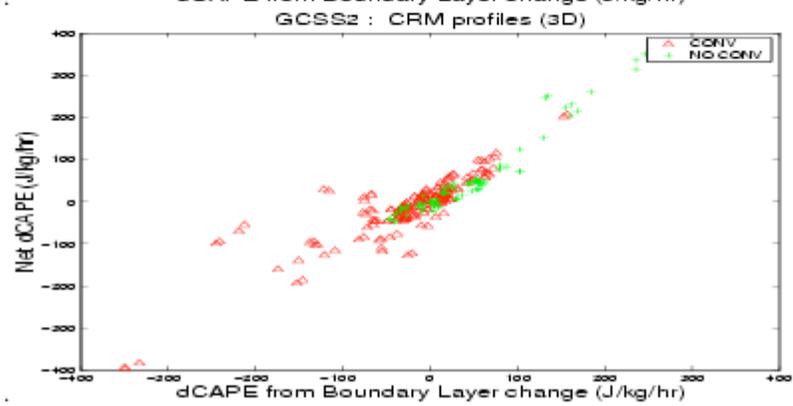
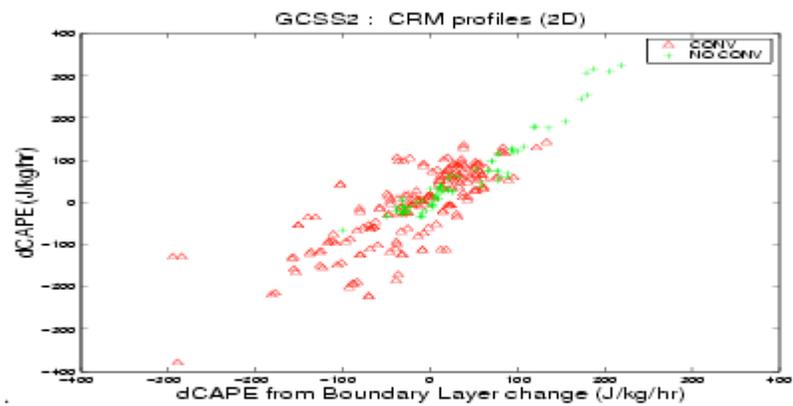
(b) 3-D Vertical Velocity at 9.75 km & 11.25 hr (m/s)



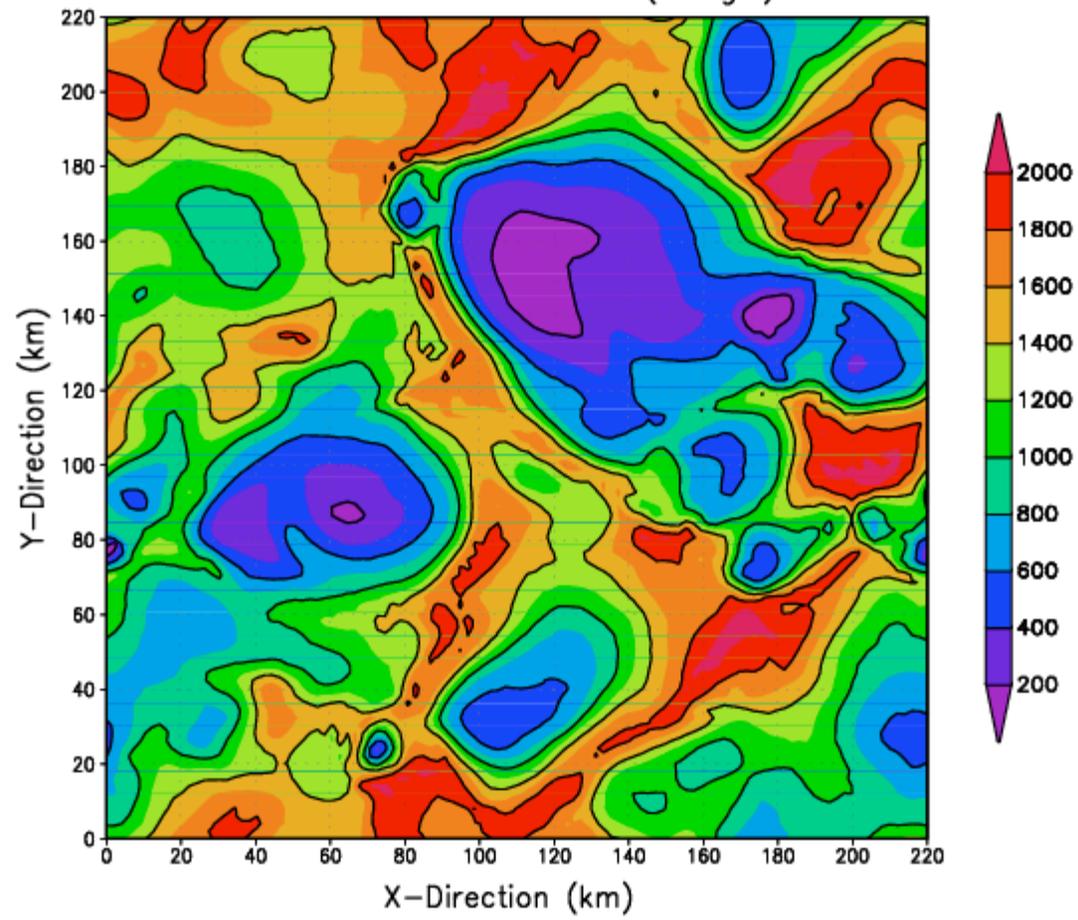
(c) 3-D Vertical Velocity at 11.25 km & 61.25 hr (m/s)



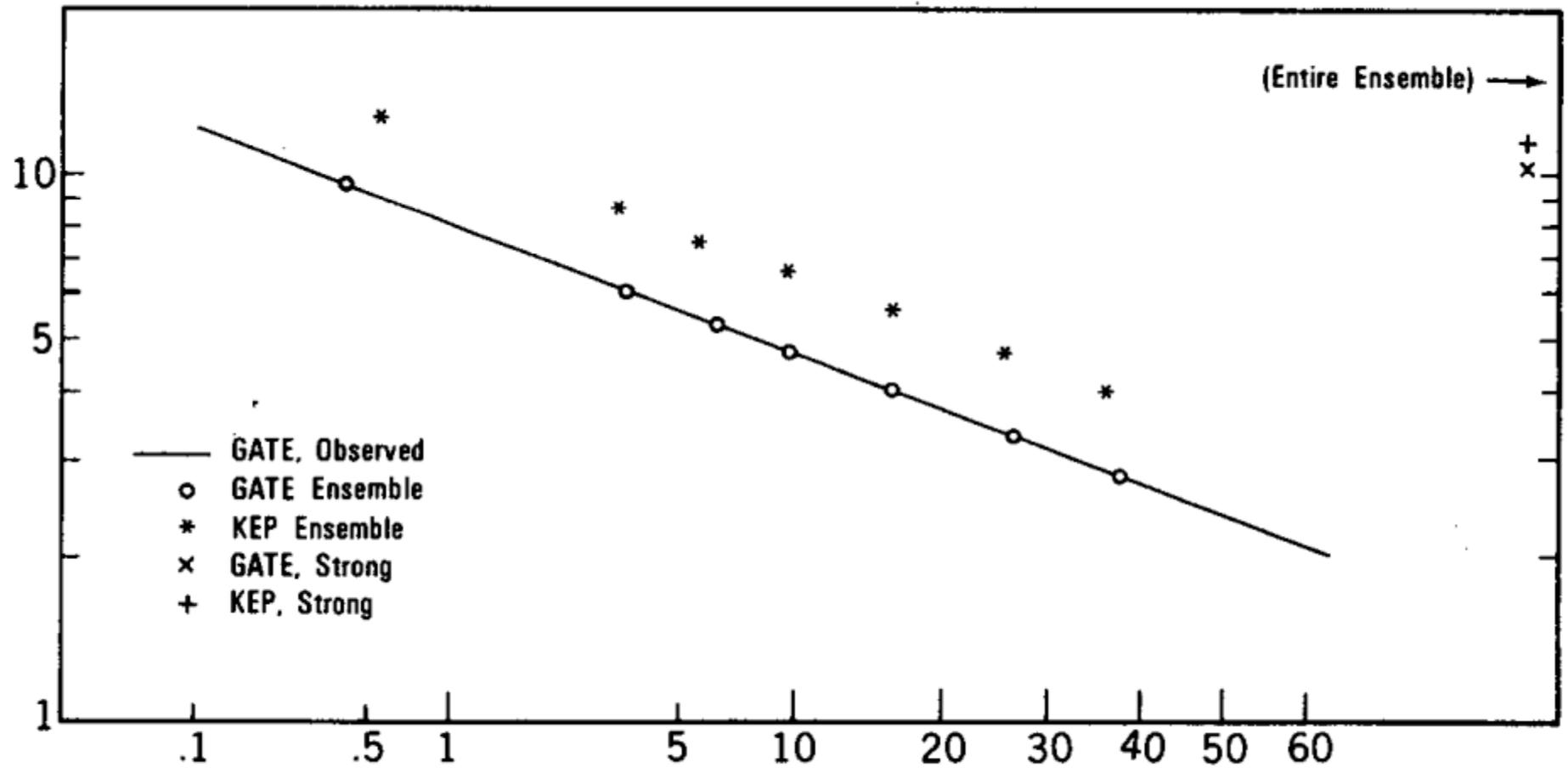




3-D CAPE at 20 hr (J kg^{-1})

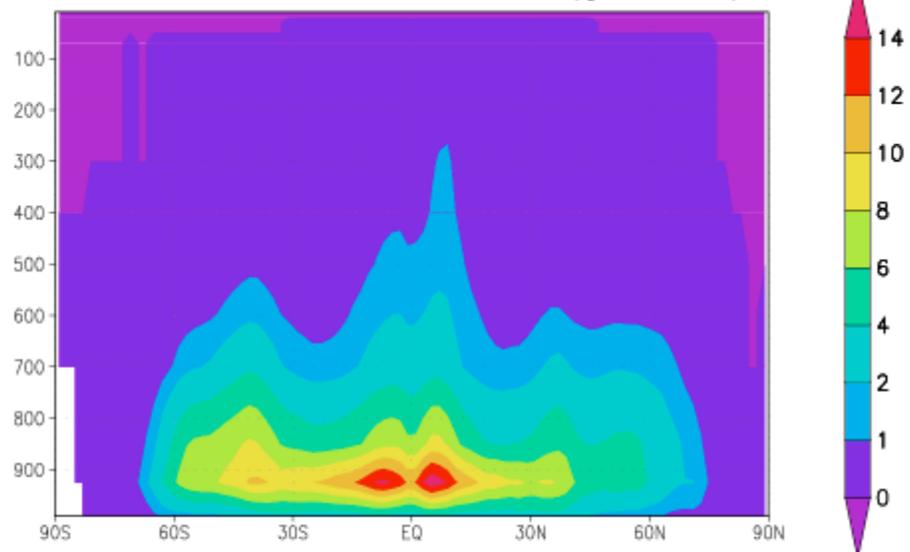


VERTICAL-VELOCITY SPECTRA

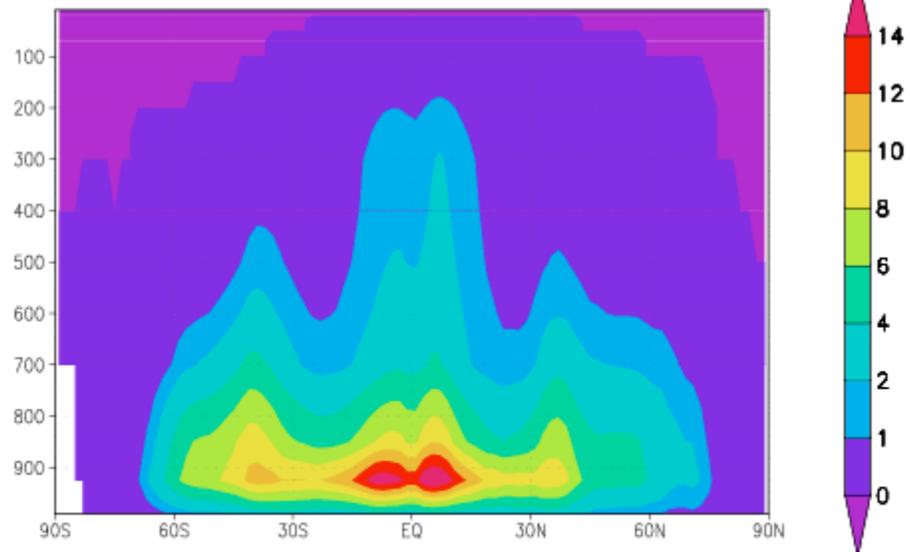


CUMULATIVE FREQUENCY (%) from Donner (1993, JAS)

Donner 1986: Cu Mass Flux ($\text{g m}^{-2} \text{s}^{-1}$)

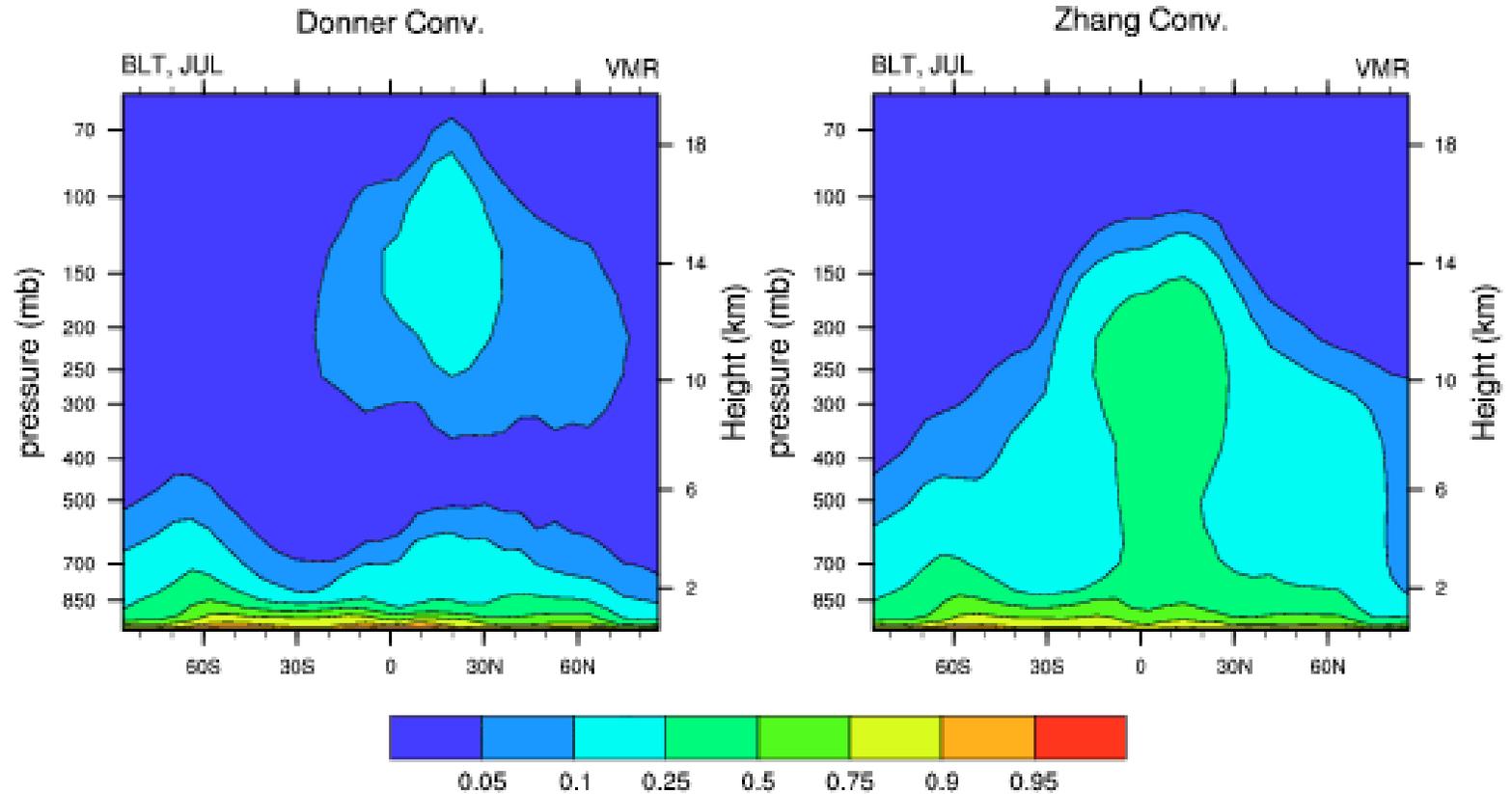


Donner w/out Meso 1986: Cu Mass Flux ($\text{g m}^{-2} \text{s}^{-1}$)



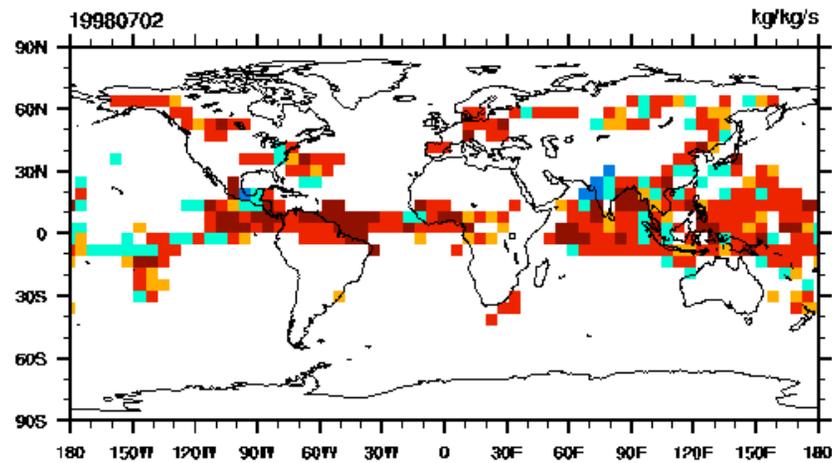
MATCH, BL Tracer, JUL

(Donner vs. Zhang)

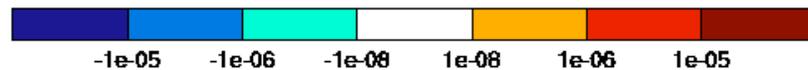
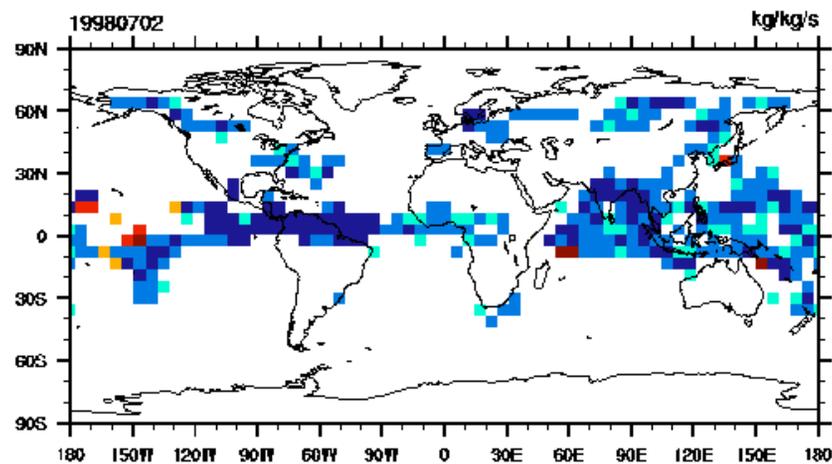


Boundary Layer Tracer, 502mb, JUL MATCH

QTR (Donner Convection)

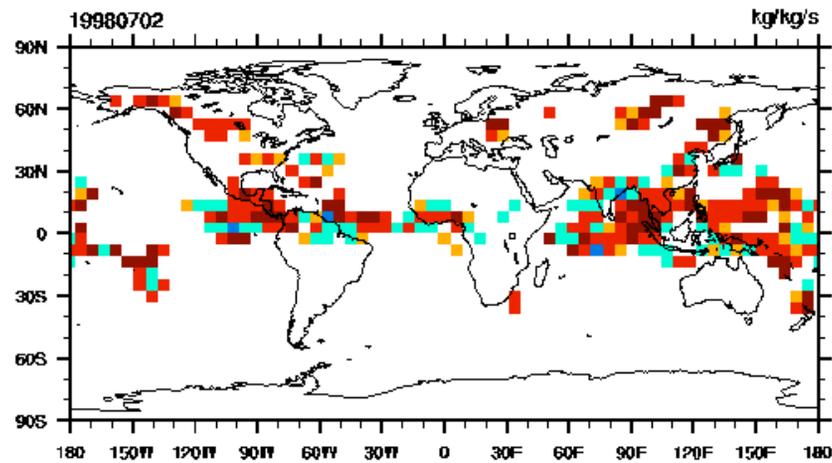


QTMES (Donner Convection)

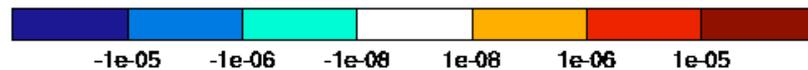
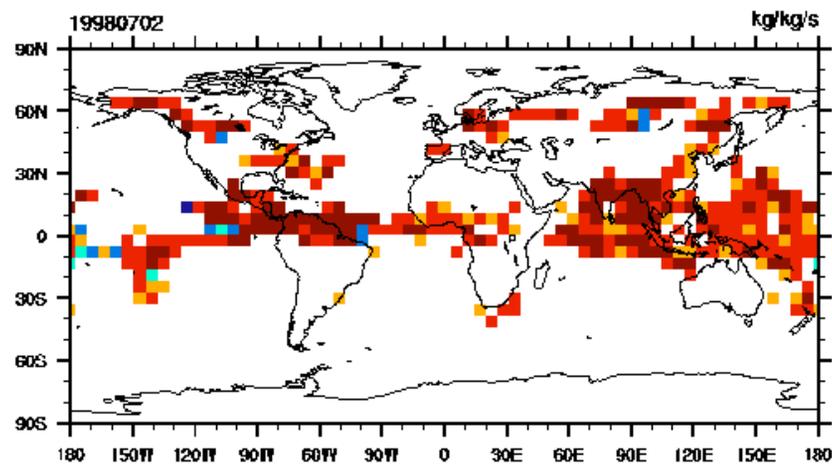


Boundary Layer Tracer, 210mb, JUL MATCH

QTR (Donner Convection)



QTMES (Donner Convection)



CONCLUDING CHALLENGES

I. Super-parameterized GCMs should be relentlessly challenged against observations. Doing so is likely to highlight lack of understanding in microphysics and stratiform cloud parameterization. These problems (at least for microphysics) are likely to be much better posed than is presently the case. There may be a continuing role for “classical” stratiform parameterization, even in super-parameterized GCMs. Perhaps “classical” stratiform parameterization could be based on an LES approach, analogous to CSRMs for deep cumulus.

II. We have CSRMs and case studies already, but no major “classical” parameterization breakthroughs have resulted. Will “going global” with CSRMs change this?