

TROPICAL CONVECTION:

25 years after GATE

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HISTORY.

Betts, A. K., 1974: The Scientific Basis and Objectives of the U.S. Convection Subprogram for the GATE. *Bull. Amer. Meteor. Soc.*, **55**, pp. 304-313.

Rodenhuis, D. R., and A. K. Betts, 1974: The Convection Subprogram for GATE, W.M.O. GATE Report No. 7.

Garstang, M., and A. K. Betts, 1974: A Review of the Tropical Boundary Layer and Cumulus Convection: Structure, Parameterization, and Modelling. *Bull. Amer. Meteor. Soc.*, **55**, pp. 1195-1205.

Betts, A. K., and D. R. Rodenhuis, 1975; Report on the Field Phase of the GATE Scientific Programme. Chapter 6, Convection Subprogramme. GATE Report No. 16, WMO-ICSU.

Betts, A.K., 1978: Convection in the Tropics. RS/RMS/AMS/DMG Conf. on Meteorology over the Tropical Oceans. *Quart. J. Roy. Meteor. Soc. Supplement*, 105-132.

Houze, R. A., and A. K. Betts, 1981: Convection in GATE. *Rev. Geophys. and Space Phys.*, **19**, 541-576.

Betts, A.K., 1997, 'THE PARAMETERIZATION OF DEEP CONVECTION', Chapter 10 (pp 255-279) in "The Physics and Parameterization of Moist Atmospheric Convection, Ed. R. K. Smith, NATO ASI Series C: Vol. 505, Kluwer Academic Publishers, Dordrecht.

WHAT HAVE WE LEARNT?

1) Deep convective and stratiform modes: both important

- distinct dynamic /thermodynamic structure
- precipitation and θ_E transports not tightly coupled

PROGRESS

2) How is convection “controlled” by the large-scale fields?

- What are the interactions with the large-scale dynamics?
- What controls convective organization and how does it matter?

PROGRESS BUT STILL OPEN

3) Is convection “parameterizable” ?

- On what scales?

STILL OPEN

4) Are simple mass-flux models adequate?

NO

Are simple adjustment models adequate?

NO

[– But we use them anyway!]

5) Do we know where we are going?

?

6) Are we wiser?

YES

WISHFUL THOUGHT.

ALL THAT GATE AIRCRAFT DATA COULD BE REVISITED

– HOW ABOUT A CD-ROM?

DESCRIPTIVE STUDIES OF TROPICAL CONVECTION

- “Cloud clusters”: convective and mesoscale structures with 12-hr lifecycle
- Importance of mesoscale (10-100km) and stratiform precipitation .. fed by convection

[talks here by Joanne Simpson and Ed Zipser]

[continuum with stratocumulus above cumulus eg ASTEX]

- Difference between convective and stratiform heating rates
[This talk and Houze 1997]
- Divergence of mass transport perturbs large scale circulation.
[AMEX/EMEX/TOGA: Mapes and Houze 1992, 1993, 1995]

*Most of this talk was on transparencies -
which have not yet been scanned*