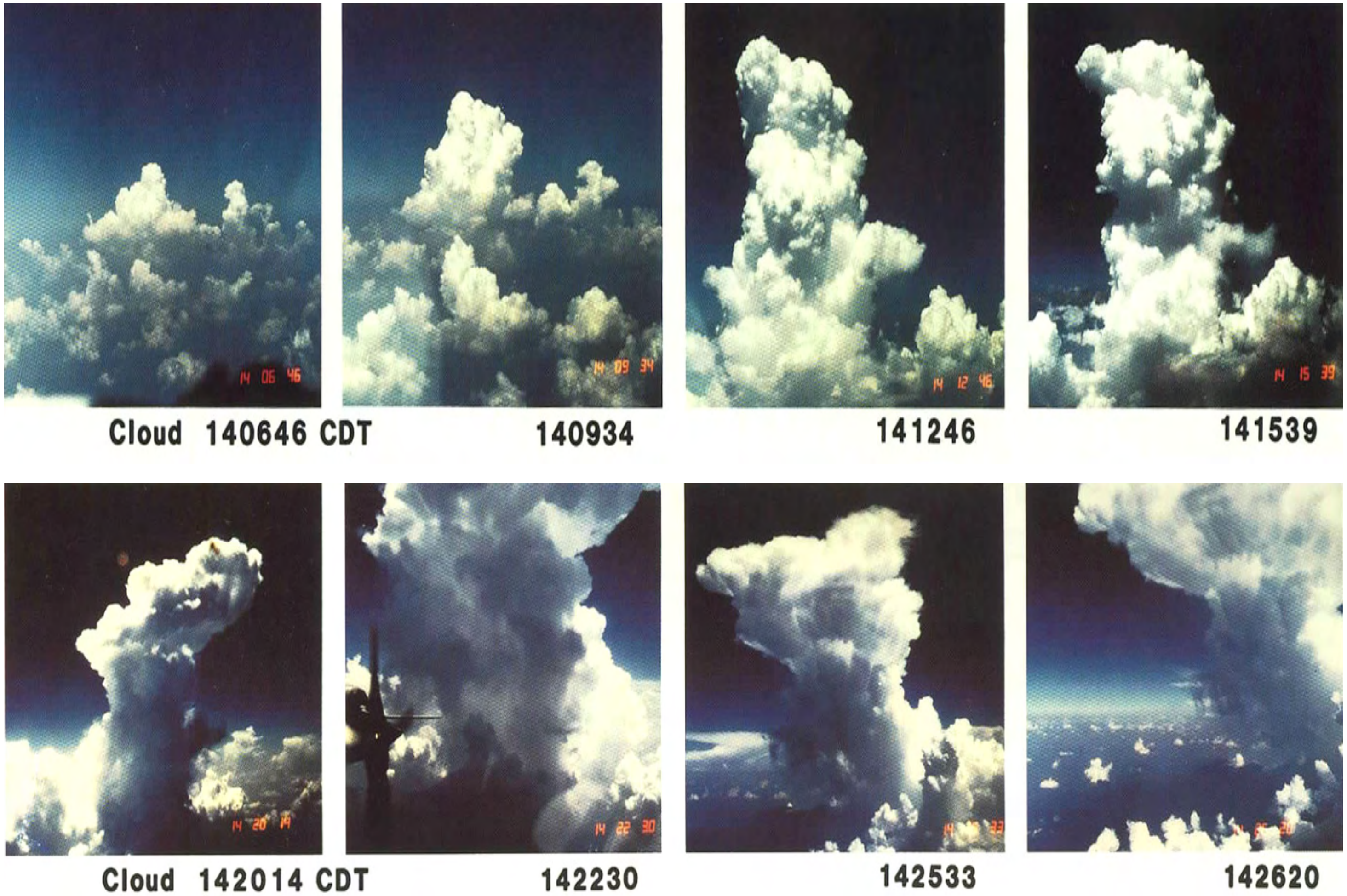


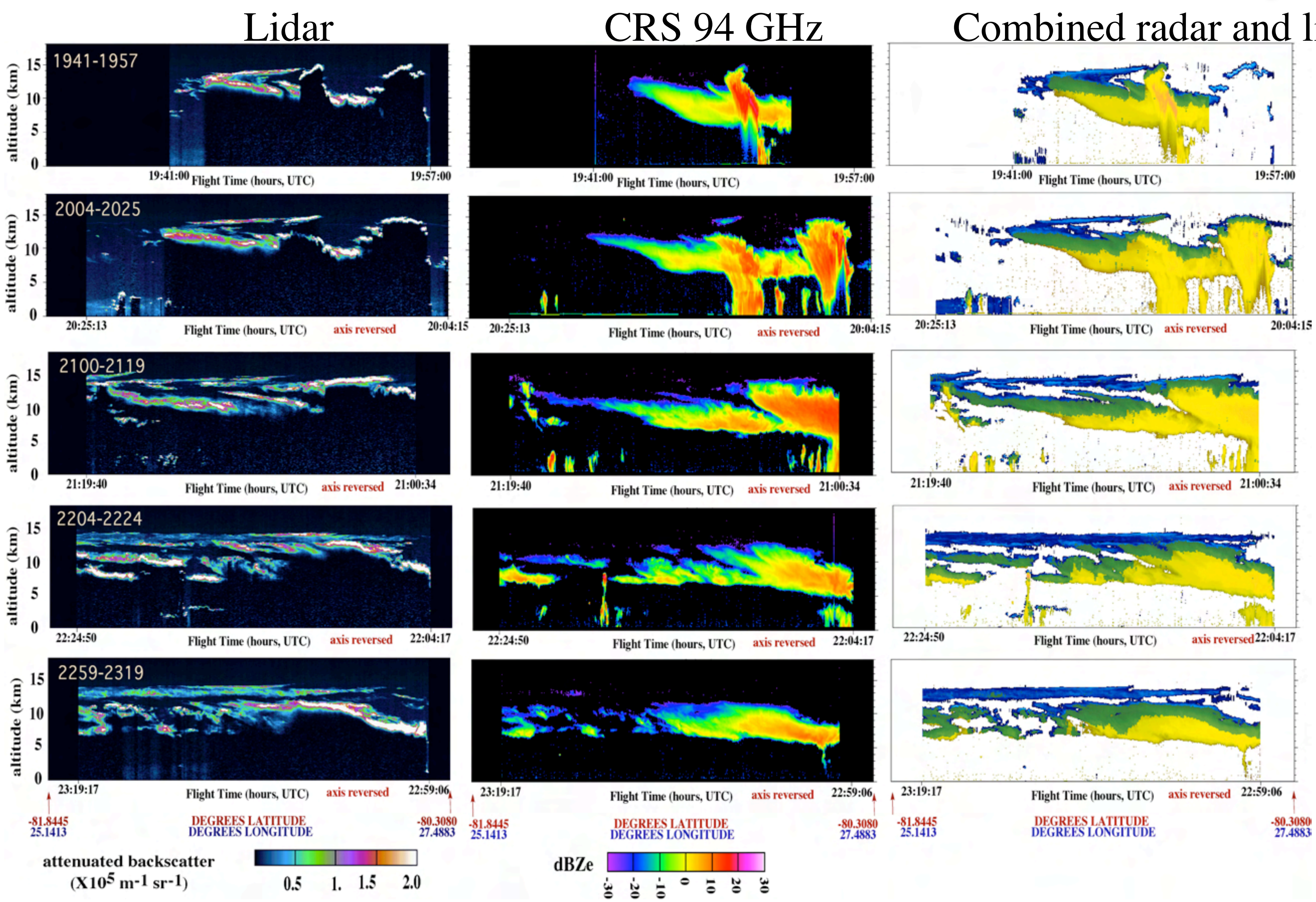
Fast Processes

In 20 minutes period: Cloud Mergers, Turbulence, Microphysics, and Dynamic

T. Fujita

Cloud Resolving Model Simulation: can capture observed cloud evolution with improved microphysics and with 250 m grid spacing, 3 second time step (Lang et al. 2007)

Evolution of Convection and Cirrus Layers



7 min

~1 hr

Horizontal scale: 150 km

G. Heymsfield

Microphysics in GCE, WRF, MMF and Stretched Global CRM

One-Moment (Warm Rain only, 2ICE, 3ICE-graupel, 3ICE-hail)

One-moment 3ICE-graupel but improved - reducing 40 dBz aloft (Lang et al. 2010): LBA, KWAJEX, TWP-ICE, C3VP and Typhoon Morakot

One-moment 3ICE-graupel - Temperature Dependent Drop Size Distribution (TeDD) (Matsui et al. 2009; Zeng et al. 2010)

One-moment - 4ICE (cloud ice, snow, graupel and hail)

Two-moment - 2-liquid, 3ICE-graupel (based on spectral bin microphysics – could add more moments for chemistry, testing now) 30% more expensive

Spectral bin microphysics (Tao et al. 2007; Li et al., 2009; Iguchi et al. 2010)
16 times or 1600% more expensive; 256 CPUs

Climatologically, 40-dBZ penetrations above 10 km are rare even over land (Zipser et al. 2006; Liu et al. 2008)

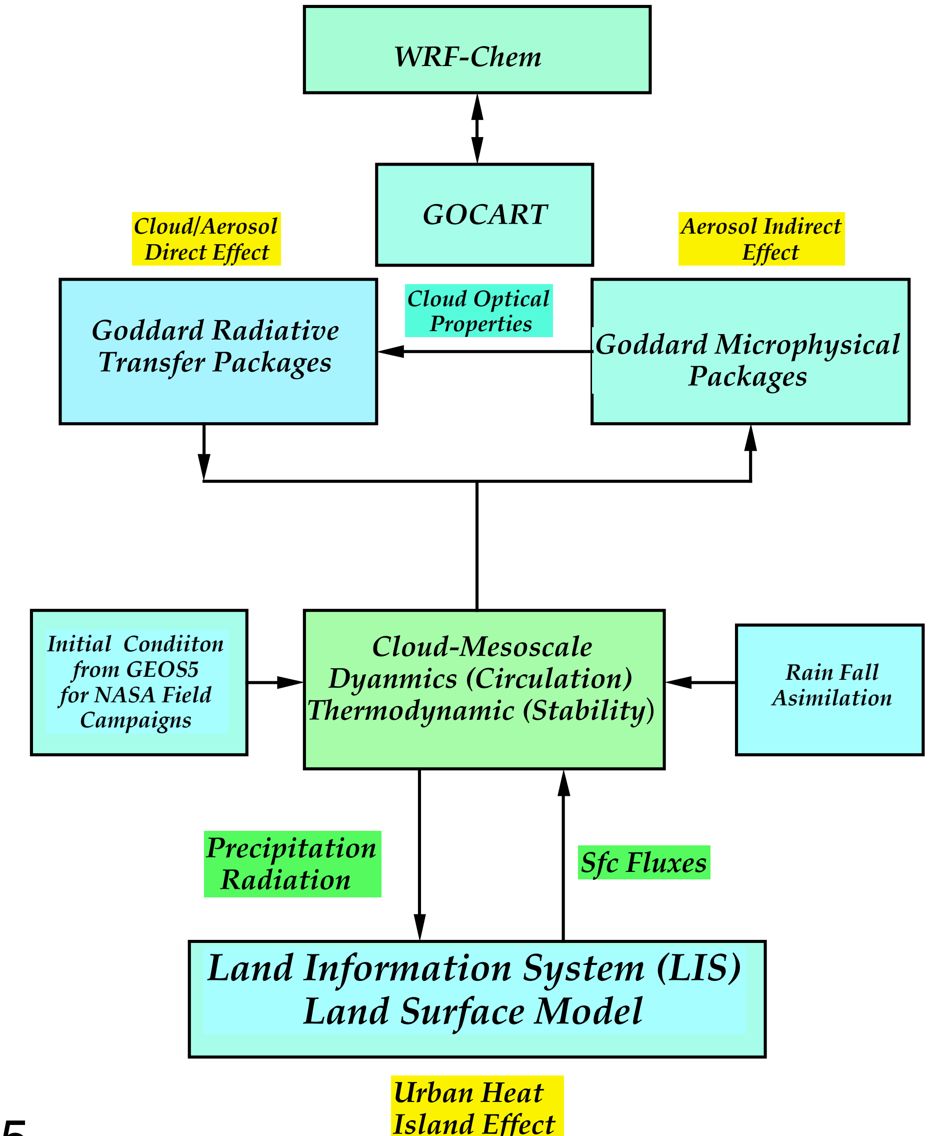
Reducing the Biases in Simulated Radar Reflectivities from a Bulk Microphysics Scheme: Tropical Convective Systems

Lang, Tao, Zeng et al. (JAS, 2010)

- Relative humidity and mean cloud ice mass accounted for in the Bergeron process for snow,
- Added a simple Hallett-Mossop rime splintering parameterization,
- Replaced the Fletcher curve, which determines the number of active ice nuclei as a function of temperature, with the Meyers *et al.* (1992) curve, which determines the active ice nuclei as a function of ice supersaturation, in the cloud ice nucleation, depositional growth and Bergeron growth parameterizations,
- Relaxed the saturation scheme to allow for ice supersaturation,
- Added two additional parameterizations for contact nucleation and immersion freezing,
- Included cloud ice fall speeds and their effect on sweep volumes,
- Made collection efficiency for snow accreting cloud ice function of snow size & efficiency for graupel accreting cloud water function of graupel size,
- Lowered snow riming efficiency & increased threshold to produce graupel,
- Allowed graupel and snow to sublimate (original R&H scheme only allows graupel and snow deposition but not sublimation), and
- Mapped the snow and graupel intercepts (effectively the mean snow and graupel particle diameters) as functions of temperature and mass.

NASA Unified WRF

Blue Boxes: NASA Physical Packages



Goddard Cumulus Ensemble (GCE) Model

2D/3D Anelastic or Compressible
Close or Open Upper, Cyclic or Open Lateral B.C.

Microphysics: 13 different schemes (Warm rain, 3ICE, 2-moment 4-ICE; spectral-bin scheme allowing cloud-aerosol-precipitation interactions) - RAMS’2-moment

Positive definite advection scheme: Scalar variables (cloud species)

Stretched Grid: Horizontal and vertical

Radiative transfer model: Efficient - explicit cloud optical properties and aerosol direct effect

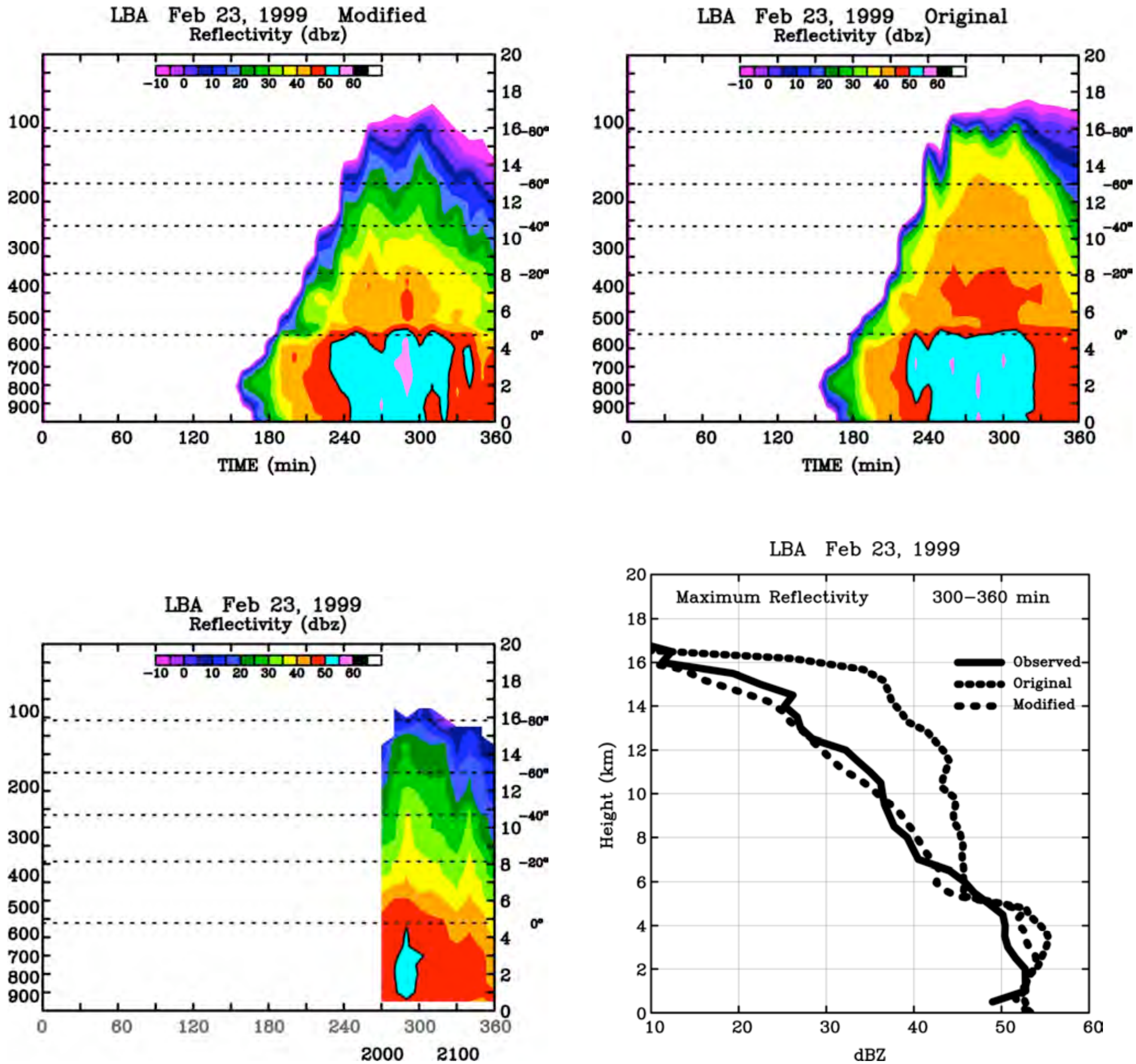
Land surface models: Land Information System (LIS) and PLACE - 1 km land characteristics

Ocean mixed layer model

MPI (Juang et al. 2007): 100-100,000 CPUs

Improved

Observed

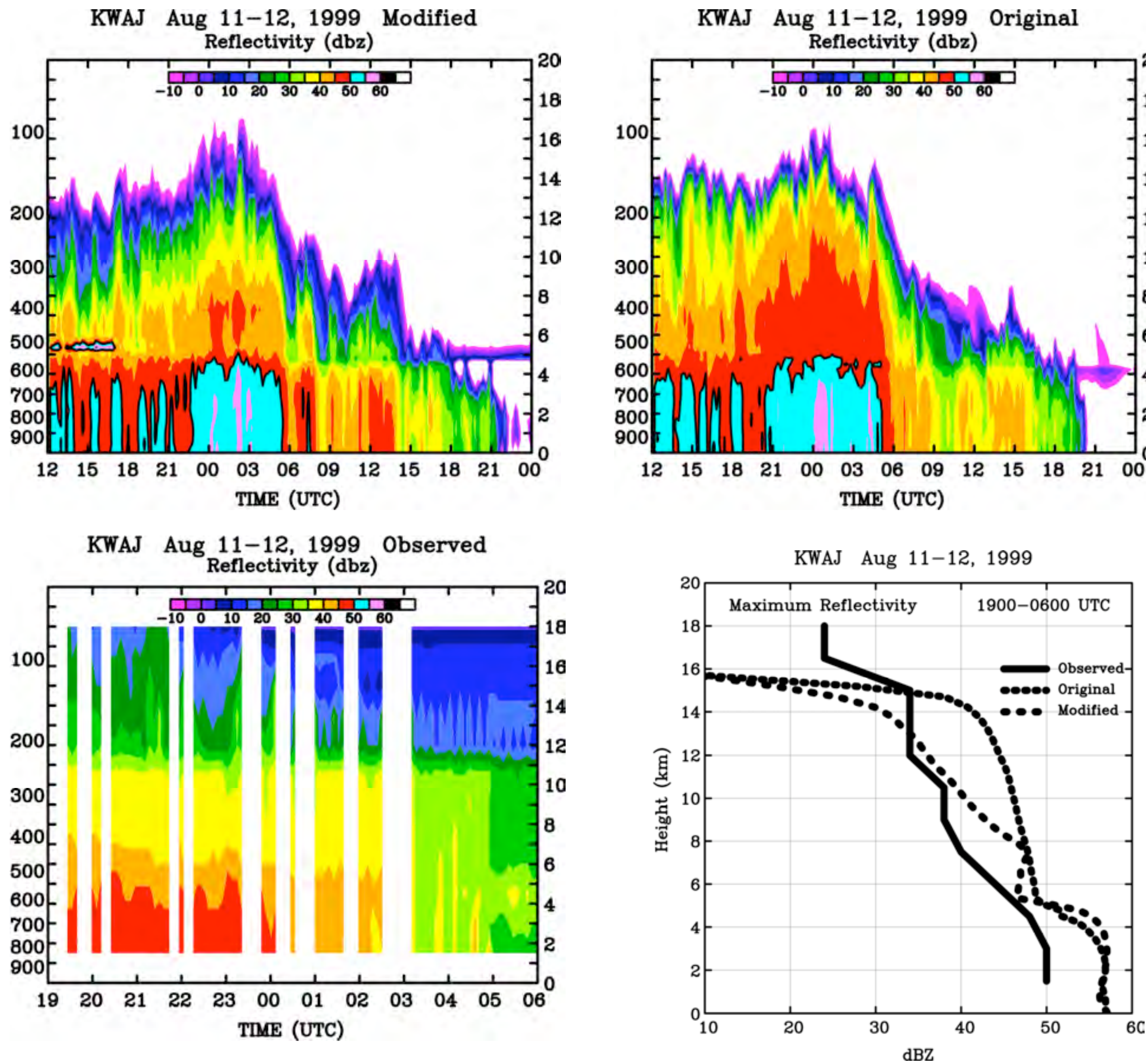


LBA (GCSS)

Lang et al. 2010

Improved

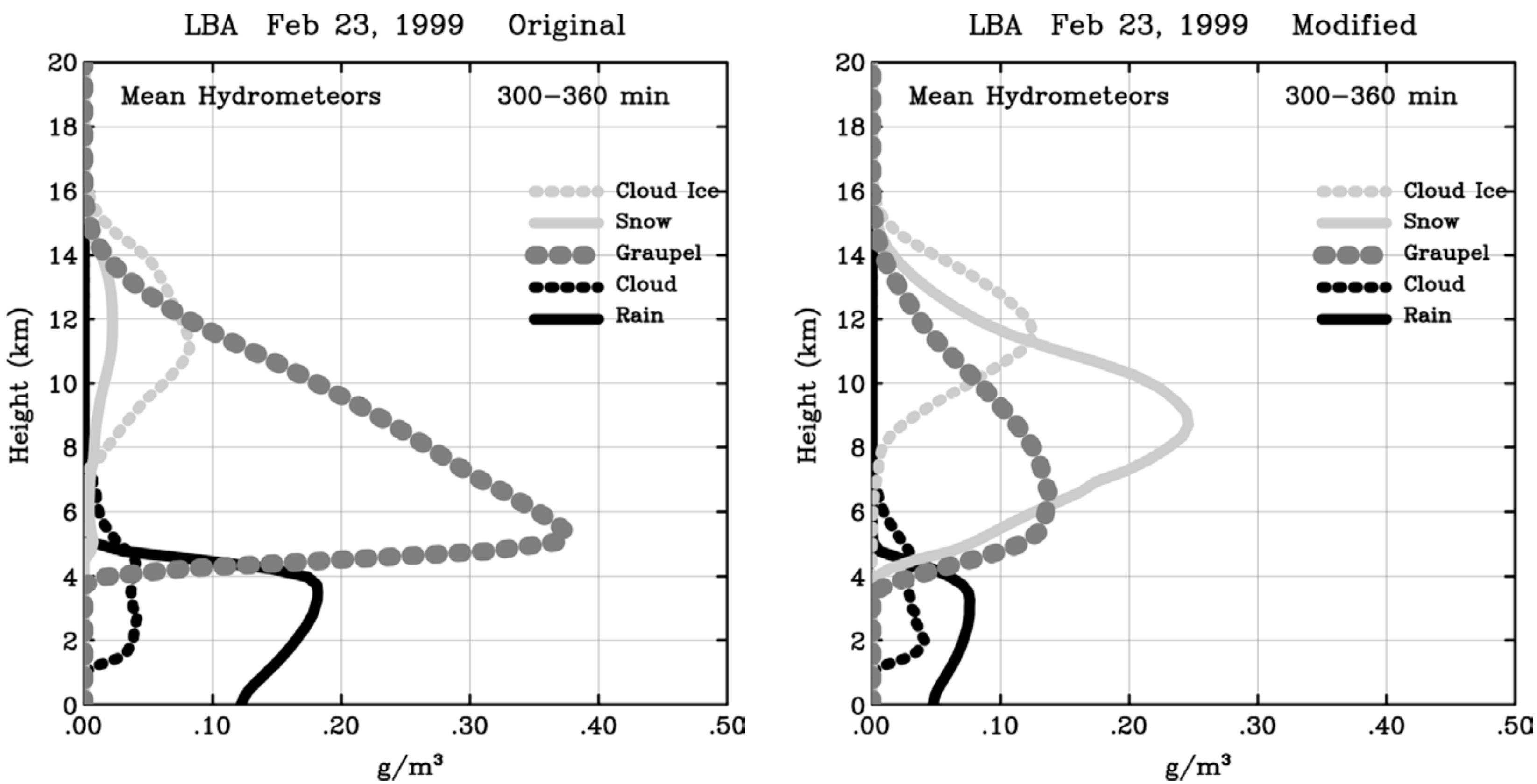
Zipser



KWAJEX

Lang et al. (2010)

Improved

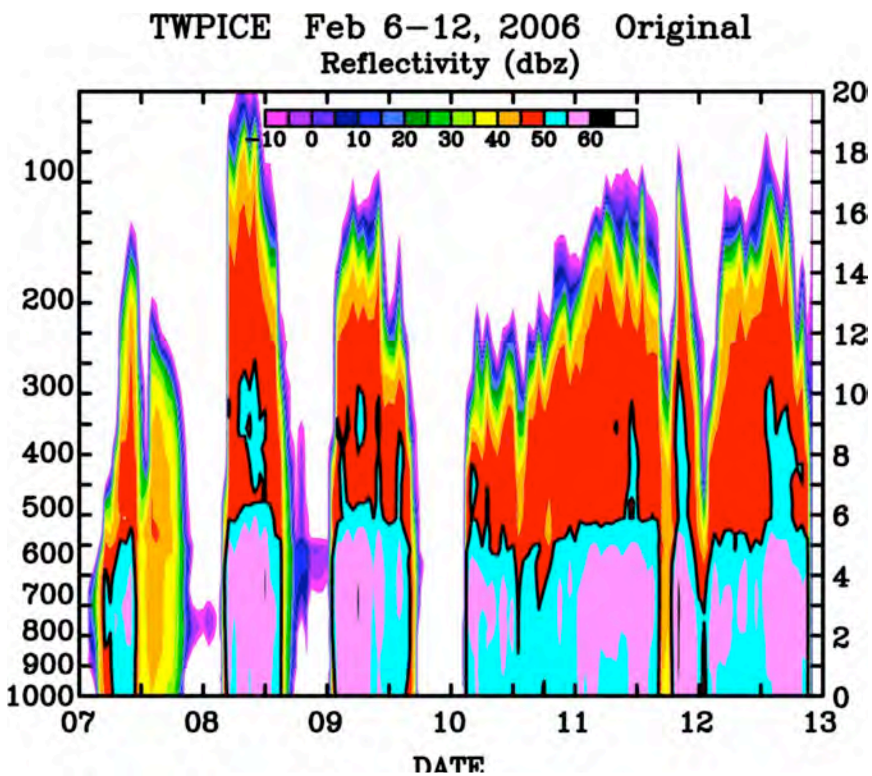


Reduce the graupel, but increase both cloud ice and snow

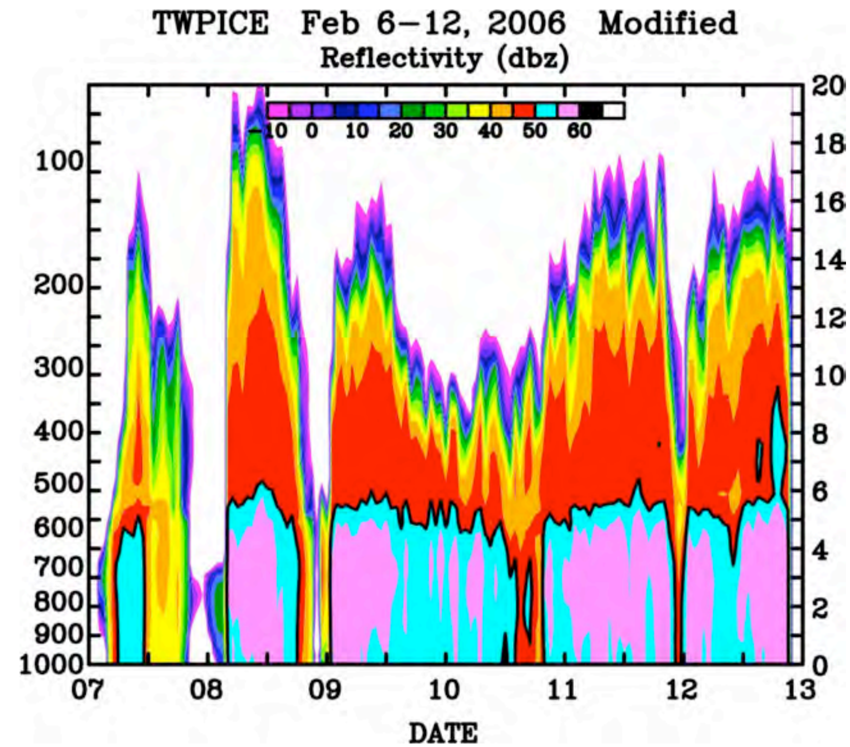
Lang et al. (2010)

TWPICE

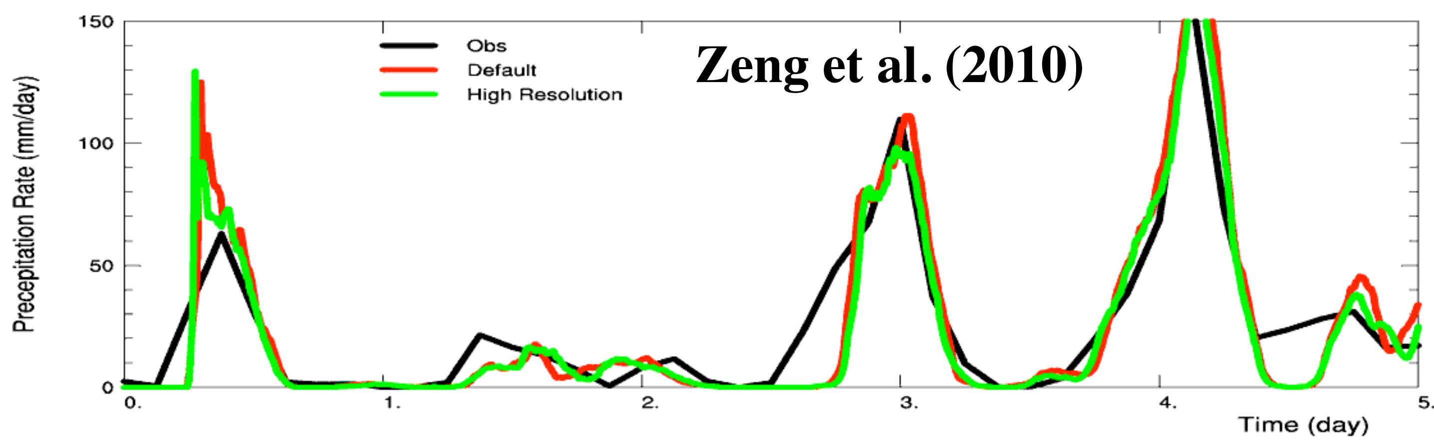
Original



Improved

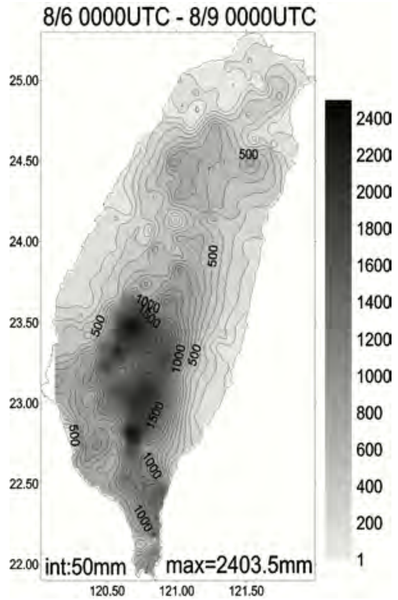


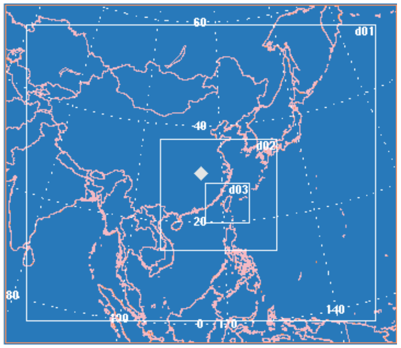
Rain Rate



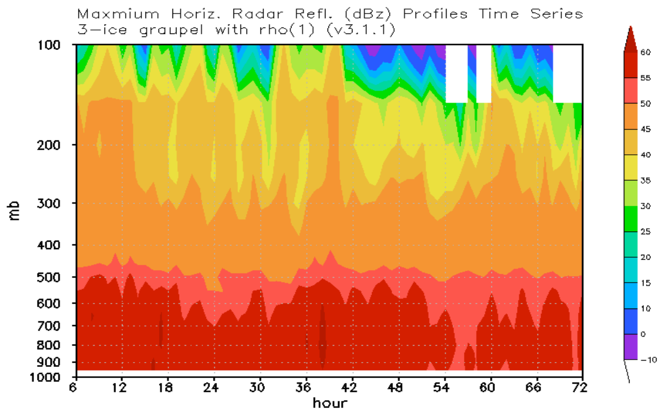
Typhoon Morakot (2009)

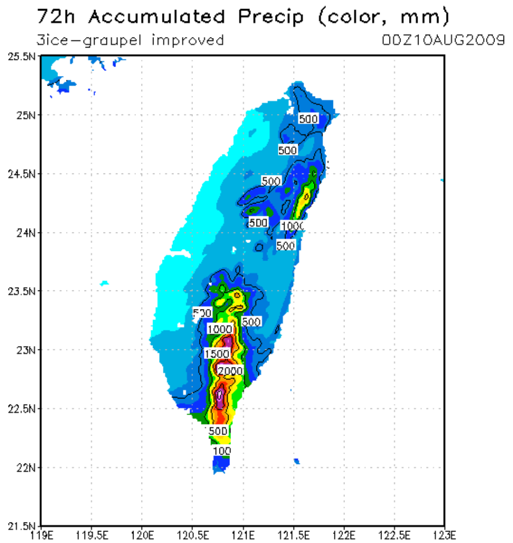
2403 mm



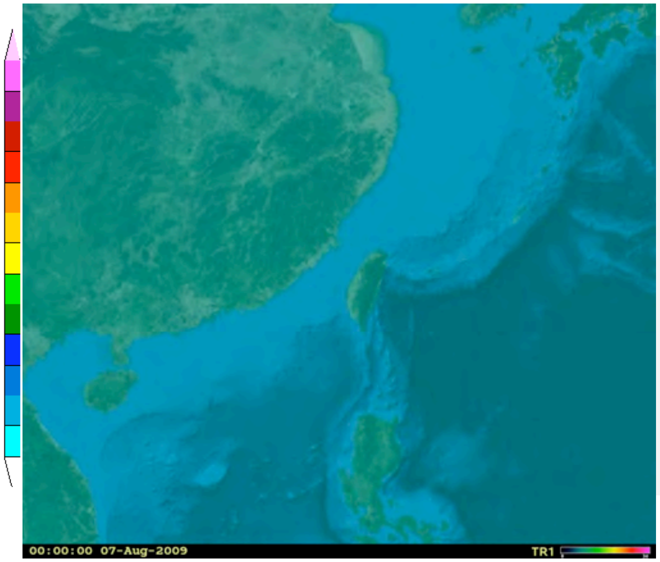


391x322, 475x427, and 538x439,
18, 6 and 2 km,
dt=18, 6 and 2 second
61 vertical layers

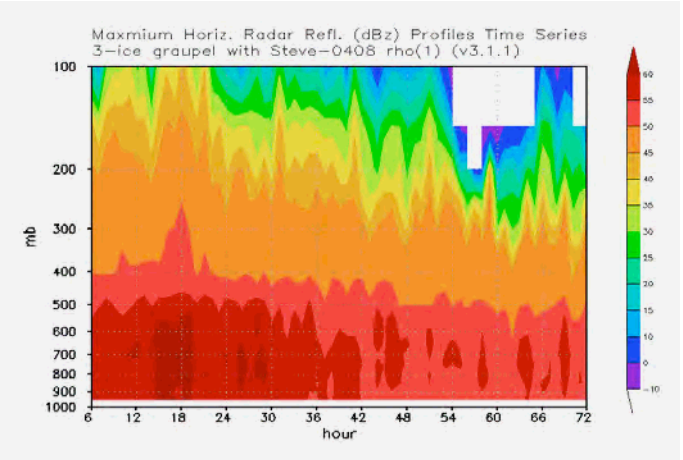




2679 mm



Tracer - PBL



Improved

Goddard Cloud Library

http://portal.nccs.nasa.gov/cloudlibrary/index2.html

MMF (1998, 1999, May 2005 to September 2007, YOTC's 6 events), WRF (C3VP, Hurricanes) and GCE (SCSMEX, TWP-ICE, KWAJEX, NAMMA, GATE, TOGA COARE, ARM SGP) cloud data is current available

High resolution (spatial-1 km, and temporal-6 min) TWP-ICE and C3VP Simulated Data was used to improve moist processes in climate models and rainfall/snowfall retrievals for PMM.

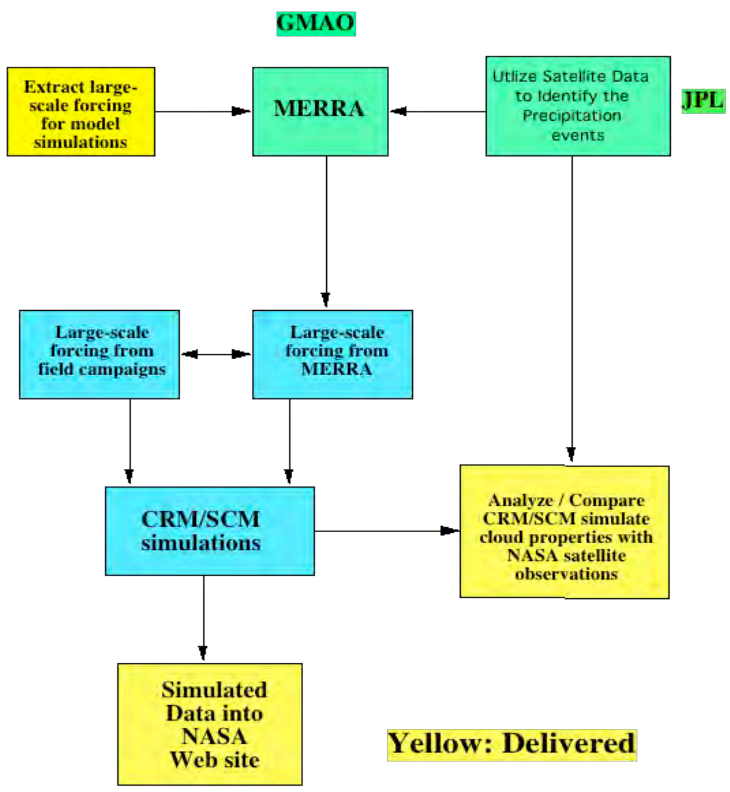
Entrainment processes associated with convection (thermodynamic properties of entrained air/environment)

Blending A-Train observation and GCE model simulation for a better "test-bed" for convection parameterization

Examination the entrainment rate and buoyancy from CloudSat and MODIS, and GCE model outputs

Cloud life cycle, evaporation and detrainment

Validation of cloud physics in CRM by conducting many simulations over different geographic locations (using large-scale forcing from MERRA)



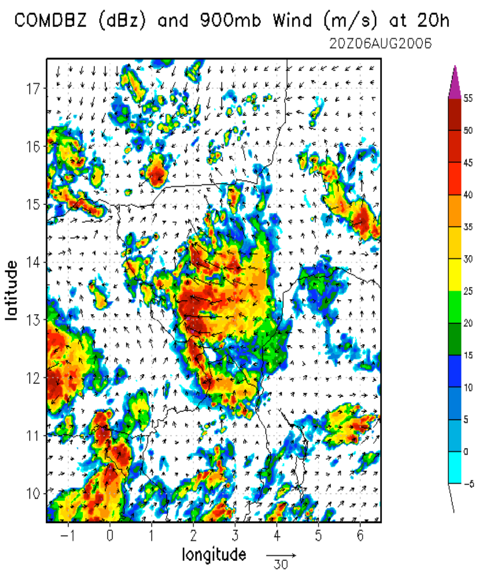
Coupling MERRA and CRM/SCM to study the cloud and precipitation processes

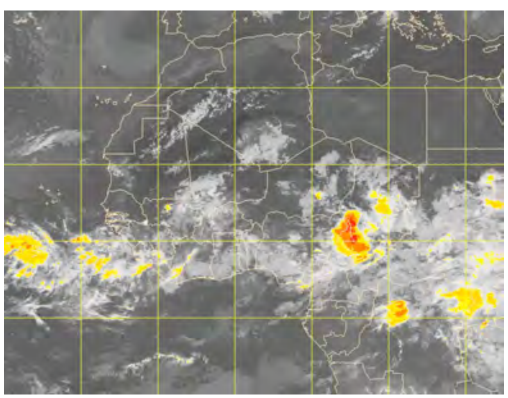
Over 8000 Datasets were downloaded in 2009
Over 600 Datasets were downloaded since March 11 2010
There are 82 Distinct Users of the cloud-library

Use of ARM observations and numerical models to achieve physically consistent representation of radiative and latent heating profiles

Wei-Kuo Tao, Xiping Zeng (NASA GSFC)
Robert Houze, Jr., Jian Yuan (University of Washington)
Sally A. McFarlane (Pacific Northwest National Laboratory)

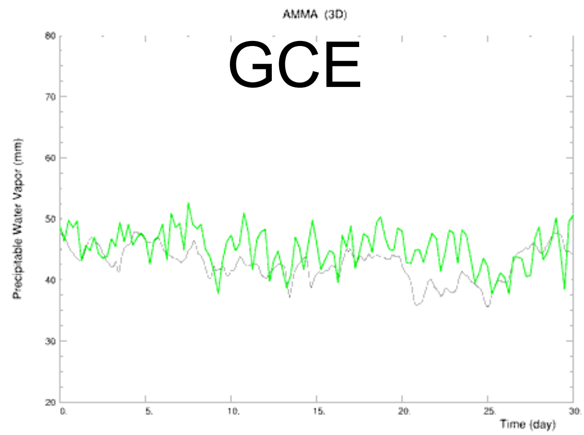
WRF

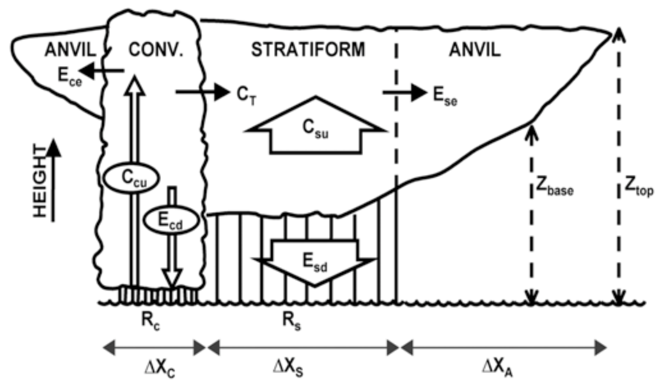




AMMA

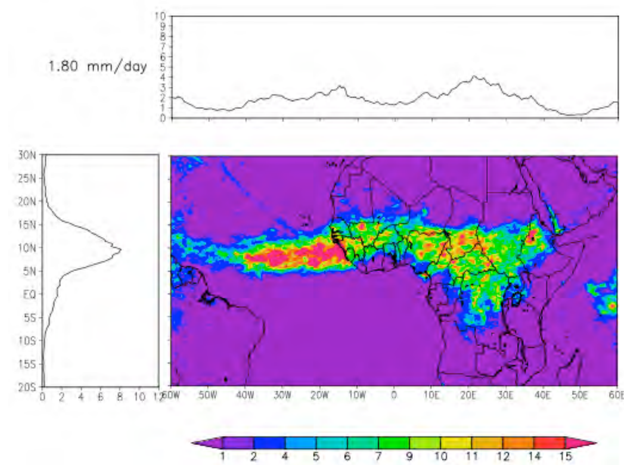
GCE

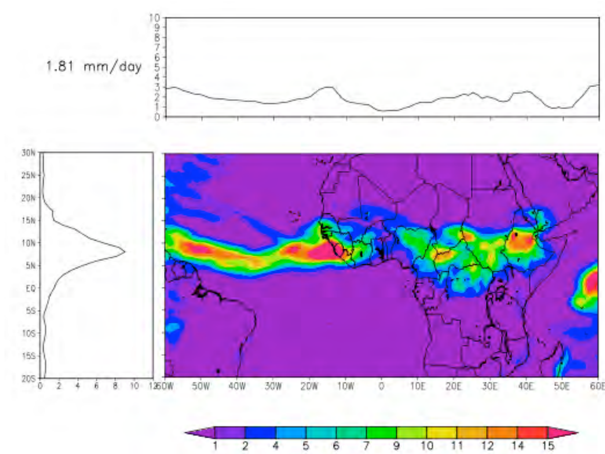




Water Budget

MMF





GPCP daily