Prototype-MMF Working Group

1st CMMAP Team Meeting

Tuesday, August 15, 2006

Agenda

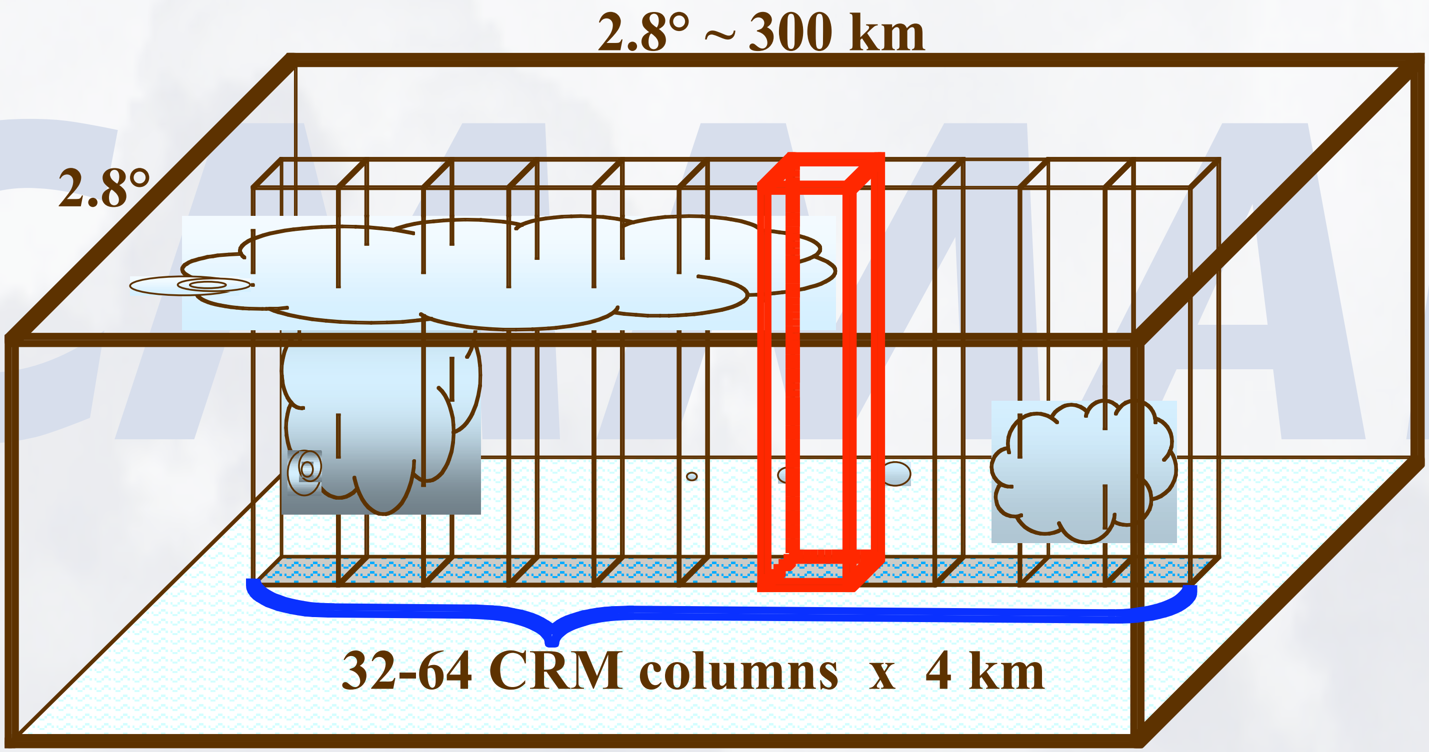
2:00-2:20	Marat Khairoutdinov	p-MMF and CMMAP Objectives
2:20-2:30	Don Dazlich	Geodesic version of p-MMF
2:30-2:40	Roger Marchand	p-MMF issues and biases
2:40-2:50	Robert Pincus	p-MMF AMIP evaluation
2:50-3:00	Wei-Kuo Tao	Goddard MMF
3:00-3:10	Anning Cheng	Shallow cumuli in SAM with IP HOC
3:10-3:30	Discussion, action items for the next 6 months	

CMMAP

Reach for the sky.

Prototype MMF Approach:

p-MMF = GCM + SP (Super-parameterization)



Reach for the sky.

✦ p-MMFs will be around for long time because

- *it is a tested framework;*
- *takes much less computational resources than GCRM yet has explicit clouds;*
  - *may well become a poor-man's MMF in the future;*
- *well-suited for massively parallel computers;*
  - *even though MMF takes about 250 times more computations, it can run efficiently on at least 10 times more processors efficiently, so the wall-clock time expense is only an order of magnitude higher than conventional GCMs;*
- *increase in computer power -> higher SP resolution and 3D SP;*
  - *each SP can run on its own set of processors, so p-MMF can utilize hundreds of thousands or even millions PEs efficiently*
- *input/output is directly compatible with conventional GCMs;*
- *allows easy switch between conventional parameterizations and SP;*
- *relatively easy to make from existing GCMs and CRMs;*
- *experience gained can be directly used in quasi-3D MMF and GCRM as well as in improving conventional GCMs;*

CMMAP

Reach for the sky.

WG Objective: Extensions, evaluations, and applications of the p-MMF

Actions (from the CMMAP SI Plan):

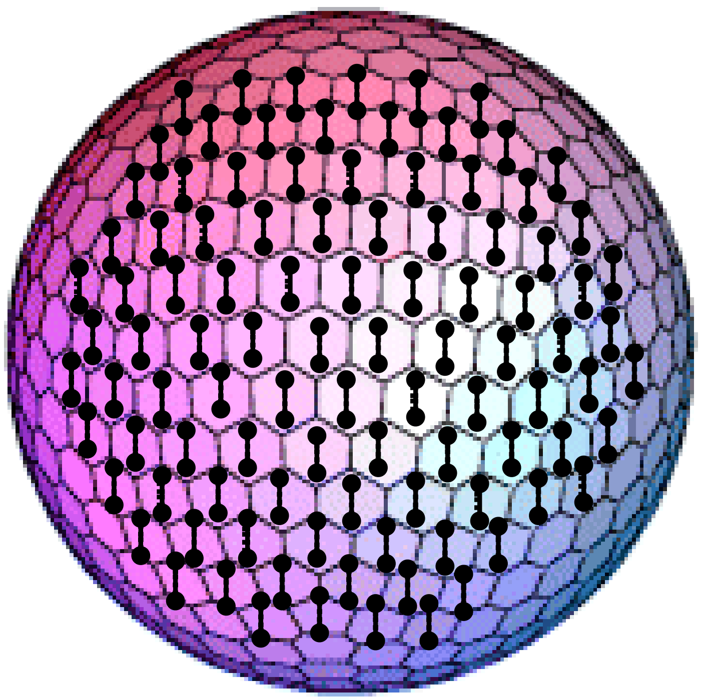
1. Perform and analyze AMIP simulations - Year 1(Ongoing)
    - 19-year (1985-2004) AMIP run output is already available
2. Create and test a geodesic version of the p-MMF - Year 1
    - preliminary short aqua-planet run with super-BUGS GCM has been done
3. Perform and analyze coupled ocean-atmosphere simulations - Year 2

Action 3 will require elimination/mitigation of many MMF biases which will be the main goal of this WG for the next 12 months

4. Perform and analyze 21st century coupled climate-change simulations - Years 3 & 4

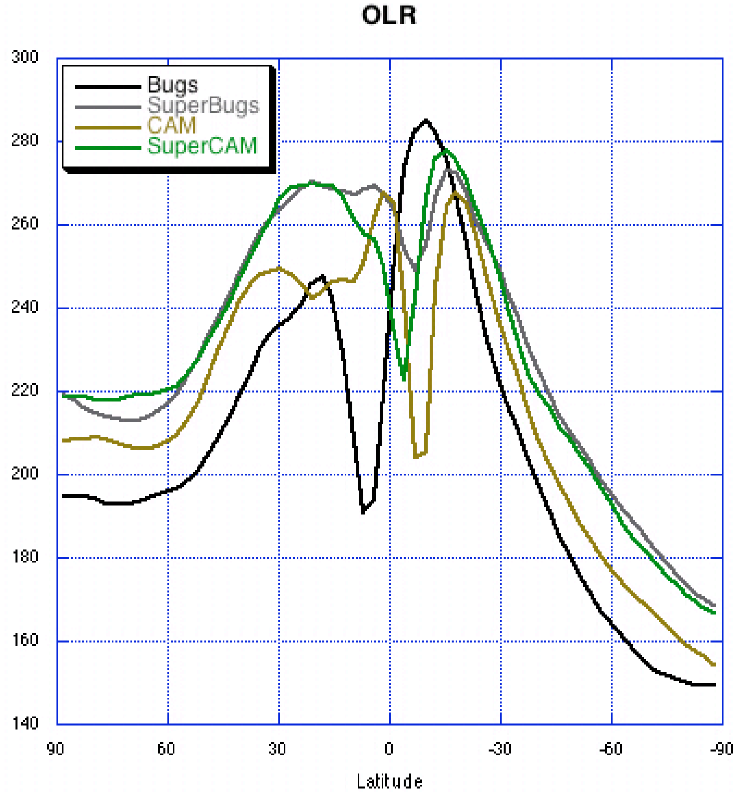
2:20-2:30 Don Dazlich Geodesic version of p-MMF

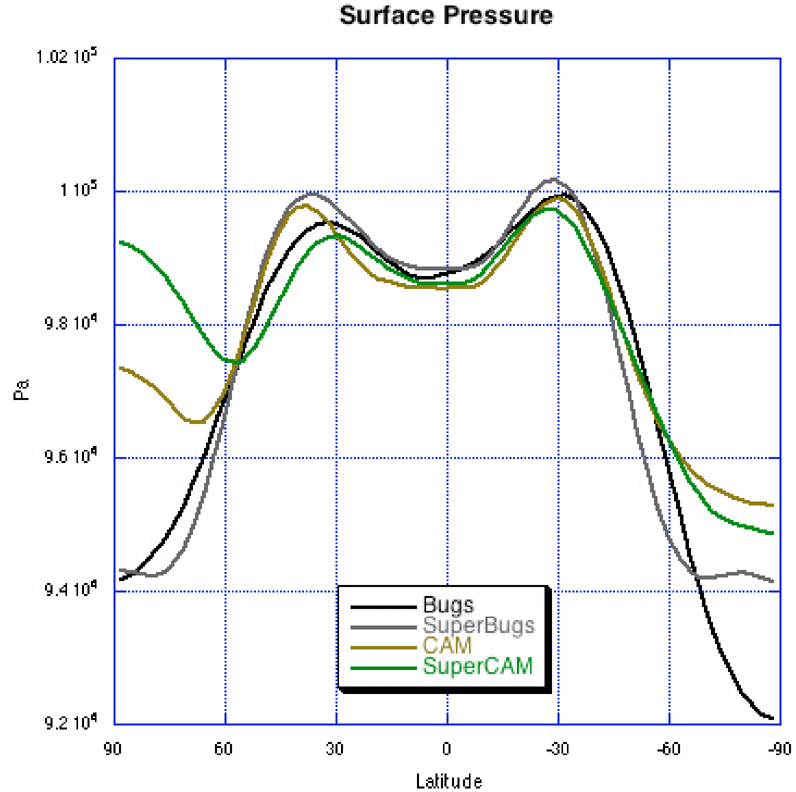
CSU AGCM with MMF (SuperBUGS)



- Sigma Coordinate - no mixed layer PBL
- N-S oriented 2D CRM (SAM) in each grid-cell: horizontal grid, cyclic boundary condition
- No convective or cloud microphysical parameterization; surface flux and radiation parameterizations computed for each CRM grid cell.

Comparison:
Cam, SuperCam, Bugs, SuperBugs





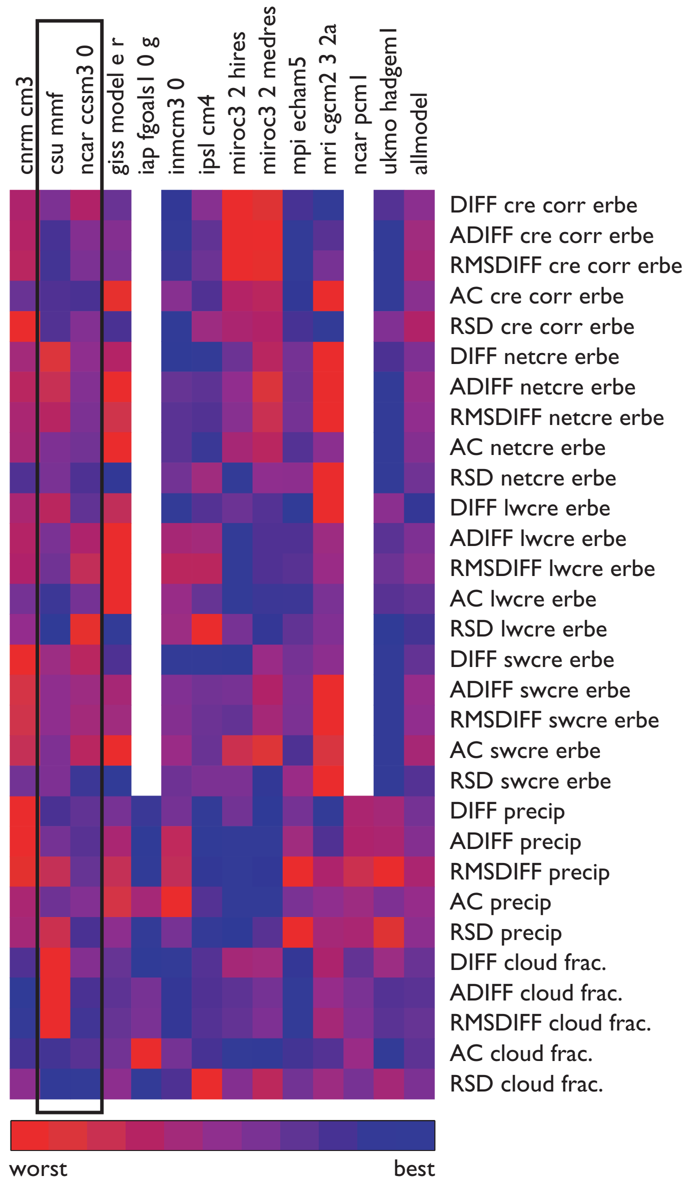
Main Points

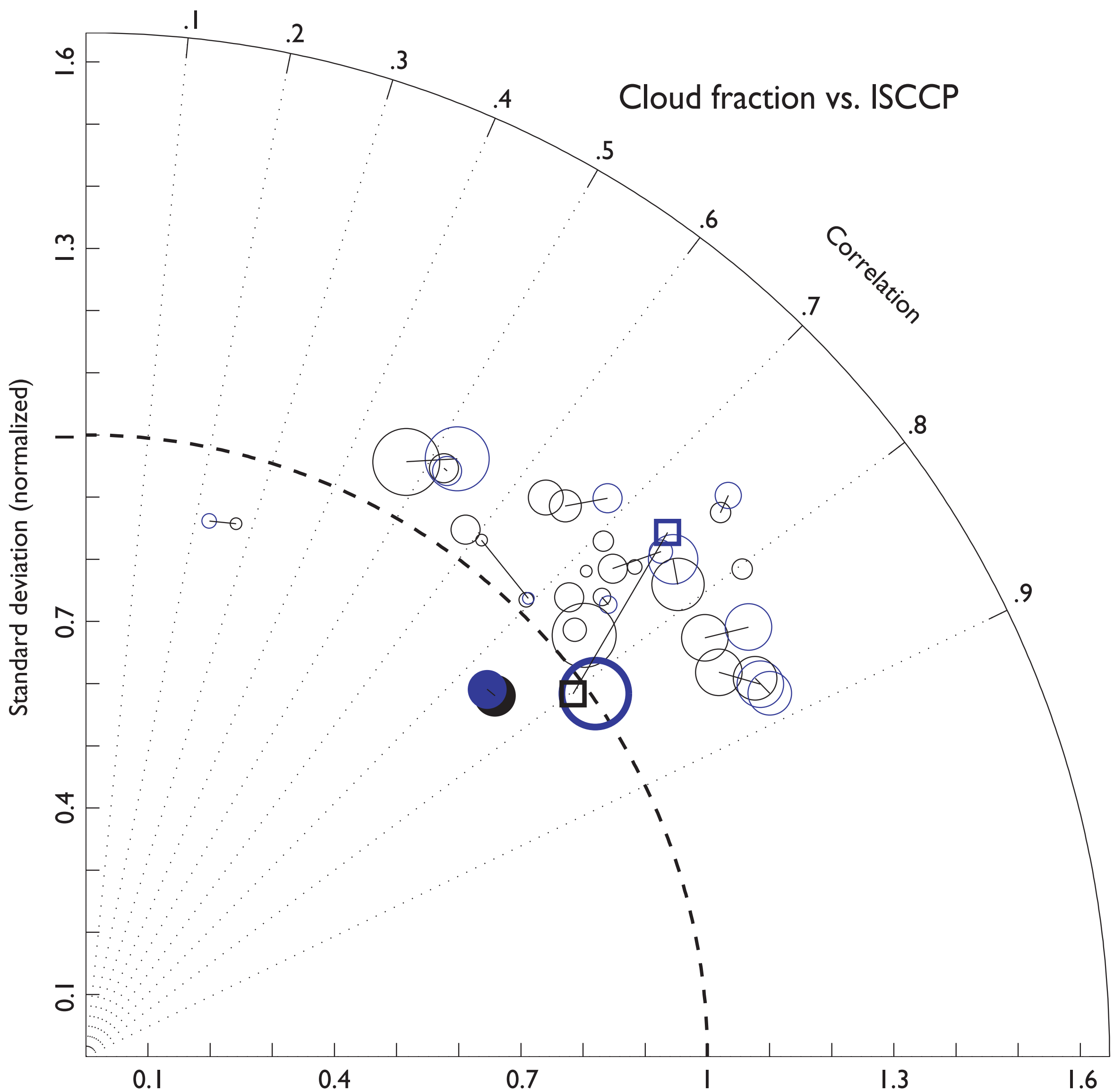
- Broadly speaking, the global cloud biases in the current MMF (4 k CRM) are remarkably similar to global biases in CAM.
  - Low clouds and high clouds (with optical depth > 0.3) are too optica thick.
  - Both models produce too much high optically thin cloud (esp. the CA in the tropics.
  - Both produce too little cloud coverage over subtropical and mid-latit (esp. over land areas)

- Observation at ARM SGP and TWP site support satellite biases discussed here, as well as provide additional details on distributio properties.
  - Ovtchinnikov, Ackerman, Marchand, and Khairoutdinov, 2006 : "Evaluation of the Multiscale Modeling Framework Using Data from the Atmospheric Radiation Measurement Program", *J. of Climate*, vol. 19, p. 1716-1729.
  - This paper shows improvement in mean precipitation and distributio cloud fraction at the ARM TWP sites.

- Our group plans to focus on using ARM ground-based and multip satellite dataset (primarily CERES, ISCCP, MISR and CloudSat) in evaluation MMF improvements
  - One should be cautious interpreting ISCCP retrievals which tend to s much more mid-level cloudiness than MODIS or MISR.

Robert Pincus **p-MMF AMIP evaluation**

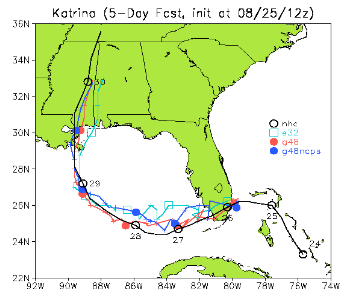




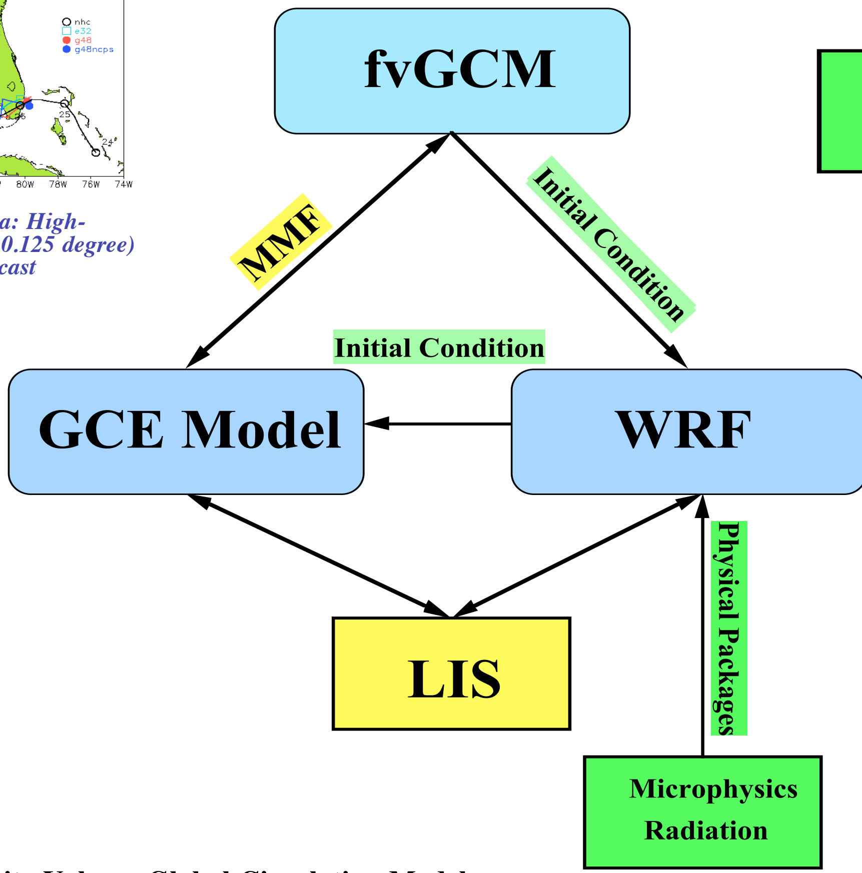
Cloud fraction vs. ISCCP
Correlation
.1
.2
.3
.4
.5
.6
.7
.8
.9
Standard deviation (normalized)
0.1
0.4
0.7
1
1.3
1.6

Wei-Kuo Tao **Goddard MMF**

Multi-Scale Modeling Systems



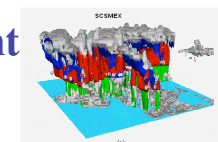
Hurricane Katrina: High-resolution (0.25 - 0.125 degree) fvGCM 5 day forecast



Observation

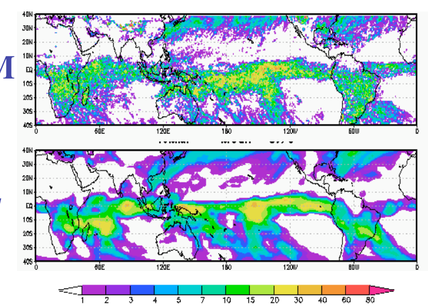
Satellite Data
Field Campaigns
Re-analyses

Data Management
Visualization



TRMM

MMF

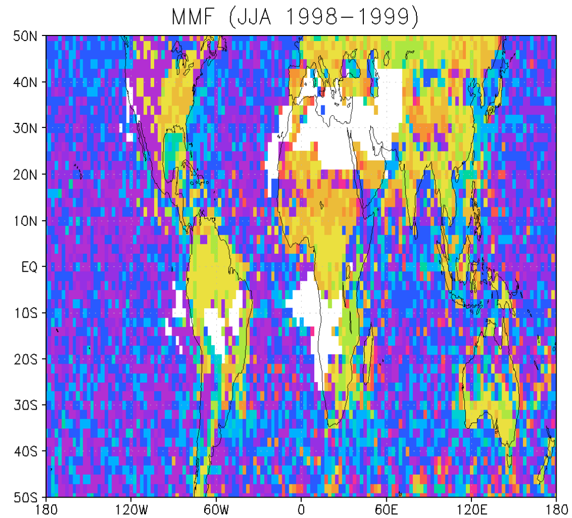


fvGCM: Finite Volume Global Circulation Model
MMF: Multi-Scale Modeling Framework
LIS: Land Information System
GCE: Goddard Cumulus Ensemble Model
WRF: Weather Research Forecast

Microphysical Package (4 options)
Long/Shortwave Radiative Transfer
GOCART

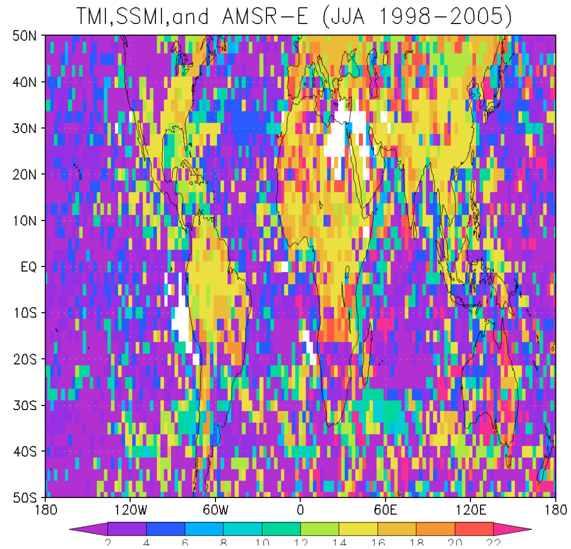
Local Time of Maximum Precipitation Frequency (Summer)

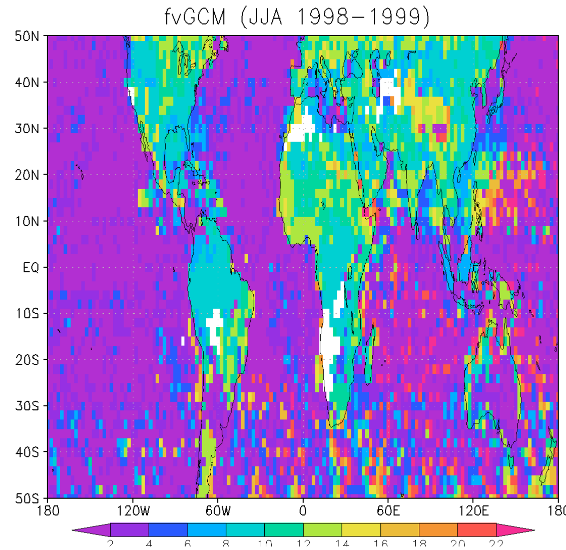
MMF
JJA
1998-1999



	Land	Ocean
MW	1600-1800	0200-0600
MMF	1600-1800	0200-0600
GCM	0800-1000	0000-0400

Merged MW
JJA
1998-2005



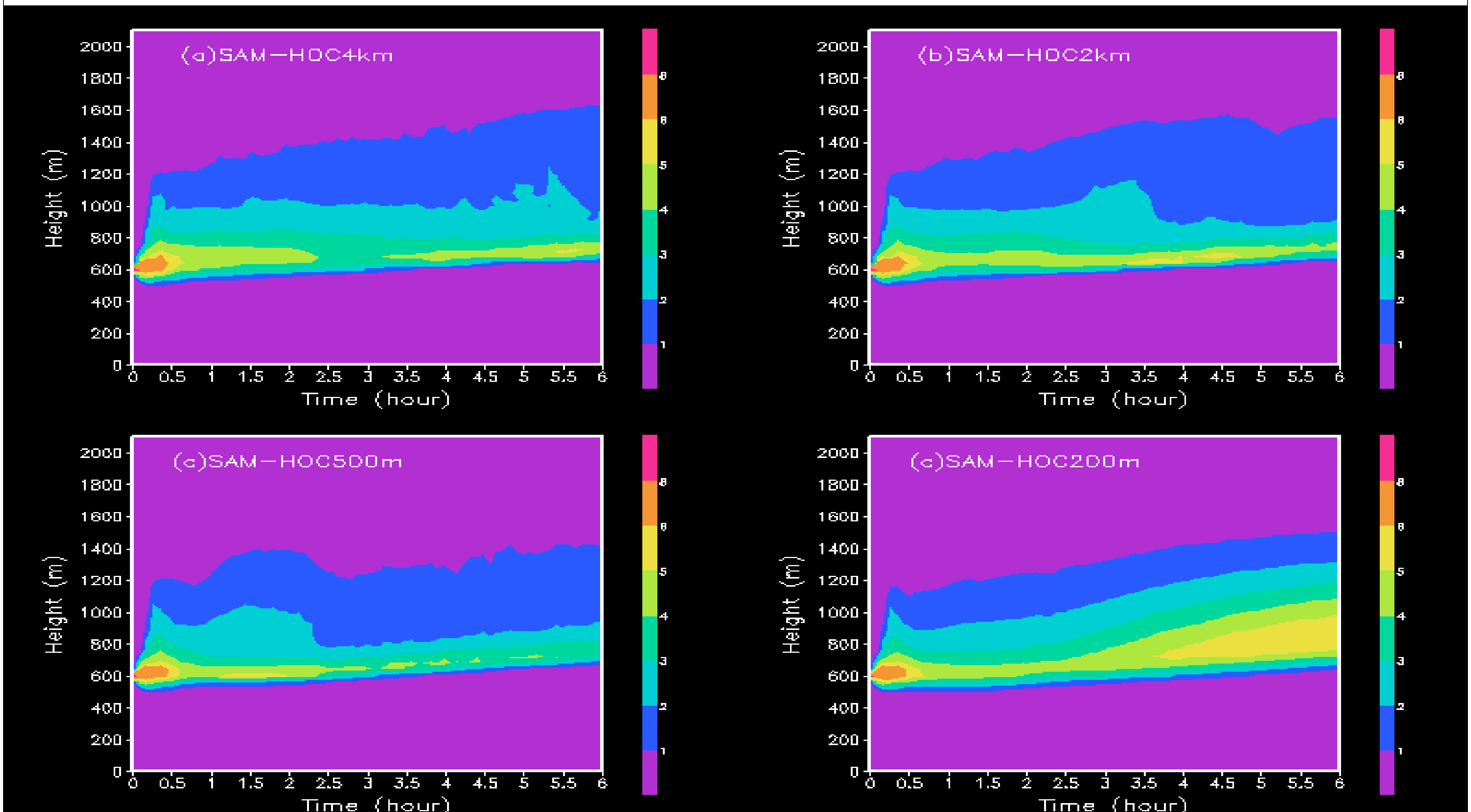


fvGCM
JJA
1998-1999

Anning Cheng

Shallow cumuli in SAM with IP HOC

Cloud Fraction Evolution for IP-HOC SAM



Action Items for the next 6 months:

- Develop objective metrics (and necessary software) to evaluate the current and future versions of p-MMF (Bretherton, Pincus, LLNL);
- Run the MMF in a weather-forecasting mode; study sensitivity of biases to SP parameters/ configurations (Khairoutdinov, PNNL, LLNL);
- Test alternative microphysics packages in SAM and BB-SAM (Krueger, Grabowski, Khairoutdinov);
- Test the mini-LES super-parameterization for PBL clouds and shallow cumuli in BB-SAM and MMF (Khairoutdinov);
- Test alternative SGS parameterization for PBL clouds in SAM/MMF (Xu, Cheng);
- Simulation of the Earth climate with the geodesic p-MMF (Dazlich);
- Incorporation of cloud-scale topography effects into the p-MMF (Grabowski);
- Make SP fully code compatible with SAM (Khairoutdinov)