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
Prototype MMF Approach:

\[ p\text{-MMF} = \text{GCM} + \text{SP} \text{ (Super-parameterization)} \]

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

Observation at ARM SGP and TWP site support satellite biases discussed here, as well as provide additional details on distribution properties.
- This paper shows improvement in mean precipitation and distribution cloud fraction at the ARM TWP sites.

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

fvGCM

GCE Model

WRF

LIS

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

Observation

Satellite Data Field Campaigns Re-analyses

Data Management Visualization

Hurricane Katrina: High-resolution (0.25 - 0.125 degree) fvGCM 5 day forecast
Local Time of Maximum Precipitation Frequency (Summer)

<table>
<thead>
<tr>
<th></th>
<th>Land</th>
<th>Ocean</th>
</tr>
</thead>
<tbody>
<tr>
<td>MW</td>
<td>1600-1800</td>
<td>0200-0600</td>
</tr>
<tr>
<td>MMF</td>
<td>1600-1800</td>
<td>0200-0600</td>
</tr>
<tr>
<td>GCM</td>
<td>0800-1000</td>
<td>0000-0400</td>
</tr>
</tbody>
</table>

**MMF**

JJA 1998-1999

**Merged MW**

JJA 1998-2005

**fvGCM**

JJA 1998-1999
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)