

Recent Progress from the CCPP-ARM Parameterization Test bed (CAPT)

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Outline

- What is CAPT?
- ARM
- Using ARM to improve parameterization development for climate model
- Future Plans
- Conclusion

What is CAPT?

CAPT = CCPP-ARM Parameterization Testbed

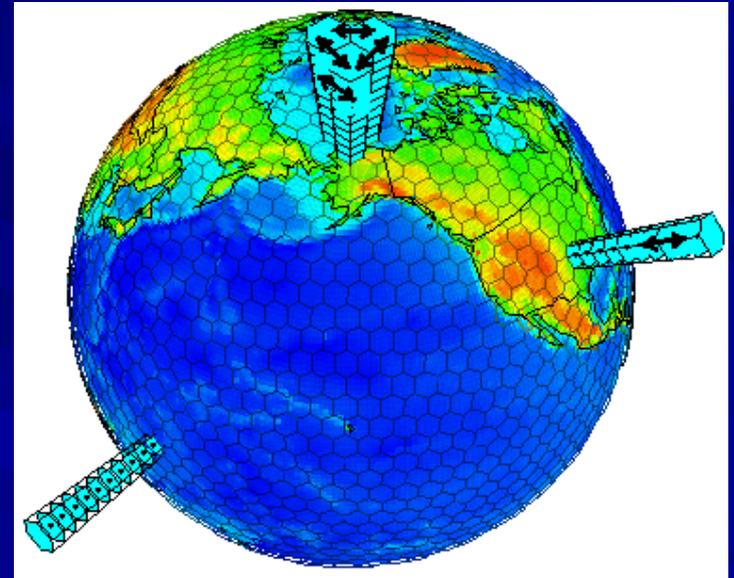
CAPT combines the strengths of two DOE programs with complementary missions:

CCPP (*Climate Change Prediction Program*) Focus on GCM performance

ARM (*Atmospheric Radiation Measurement*) Focus of radiation and cloud processes and their parameterization in GCMs

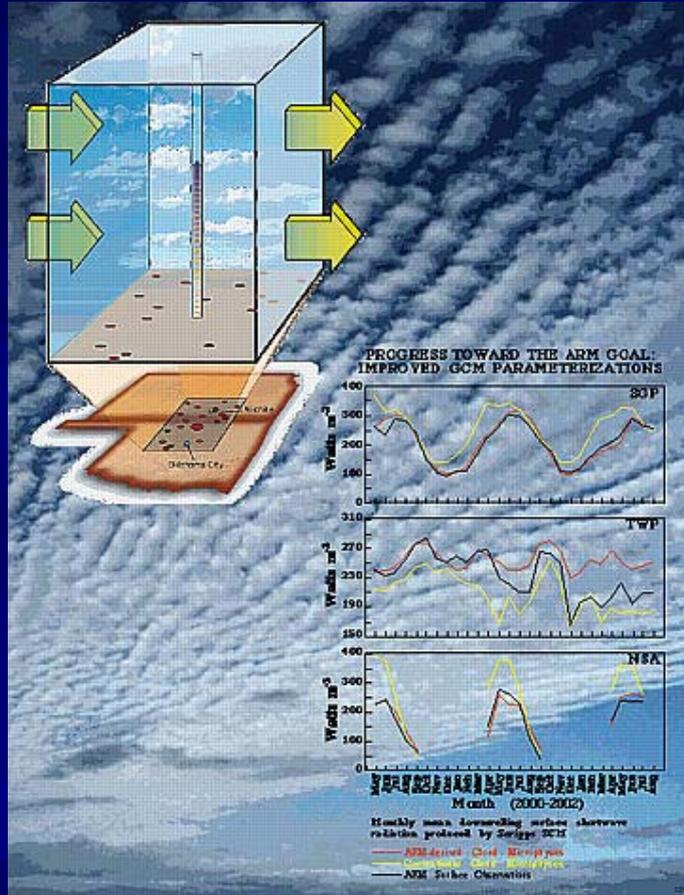
CAPT provides a flexible user environment for running GCMs in NWP 'forecast' mode:

- > global initialization data sets
- > processed global and local observations
- > high-frequency GCM forecast output
- > diagnostic analysis and visualization tools
- > experienced scientific staff to collaborate with parameterization developers



from Dave Randall

ARM has used the SGP column data



ARM observations collected during Intensive Operational Periods (IOPs) have been analyzed to provide large-scale forcing for **Single-Column Models** and **Cloud-Resolving Models**;

Detailed cloud and radiation observations have been used to evaluate and improve GCM parameterization performance in different seasons of the year.

Why use CAPT approach to test GCM parameterizations?

There are other ways to test parameterizations

■ **Climate models with climate simulations**

- Complicated and depend on all aspects of the model;
- computationally expensive and time consuming;
- not able to link to particular synoptic process, only statistical comparison

■ **NWP models with short-range forecasts**

- Parameterizations may not be designed for climate models
- Model resolutions are much higher than those in climate models

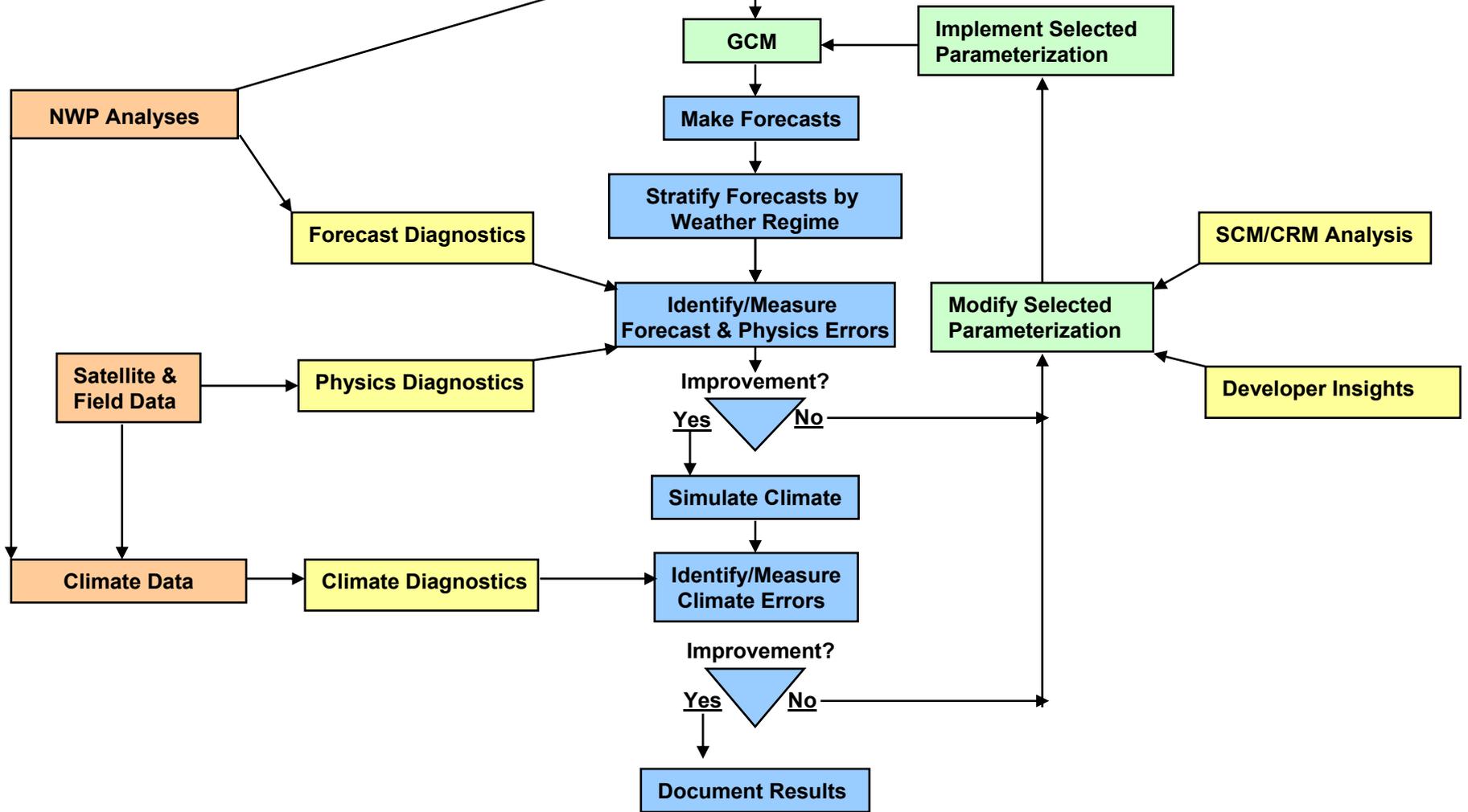
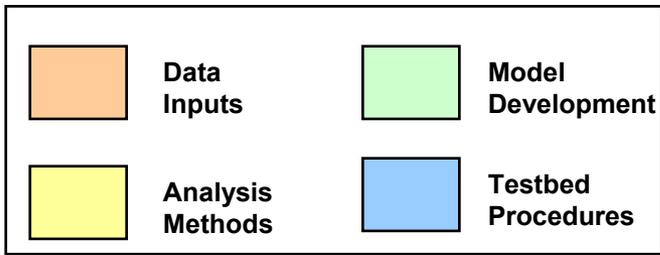
■ **SCMs/CRMs with specified large-scale forcing (*done in ARM*)**

- Results are highly dependent on quality of large-scale forcing
- No internal feedback from dynamic processes

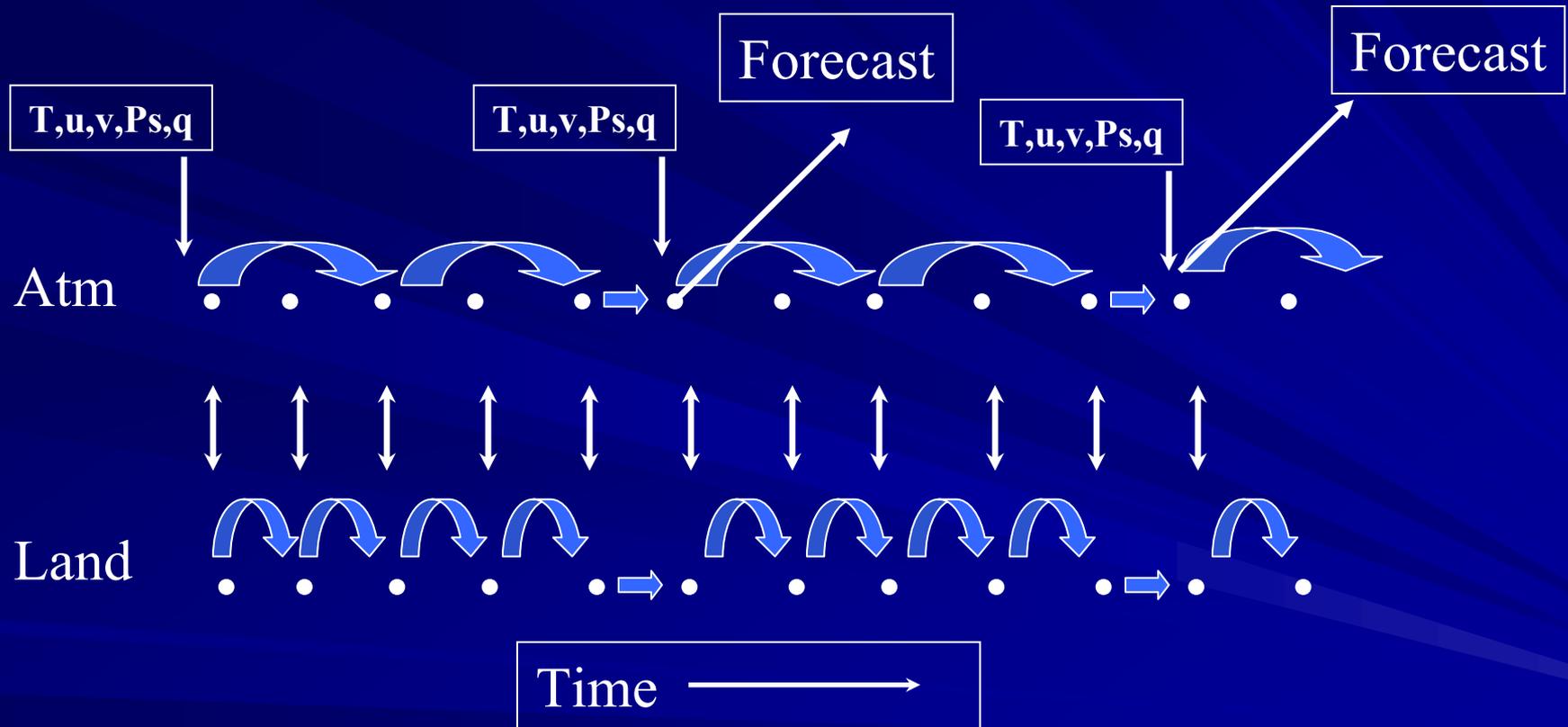
But, running climate models in NWP mode (CAPT)

- *provides high-frequency NWP analyses*
- *uses more available observations*
 - >> *able to link deficiencies with atmospheric processes through case study*
- *allows systematic errors to be identified before multiple errors compensate*
- ...

CAPT Diagnostic Protocol



Utilize New Initialization Techniques “Forecast Analysis System”



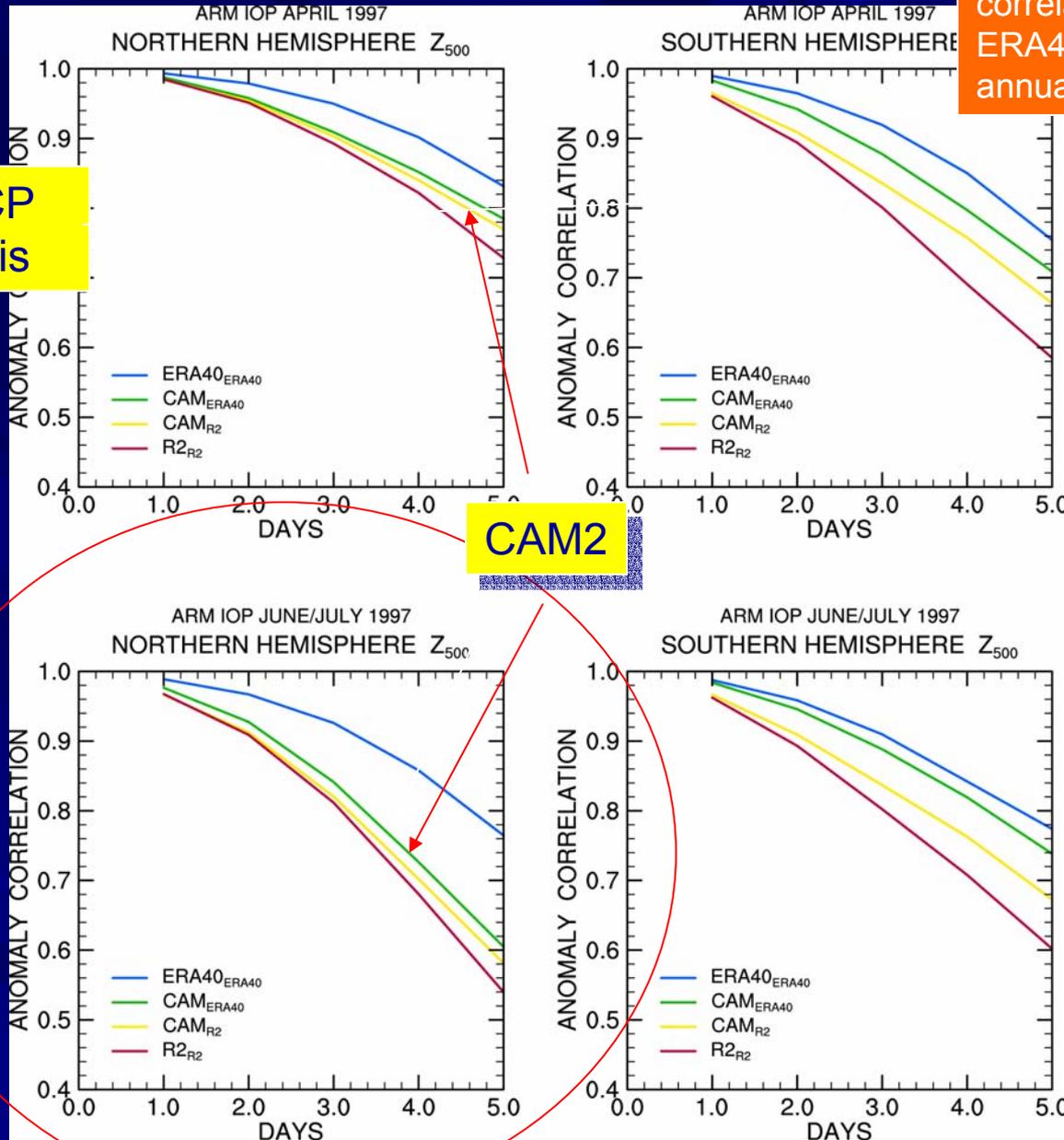
This approach is to restart the Land and initialize the Atmosphere

Initialization

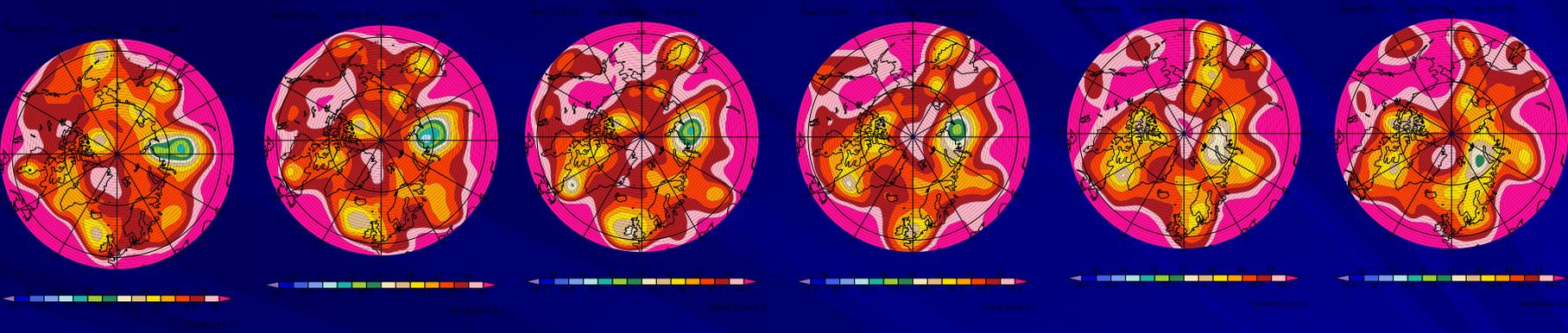
- We are confident that the procedure is adequate to isolate parameterization errors from large scale dynamics
 - ERA-40 – for all practical purposes *is* observations
- Use NWP measures to test initialization skill
 - Standard 500mb height anomaly correlation

500mb height anomaly correlation taken from ERA40 30-year mean annual cycle

Note the NECP "R2" reanalysis



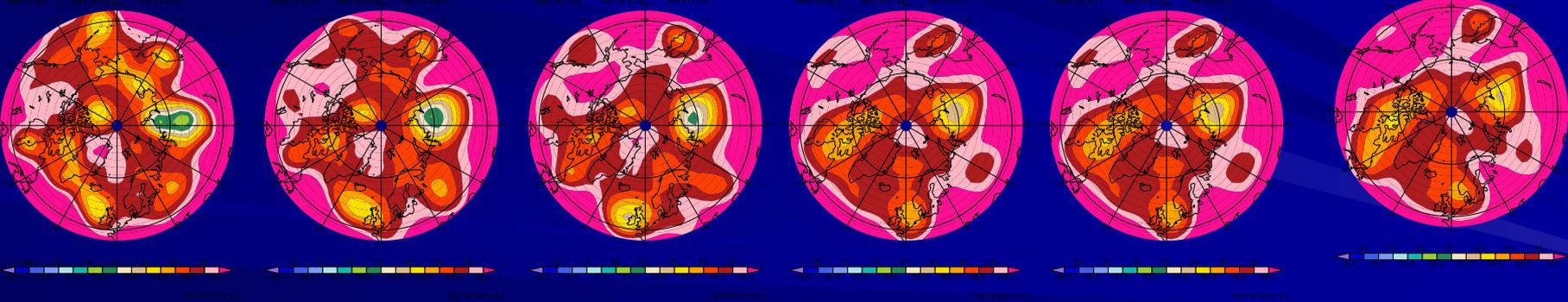
ERA40 500mb height (hectometers)



June 19, 1987 00Z June 20 June 21 June 22 June 23 June 24

Start

Forecast



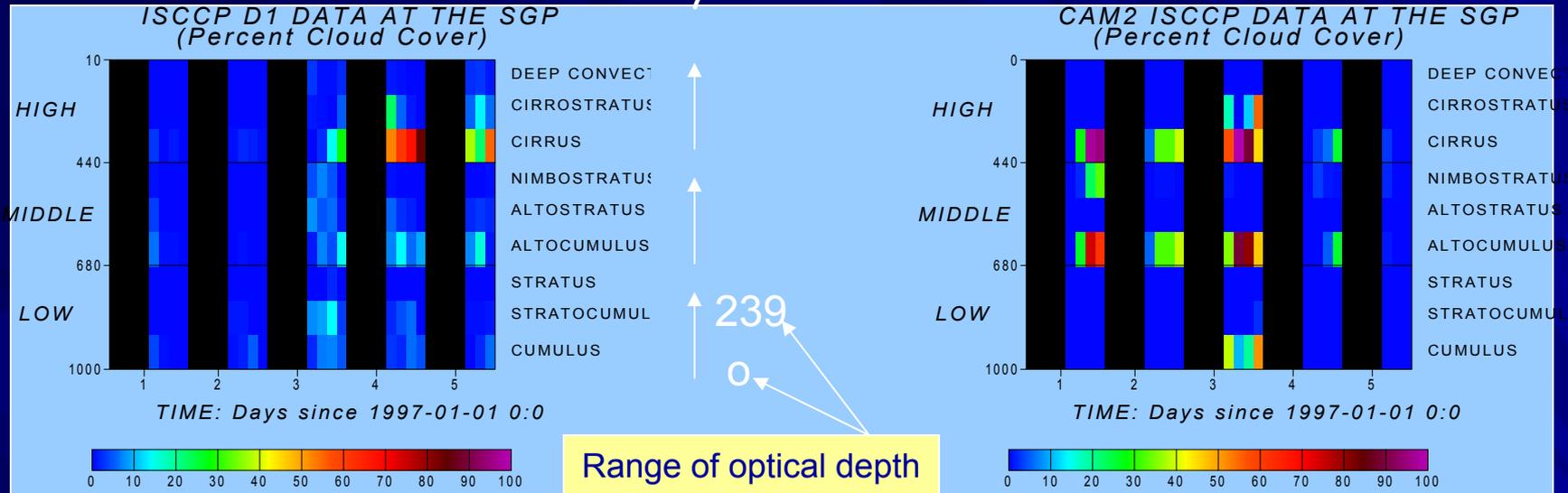
CAM2 5-day forecast sampled at 00Z

Evaluating clouds over the SGP and other sites

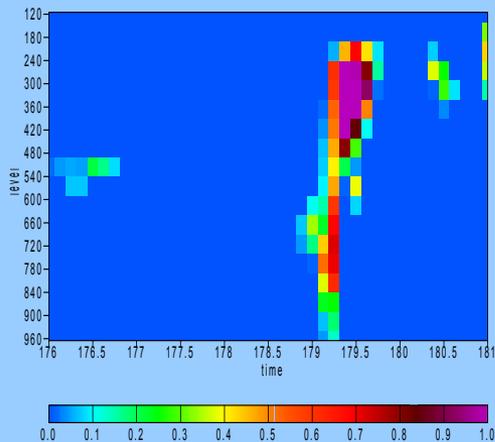
ISCCP D1 data

July 1-4 1997

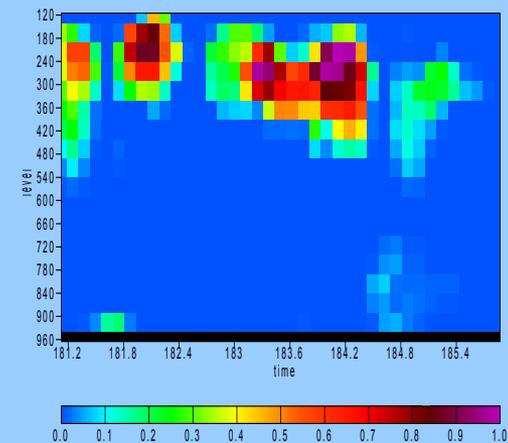
ISCCP simulator



ARM



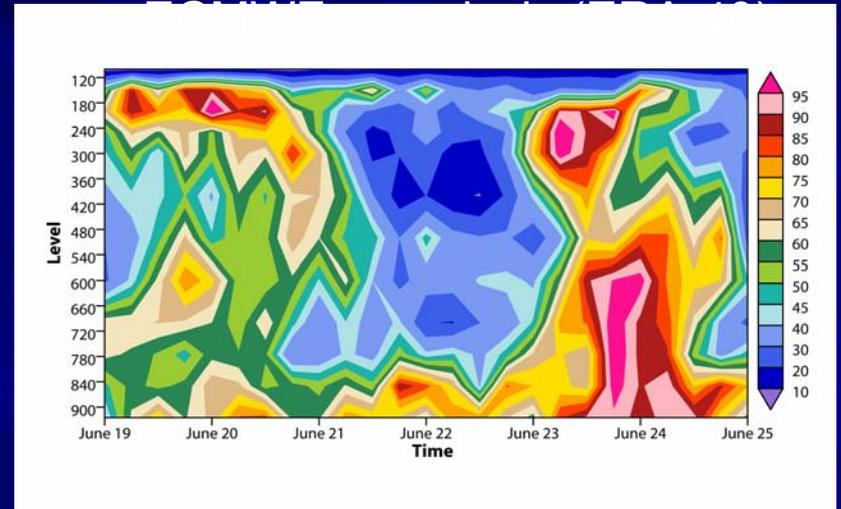
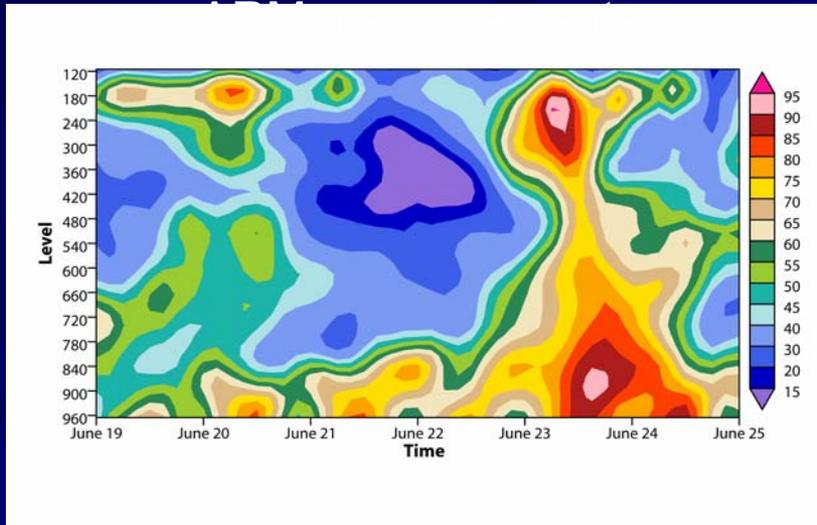
CAM2 CLOUDS



An example of CAPT activities

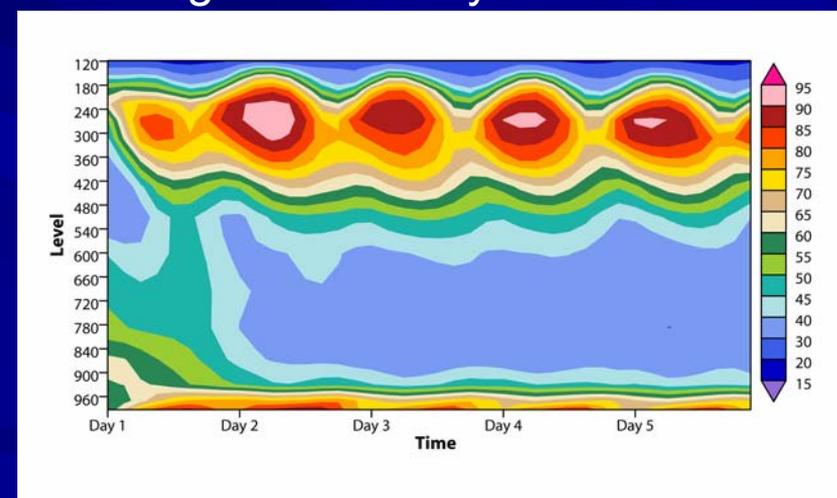
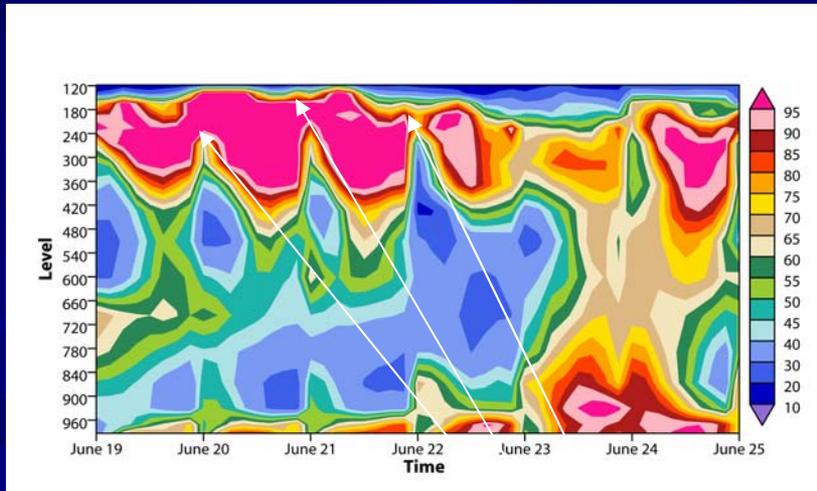
- Detailed evaluation of the CAM2 at the SGP during one of the IOPs shows a major problem

ARM – Southern Great Plains Site Relative humidity



Series of CAM2 forecasts valid 0-24 hours

Average of all 5-day forecasts



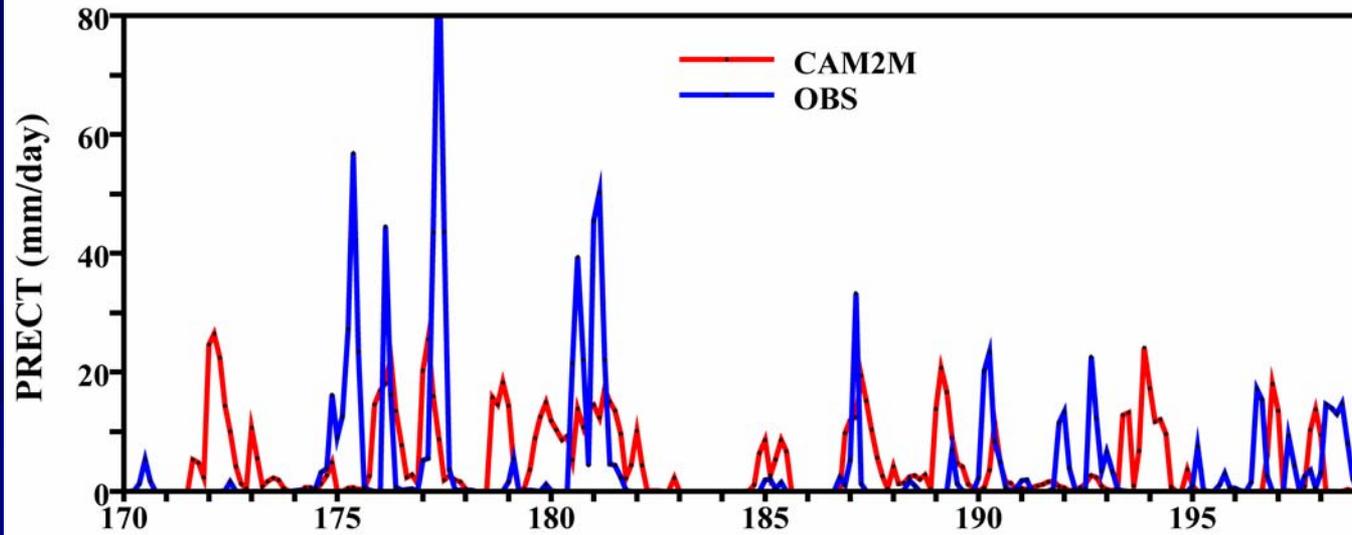
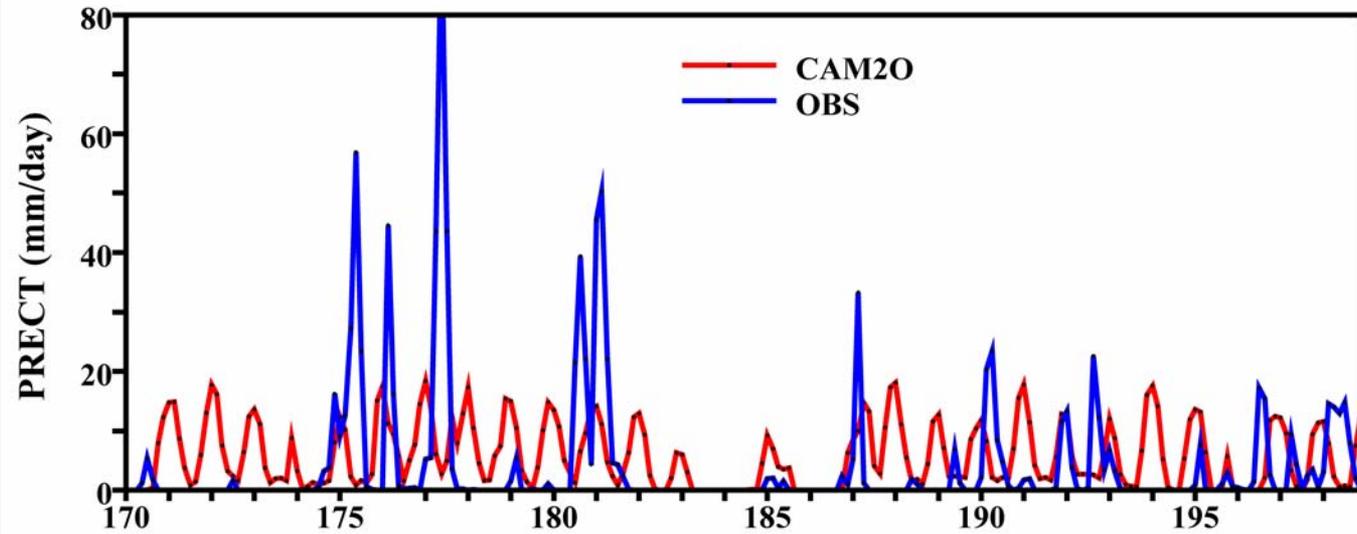
19-24 June, 1997

Model initialized

CAPT provided the environment to address the errors related to convection

- Shaocheng Xie developed a new trigger function for CAPE and tested in single column models
- See: Xie, S. and Zhang, M., 2000, “Impact of Convection Triggering Function on the Single-Column Model Simulations”, *J. of Geophys. Res.*, 105, D11, 14,983-14996,

Simulated and Observed Precipitation

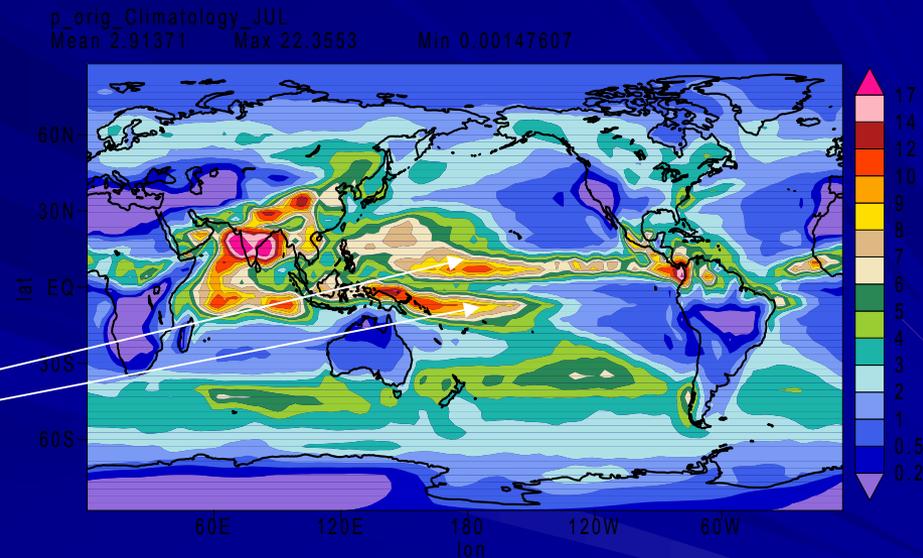


Time (Julian Days)

Do improvements have effects
beyond the SGP site?

An example of using CAPT to address a large-scale problem

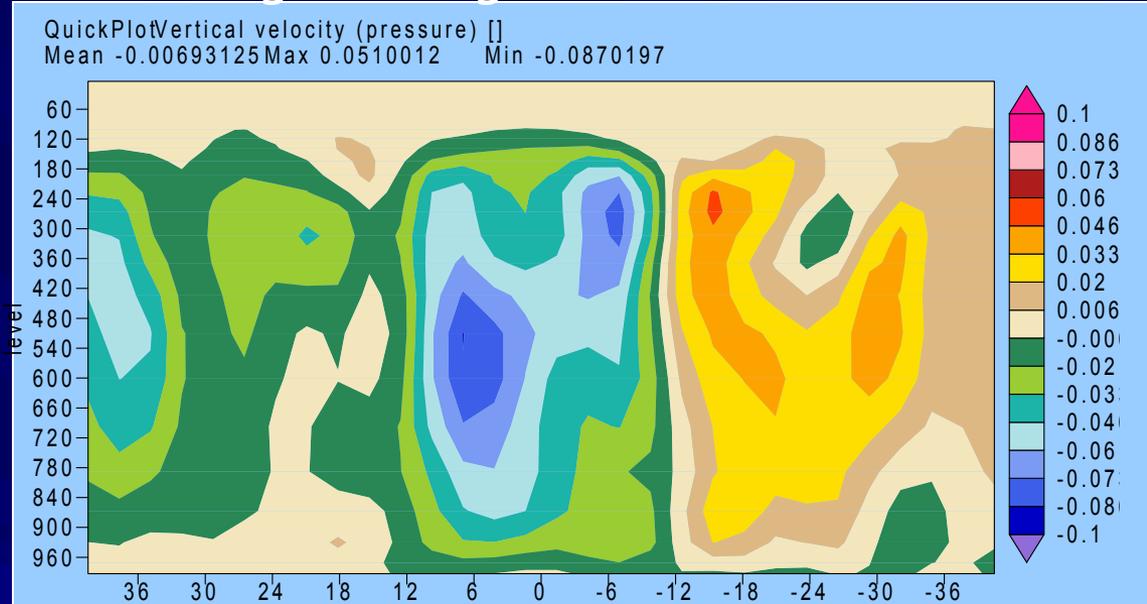
- One of the lingering problems with GCMs is the persistence of a double ITCZ in the Western Tropical Pacific.



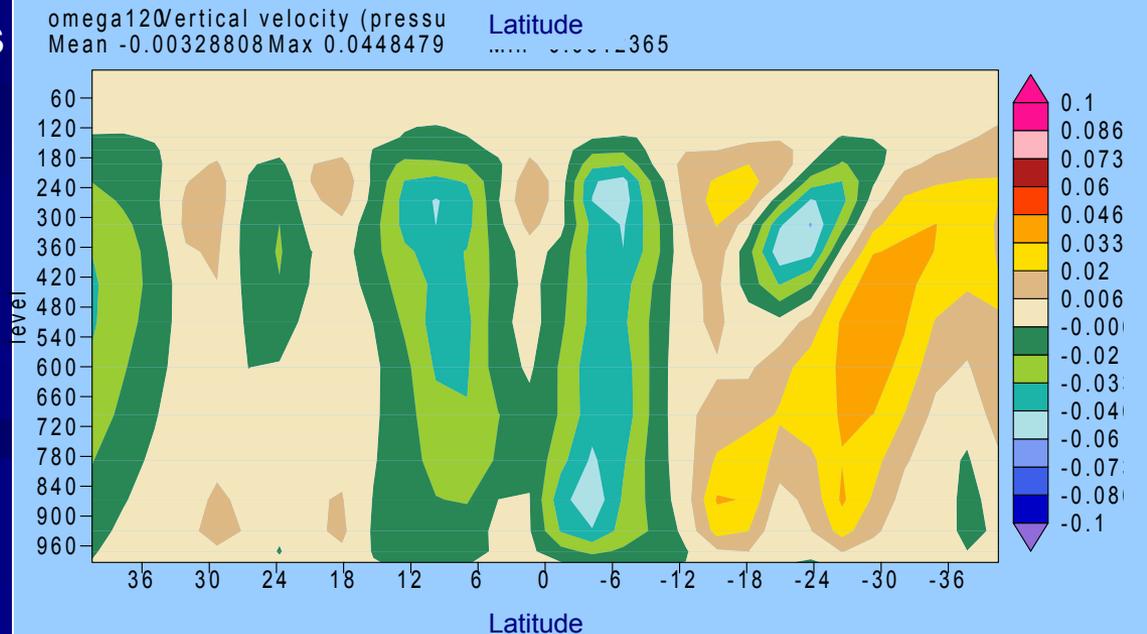
Appears to be more severe in coupled models

Latitude-height Omega at the international dateline

24 hours

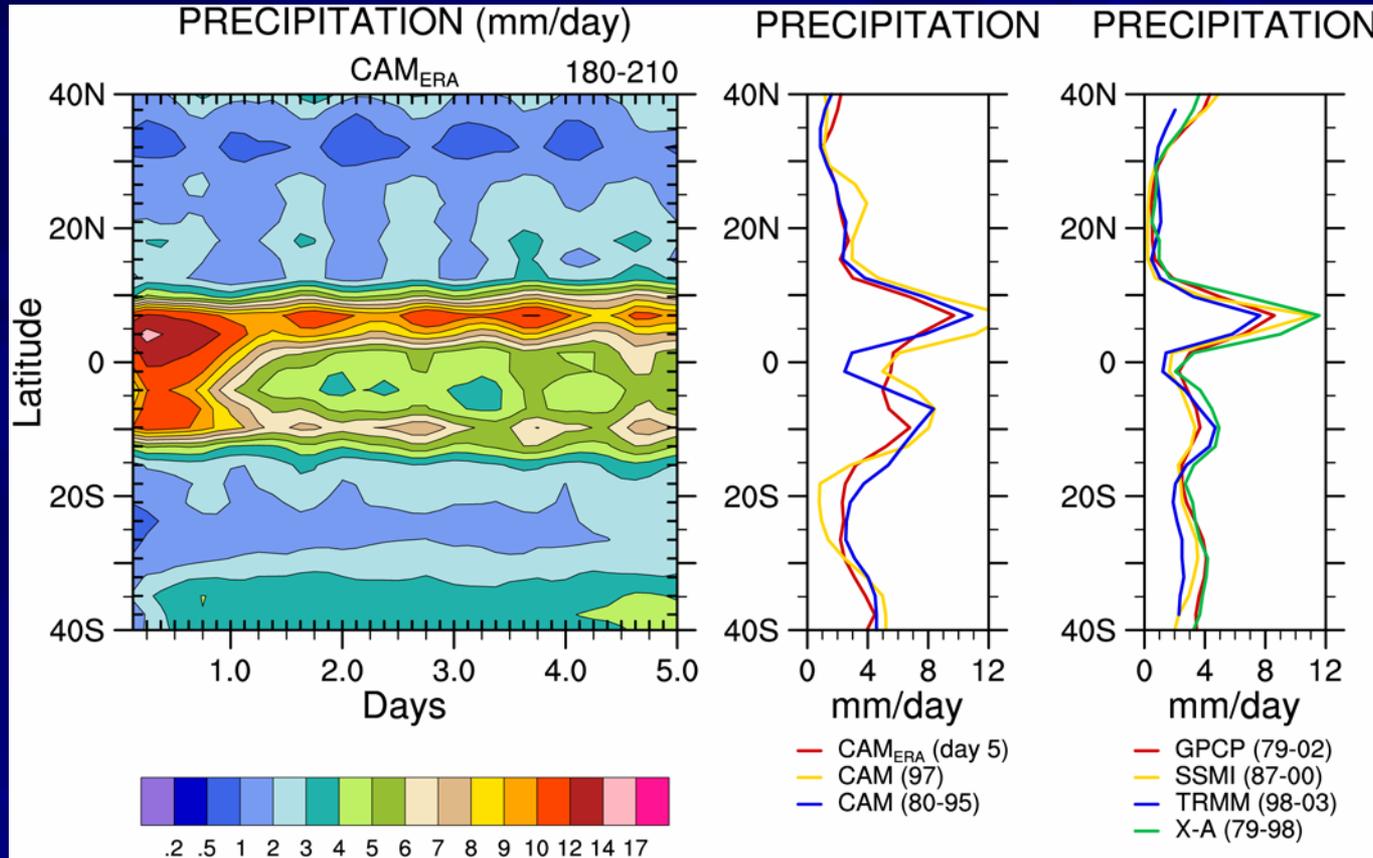


Ensemble averages



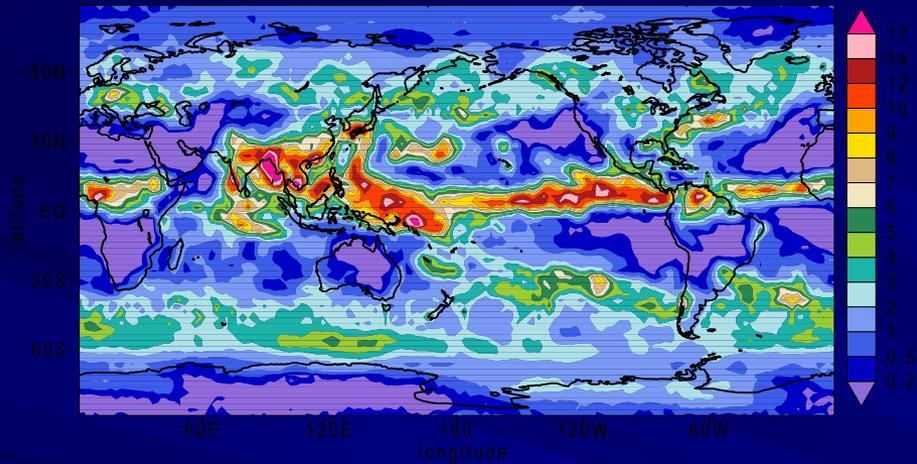
120 hours

The double ITCZ appears very soon after initialization in a CAPT study

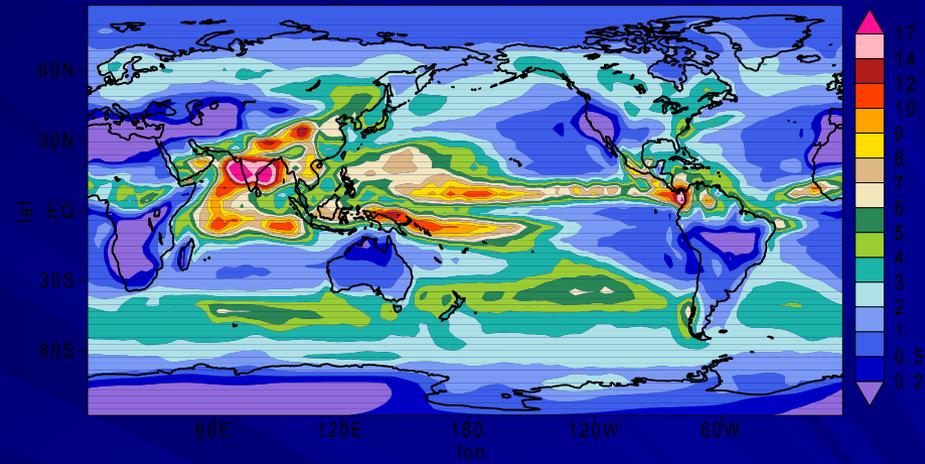


The new Xie trigger function shows a major improvement in global precipitation

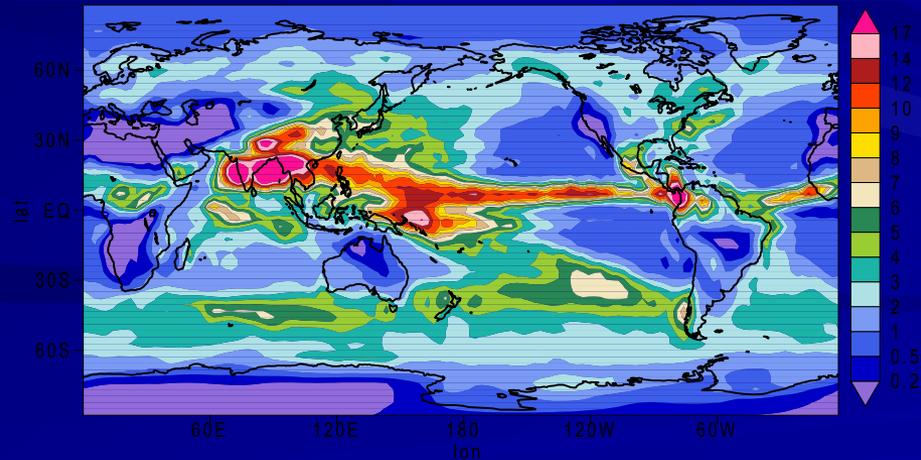
GPCP (observed July 1997 Precipitation)



CAM2 model JJA (original version)



Xie trigger imposed on the CAM2 model



The future

- Prepare ARM and other data sets for comparison with model output
- Publish methodology and analysis of 1997 and 2000 IOPs
- Establish additional collaboration with GCM parameterization developers
- Expand CAPT to other models (GFDL ...)
- Make the test bed available to the modeling community

Summary

- One of ARM's goals – improve climate models – use of CRM, SCM, etc.
- We are using a climate model in NWP mode using ERA-40 for initialization
- Compare with detailed observations (ARM site)
- First test with CAPE trigger
- Expand to other models