

# 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

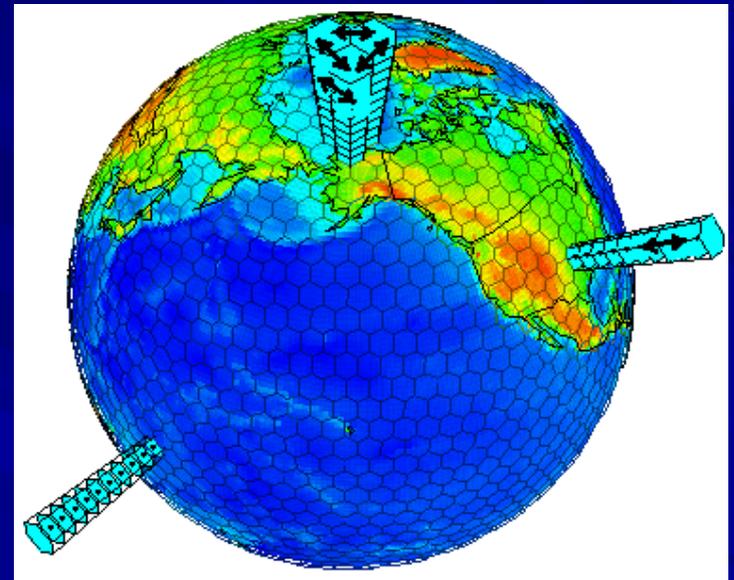
CAPT combines the strengths of two DOE programs with complementary missions:

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

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

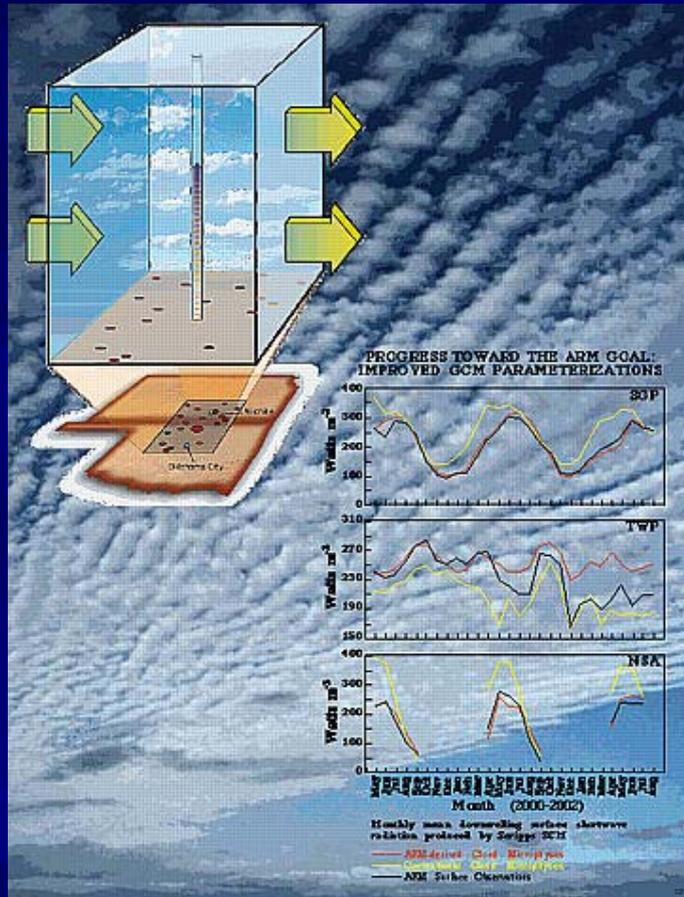
CAPT provides a flexible user environment for running GCMs in NWP 'forecast' mode:

- > 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

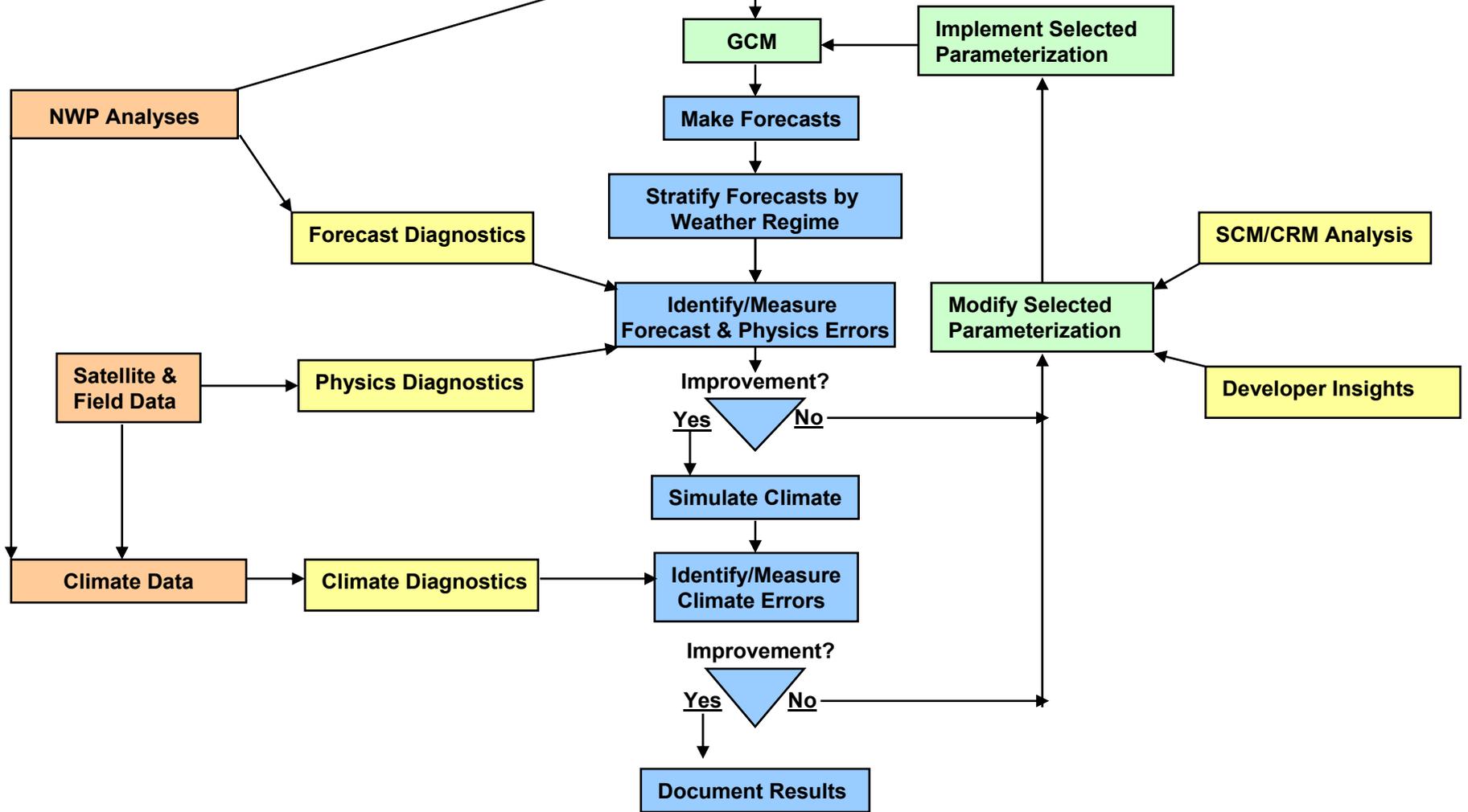
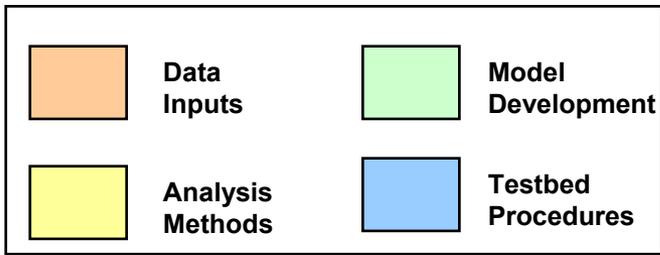
## ■ **SCMs/CRMs with specified large-scale forcing (*done in ARM*)**

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

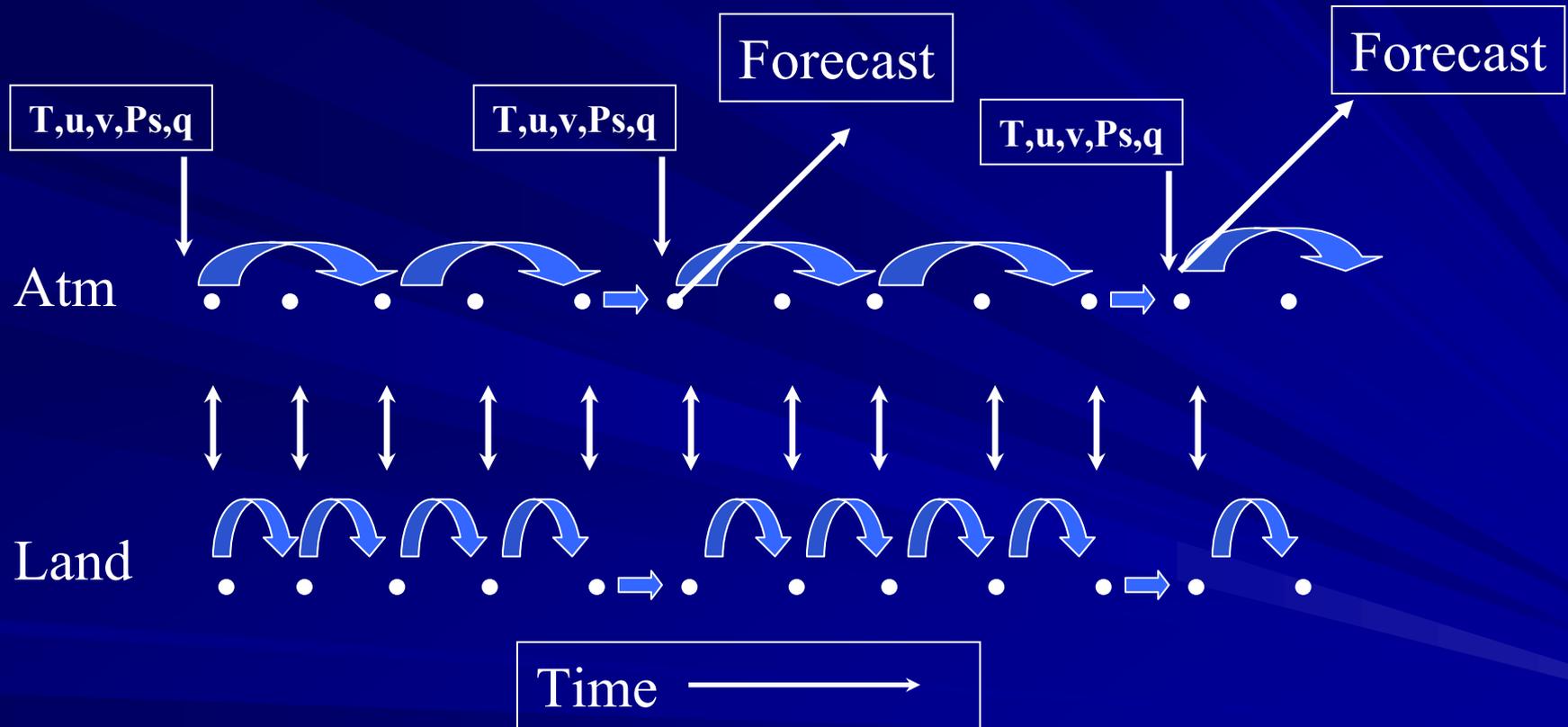
*But, running climate models in NWP mode (CAPT)*

- *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”



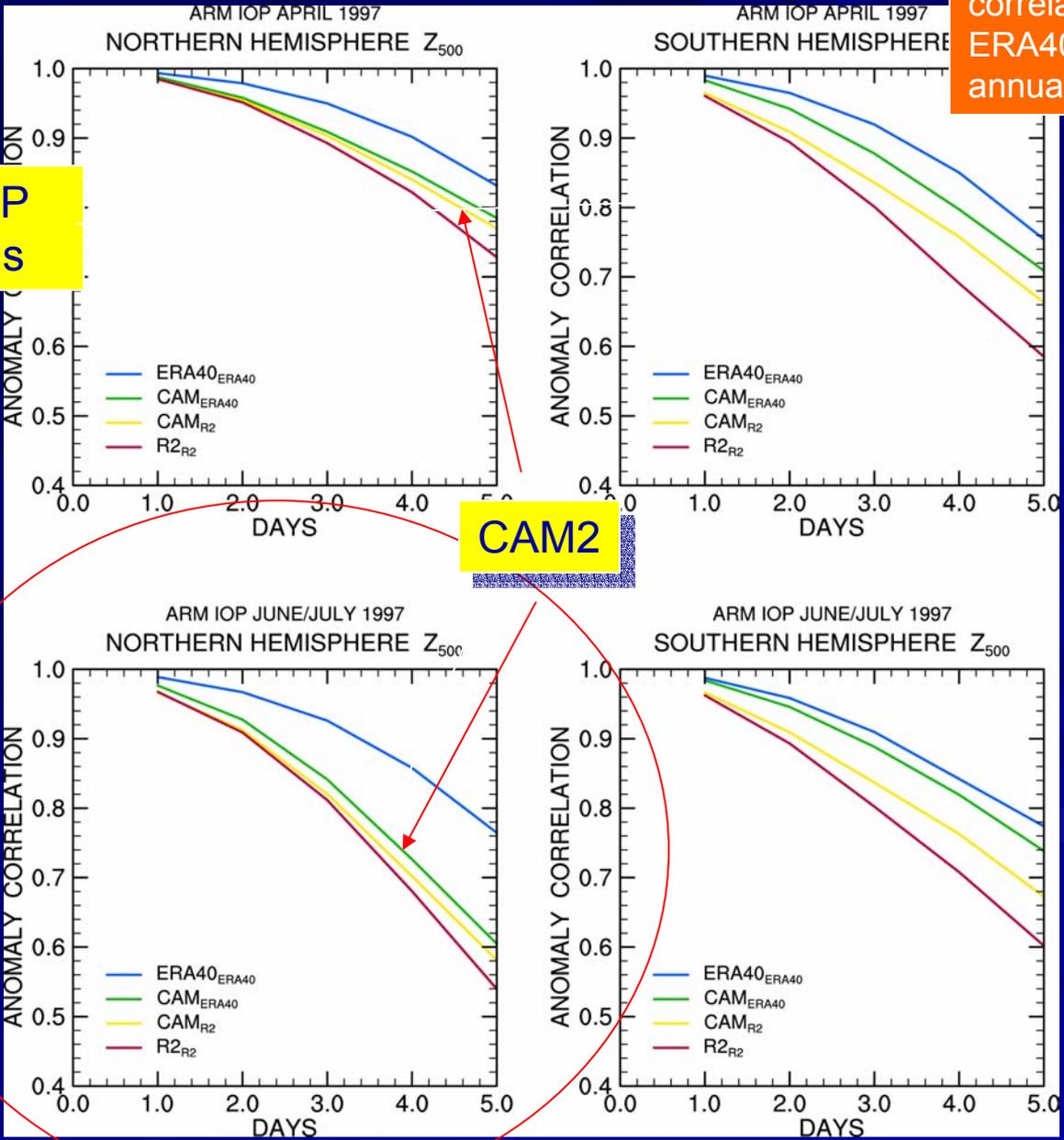
This approach is to restart the Land and initialize the Atmosphere

# 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

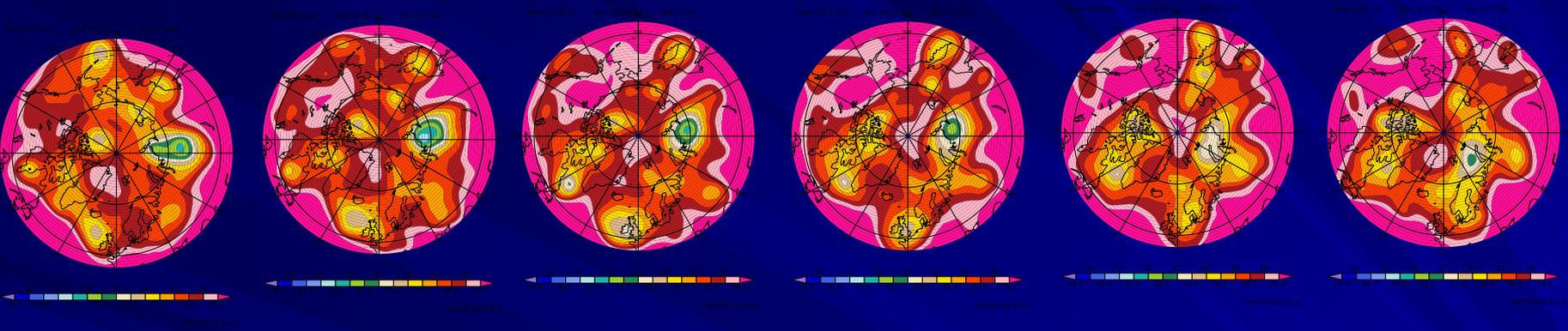
500mb height anomaly correlation taken from ERA40 30-year mean annual cycle

Note the NECP "R2" reanalysis



CAM2

# ERA40 500mb height (hectometers)

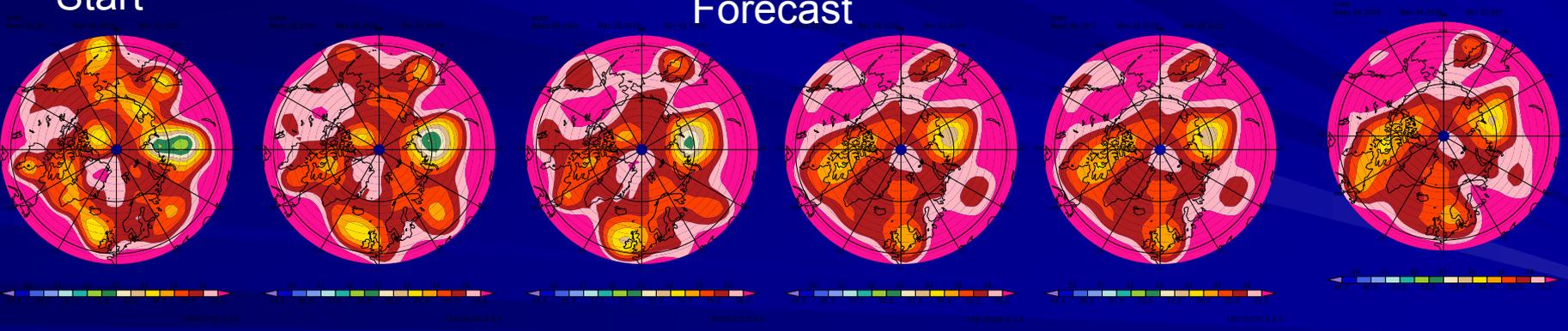


June 19, 1987 00Z    June 20    June 21    June 22    June 23    June 24

Start



Forecast



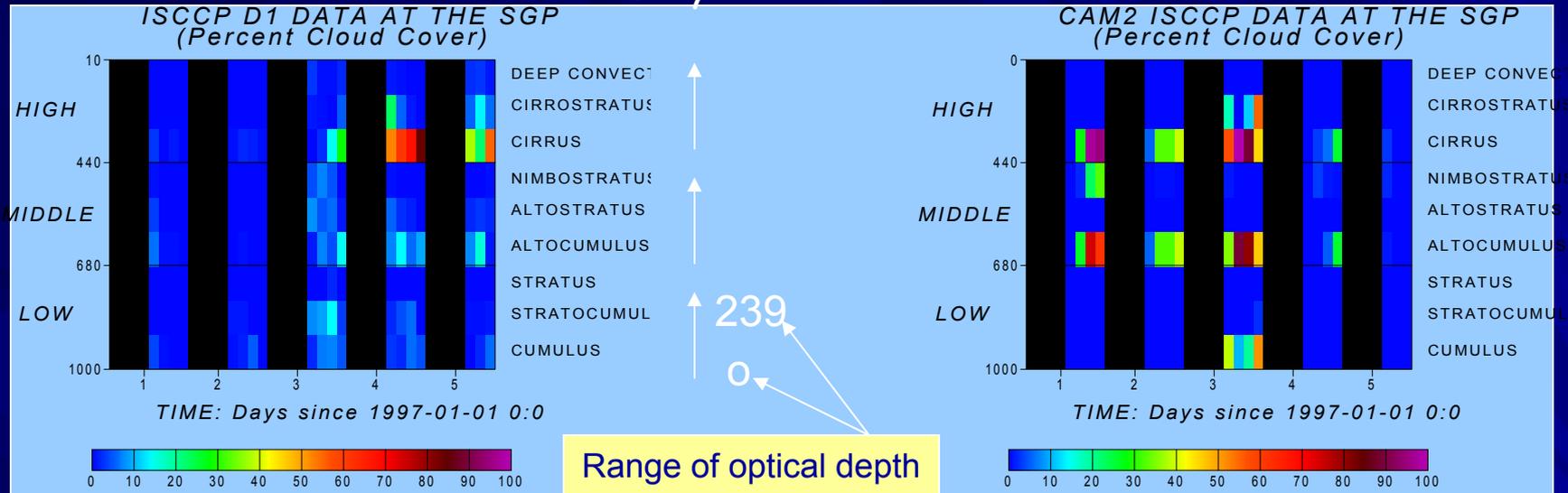
# CAM2 5-day forecast sampled at 00Z

# Evaluating clouds over the SGP and other sites

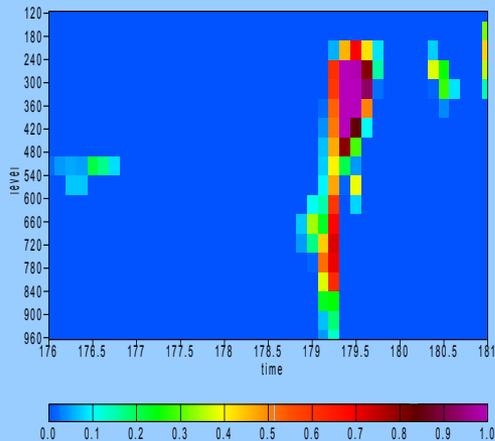
ISCCP D1 data

July 1-4 1997

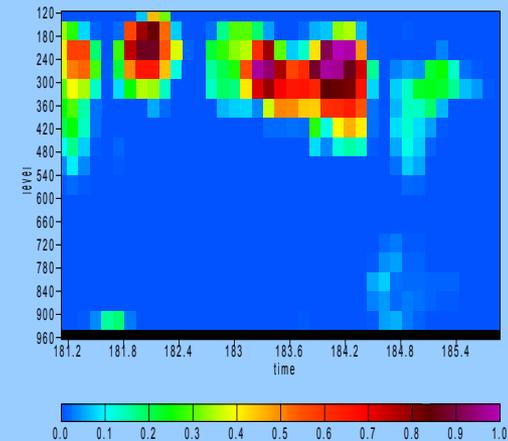
ISCCP simulator



ARM



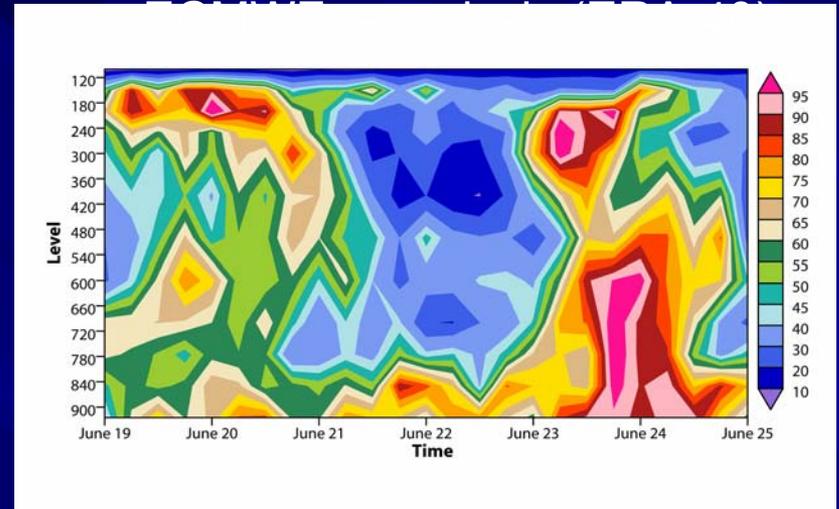
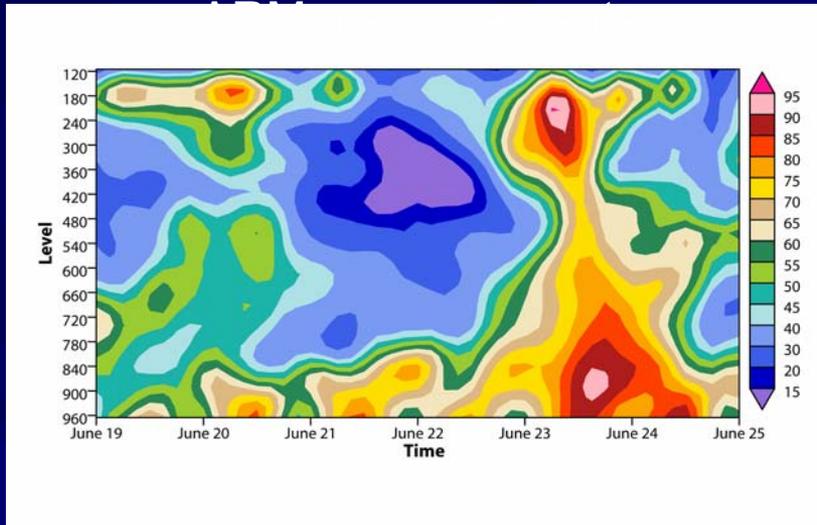
CAM2 CLOUDS



# An example of CAPT activities

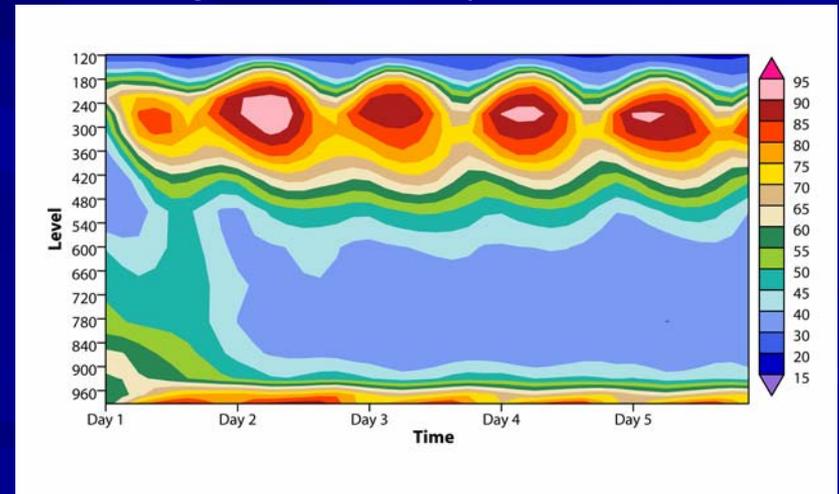
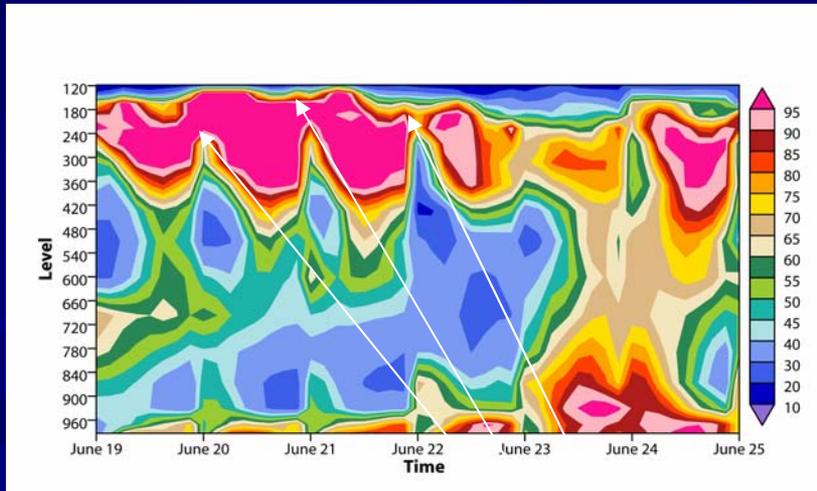
- Detailed evaluation of the CAM2 at the SGP during one of the IOPs shows a major problem

# ARM – Southern Great Plains Site Relative humidity



Series of CAM2 forecasts valid 0-24 hours

Average of all 5-day forecasts



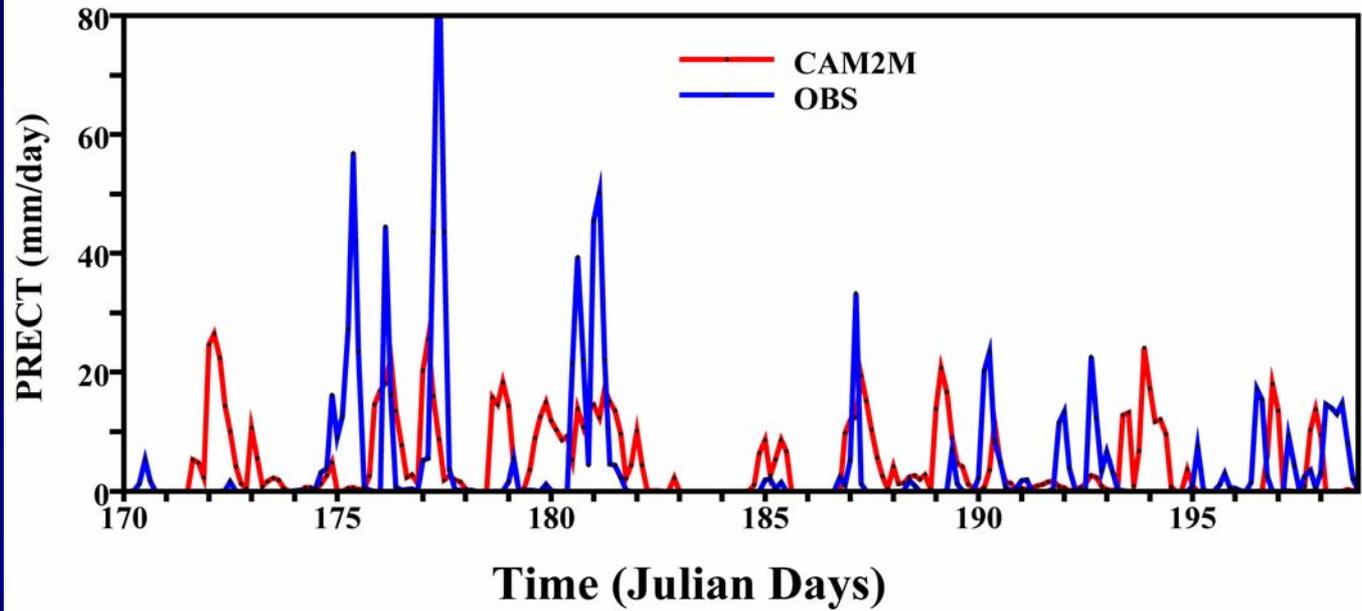
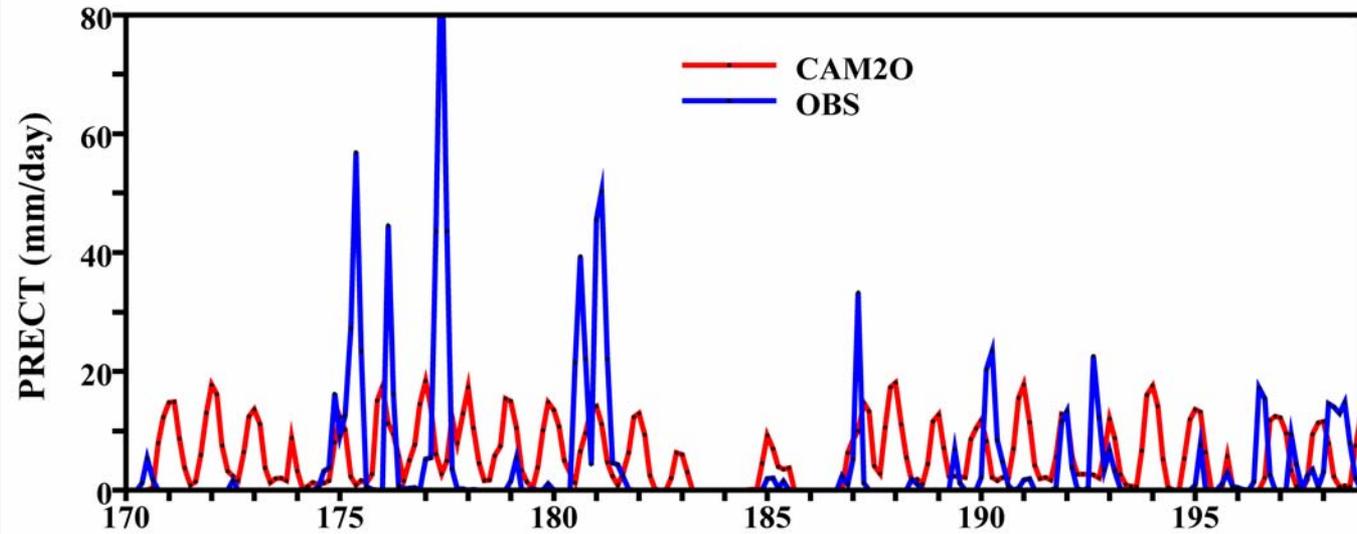
19-24 June, 1997

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,

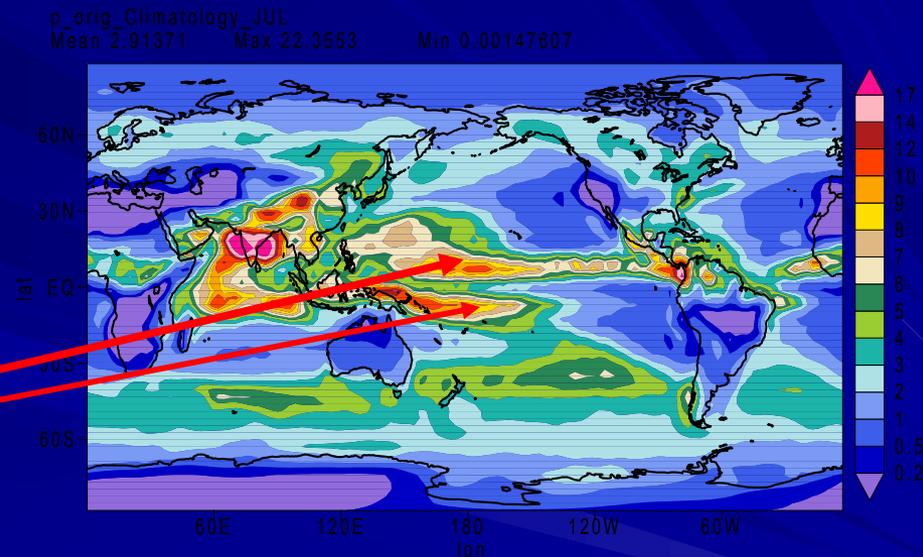
# Simulated and Observed Precipitation



Do improvements have effects  
beyond the SGP site?

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

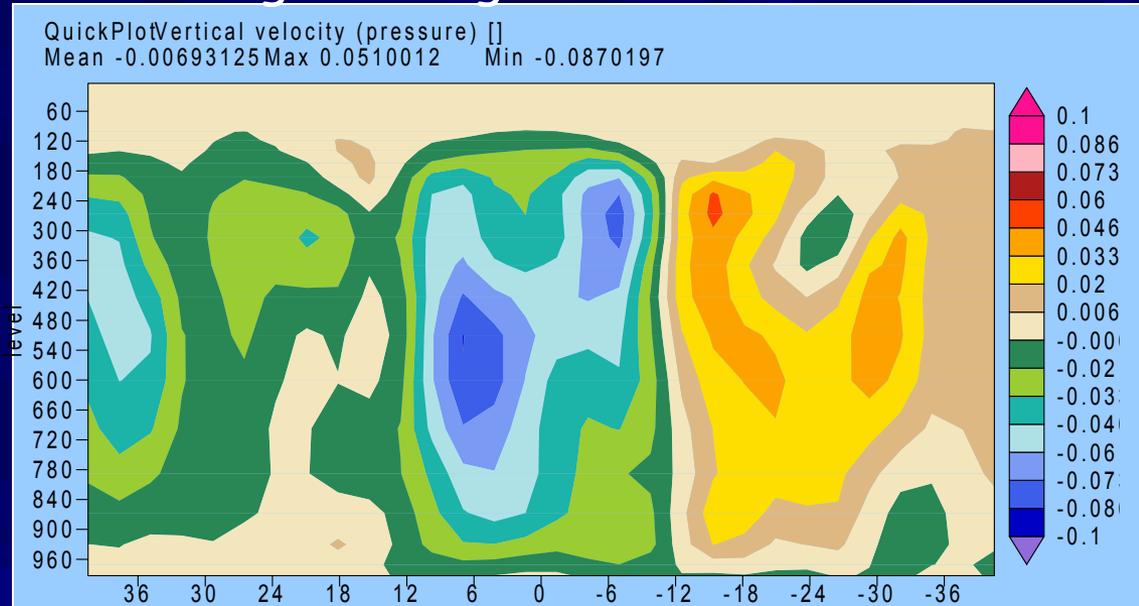
- One of the lingering problems with GCMs is the persistence of a double ITCZ in the Western Tropical Pacific.



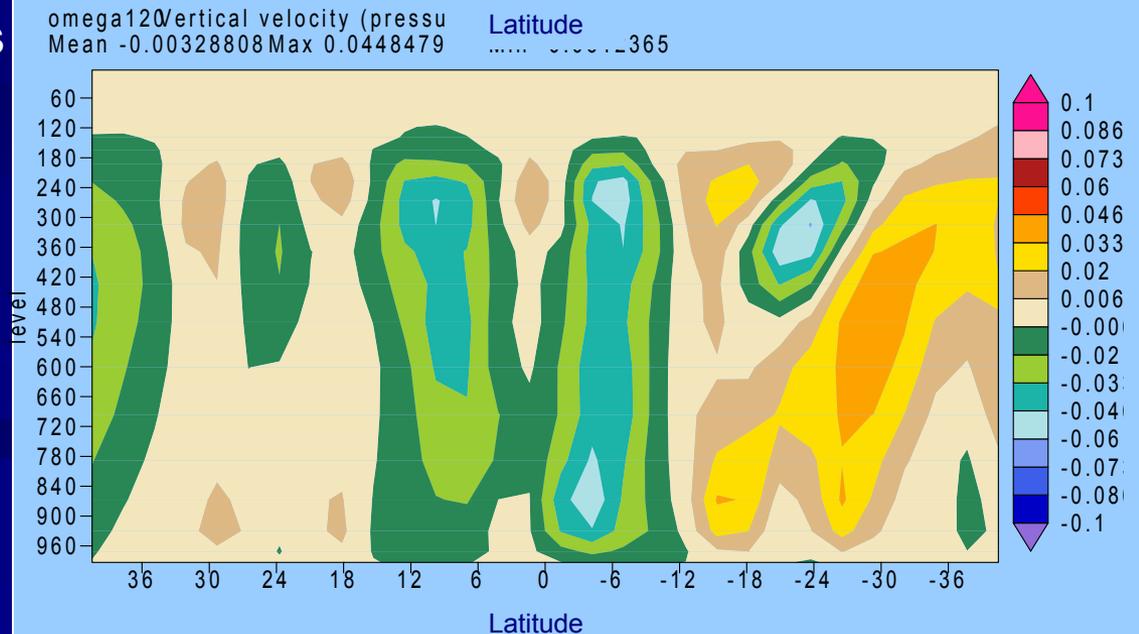
Appears to be more severe in coupled models

# Latitude-height Omega at the international dateline

24 hours

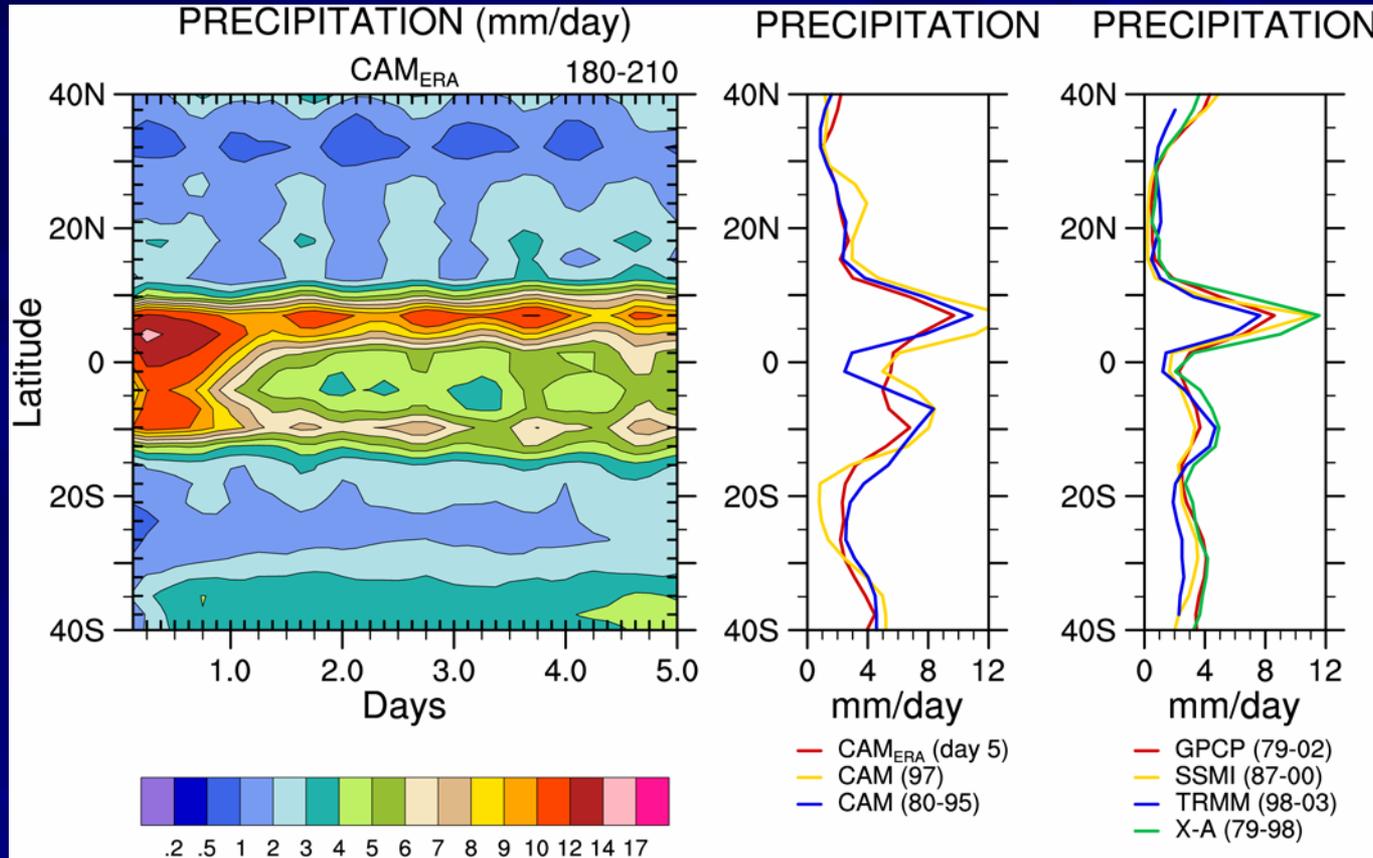


Ensemble averages



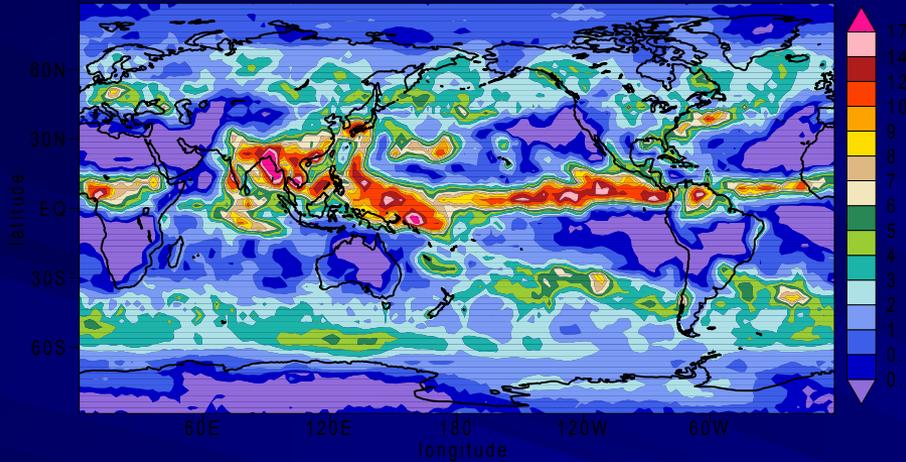
120 hours

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

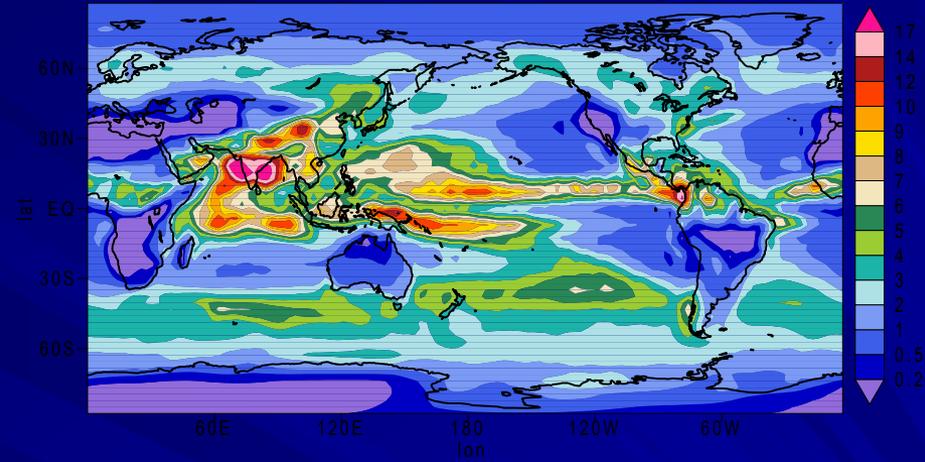


# The new Xie trigger function shows a major improvement in global precipitation

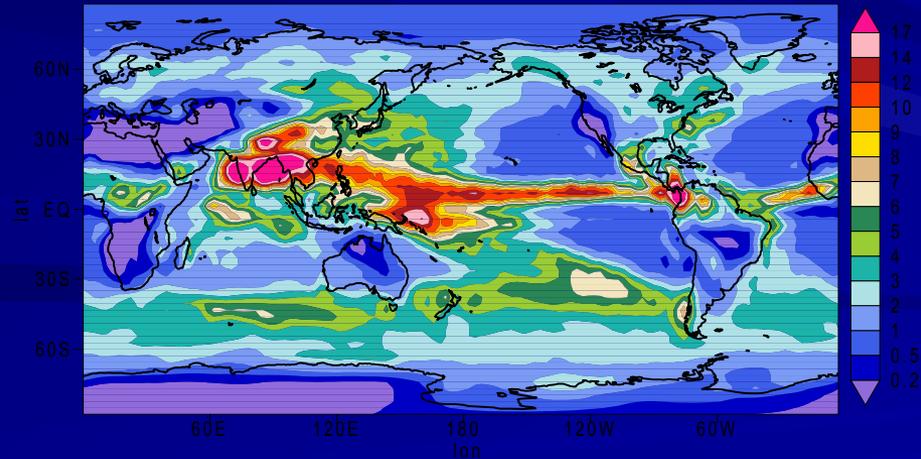
## GPCP (observed July 1997 Precipitation)



## 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

- Goal to 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 etc.
- Possible model improvement
  - CAPE trigger
- Expand to other models
  - GFDL ...