FORECASTING EFFORTS AT THE GLOBAL MODELING AND ASSIMILATION OFFICE (GMAO)

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Global Modeling and Assimilation Office
NASA Goddard Space Flight Center

APCC Member Working Group Meeting
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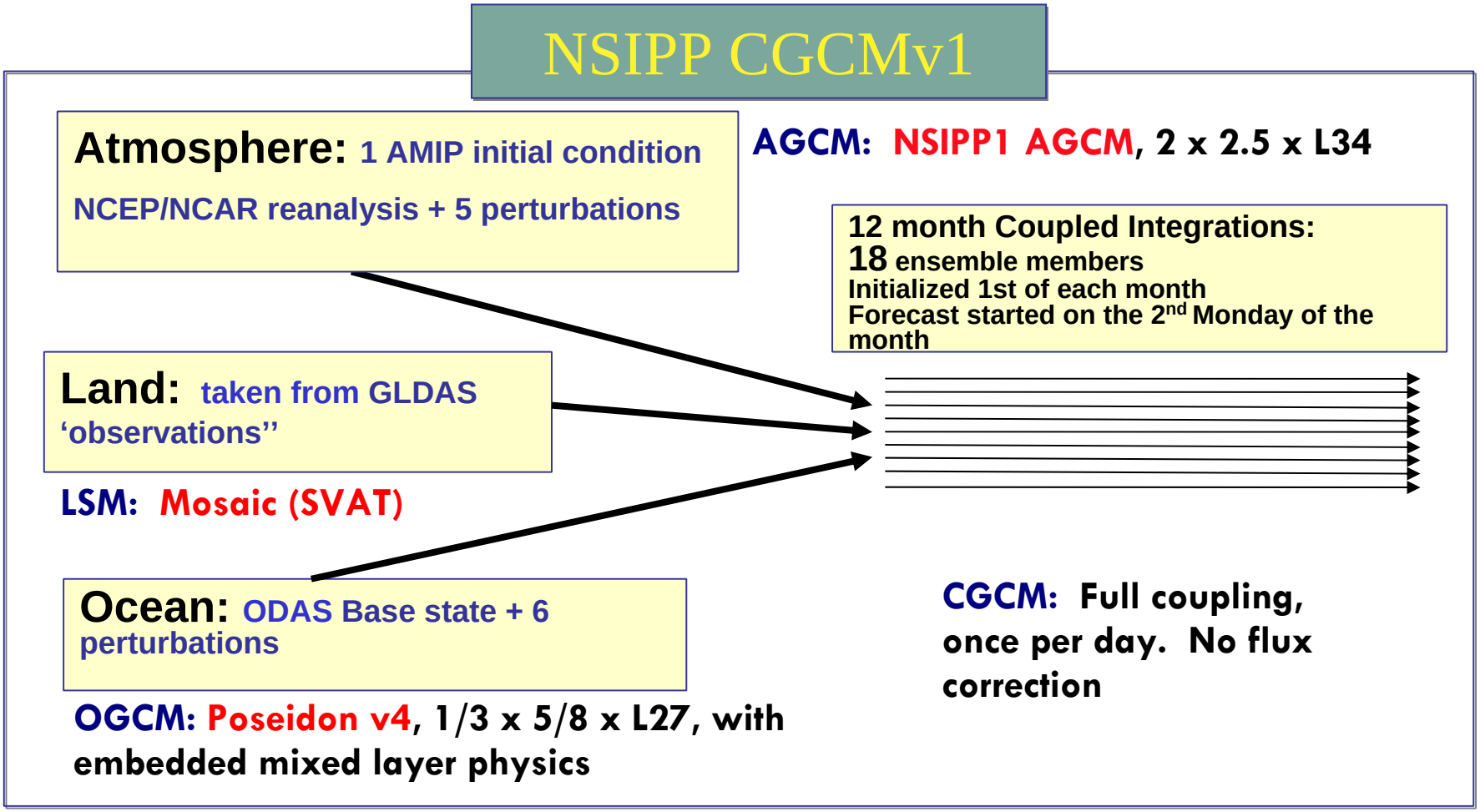
GMAO forecasts

- **Seasonal-to-Interannual prediction:** 12 month long forecasts with the coupled model. Primary emphasis is on ocean data assimilation.
- **Sub-seasonal prediction:** 3 month forecasts with the coupled model. Focus on ocean and land and atmosphere initializations.
- **High-resolution Weather prediction** (for the NASA's special missions): 5-day forecast with a 1/4-degree version of the AGCM. Focus on atmospheric data assimilation.

The current GMAO Seasonal Forecast System



ODAS: (Surface wind analysis from R. Atlas, Reynolds SST, Temperature profiles) Optimal Interpolation of *in situ* temperature profiles - daily, salinity adjustment (Troccoli & Haines)

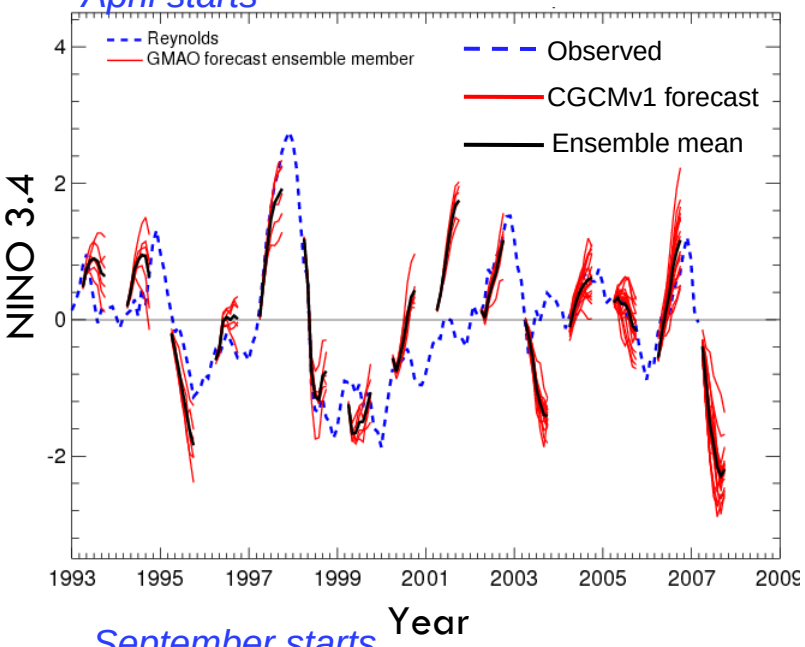
AMIP: AGCM run with observed SSTs (Reynolds)

GLDAS: Global Land Data Assimilation System

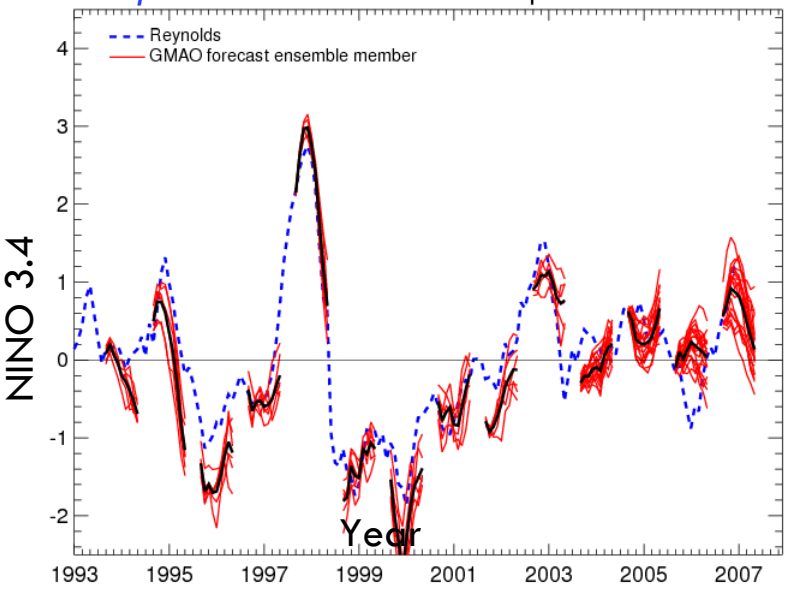
GMAO CGCMv1 forecast skill for Nino3.4 SST anomalies

9-month ensemble forecasts

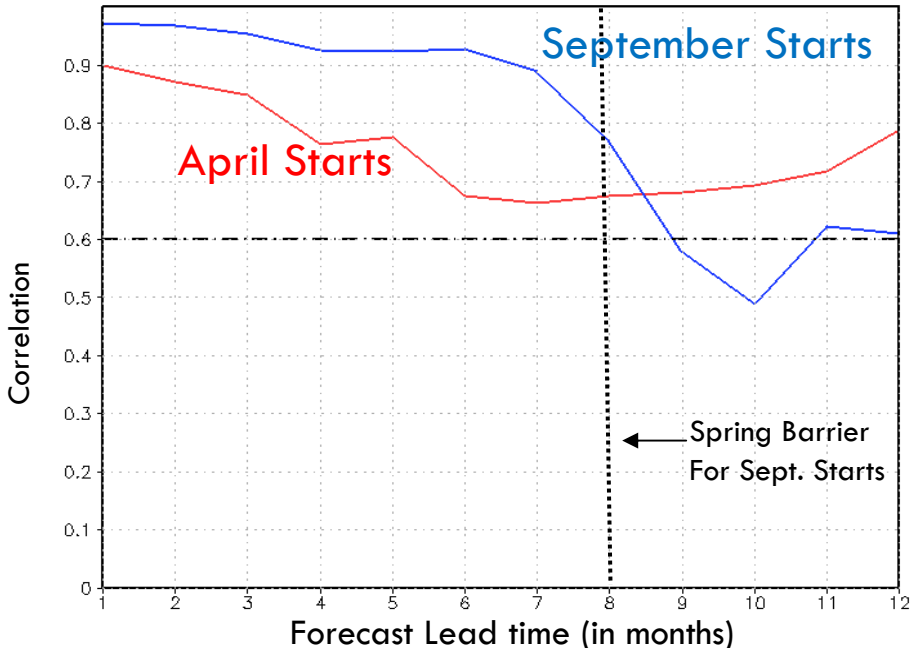
April starts

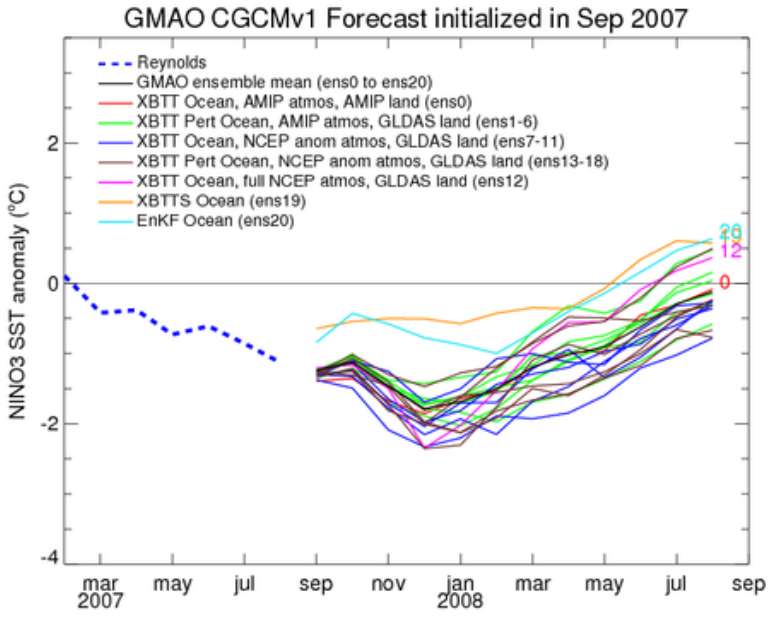


September starts



Nino3.4 Anomaly Correlation





Near-term plans

(1) Forecast System

- Replace with our next generation coupled model (GEOS-5)
- An ensemble Kalman Filter ODAS
- GEOS-5 atmospheric data assimilation system

(2) Coupled Hindcasts with GEOS-5

- January 1981 – present (focus on seasonal)

  12-month, 5-member ensemble hindcasts, starting on the 1st, 11th,and 21st of the month (3 times a month)

- January 1998 – present (focus on subseasonal)

  90-day, 5-member ensemble hindcasts, started on the 6th, 16th, and 26th of each month (6 times a month from 1998 onwards

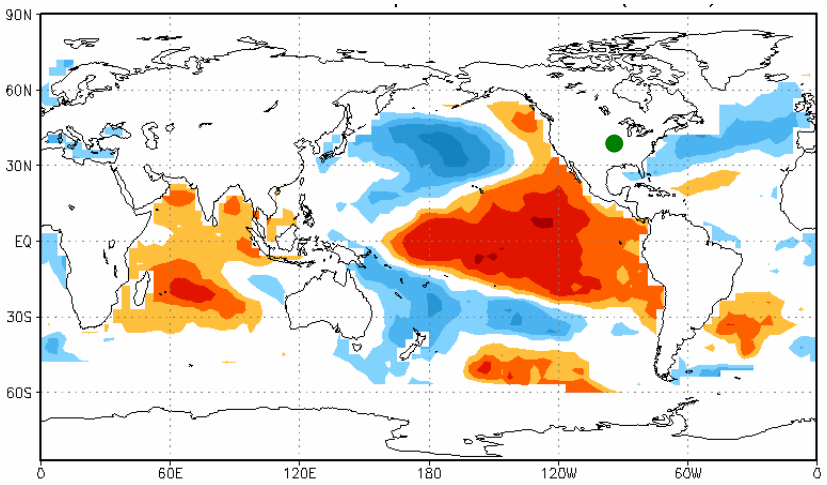
On-going Research

Soil moisture and long-term Droughts

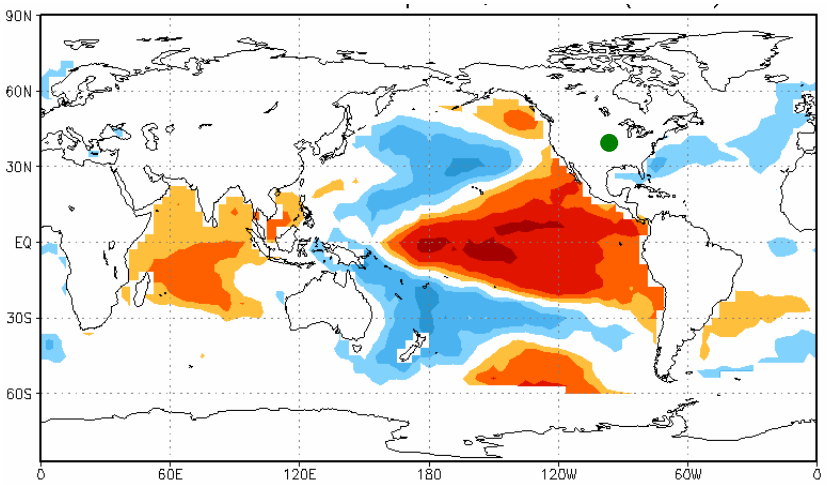
- Experiments to address issues of model dependence on the response to SSTs (and the role of soil moisture),
- To look in more detail at the physical mechanisms linking the SST changes to drought

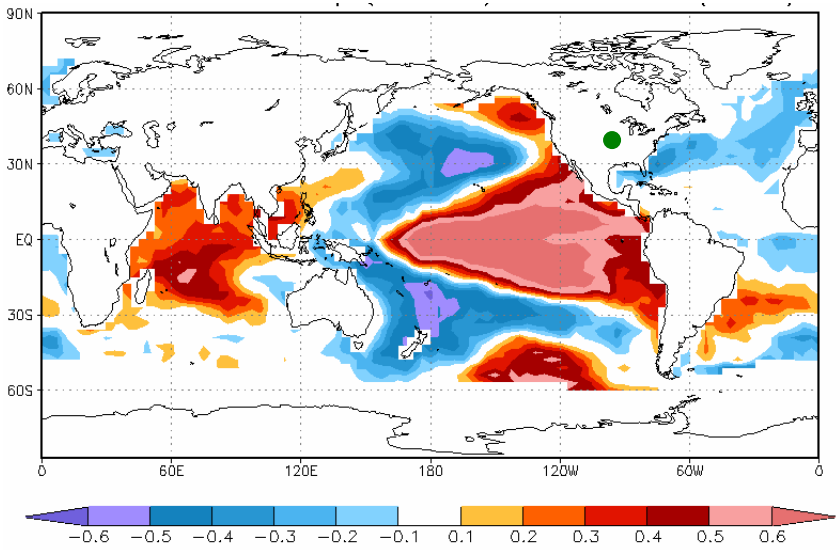
Annual Mean Great Plains Precipitation Correlated with SST (1901-2004)

Observations



Model
(individual ens. Members)





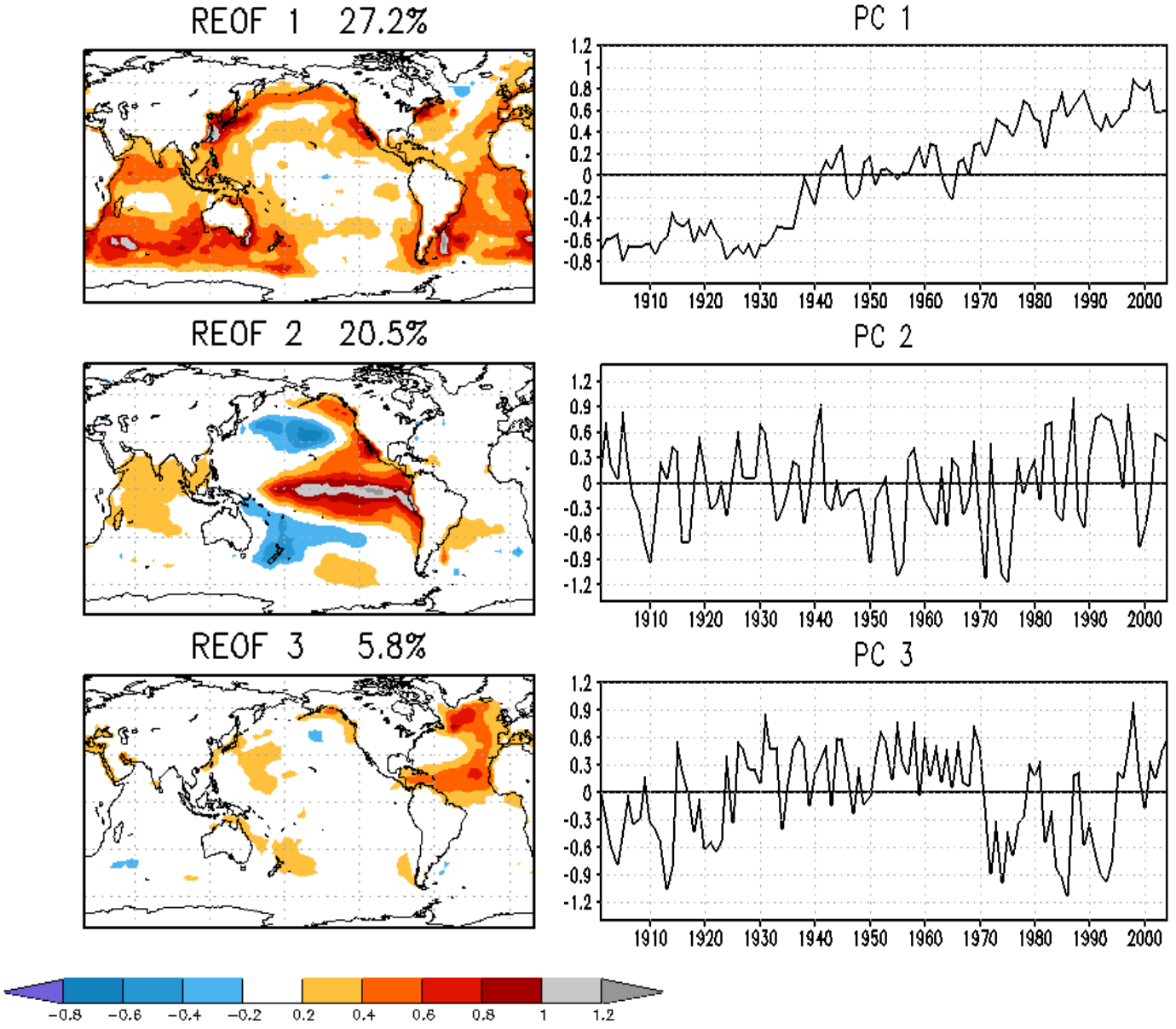
Model (correlation with ensemble Mean)

Leading EOFs and Time series (annual mean SST - 1901-2004)

Linear Trend Pattern (LT)

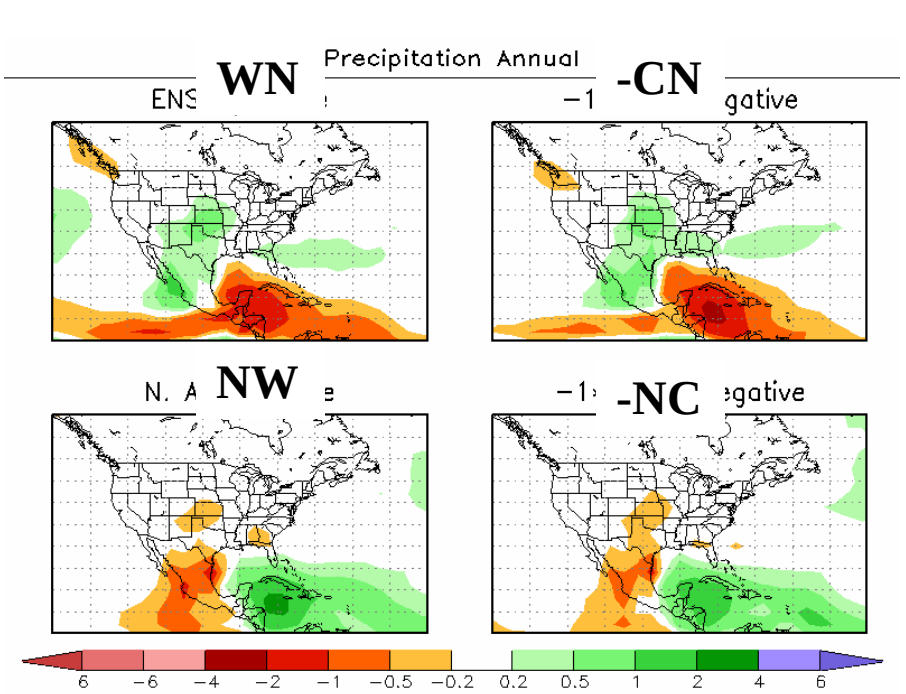
Pacific Pattern (Pac)

Atlantic Pattern (Atl)

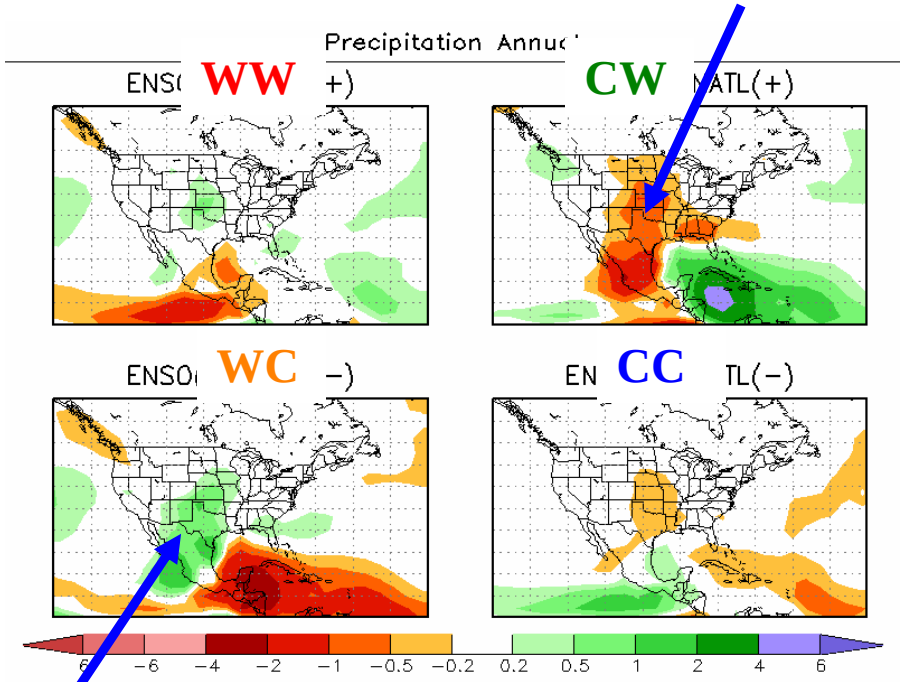


Annual Mean Precipitation Responses

Major drought conditions



Responses to individual EOFs



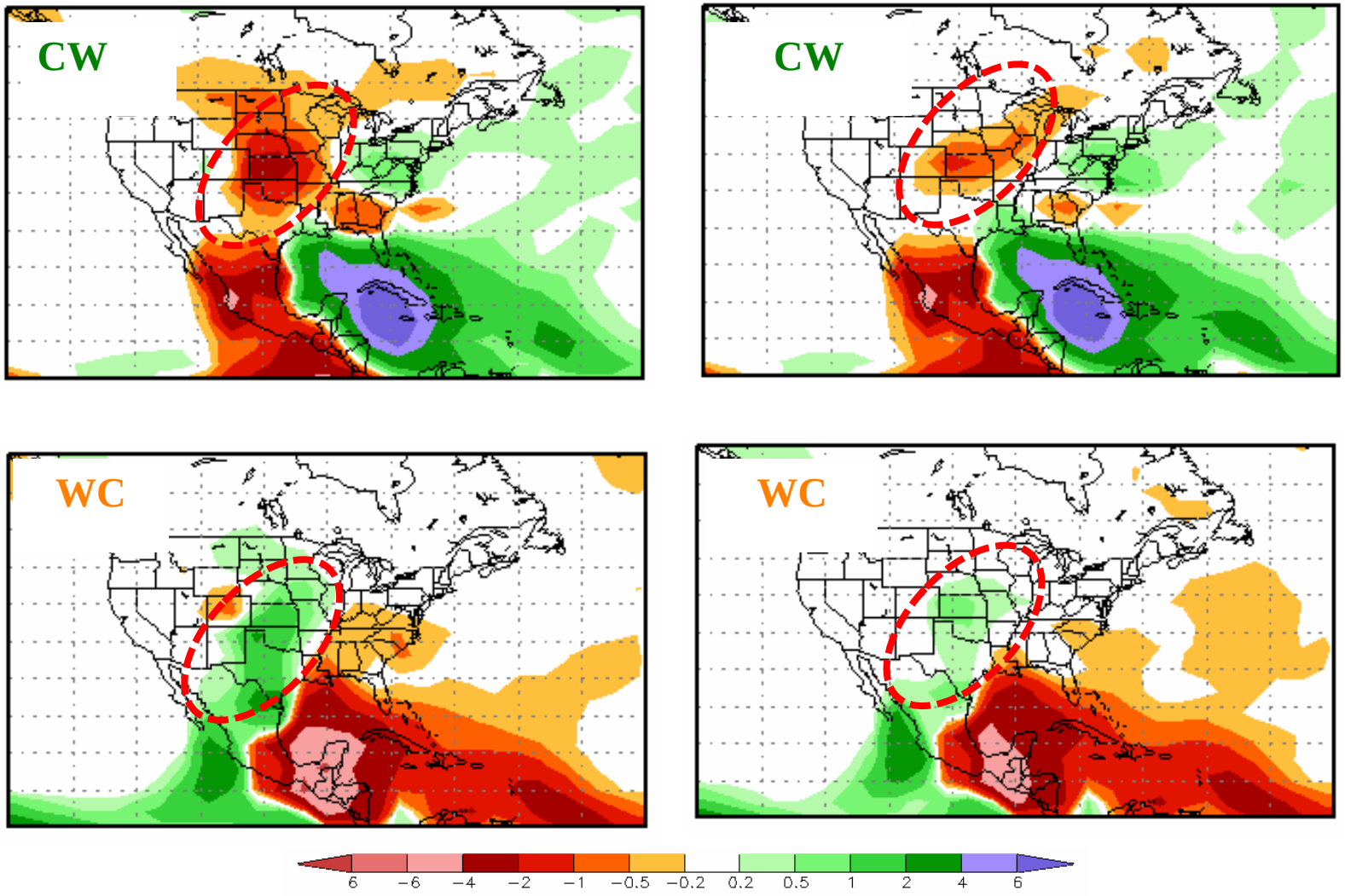
Responses to combined EOFs

Pluvial conditions

Impact of Soil Moisture Feedbacks on JJA Precipitation

Interactive soil moisture

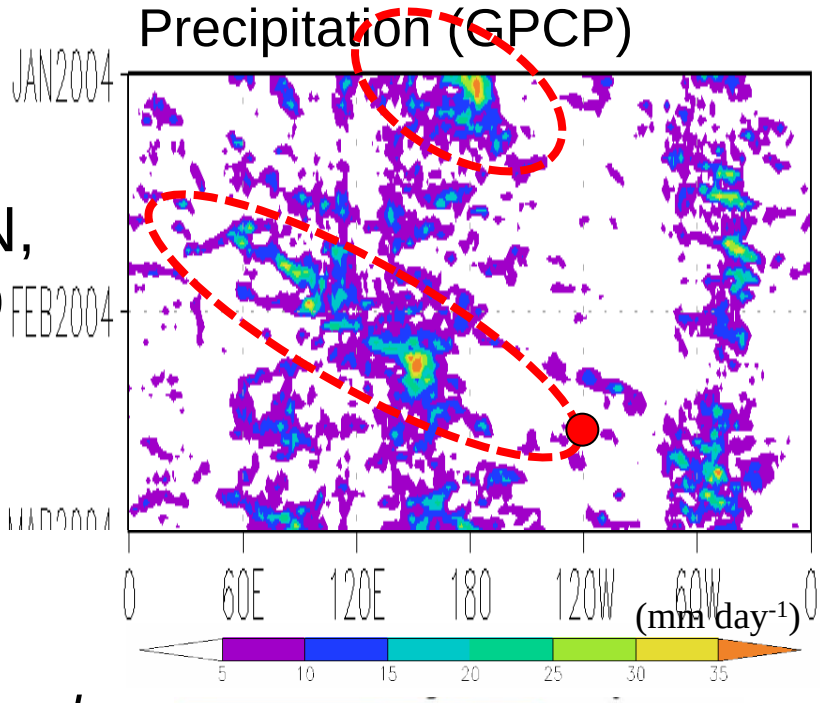
No soil moisture feedbacks

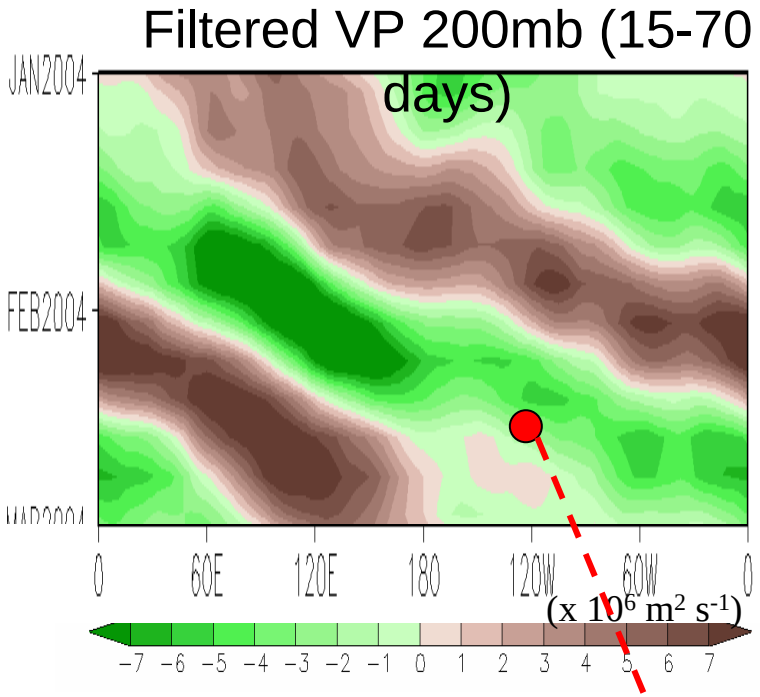


Predictions in sub-seasonal time scale

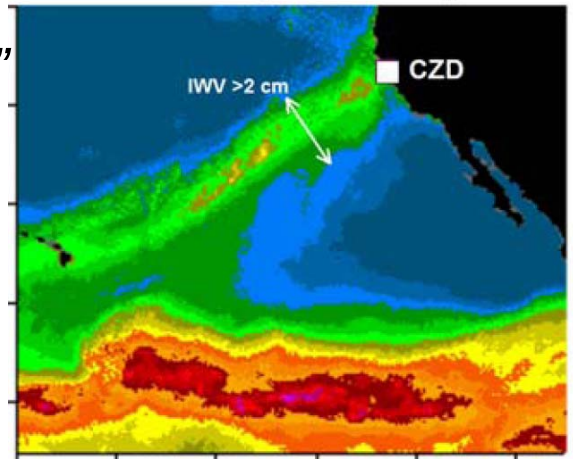
-Assessing the impact of the tropics

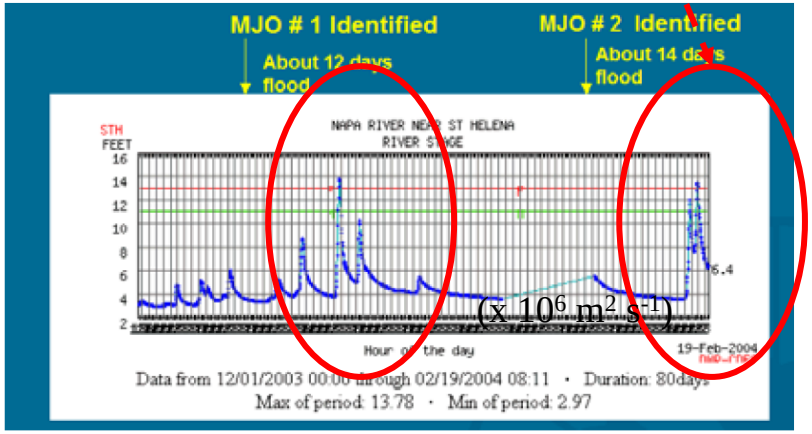
MJO (10S-10N, Jan-Feb 2004)





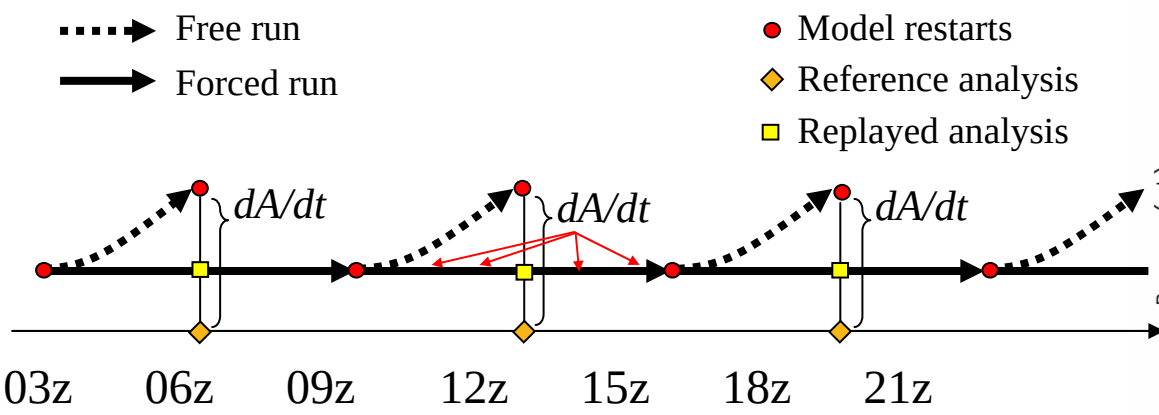
"Pineapple Express storms" (Feb 16, 2004)

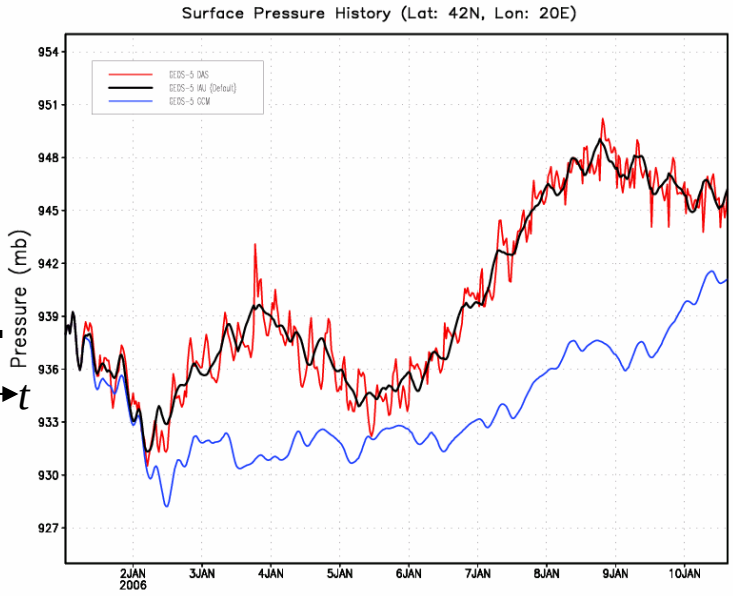


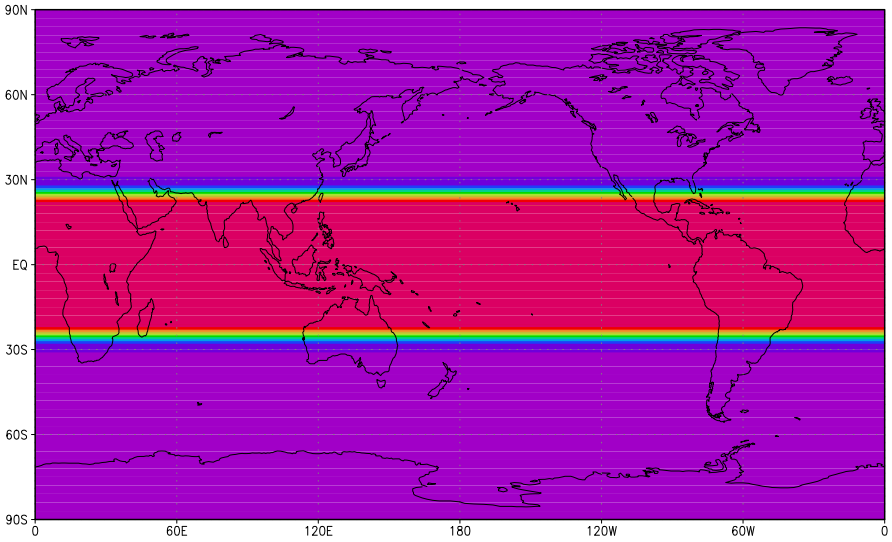


Data Assimilation Technique

IAU (Incremental Analysis Update)

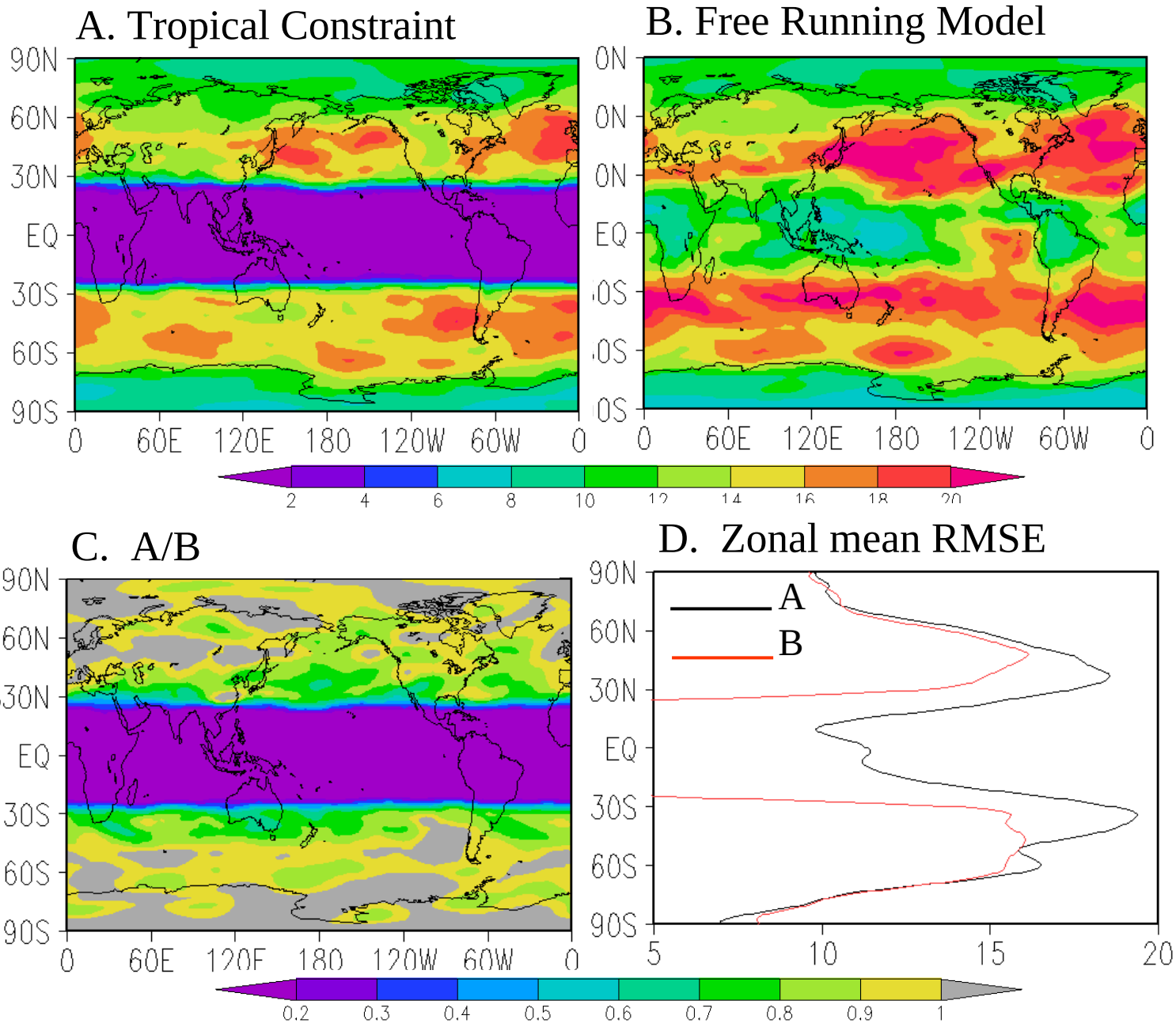






- Develop an idealized approach by constraining the tropics (30S-30N) to a reference analysis
- Assess the tropical influences on the extra-tropics

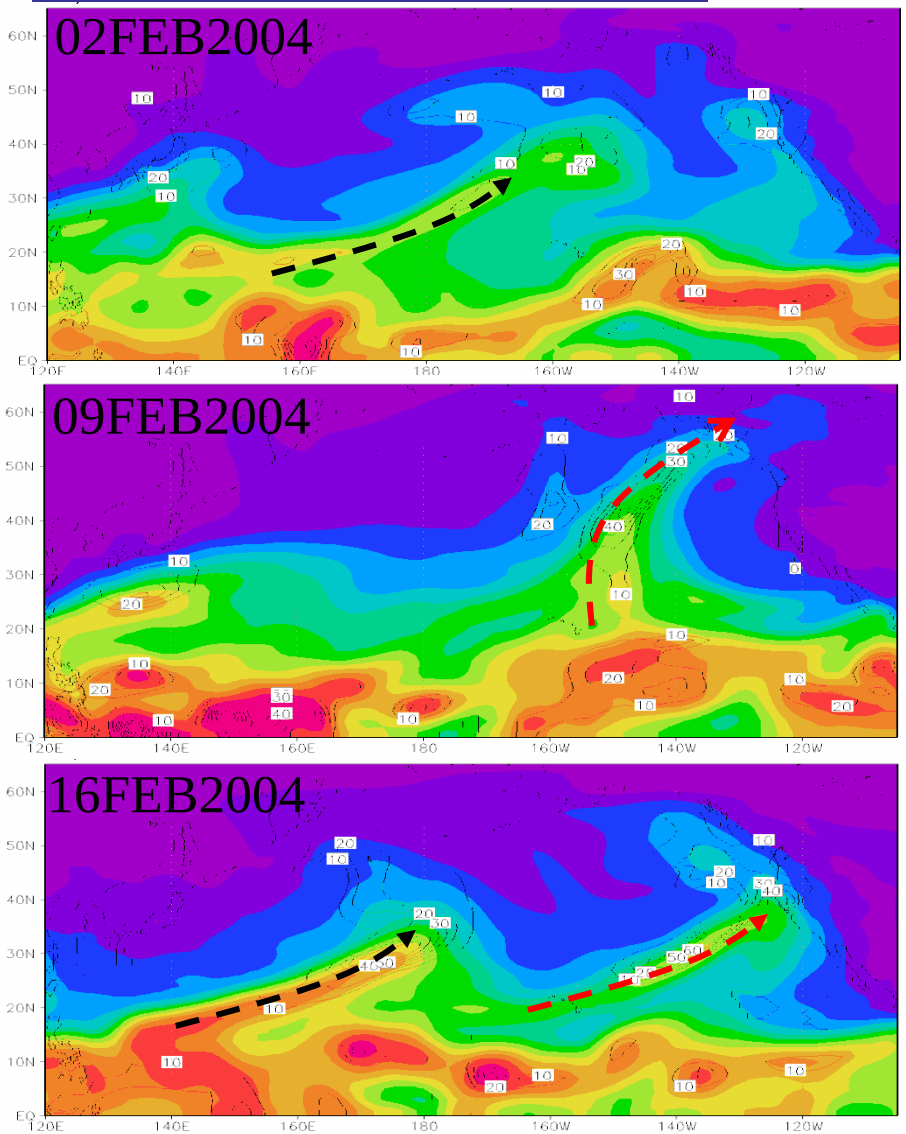
Root-Mean-Squared Error of 200mb u-wind



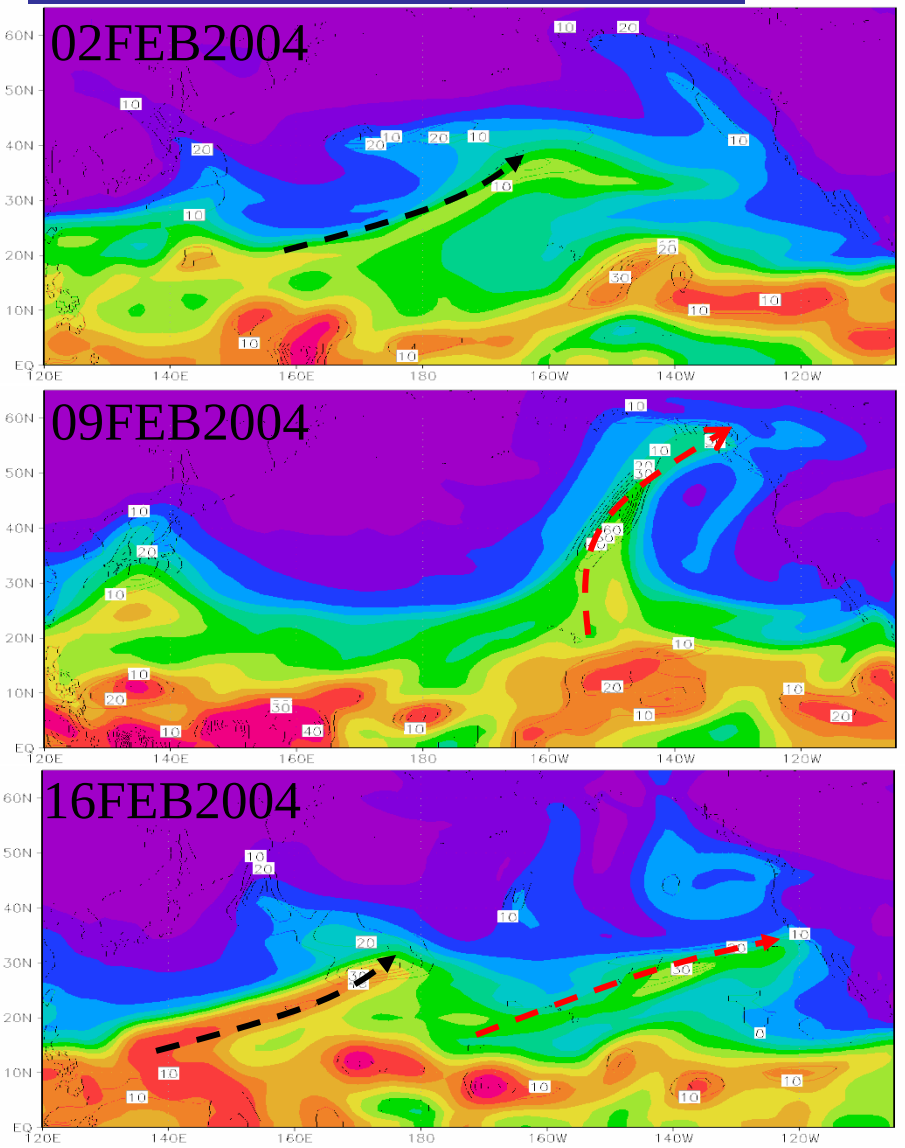
Decreased RMS Error in the extra-tropics

Temporal evolution of total precipitable water

Global Constraint Run

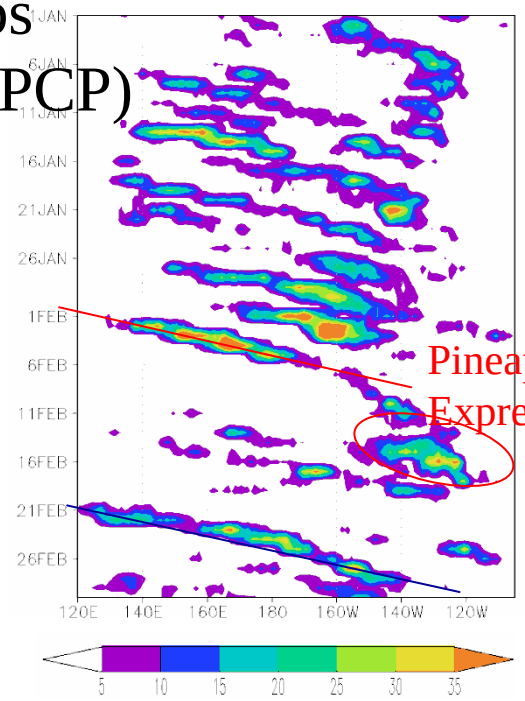


Tropical Constraint Run



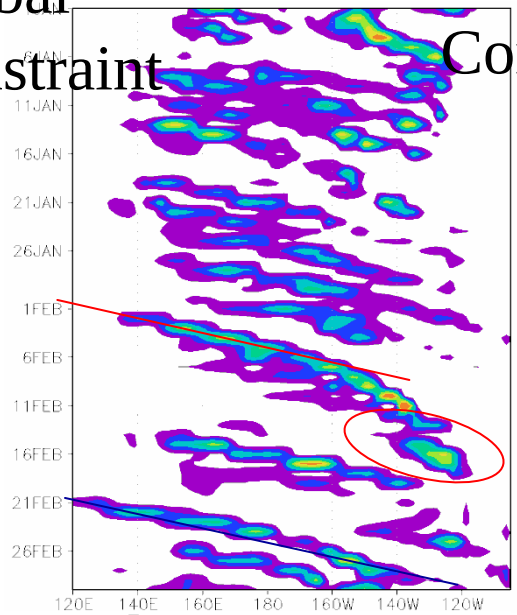
Hovmuller Precipitation (35- 45N)

Obs (GPCP)

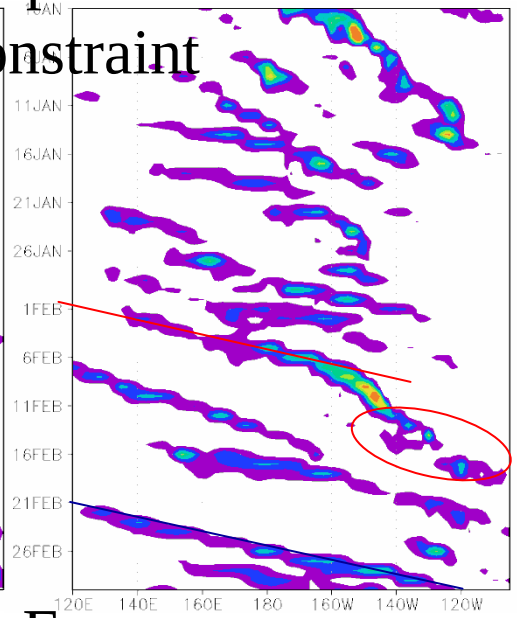


Pineapple Express

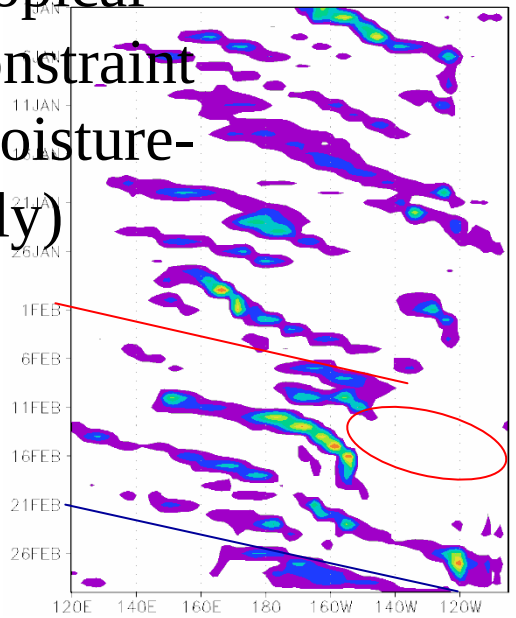
Global Constraint



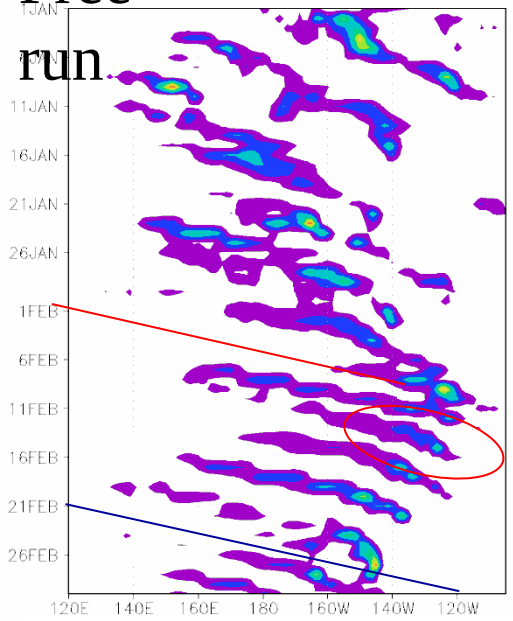
Tropical Constraint



Tropical Constraint (moisture-only)



Free run

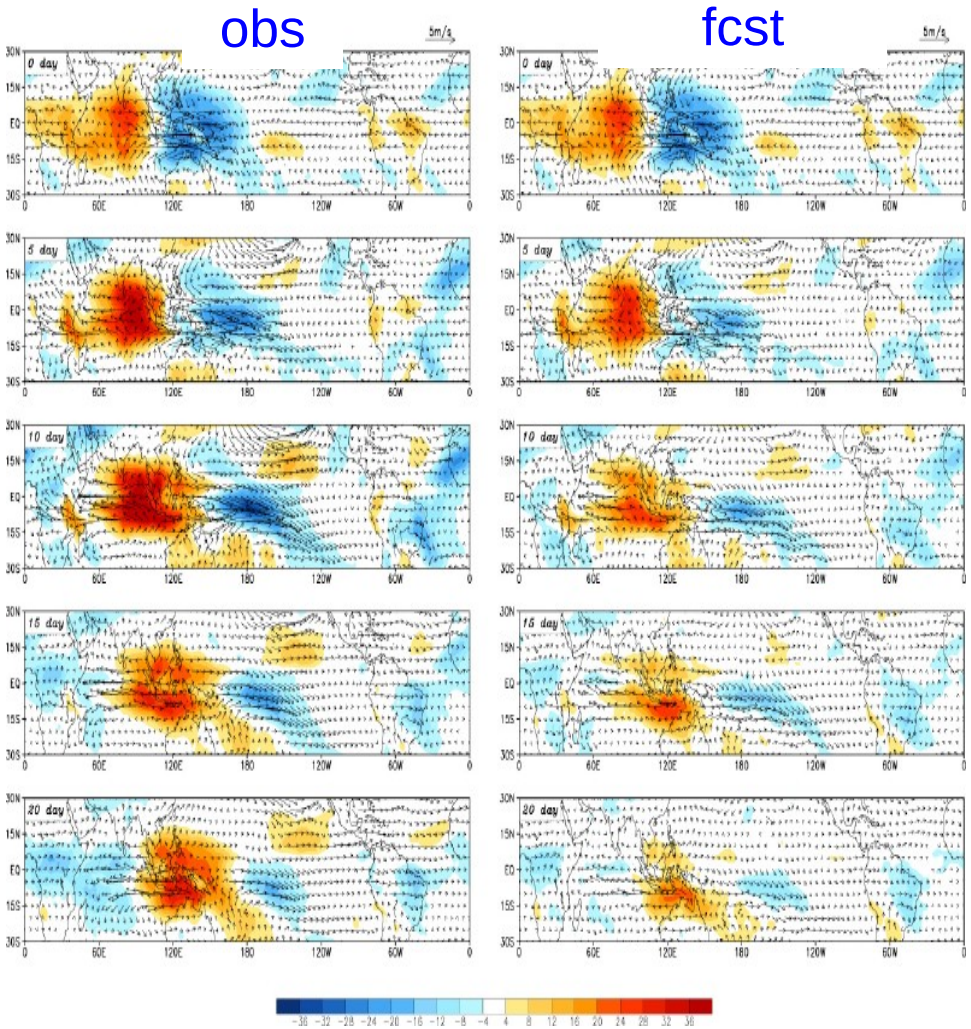


Some of the extra-tropical weather systems apparently associated with the tropical MJO are resolved (Pineapple Express Storms in California)

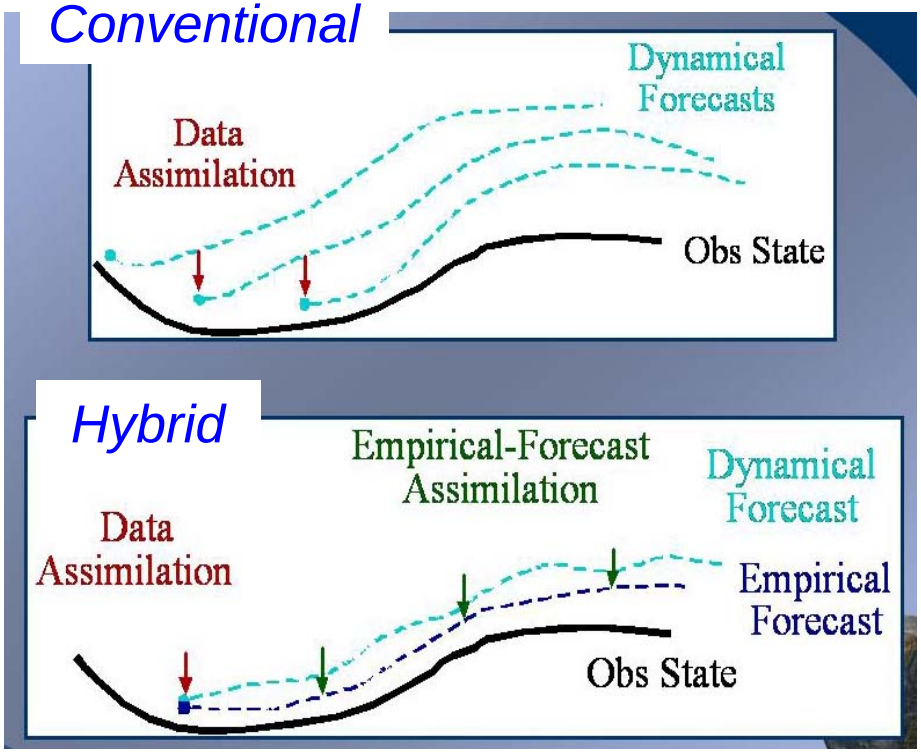
Hybrid Forecast (Empirical+Dynamical)

(With Waliser, Jiang, JPL)

- Develop an empirical method for predicting the 3-dim structure of the MJO
- This technique will be applied to the hybrid forecast (empirical+dynamical)



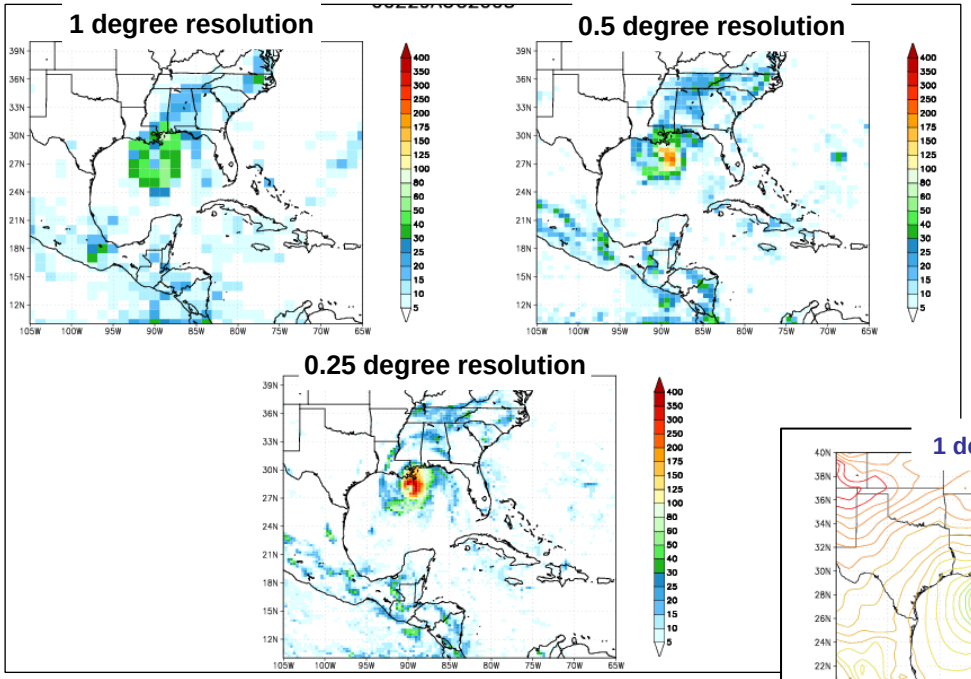
Hybrid Forecast Strategy



20-day forecast of OLR and 850mb wind

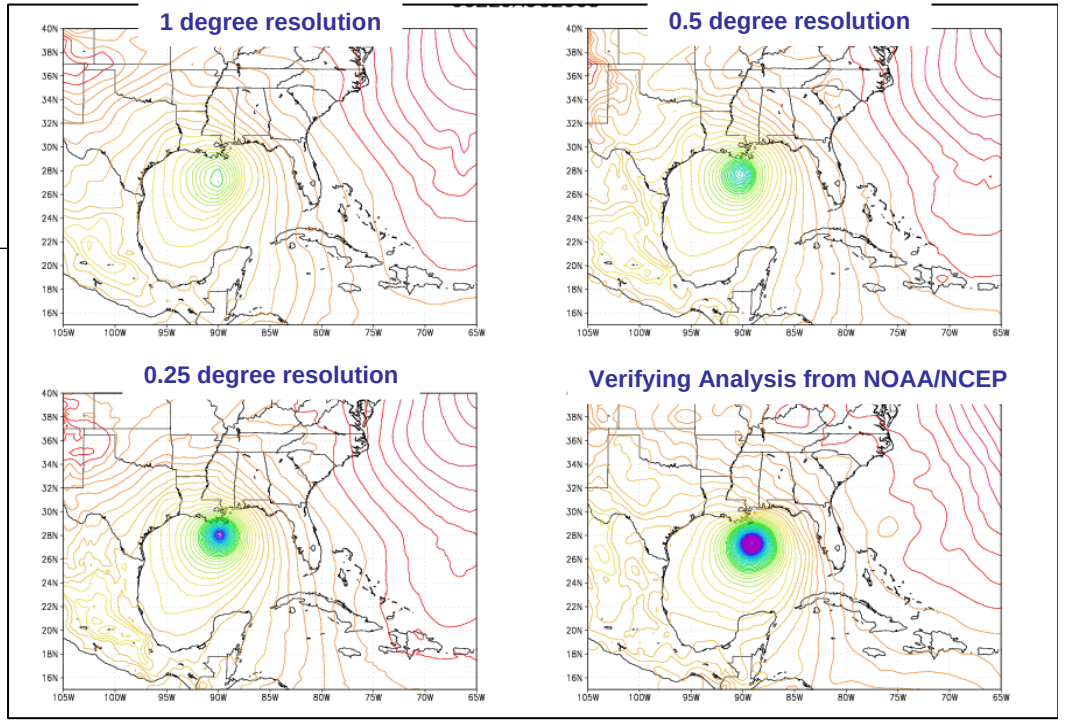
Tropical Storms/Hurricanes Simulations

Precipitation Rate



GEOS5 & Katrina: The benefits of improved horizontal resolution

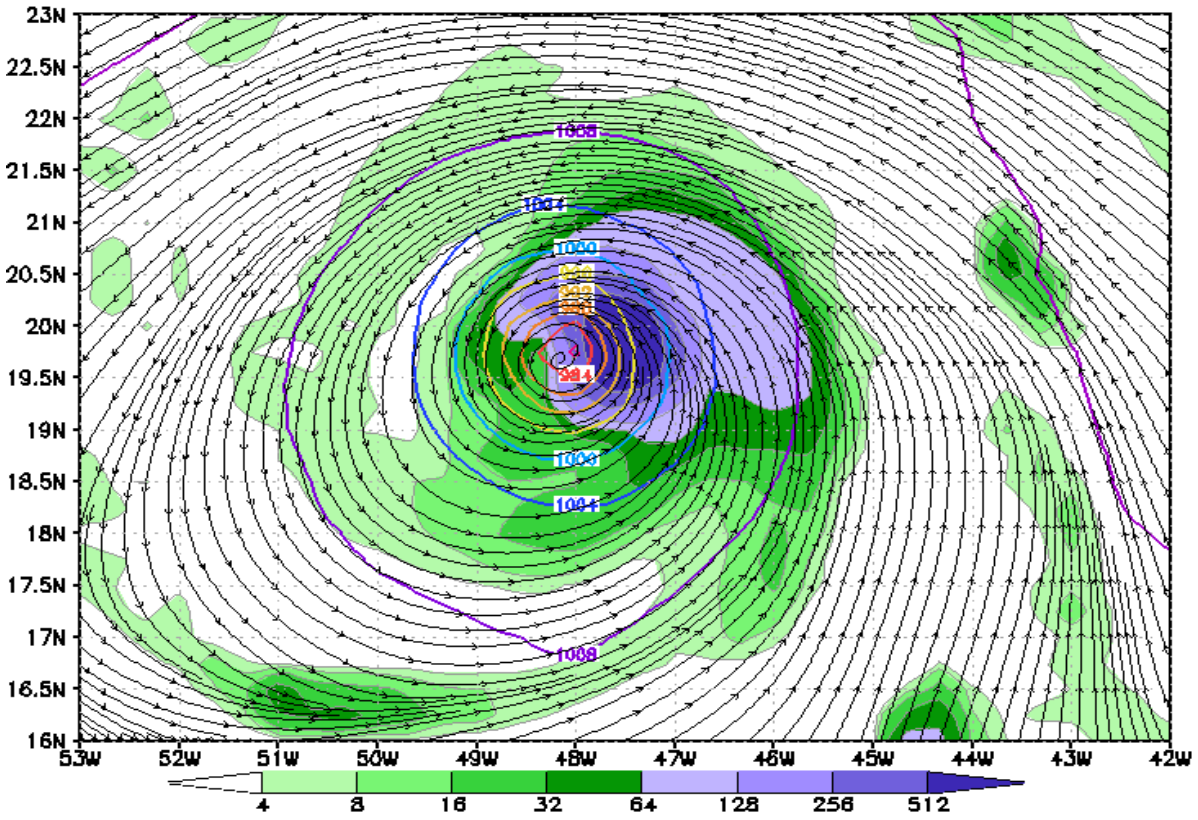
Sea Level Pressure



Improving the simulation of hurricanes on a global scale will improve our ability to understand the impacts of interannual variability and climate change on hurricanes

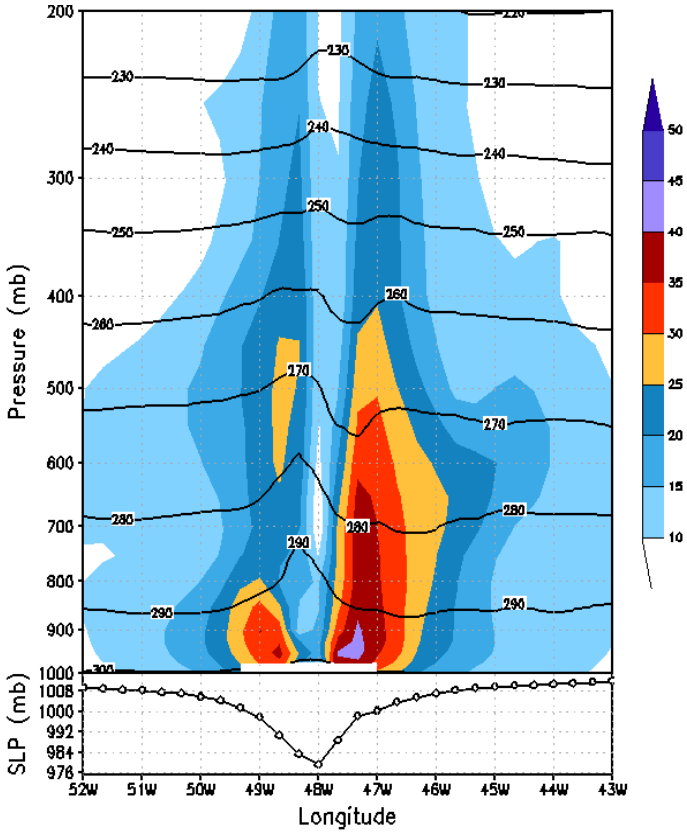
Model Generated Hurricanes in Free Run

Horizontal structure



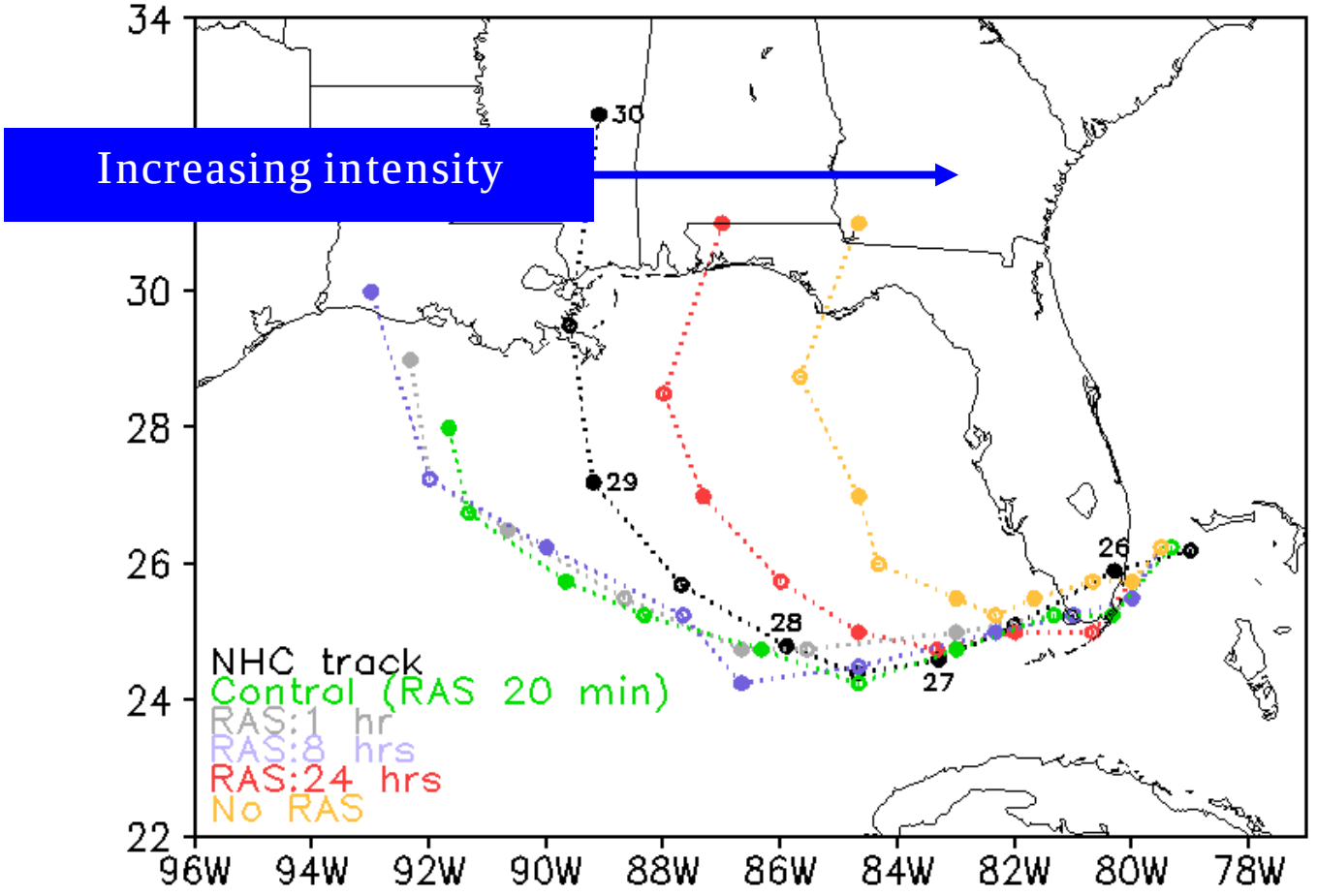
Precipitation (shaded), 925mb winds (streamline), and sea-level pressure (contour)

Vertical structure

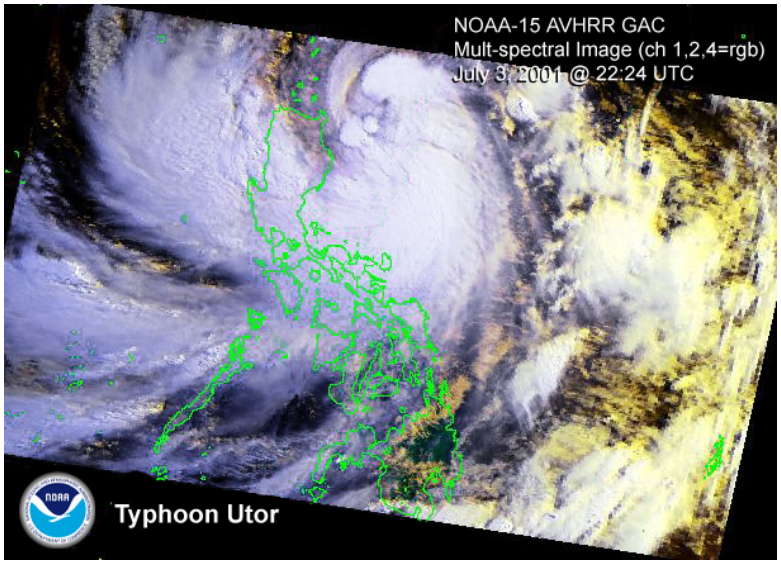


Wind speed (shaded), temperature (contour), and SLP (bottom)

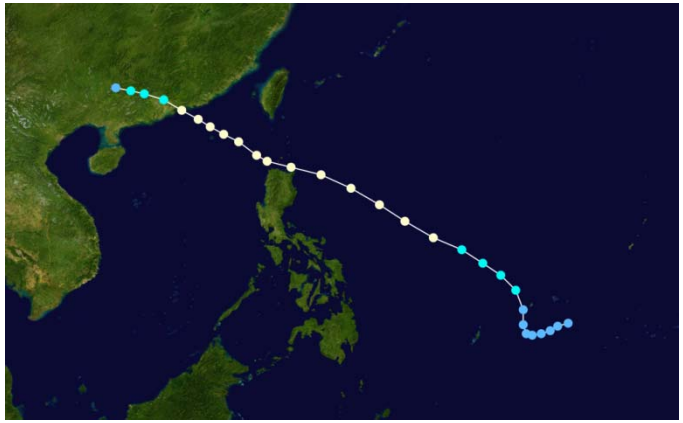
Sensitivity of Hurricane Katrina Tracks to Convection Scheme (RAS Time Scale, 1/4 deg runs with GEOS-5 AGCM)

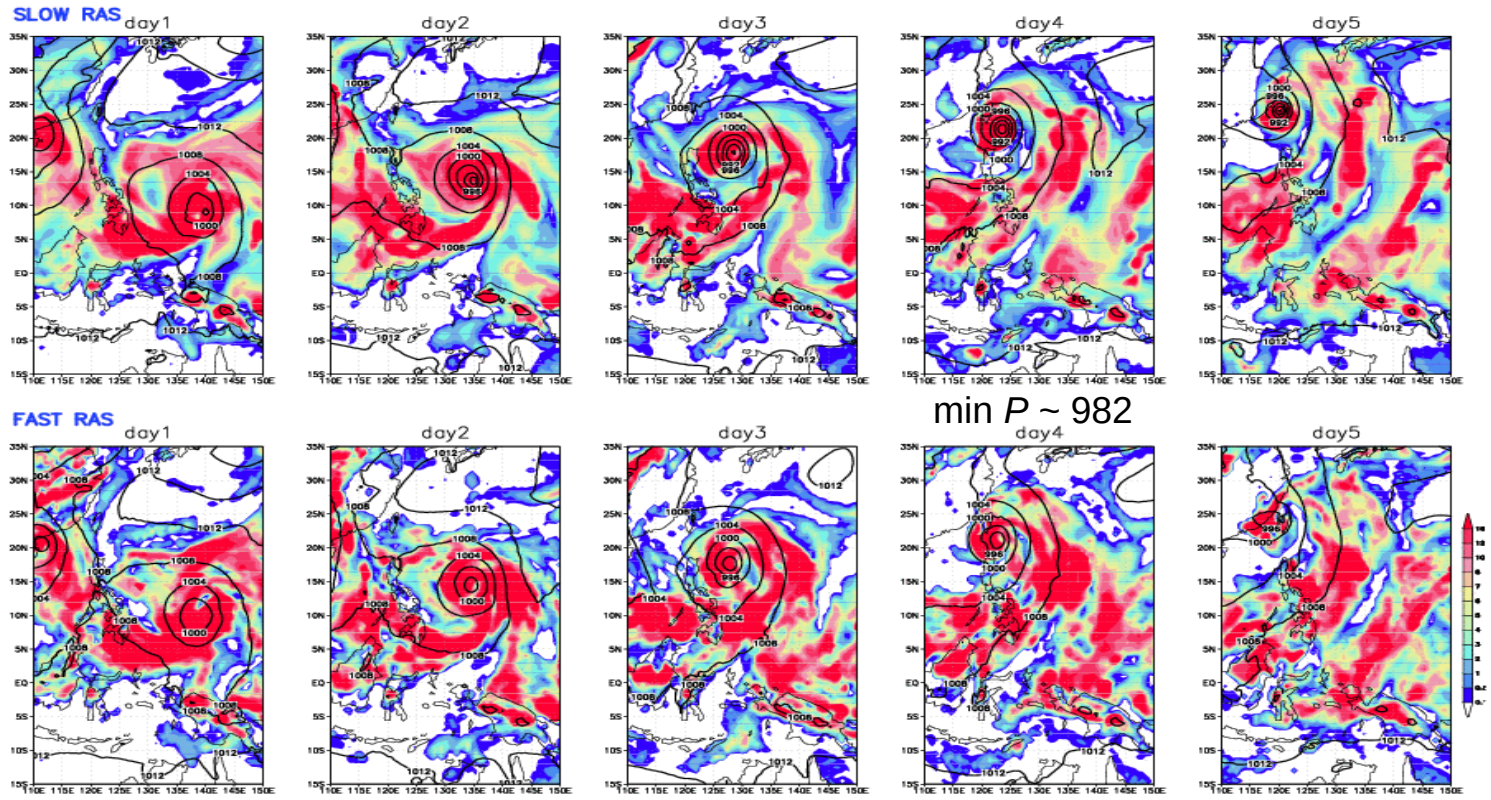


"Hurricane tracks and intensity are sensitive to the parameter change (relaxation time scale) of the RAS convection scheme"



Typhoon UTOR
June 26-July 5 2001





min *P* ~ 982

5-days of 0.66x0.5 forecast initialized with GEOS5 analysis on 00Z July 1

Summary

- The GMAO produces a 12-month coupled model forecast each month. In addition, a 5-day forecast with a high resolution (1/4 degree) AGCM is made every day.
- We're moving on for the coupled forecast with our next generation model (GEOS-5). This unified system for weather and climate will produce a seamless forecast products for seasonal, intra-seasonal, and 5-day forecasts.
- On-going research efforts focus on the improvement of the forecast system, and the better prediction for various time scales from weather to climate.