



# Prospects for subseasonal forecast of Tropical Cyclone statistics with the CFS

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(1) SAIC (2) GFDL (3) EMC/NCEP/NOAA

During the period between 2002 – 2006 there were no major ENSO events to dominate climate signals (weak El Ninos occurred in 2002-2003 and 2004-2005 seasons)

During the same period two interesting episodes occurred in the tropical Atlantic: August 2002 was a quite period in respect to Tropical Cyclones (though September 2002 was very active) in contrast to August 2005 which was very active (as with the whole season of 2005)

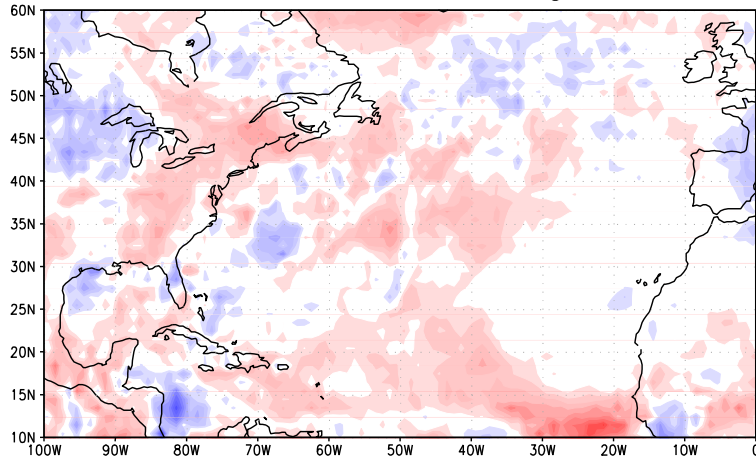
The simple question that we are asking the CFS is:

- Can the CFS predict the anomalies which occurred in the Atlantic ocean in August 2002 and 2005 in one month in advance?

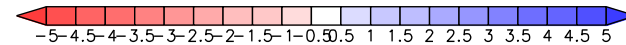
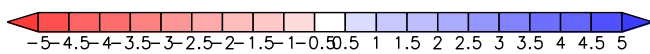
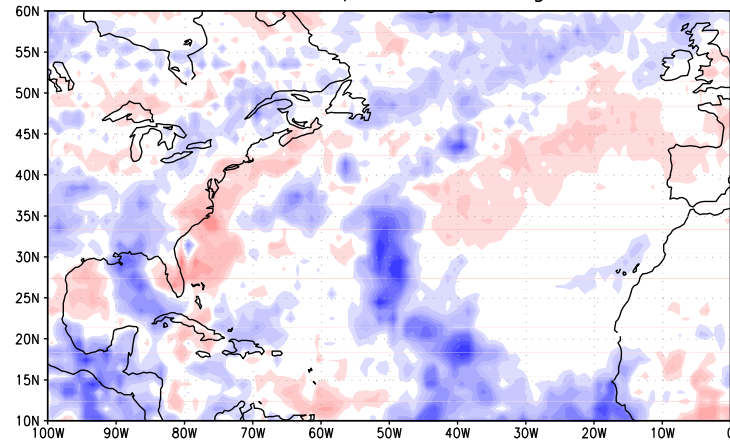
# GPCP Observed Precipitation Anomalies (base mean period 2002 – 2006)

August 2002 (a calm period) vs. August 2005 (a vigorous season)

GPCP Obs. Precip Anom. August 2002

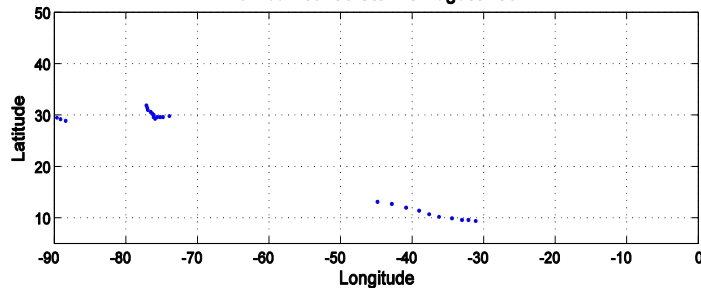


GPCP Obs. Precip Anom. August 2005

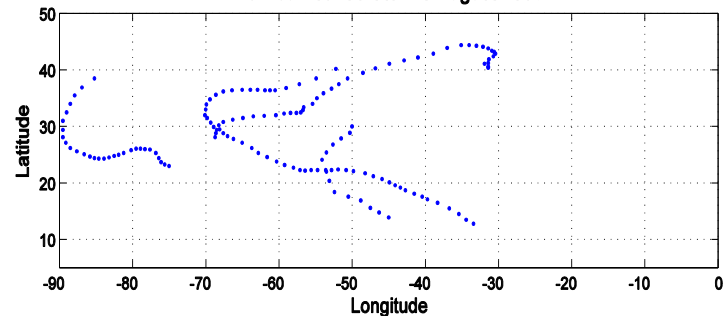


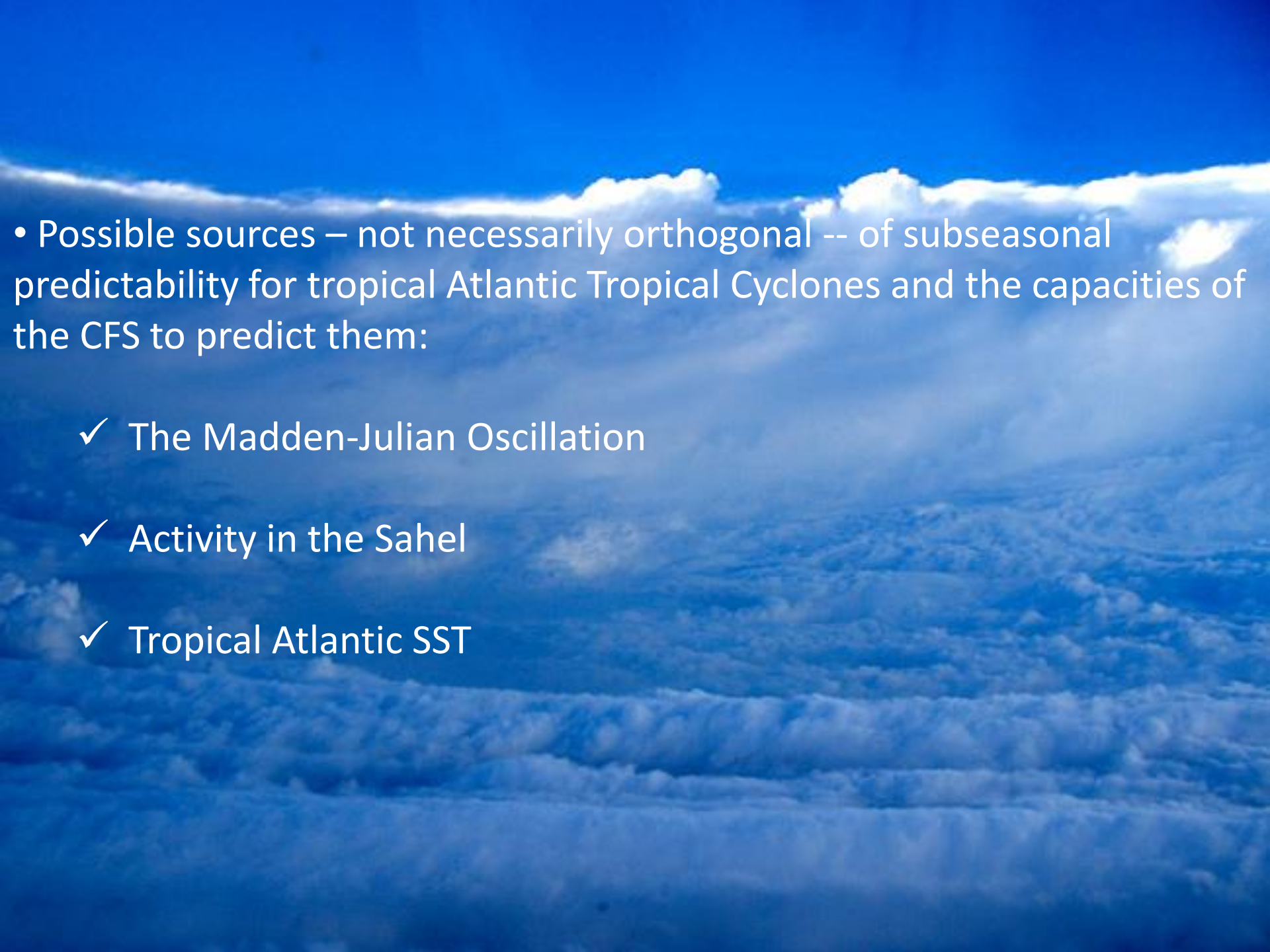
## Observed name Tropical Storms

Named Atlantic Storms August 2002



Named Atlantic Storms August 2005





• Possible sources – not necessarily orthogonal -- of subseasonal predictability for tropical Atlantic Tropical Cyclones and the capacities of the CFS to predict them:

✓ The Madden-Julian Oscillation

✓ Activity in the Sahel

✓ Tropical Atlantic SST



Predicting the MJO may help with prediction of Tropical Cyclone statistics at subseasonal lead times

This is an idea reflected in published work e.g.:

Maloney and Hartmann, *Science*, 2000

Mo, *Monthly Weather Review*, 2000

Higgins and Shi, *Journal of Climate*, 2001

Are there any other potential sources of subseasonal predictability for Tropical Cyclone statistics?

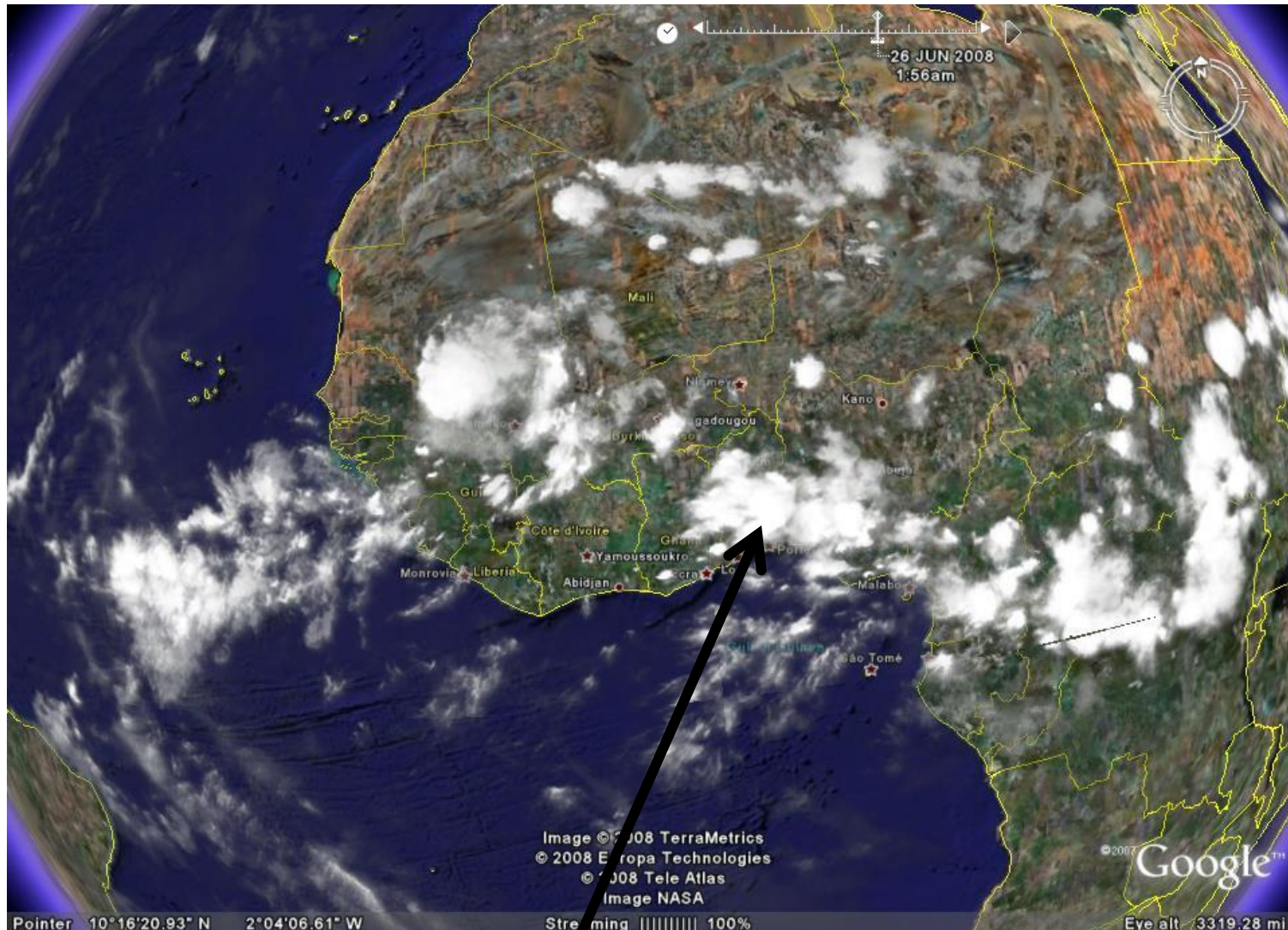
Activity in West Africa during the Monsoon Season

Gray, *Science*, 1990

Landsea *et al.*, *Journal of Climate*, 1992

Bell and Chelliah, 2006

Snapshot at 5:30 pm EST June 26<sup>th</sup>, 2008



The **GFS** claims that this will be the next Atlantic T.C. Seems much better organized this evening than it was this morning. We have traced it back to Darfur



The issues:

Is the CFS an adequate tool for predicting the MJO?

How well is the CFS forecasting the Sahel weather statistics at subseasonal lead times?

Can the CFS forecast statistics of Tropical Cyclones at subseasonal lead times?



# Retrospective forecast design (CTB experiments):

May 23<sup>rd</sup> to August 11<sup>th</sup> from 2002 to 2006

1 forecast every 5 days, with additional re-forecasts at the beginning of each month

Forecast lead: 60 days

Model resolution:

**Atmosphere:** T62 = 200Km x 200Km

T126 = 100Km x 100Km

T254 = 50Km x 50Km

**Ocean:** the standard CFS resolution

Initial conditions:

**Atmosphere, Land:** from Reanalysis 2 (CDAS2) and from GDAS (operational atmospheric analysis)

**Ocean:** from GODAS

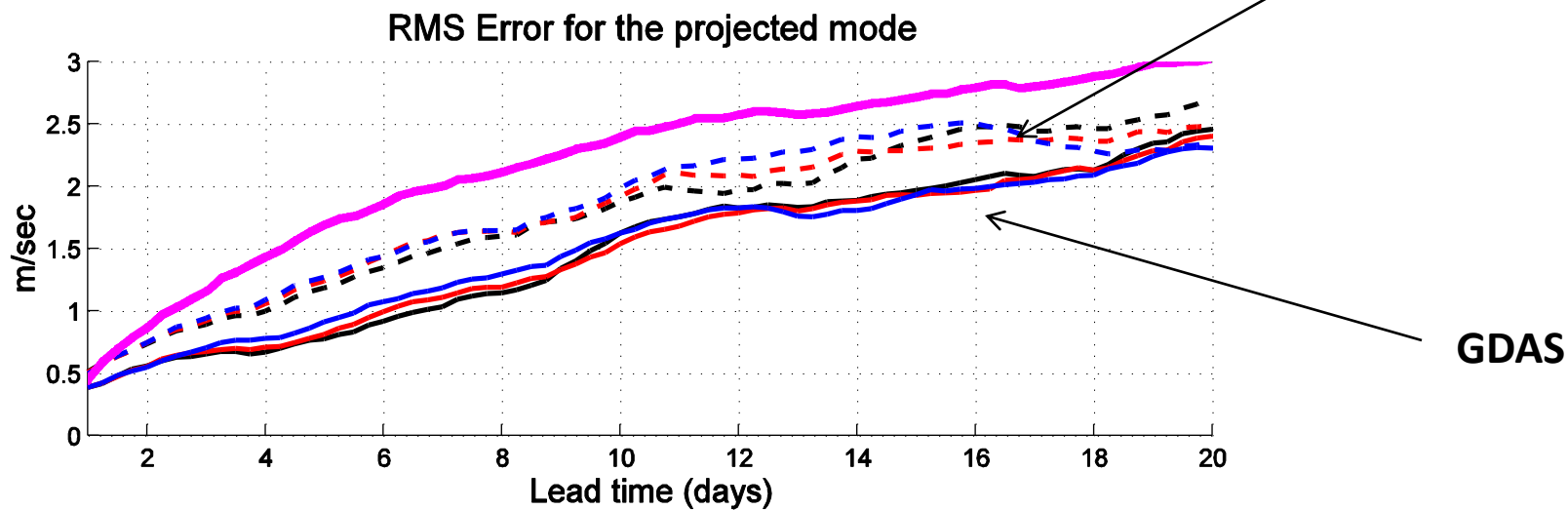
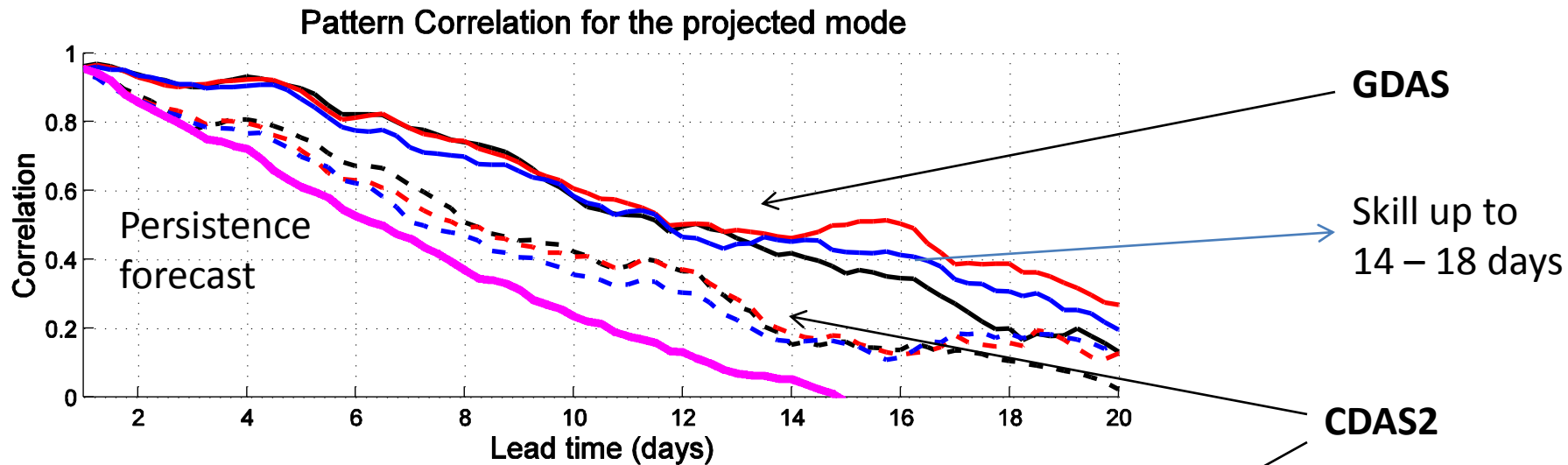
## Forecast Skill for MJO

Based on a version of the Wheeler and Hendon Index

### **Reminder:**

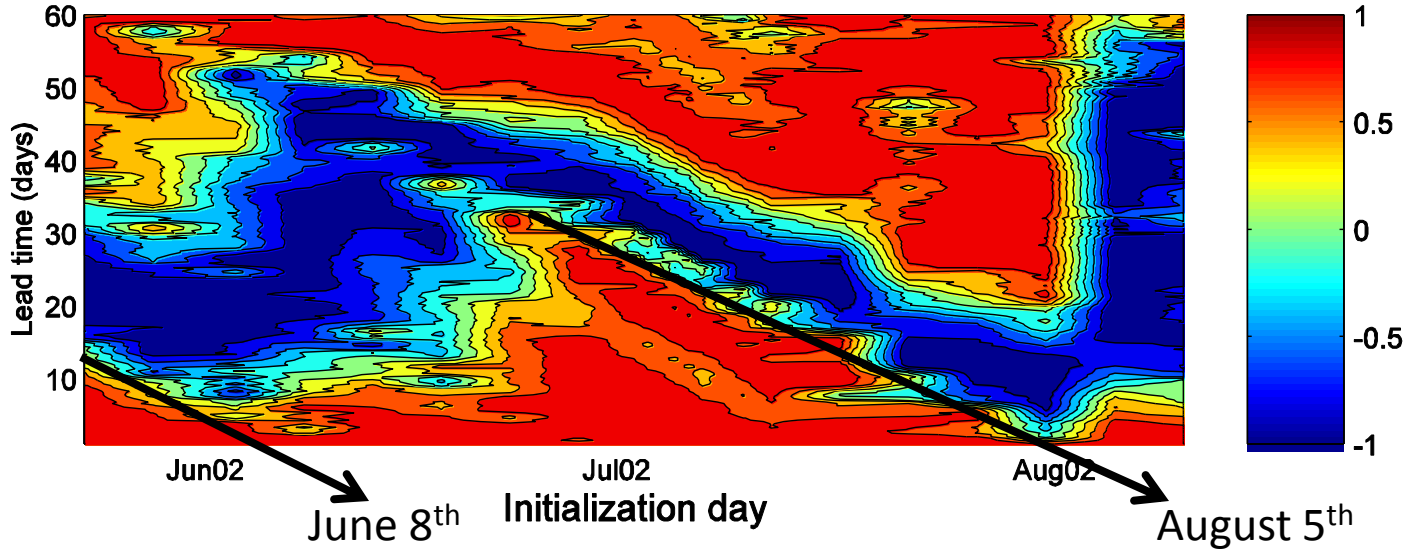
Summer cases only from 2002 – 2006 i.e., no significant ENSO

# Skill for the TIO mode (verification CDAS2)



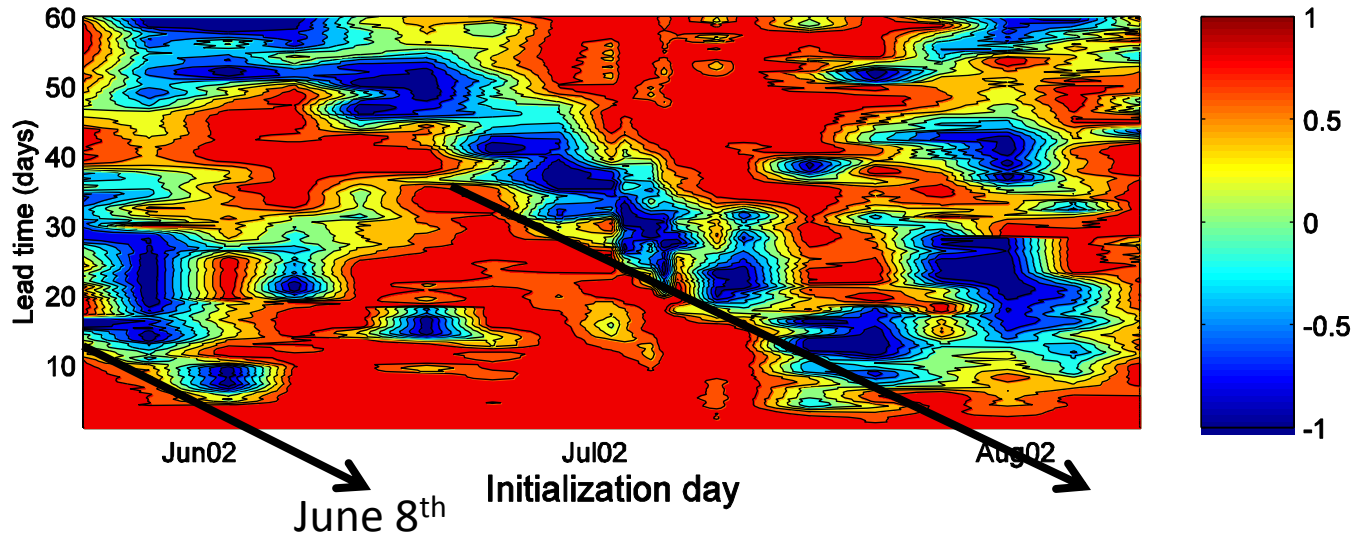
# Pattern correlation as a function of initialization day and lead time

## Pattern Correlation for Pers. Frcst



Persistence forecast cannot capture transitions

## Pattern Correlation for CDAS Frcst



CFS forecast captures well some transitions but not well other ones



The operational CFS as a tool for forecasting  
cumulative precipitation anomalies at  
subseasonal lead times over the Sahel

(Vintzileos and Thiaw, 2006)

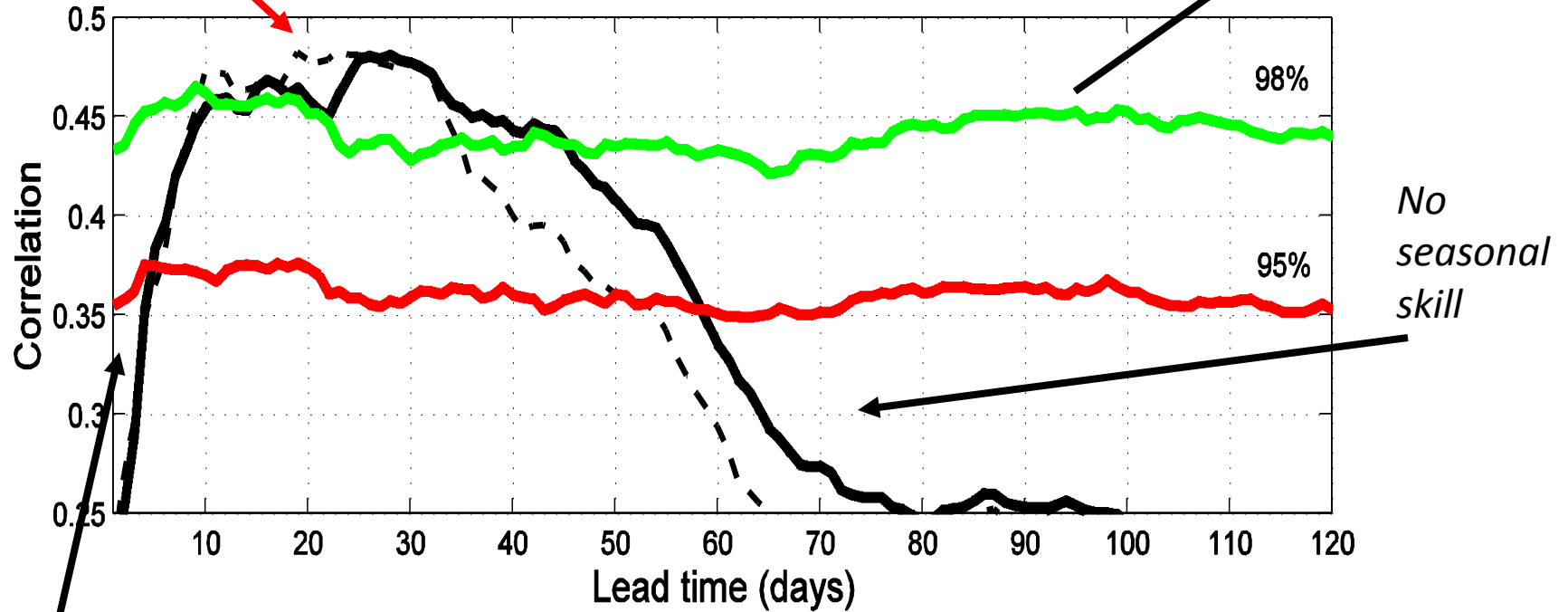
# Thick Black Line: Anomaly correlation (CFS vs. CMAP)

For initializations from May 9-13 to July 30 – August 3

*Subseasonal skill*

*Forecast with AR(1) precipitation*

CFS: Cumulative Precipitation Anomaly Correlation

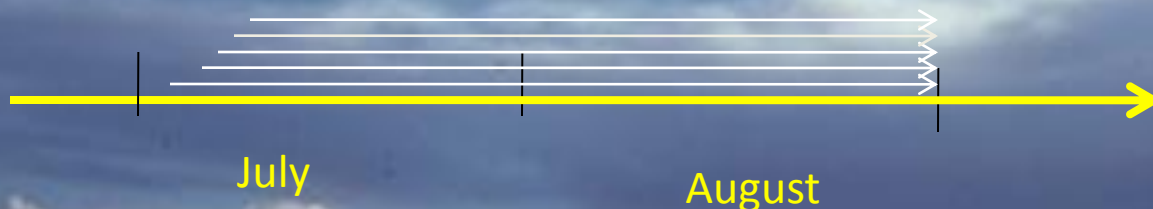


*Initialization issues? **YES!!** More details will be shown at Wednesday's Climate Test Bed session*

The background of the slide features a large, light blue watermark of the NOAA logo. The logo is circular and contains the text "NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION" at the top and "U.S. DEPARTMENT OF COMMERCE" at the bottom. In the center of the logo is a stylized wave with the acronym "NOAA" written across it in white.

**Forecasting Tropical Cyclone  
occurrences for the month of August  
from 2002 to 2006**

A lagged 14-ensemble member monthly forecast for August 2002 – 2006 initialized by Reanalysis 2 and GDAS in July 2, 3, 5, 6, 9, 10, 12



In what follows we are using the tracking system that was developed at NCEP by Tim Marchok (Marchok 2002) for each ensemble member and then combine the number of detected T.C. to produce a density field (number of T.C. per given area).



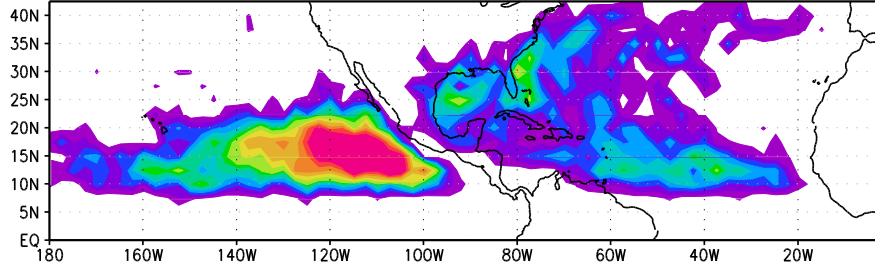
## **The tracking system** (Marchok 2002)

Produces a track based on an average of the positions of five different primary parameters (mslp, 700 and 850 mb relative vorticity and geopotential heights) and two secondary parameters (minimum in windspeed at 700 and 850 mb).

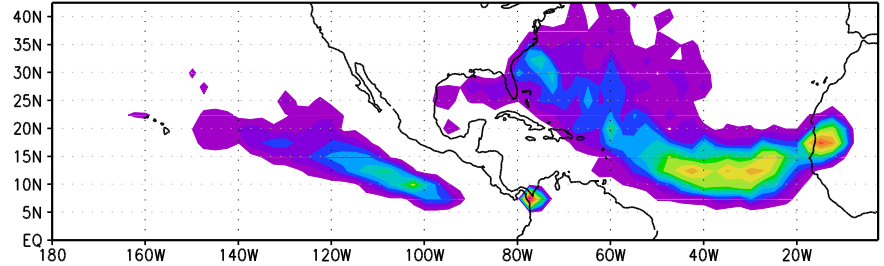
There are several criteria that each model disturbance must meet in order to be classified as a storm. **The storm must exist in the forecast for at least 24 h.** A closed mslp contour, using a contour interval of 1 mb, must surround the storm. Finally, the mean 850 mb tangential wind speed within 300 km of the storm center must be cyclonic and at least 0.75 m/s. Sensitivity tests were performed using the final two criteria, with the values of the contour interval and the tangential wind speed thresholds being changed from 2 to 1 mb, and 1.5 to 0.75 m/s, respectively.

# August Climatology

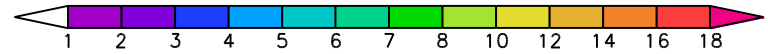
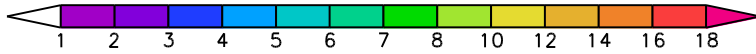
OBS Mean August 1970 - 2006



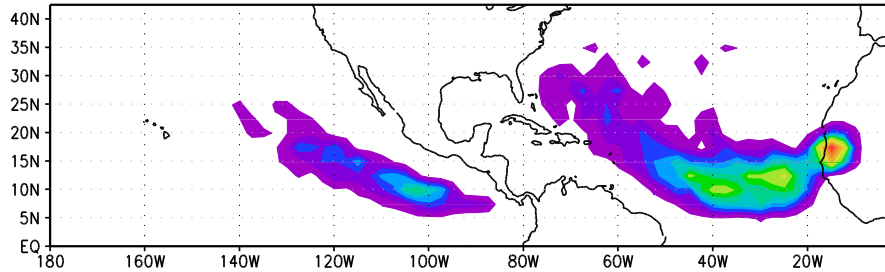
T254 Mean August 2002 - 2006



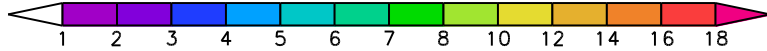
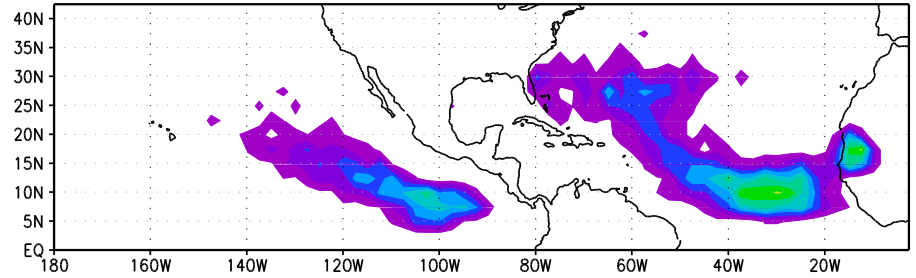
Model x 10



T126 Mean August 2002 - 2006



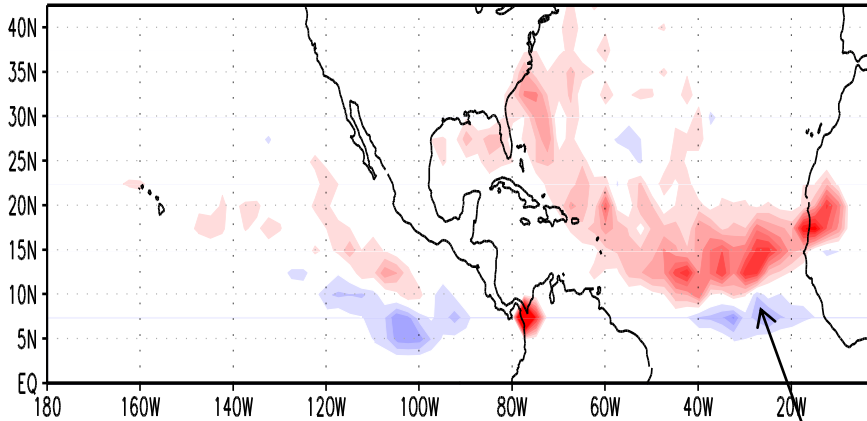
T62 Mean August 2002 - 2006



# Mean August (2002 – 2006) differences due to horizontal resolution

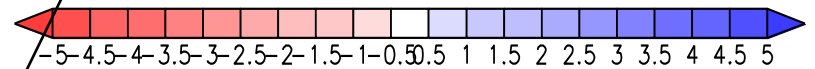
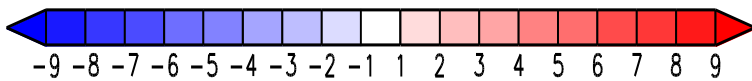
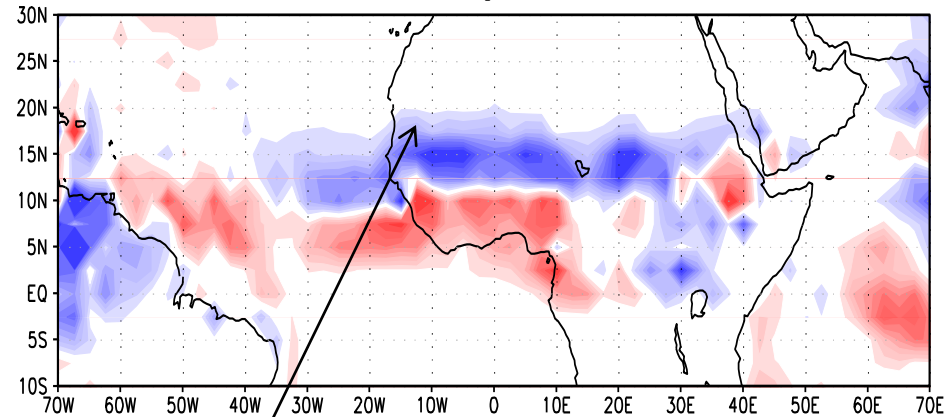
## Number of T.C. occurrences

### T254 – T62 August 2002 – 2006

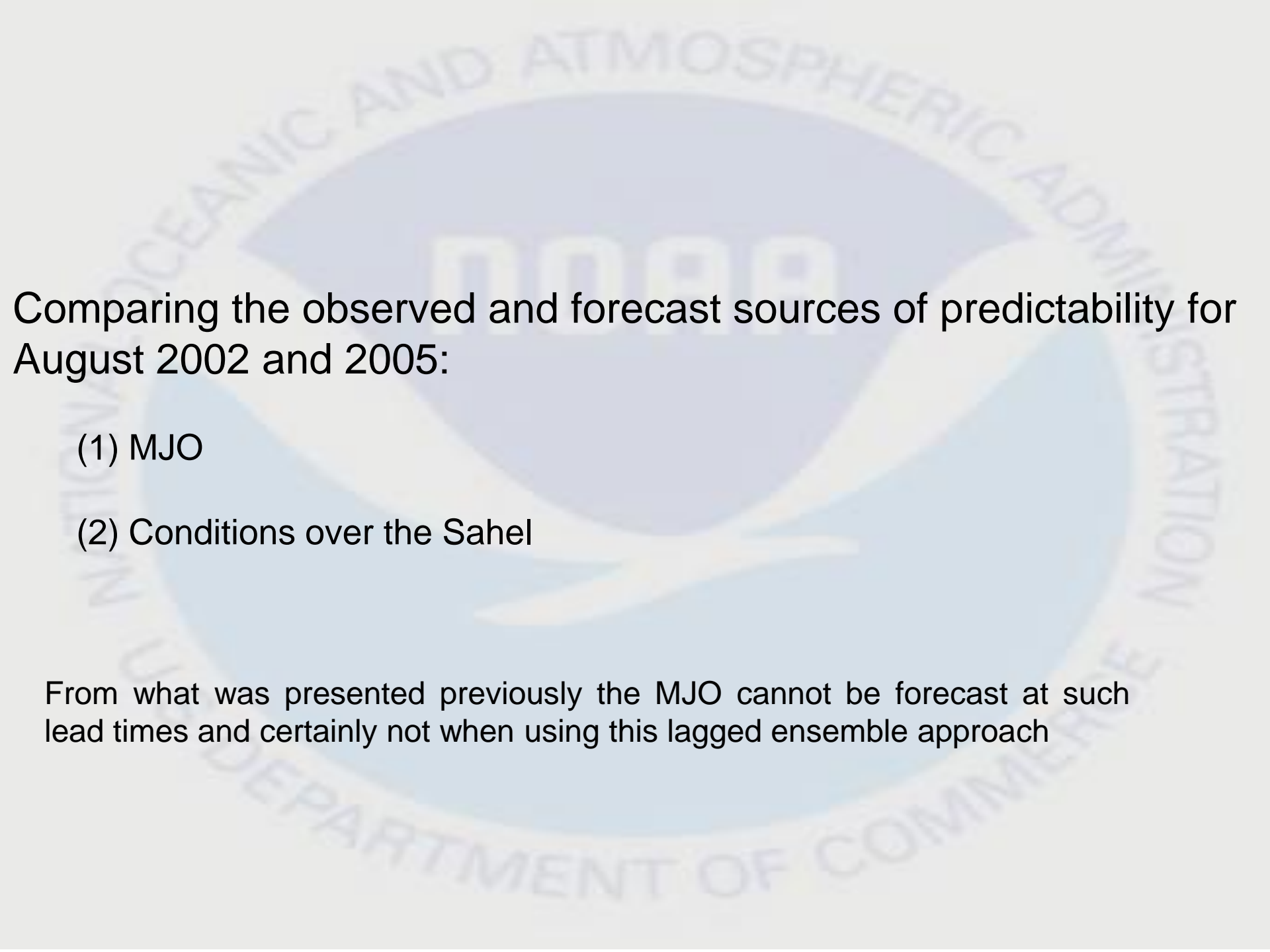


## Precipitation

### T254 – T62 : August Mean Precip.



The northward shift in T.C. occurrences also appears in precipitation and extends all across Africa



Comparing the observed and forecast sources of predictability for August 2002 and 2005:

(1) MJO

(2) Conditions over the Sahel

From what was presented previously the MJO cannot be forecast at such lead times and certainly not when using this lagged ensemble approach

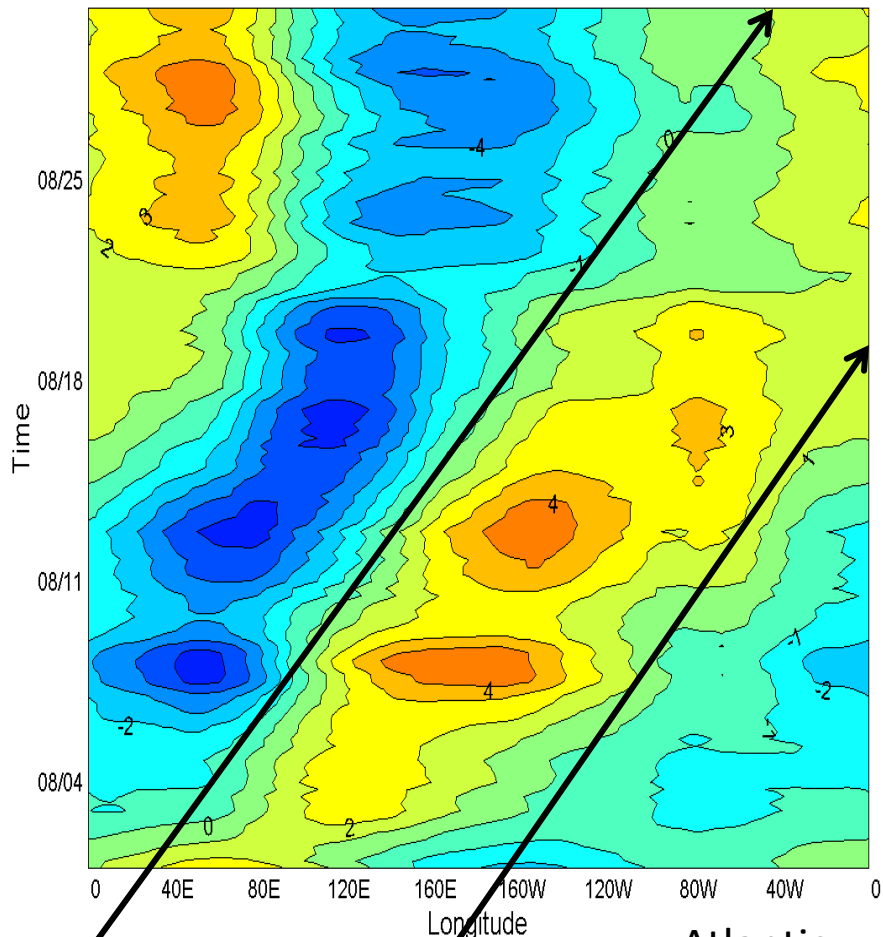


MJO

# Projection of 20S-20N averaged Zonal wind at 200hPa to the MJO mode during August 2002 and 2005

2002 not an active year (Atlantic)

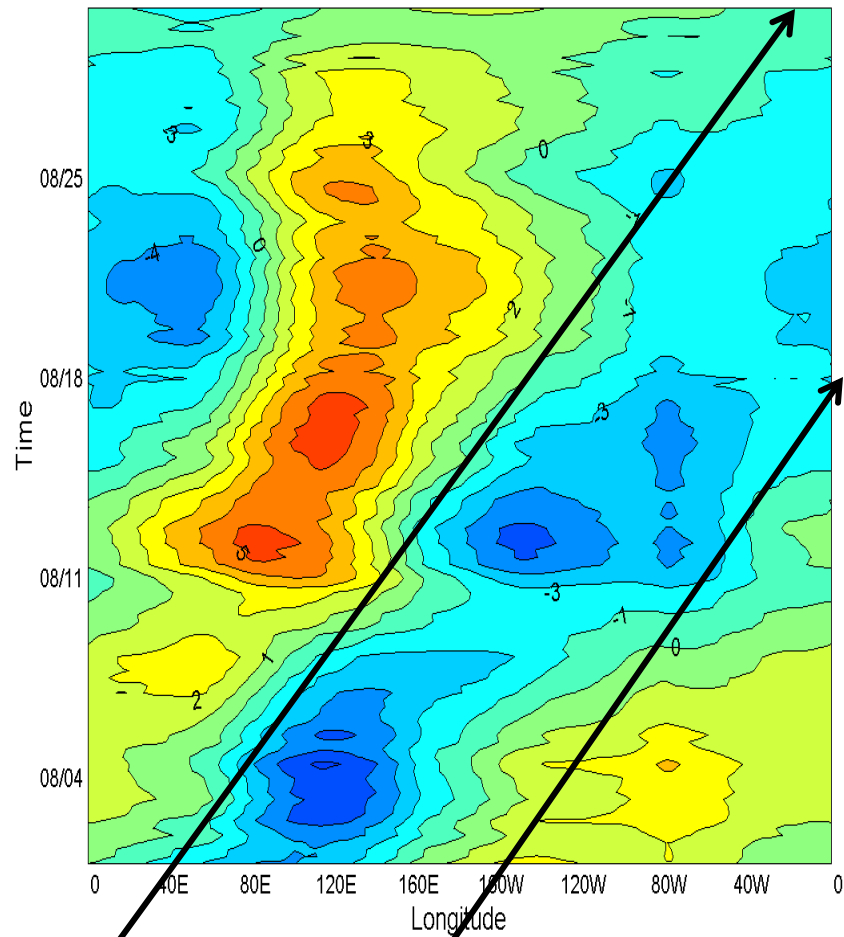
August 2002, 20°S - 20°N averaged U200 projected to MJO



Atlantic

2005 a very active year (Atlantic)

August 2005, 20°S - 20°N averaged U200 projected to MJO



Atlantic

divergence

Upper level convergence =  
decreased chances for  
convection

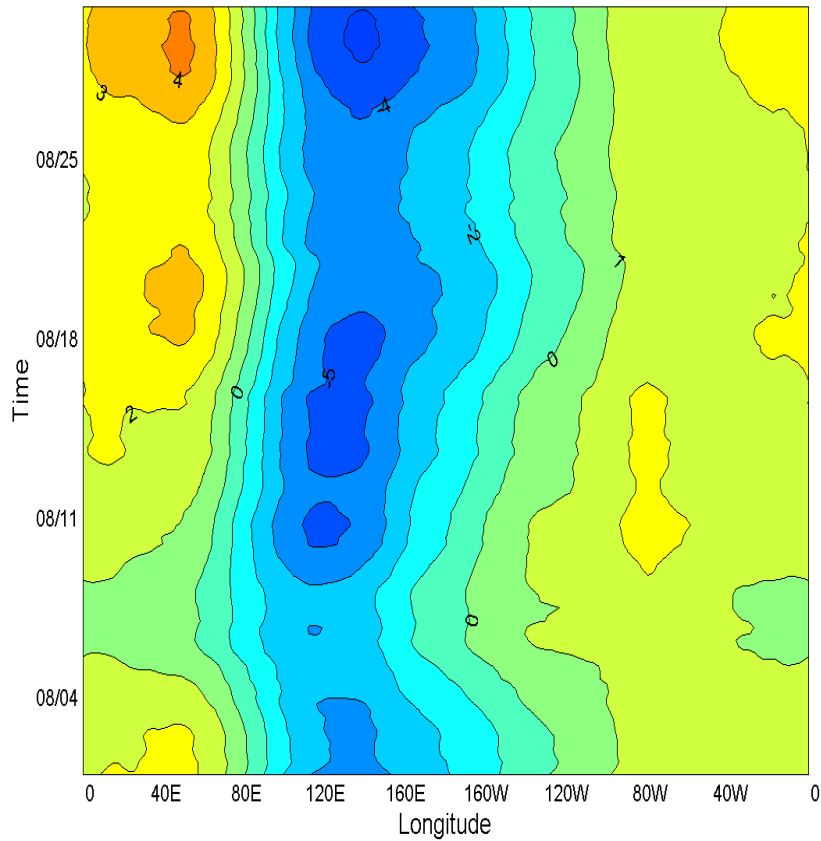
convergence

Upper level divergence =  
Increased chances for  
convection

# Forecasting the MJO for August 2002 and 2005 from early July

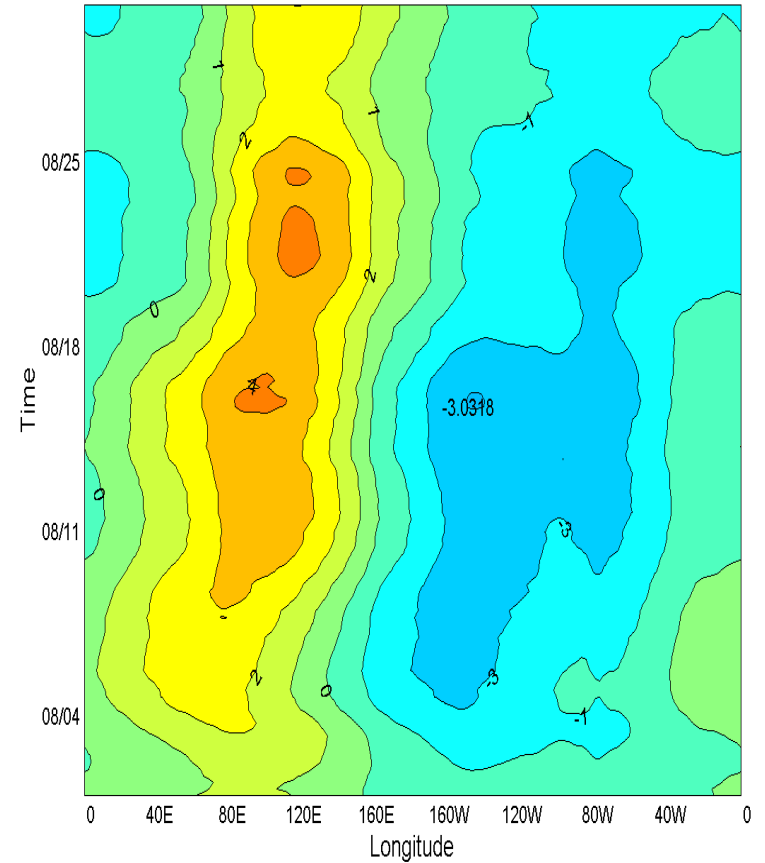
## Forecast MJO for August 2002

August 2002 FRCST, 20°S - 20°N U200 projected to MJO



## Forecast MJO for August 2005

August 2005 FRCST, 20°S - 20°N U200 projected to MJO



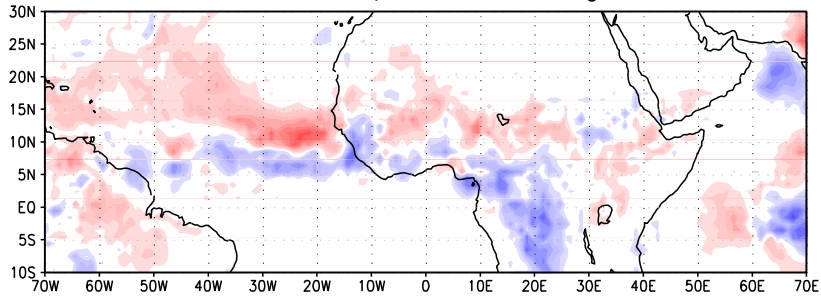
# Forecast of activity over the Sahel



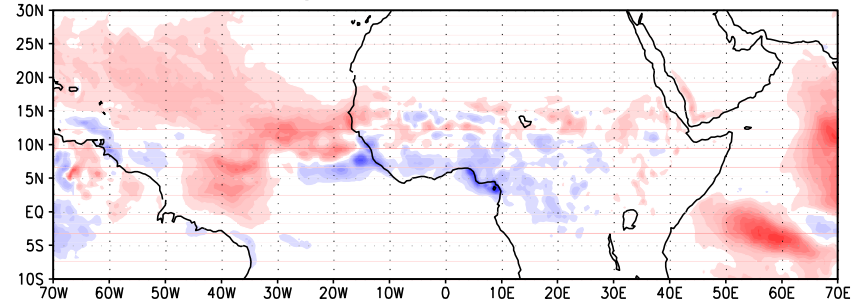


# August 2002 – a month of weak T.C. activity

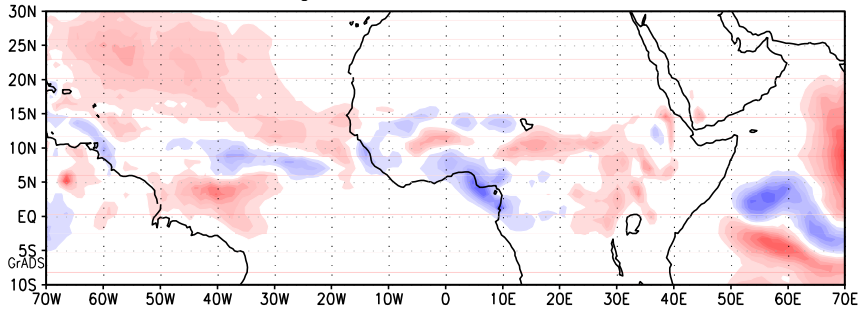
GPCP Obs. Precip Anom. August 2002



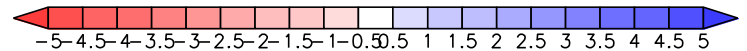
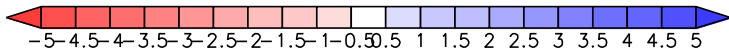
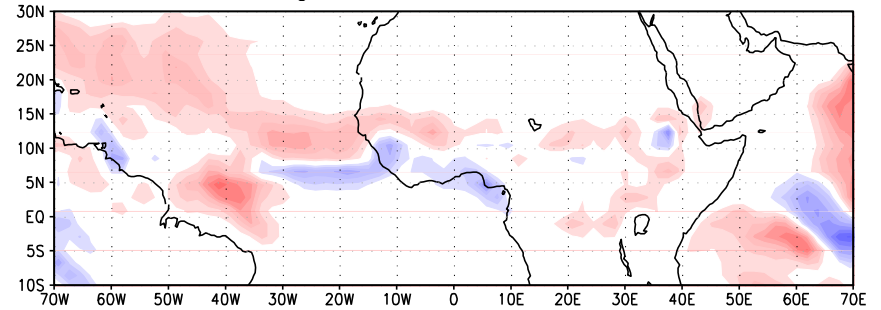
t254: August 2002 Anom. Precip.



t126: August 2002 Anom. Precip.

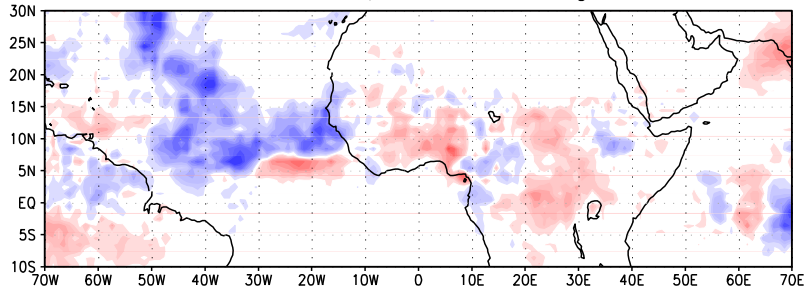


t62: August 2002 Anom. Precip.

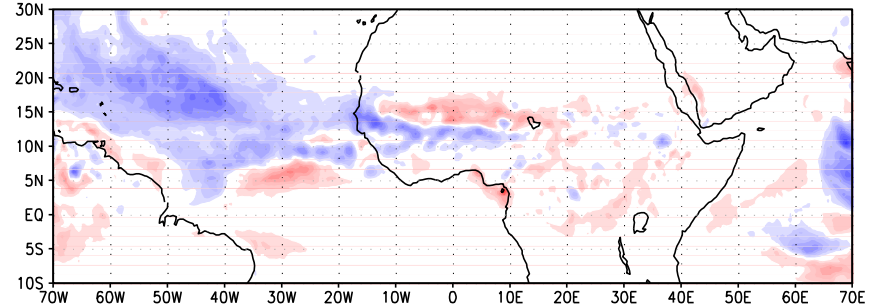


# August 2005 – a month of strong T.C. activity

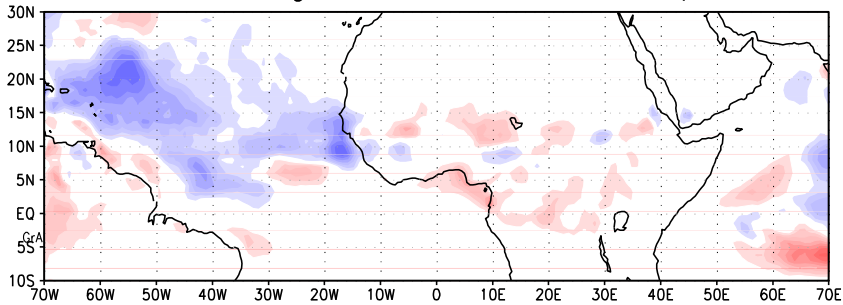
GPCP Obs. Precip Anom. August 2005



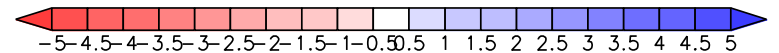
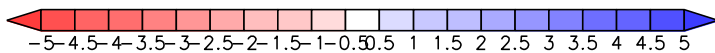
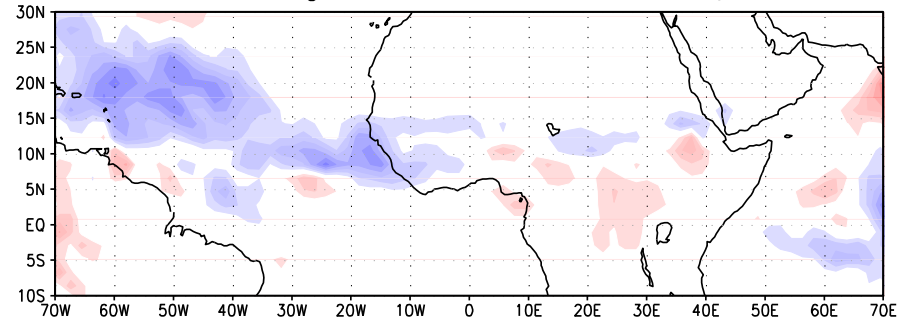
t254: August 2005 Anom. Precip.



t126: August 2005 Anom. Precip.



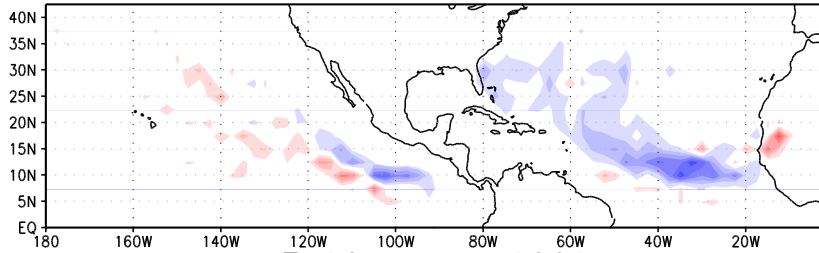
t62: August 2005 Anom. Precip.



# Forecast of anomalous occurrence of Tropical Cyclones

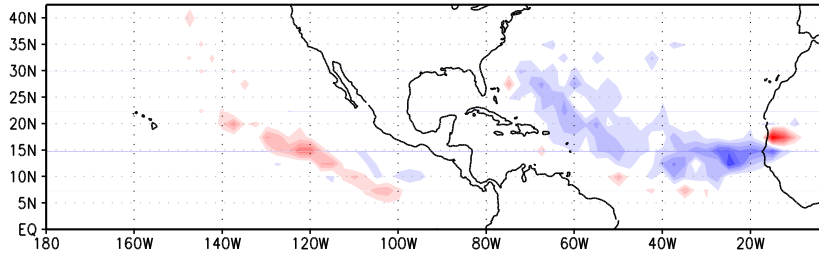
## 2002 an inactive season

T62 August 2002



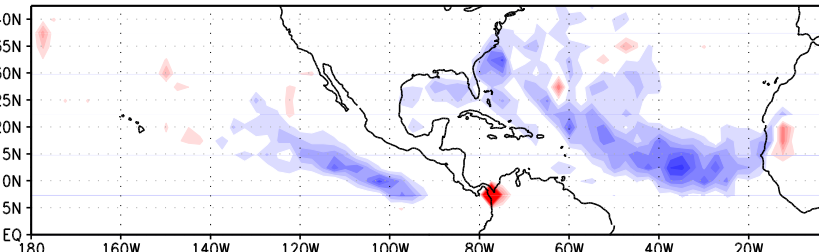
T62

T126 August 2002



T126

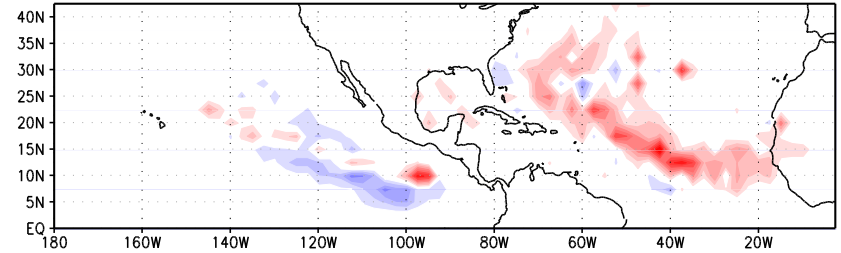
T254 August 2002



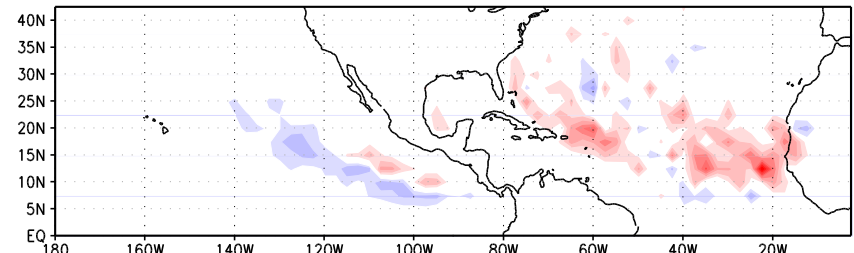
T254

## 2005 a very active season

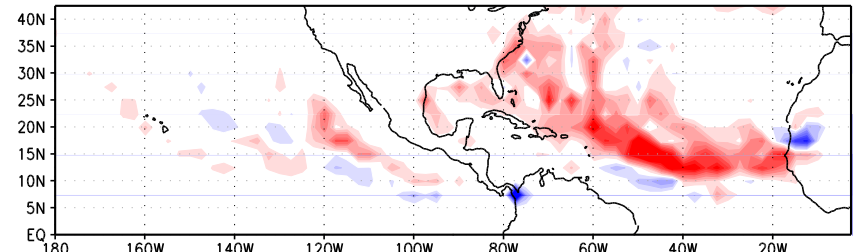
T62 August 2005



T126 August 2005

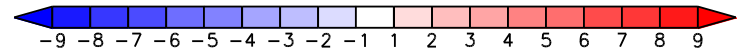
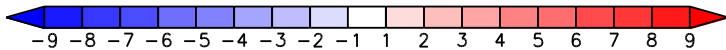


T254 August 2005



Blue = less occurrences than normal

Red = more occurrences than normal



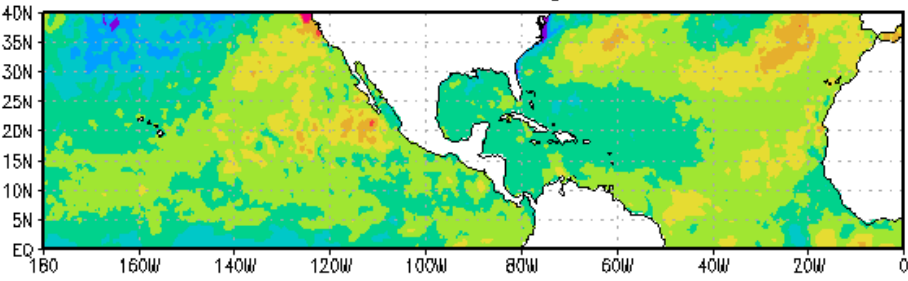
## Conclusions(I):

The CFS manages to produce an August climatology of occurrence of Tropical Cyclones which is realistic in the tropical Atlantic. Work has to be done in order to improve the results and especially understand the drawbacks noticed in the eastern Pacific.

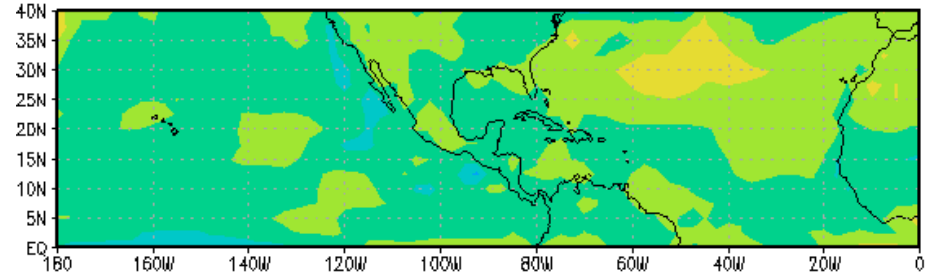
The CFS is a good tool for the forecasts of anomalous low and high occurrence of Tropical Cyclones in years 2002 and 2005. This is a promising result and work will be done using the new CFSRR hindcast database in order to extend these findings to more cases including more active ENSO years.

Reasons for these good forecasts include (1) Skillful forecast of weather statistics at subseasonal lead times over the Sahel, (2) good forecasts of the tropical Atlantic SST at 1-2 month lead time. Better forecasts of the MJO will certainly improve these forecasts. Work is currently done in order to understand and resolve the Maritime Barrier problem.

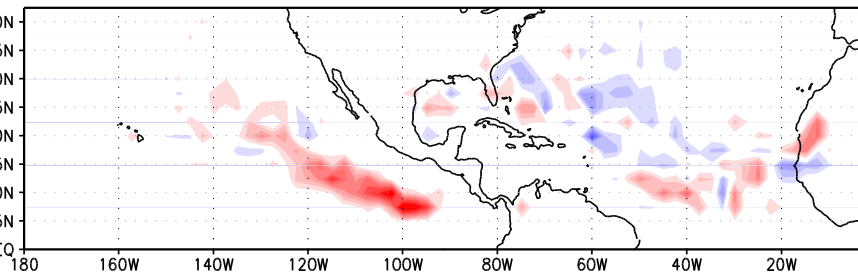
SST anomalies August 2003



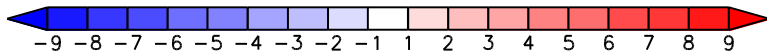
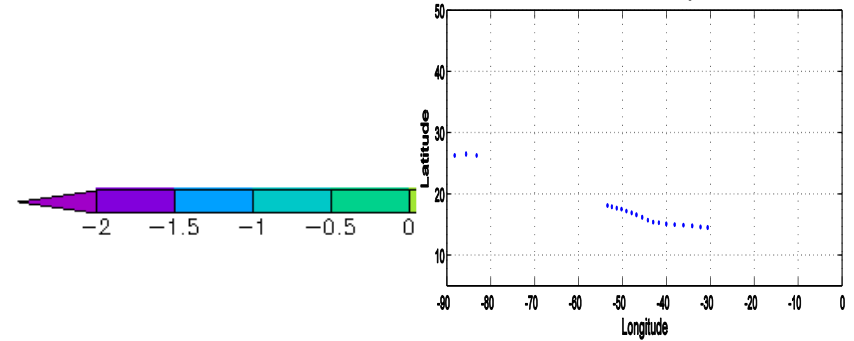
Forecast SST (T254) August 2003



T254 August 2003

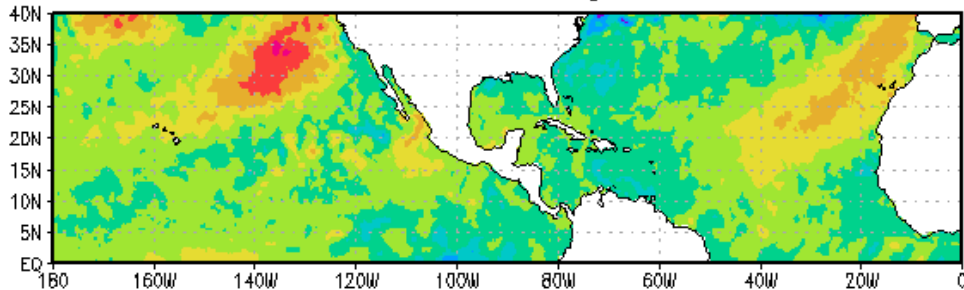


Named Atlantic Storms August 2003

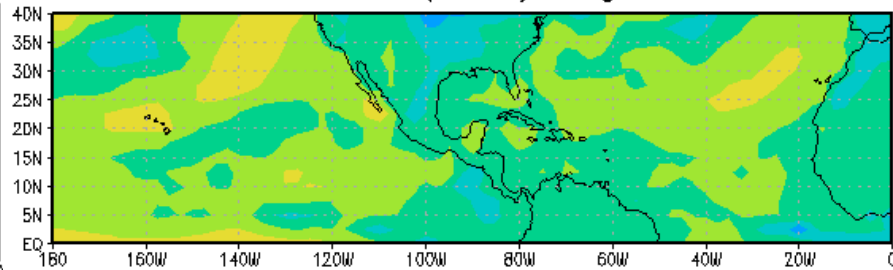


2003 not an active year (correct forecast)

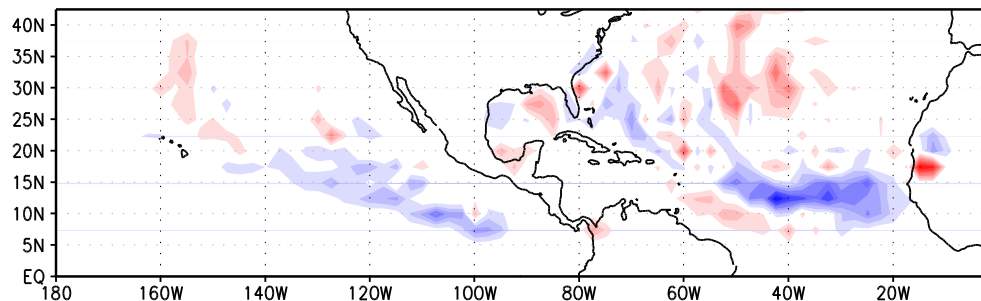
SST anomalies August 2004



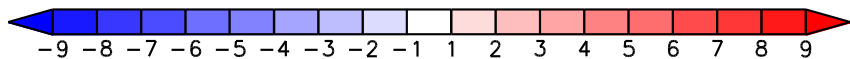
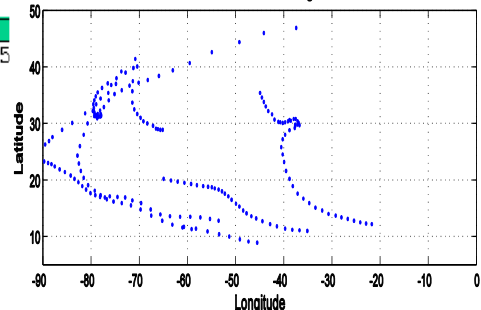
Forecast SST (T254) August 2004



T254 August 2004

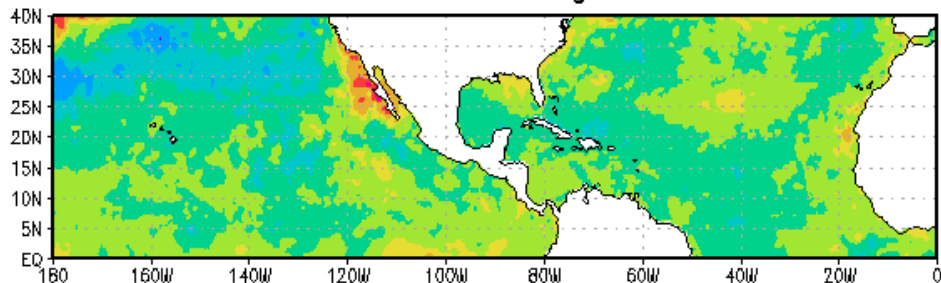


Named Atlantic Storms August 2004

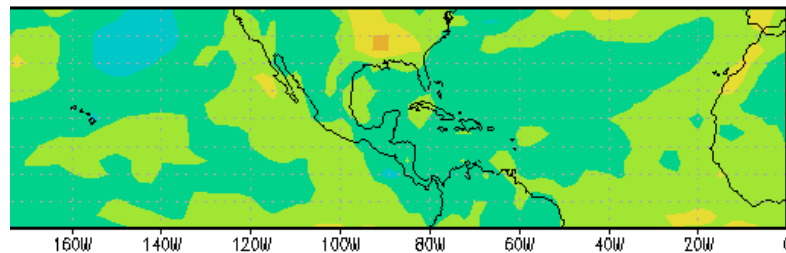


2004 an active year in the west Atlantic

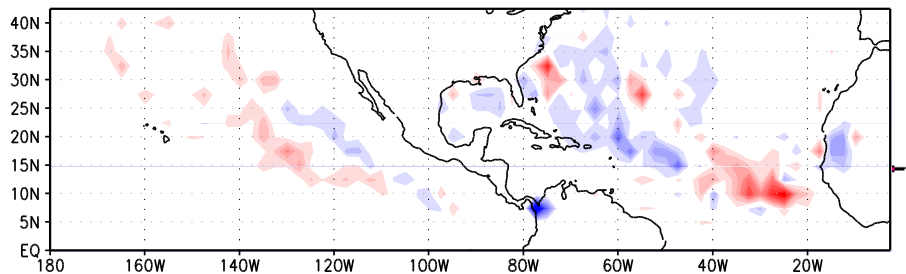
SST anomalies August 2006



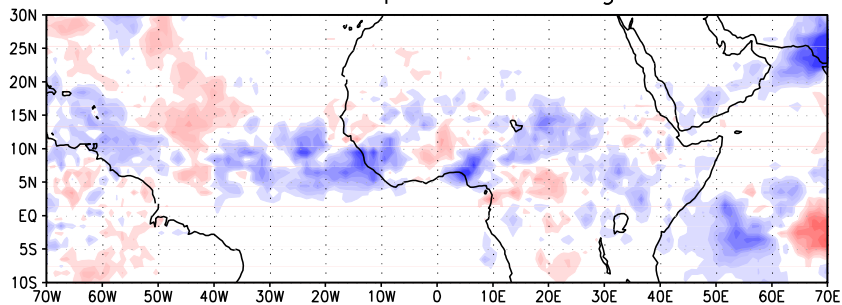
Forecast SST (T254) August 2006



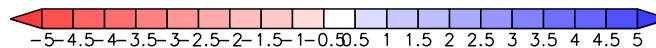
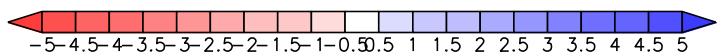
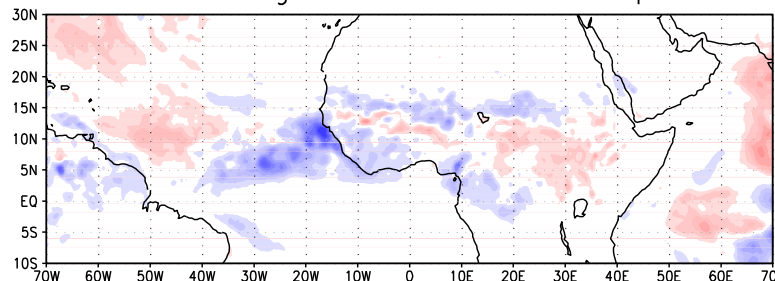
T254 August 2006



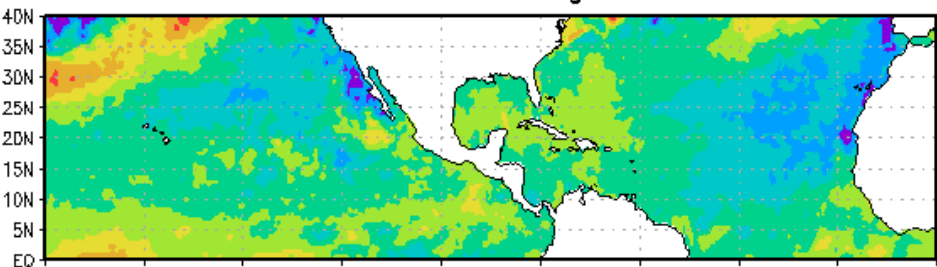
GPCP Obs. Precip Anom. August 2006



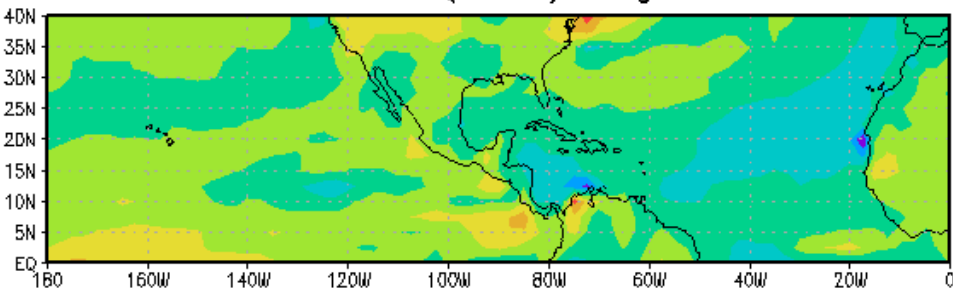
t254: August 2006 Anom. Precip.



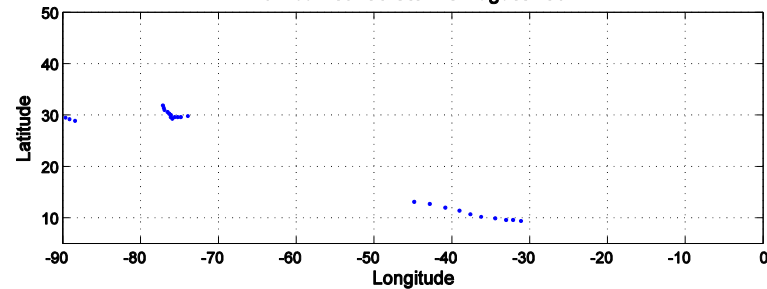
### SST anomalies August 2002



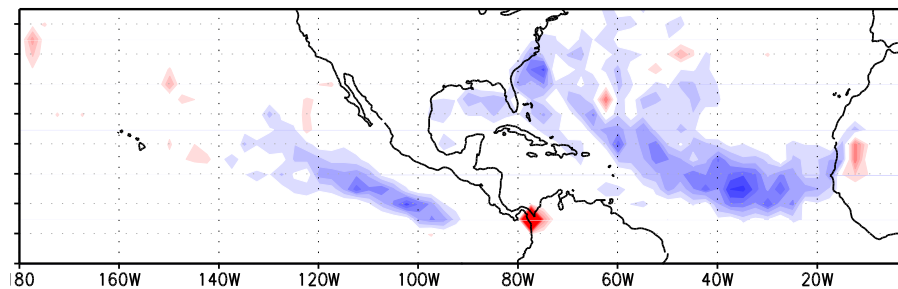
### Forecast SST (T254) August 2002



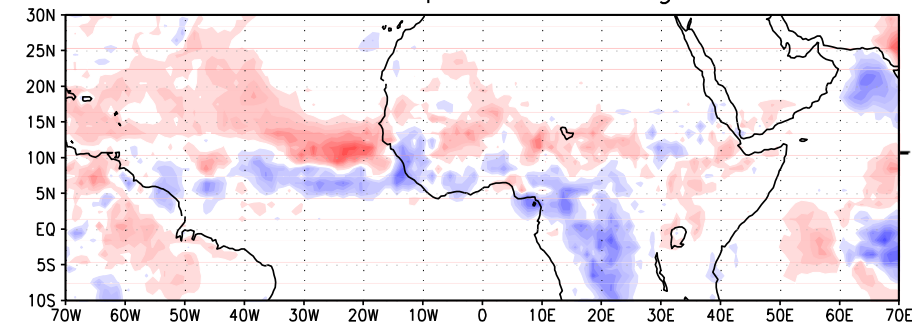
### Named Atlantic Storms August 2002



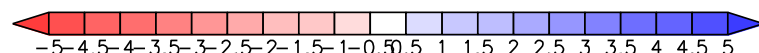
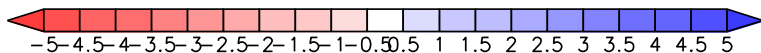
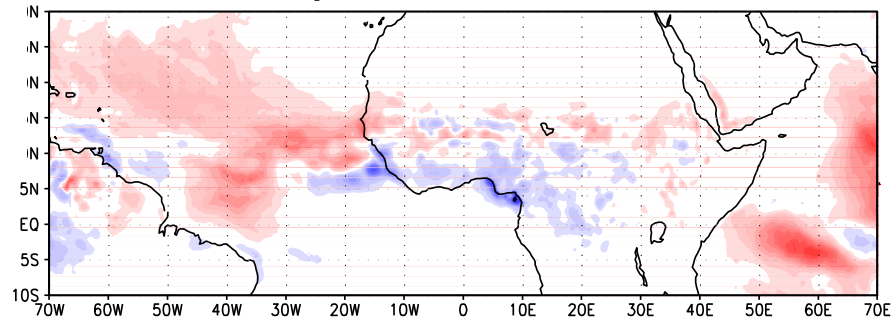
### T254 August 2002



### GPCP Obs. Precip Anom. August 2002

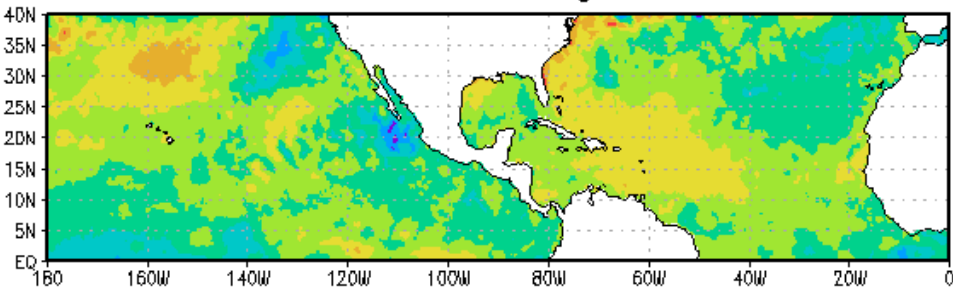


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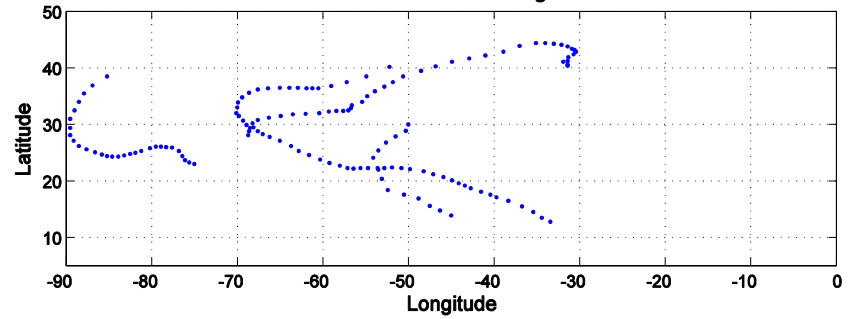




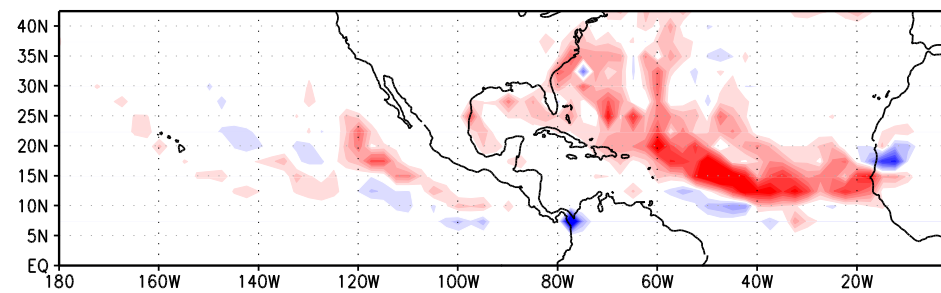
### SST anomalies August 2005



### Named Atlantic Storms August 2005



### T254 August 2005



### Forecast SST (T254) August 2005

