Prospects for subseasonal forecast of Tropical Cyclone statistics with the CFS

Augustin Vintzileos\textsuperscript{(1)(3)}, Tim Marchok\textsuperscript{(2)}, Hua-Lu Pan\textsuperscript{(3)}

and Stephen J. Lord

\textsuperscript{(1)} SAIC \textsuperscript{(2)} GFDL \textsuperscript{(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)

Observed name Tropical Storms
• 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
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 23rd to August 11th 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 for the projected mode

- GDAS
- CDAS2
- Persistence forecast

Skill up to 14 – 18 days

RMS Error for the projected mode

- GDAS

Lead time (days) vs. Correlation

Lead time (days) vs. m/sec
Pattern correlation as a function of initialization day and lead time

Persistence forecast cannot capture transitions.

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)
Initialization issues? **YES!!** More details will be shown at Wednesday’s Climate Test Bed session.
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.
Mean August (2002 – 2006) differences due to horizontal resolution

Number of T.C. occurrences

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.
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

Upper level divergence = decreased chances for convection

2005 a very active year (Atlantic)
August 2005, 20°S - 20°N averaged U200 projected to MJO

Upper level convergence = Increased chances for convection
Forecasting the MJO for August 2002 and 2005 from early July

Forecast MJO for August 2002

Forecast MJO for August 2005
Forecast of activity over the Sahel
August 2002 – a month of weak T.C. activity
August 2005 – a month of strong T.C. activity
Forecast of anomalous occurrence of Tropical Cyclones

2002 an inactive season

Blue = less occurrences than normal

2005 a very active season

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.
2003 not an active year (correct forecast)
2004 an active year in the west Atlantic