

CPC Dynamic Hurricane Season Prediction System Upgrade with the NCEP CFSv2

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Introduction

- NOAA's Hurricane Season Outlooks (HSO) for ATL and ENP have been issued since 1998.
- In 2008, a dynamic prediction system based on the T382 CFSv1 was introduced as part of the HSO prediction tools.
- In 2014, the dynamic prediction system has been upgraded with the T382 CFSv2.

Outline

1. Description of CFSv2
2. Hindcast Configuration and Analyses
3. 2014 Season Prediction
4. Summary

Climate Forecast System (CFS)

Attribute	CFS v1 (Operational Configuration)	CFS v2 (Q2FY11)
Analysis Resolution	200 km (T62)	38 km (T382)
Atmosphere model	1995: 200 km/28 levels Humidity based clouds	100 km (T126)/64 levels Variable CO2 AER SW & LW radiation Prognostic clouds & liquid water Retuned mountain blocking Convective gravity wave drag
Ocean model	MOM-3: 60N-65S 1/3 x 1 deg. Assim depth 750 m	MOM-4 fully global 1/4 x 1/2 deg. Assim depth 4737 m
Land surface model (LSM) and assimilation	2-level LSM No separate land data assim	4 level Noah model GLDAS driven by obs precip
Sea ice	Climatology	Daily analysis and Prognostic sea ice
Coupling	Daily	30 minutes
Data assimilation	Retrieved soundings, 1995 analysis, uncoupled background	Radiances assimilated, 2008 GSI, coupled background
Reforecasts	15/month seasonal output	25/month (seasonal) 124/month (week 3-6)

Hindcast Configuration

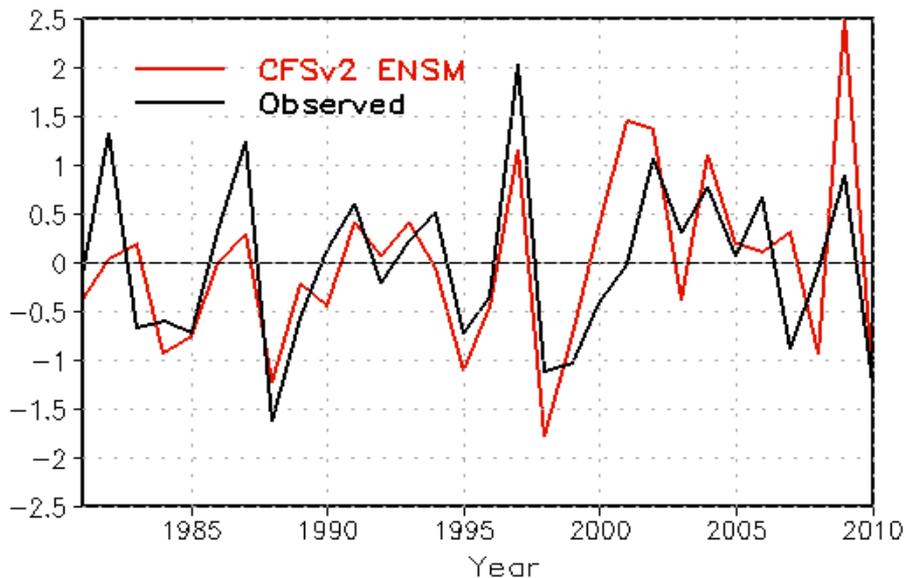
- NCEP CFSv2 in T382 (~38 km) resolution
- Hindcast Period: 1981-2010 (30 years)
 - 5-member ensemble for each year with ICs in April and July.
 - Forecast period extends out to December 1
- Used to generate the model circulation climatology and tropical storm statistics for skill evaluations and bias corrections
- Some improvement over the previous CFSv1-based system is noticed in terms of:
 - TC Seasonal cycle
 - TC Interannual variability over the ENP
 - Wind shear over the MDR

TS Detection & Tracking Method

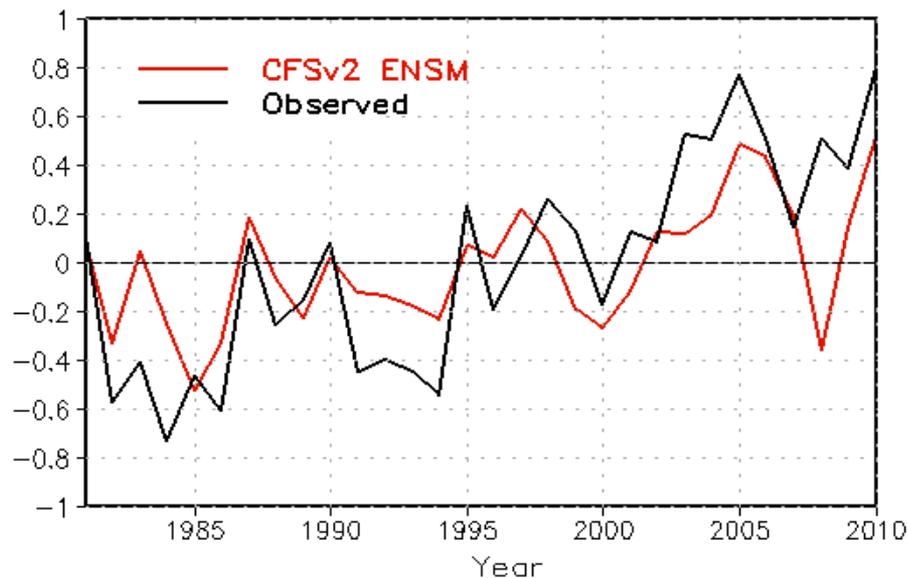
- Method based on Camargo & Zebiak (2002)
 - Point must meet 7 criteria to be considered a storm
 - Tracked forward and backward in time following vorticity maxima
- Detection thresholds unique to CFSv2
 - Created using seasonal hindcast runs for 1999-2010
- Verification
 - HURDAT and JTWC Best Track Datasets
 - Depressions and subtropical storms not included

SST and Wind Shear Indices - ASO

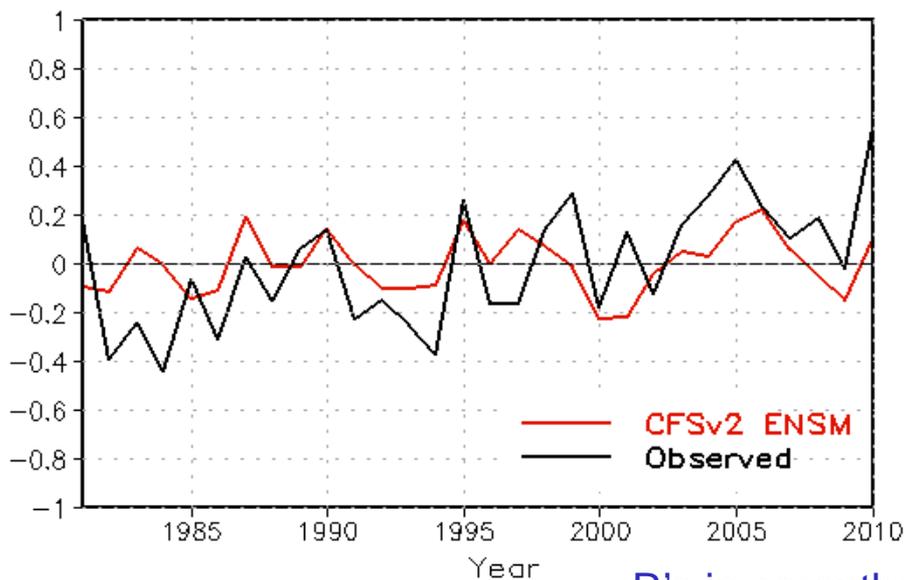
a) Nino3.4 SST, $r=0.68$ ($r=0.63$)



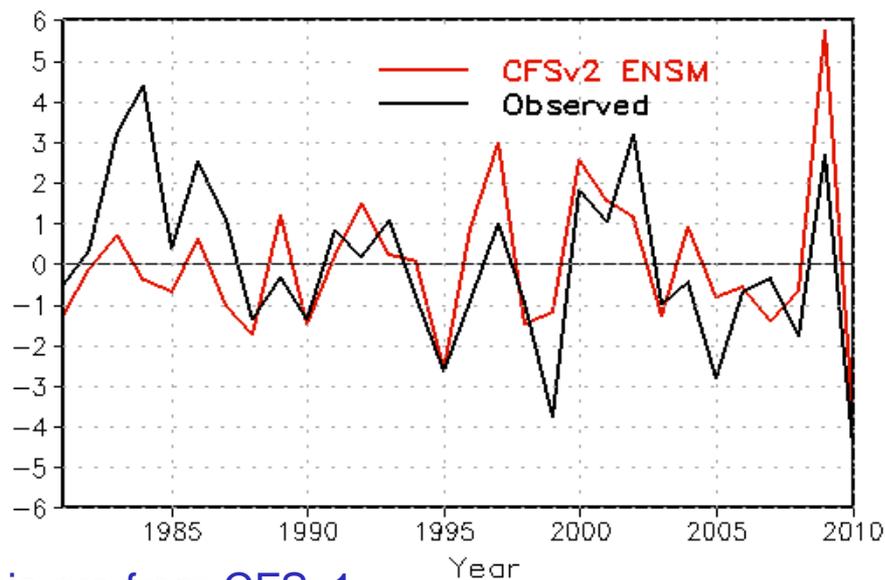
b) ATL MDR SST, $r=0.73$ ($r=0.77$)



c) ATL MDR - Global Tropic SST, $r=0.46$



d) ATL MDR Shear, $r=0.63$ ($r=0.50$)

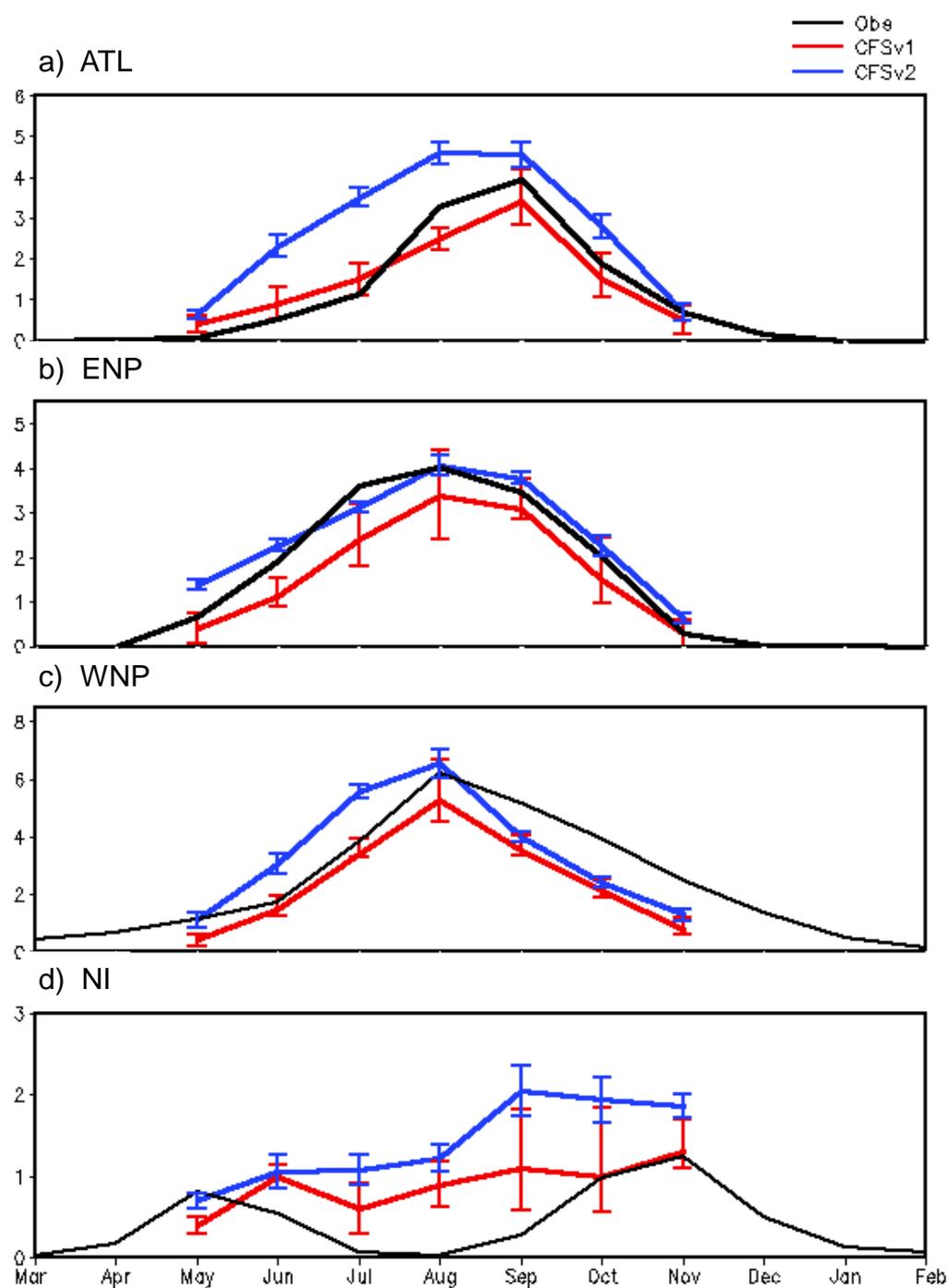


R's in parenthesis are from CFSv1

TS Seasonal Cycle

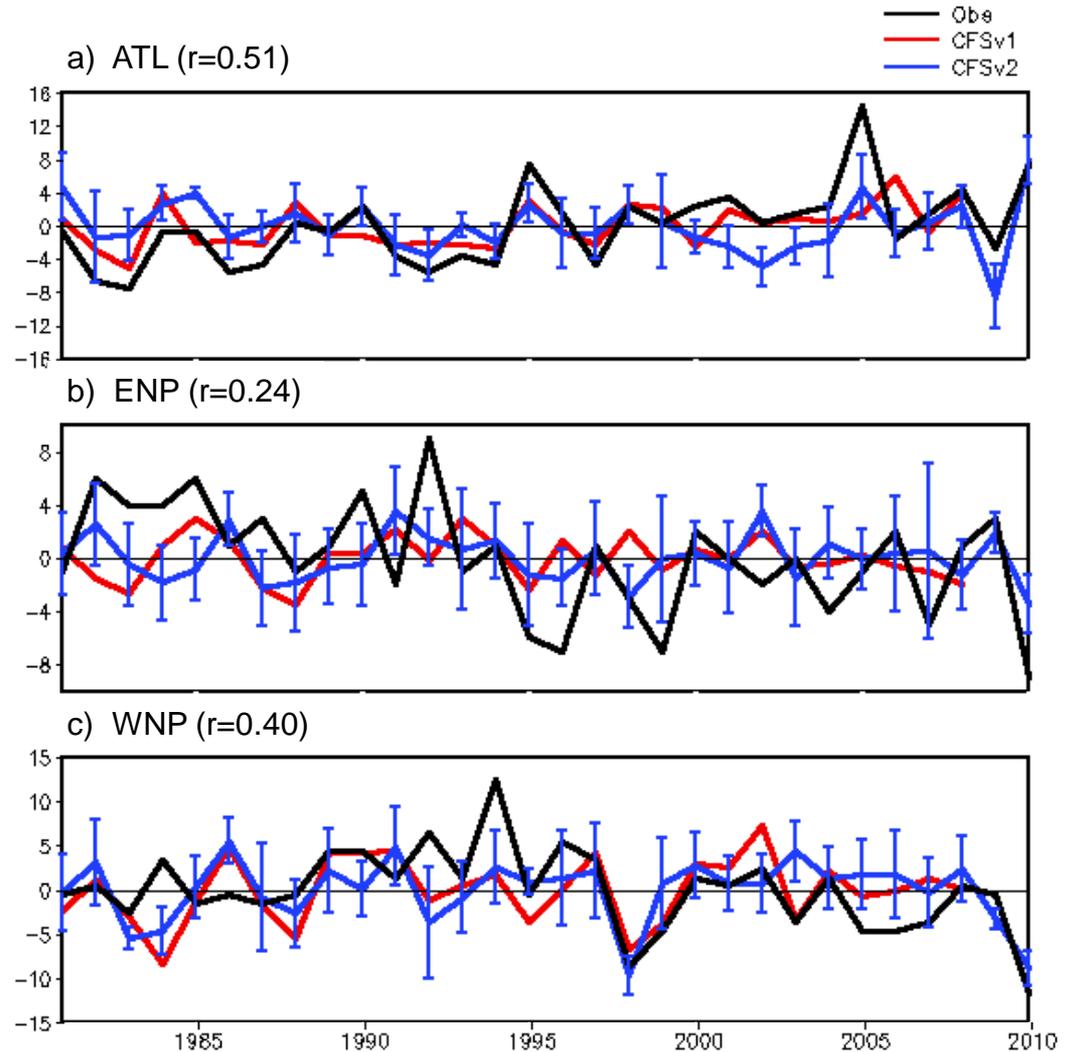
- CFSv2 does fairly well in capturing the seasonal cycle in all basins.
- It tends to overproduce storms in the earlier part of the season

Error bars represent +/- 1 Standard Deviation



Interannual Variability TS Anomaly

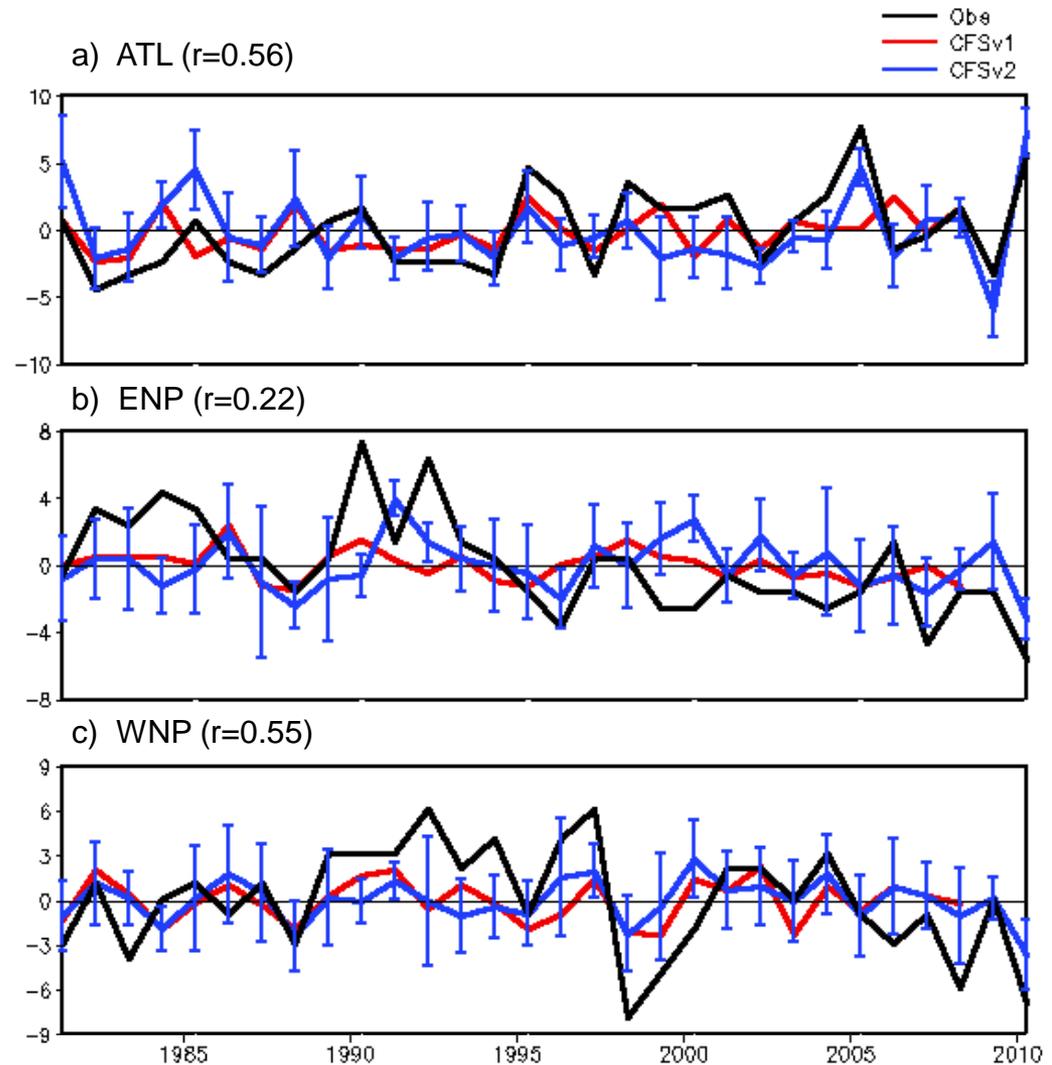
- Still need for additional improvement.
- ATL – CFSv2 lacks the upward trend in storms. Captures last decade very well.
- ENP – Much improvement over CFSv1



Error bars represent +/- 1
Standard Deviation

Interannual Variability Hurricane/Typhoon Only Anomaly

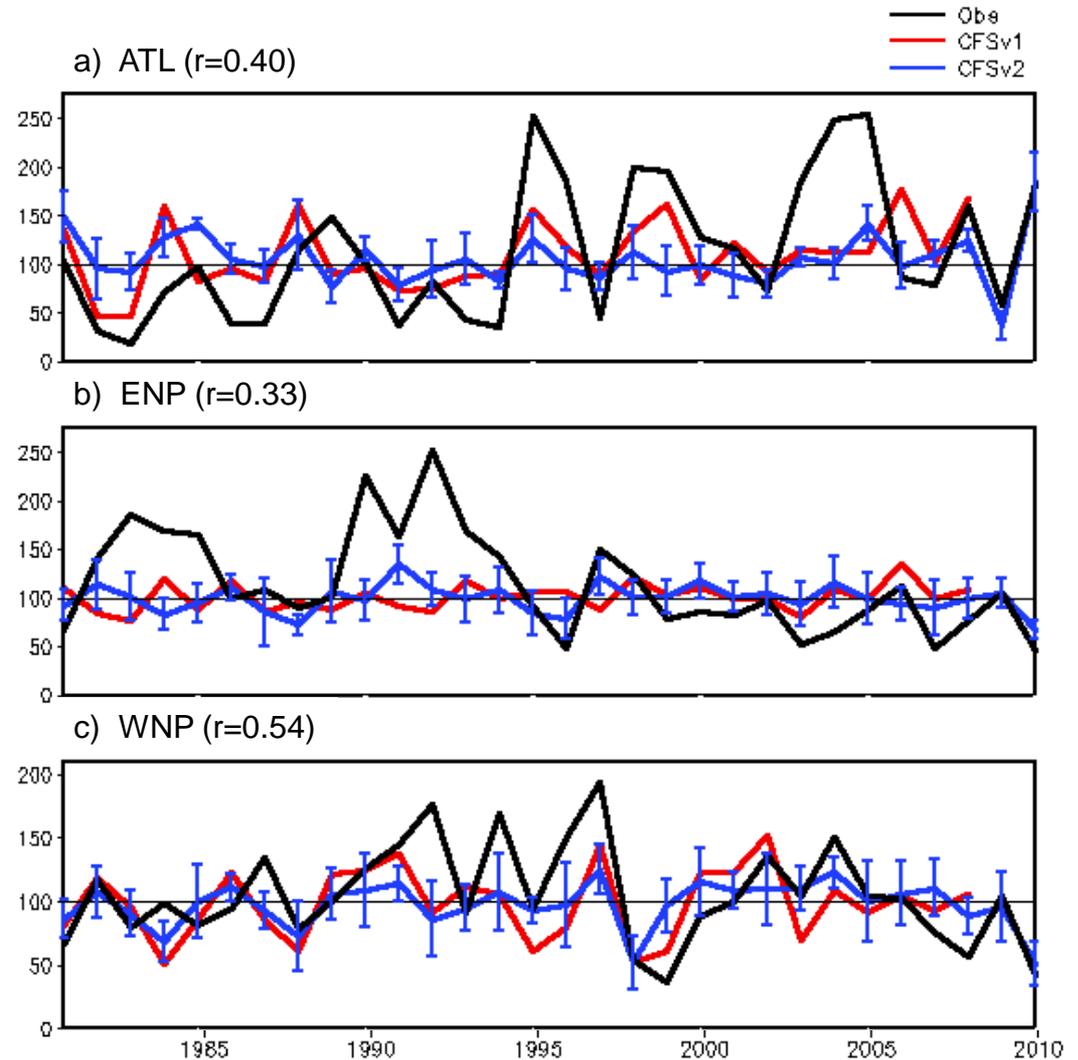
- As expected, removing TS strength storms shows improvement especially in WNP.
- ATL 2005 season better captured in CFSv2.



Error bars represent +/- 1
Standard Deviation

ACE Index (% of Median)

- ACE Index (Accumulated Cyclone Energy) measures strength of storms during season
- Models tend to simulate better than storm count



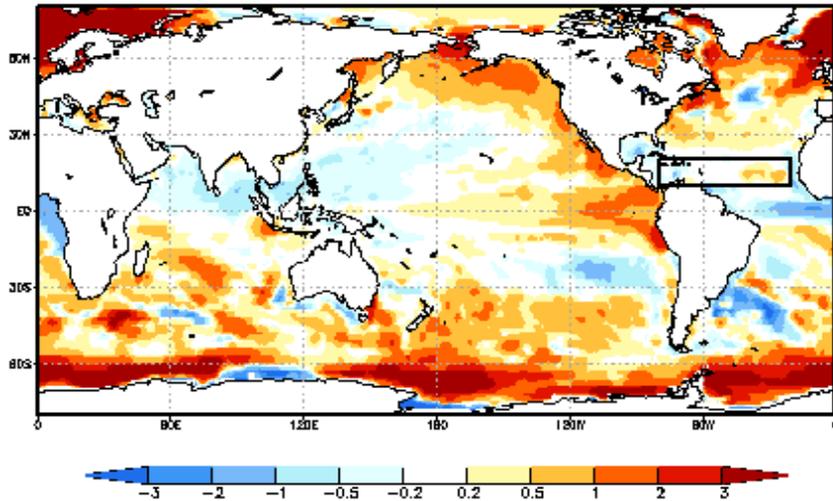
Error bars represent +/- 1
Standard Deviation

2014 Hurricane Season Prediction

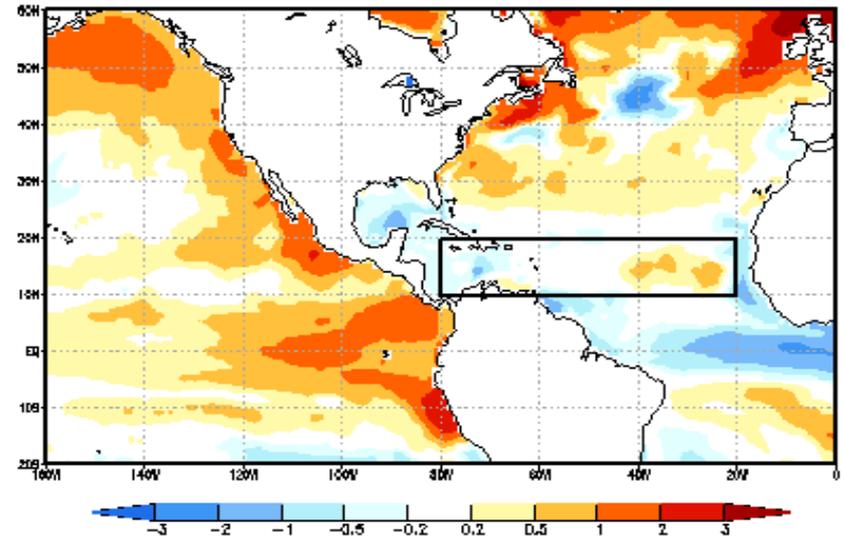
- Based on 20 member ensemble forecast runs with April 1 – 20, 2014 IC's
- Following plots are examples of information provided to the HSO forecasting team

CFSv2 T382 Forecasts, SST Anomaly

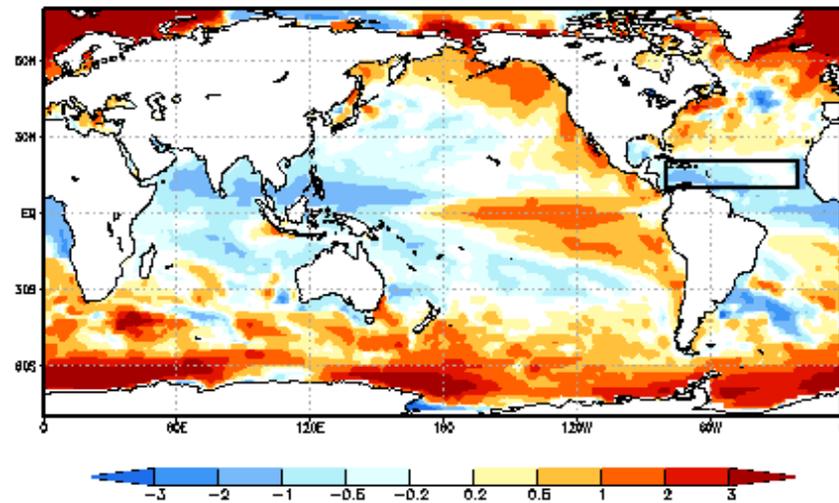
JJA 2014



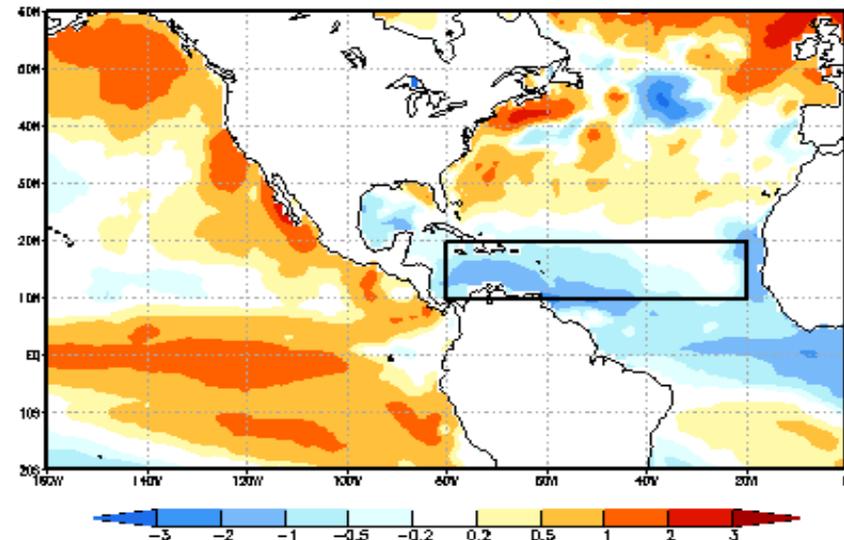
JJA 2014



SON 2014

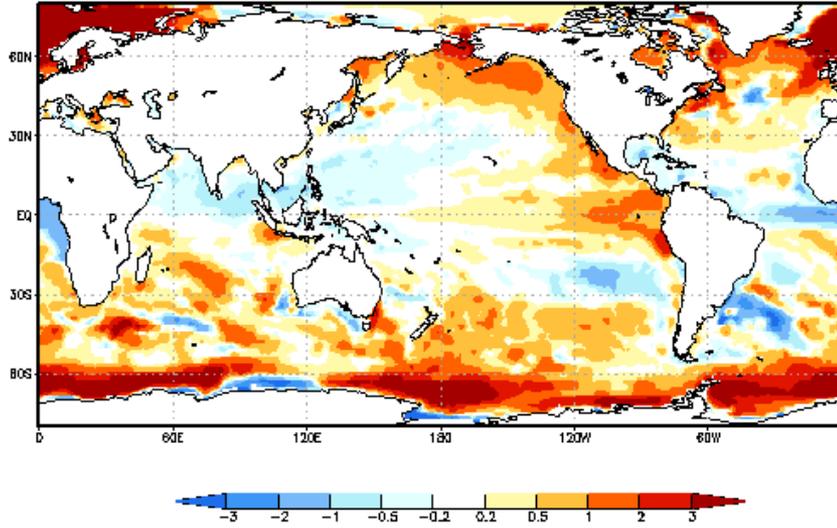


SON 2014

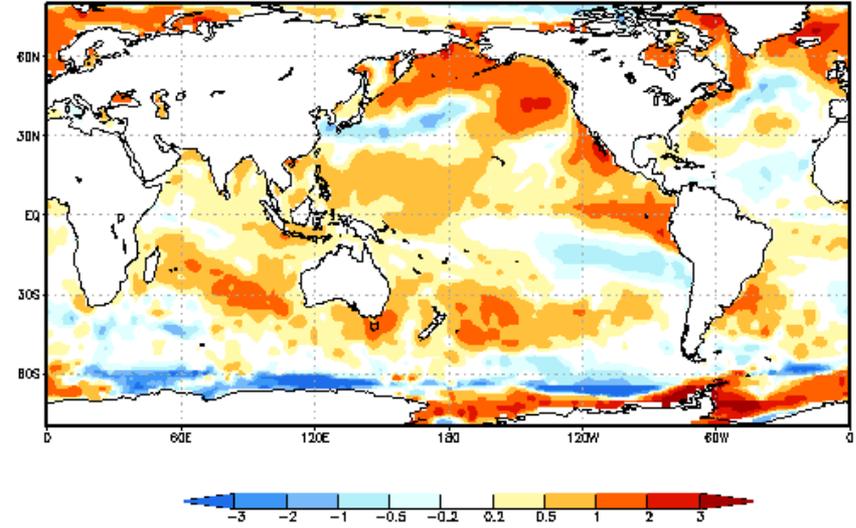


SST Anomaly Verification

Forecast Anomaly; JJA

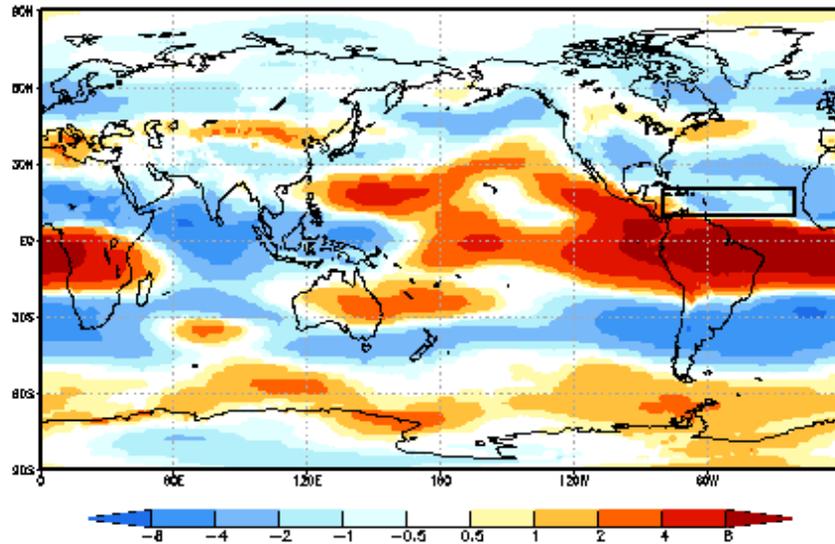


Observed Anomaly; JJA

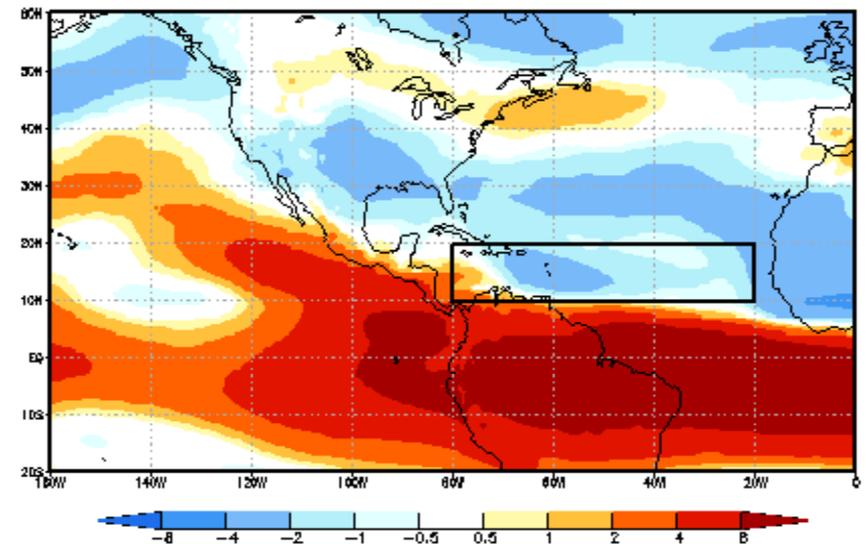


CFSv2 T382 Forecasts, Wind Shear Anomaly

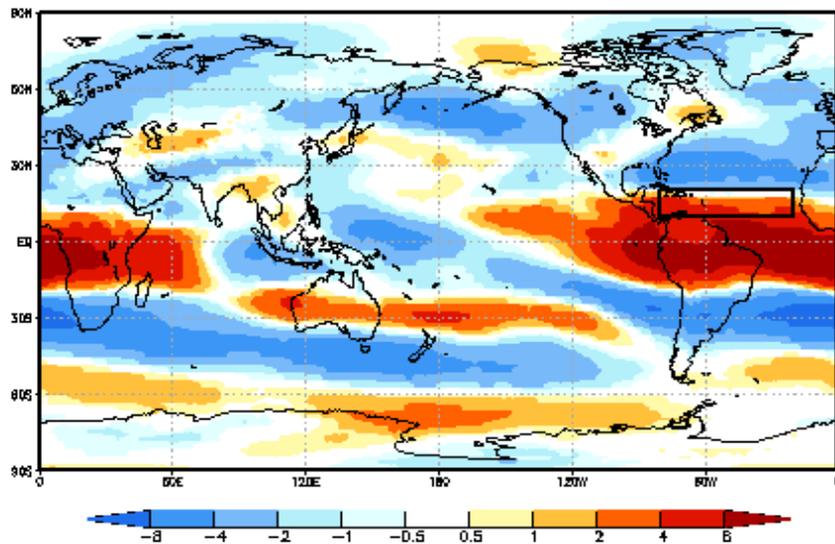
JJA 2014



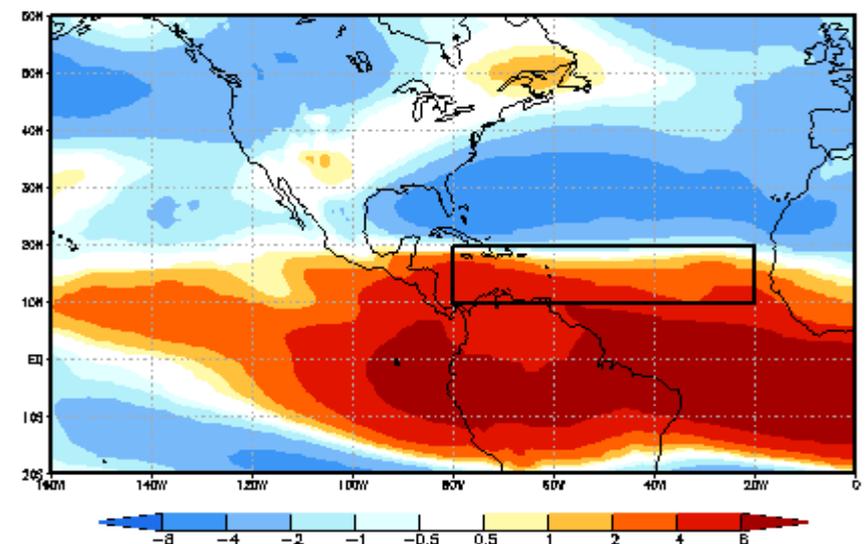
JJA 2014



SON 2014

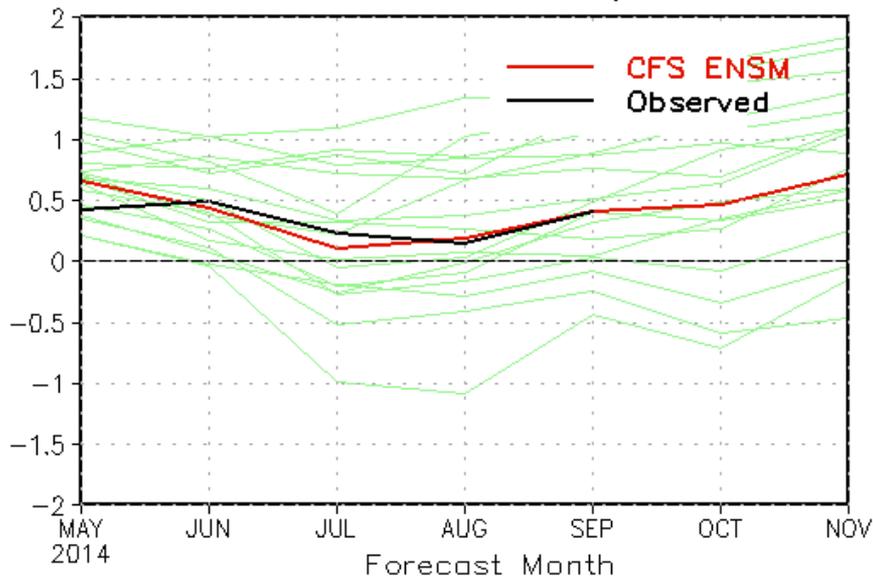


SON 2014

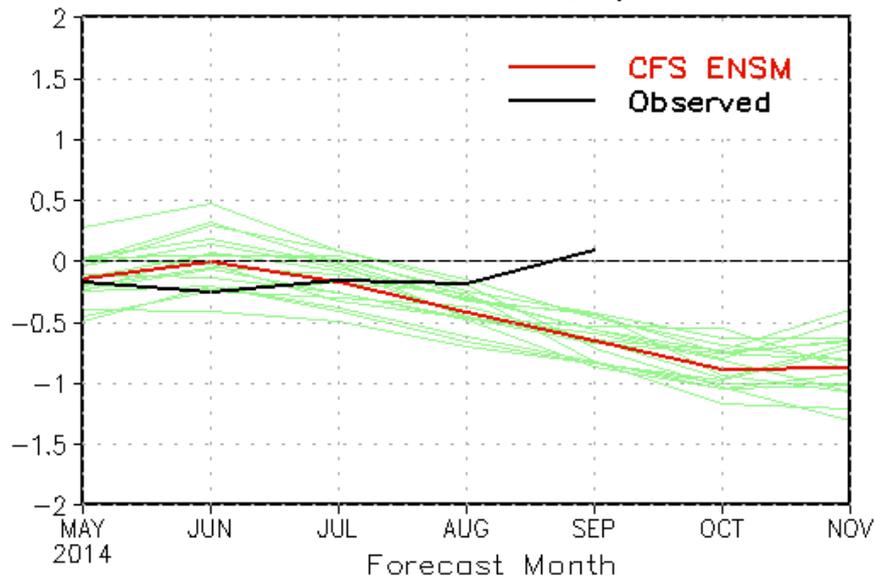


CFSv2 T382 Forecasts, SST and Shear Indices

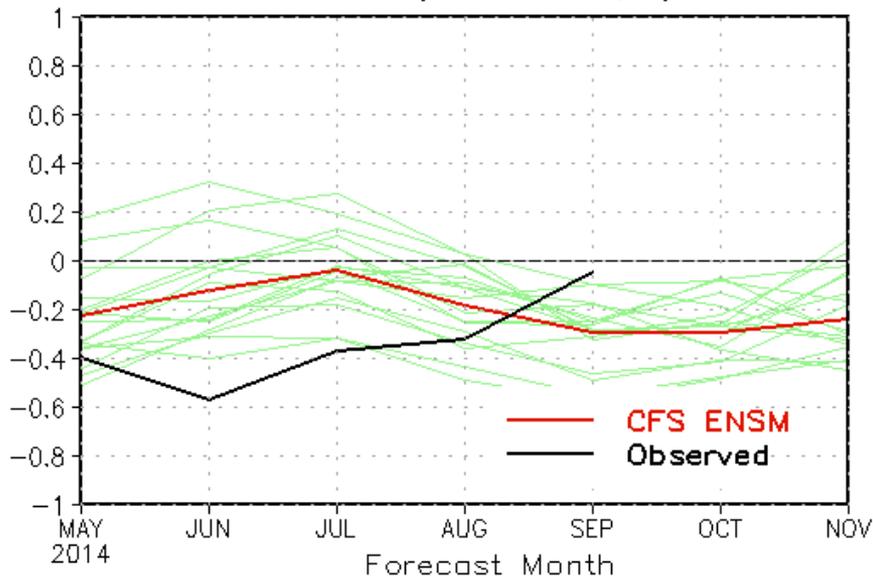
Nino3.4 SST 2014; Apr ICs



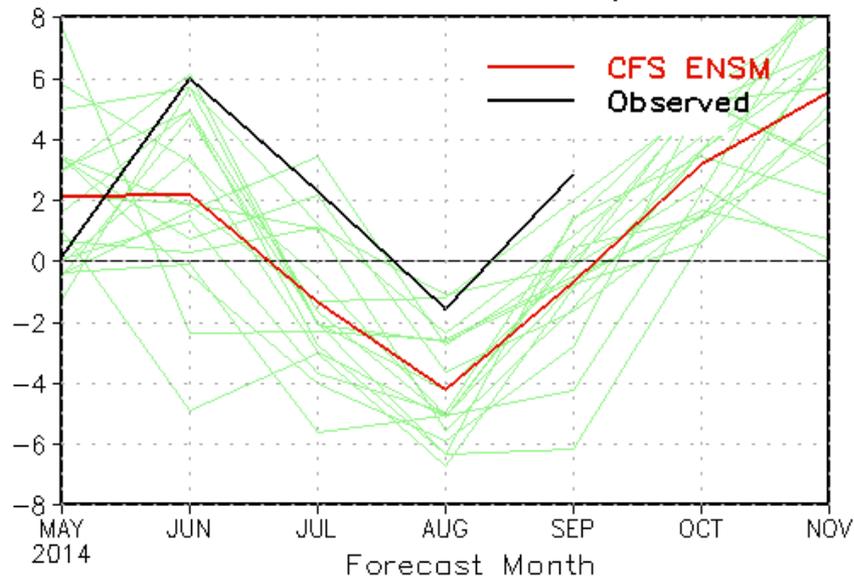
Atl MDR SST 2014; Apr ICs



MDR - GTrop SST 2014; Apr ICs



Atl MDR Shear 2014; Apr ICs



Tropical Storm, Hurricane and ACE Index Forecast Atlantic Basin

2014
Below Normal Year

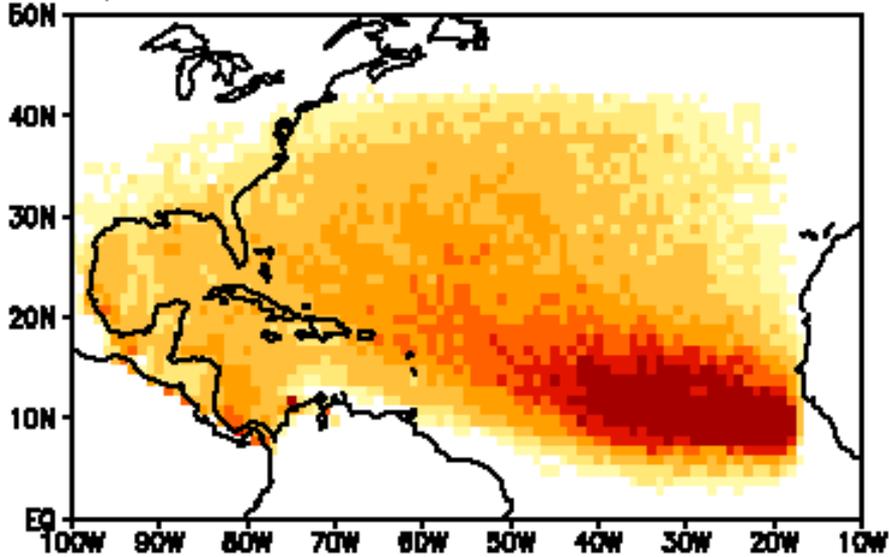
ATL	Tropical Storms	Hurricanes	ACE Index (% of Median)
Ensemble	8.4	2.0	61.1
Standard Deviation	2.8	2.2	15.6
Range	6 – 11	0 – 4	45 – 77
Obs Clim	11.6	6.4	100
Verification*	7	6	71
NOAA Forecast	8 – 13	3 – 6	40 – 100

Note: Ensemble counts have been bias corrected using observations and hindcasts from 1981-2010.

* Verification is as of 10/21/14

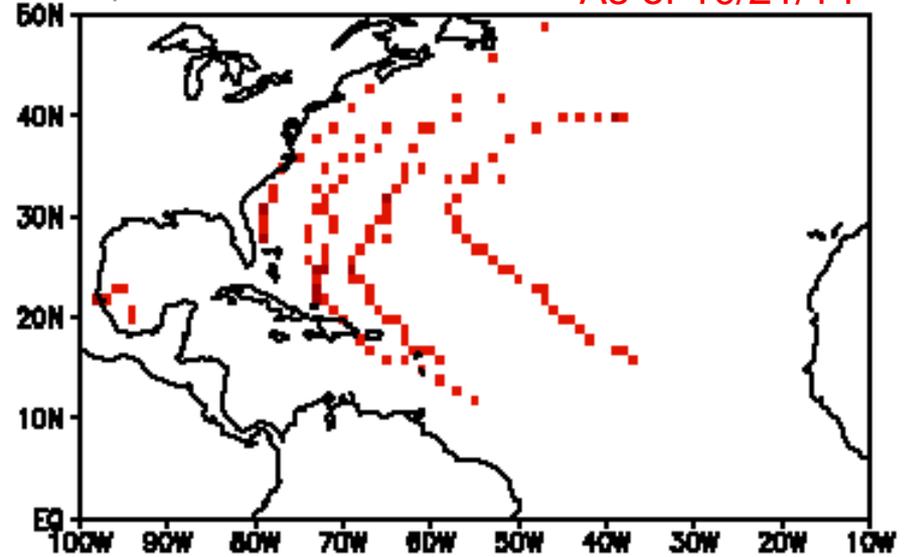
Storm Track Density Prediction

a) CFSv2 T382, 1981–2010 Clim

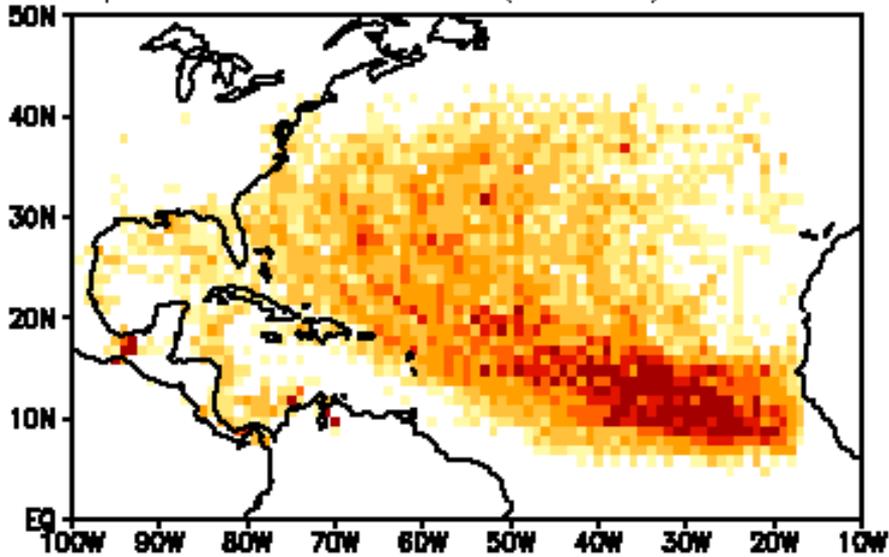


b) Observed 2014

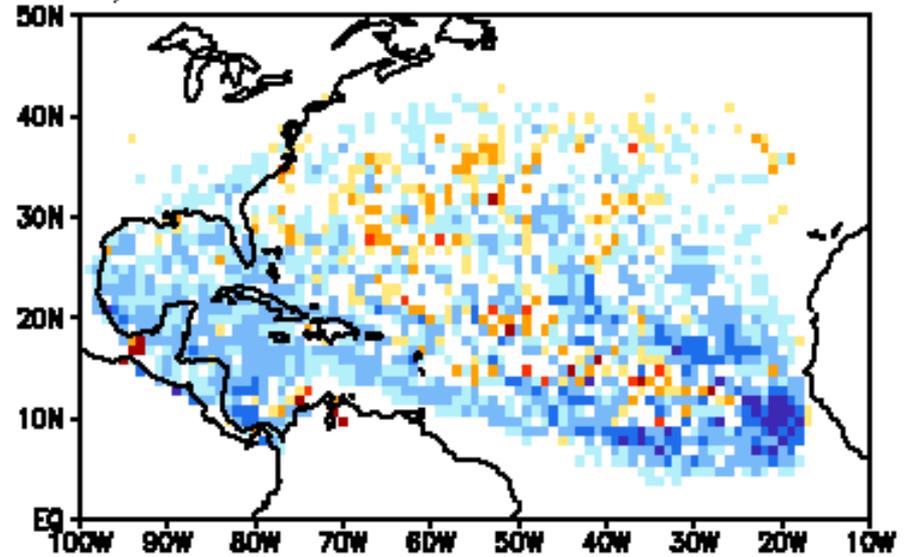
As of 10/21/14



c) CFSv2 T382, 2014 (20mem)



d) CFSv2 T382, 2014–Clim



Tropical Storm, Hurricane and ACE Index Forecast Eastern N. Pacific Basin

ENP	Tropical Storms	Hurricanes	ACE Index (% of Median)
Ensemble	17.8	5.7	82.8
Standard Deviation	3.1	2.8	17.9
Range	15 – 21	3 – 8	65 – 101
Obs Clim	16.2	8.6	100
Verification*	21	13	164
NOAA Forecast	14 – 20	7 – 11	95 – 160

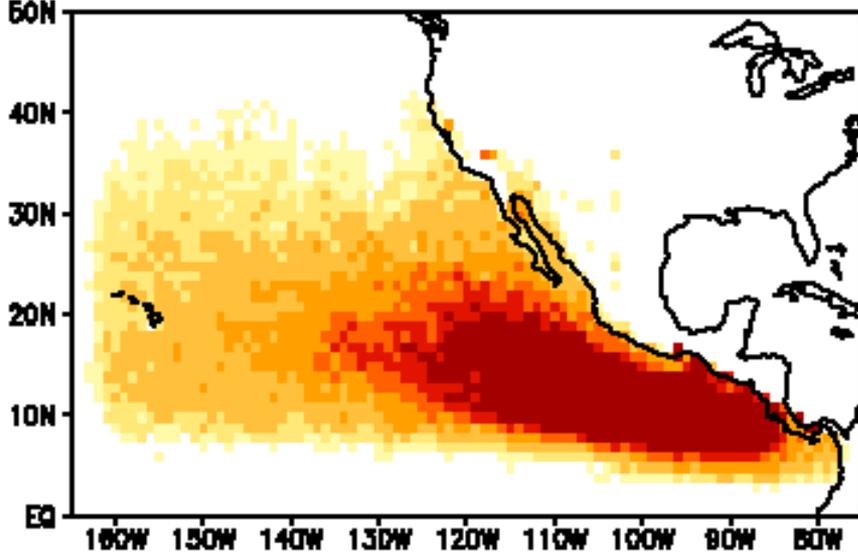
2014
Slightly Above Normal
Year

Note: Ensemble counts have been bias corrected using observations and hindcasts from 1981-2010.

* Verification is as of 10/21/14

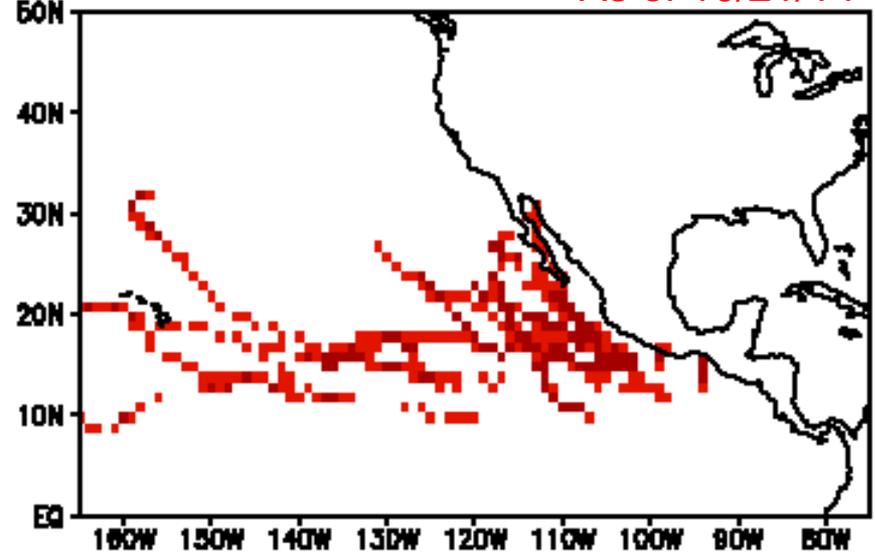
Storm Track Density Prediction

a) CFSv2 T382, 1981–2010 Clim

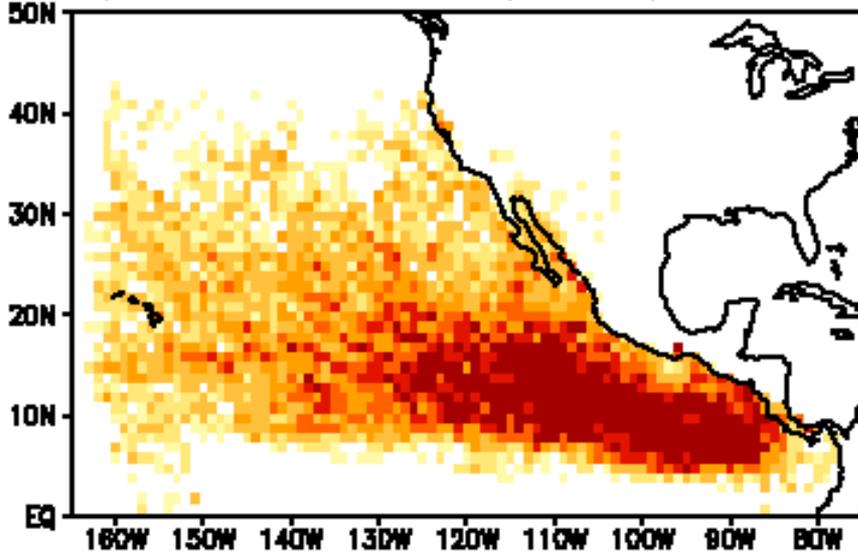


b) Observed 2014

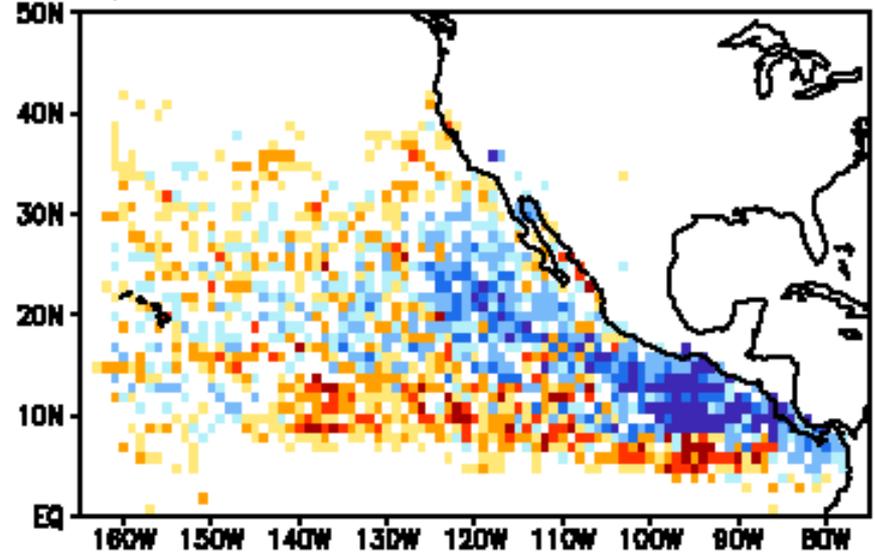
As of 10/21/14



c) CFSv2 T382, 2014 (20mem)



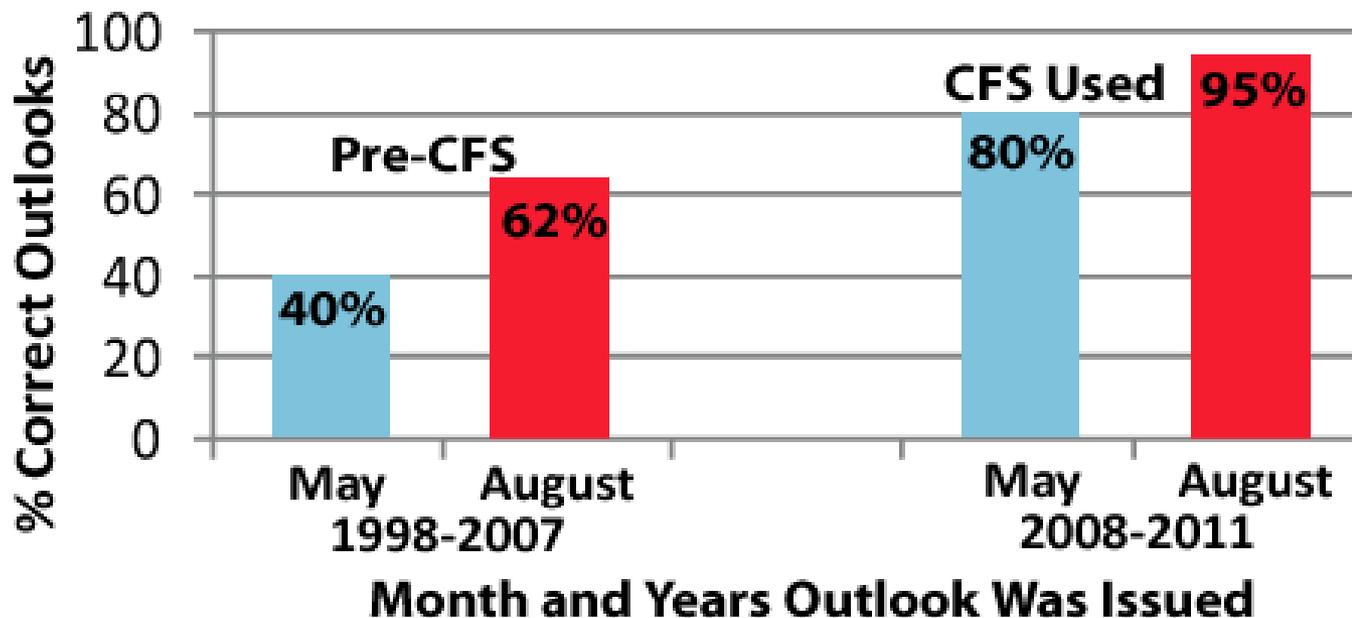
d) CFSv2 T382, 2014–Clim





Atlantic Outlook Verification: All Parameters

**NOAA: Percent of Correct Outlooks: All Parameters
1998-2007 (Pre-CFS) Compared to 2008-2011 (CFS Used)**



The use of dynamical models since 2008, especially the CFS, has contributed to a large improvement in outlook accuracy.

Summary

- A dynamic hurricane prediction system has been part of the NOAA's HSO prediction process since 2008. It has contributed significantly towards recent increase in the accuracy of the ATL HSO.
- The dynamic system was upgraded to the T382 CFSv2 in 2014, shows improvement in some basins.
- The new system predicted below normal season for ATL and above normal season for ENP for 2014