Dynamic Hurricane Season Prediction with the NCEP CFS CGCM

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Outline

- CFS in the NOAA Hurricane Season Outlooks

    - 2013 NOAA Hurricane Season Outlooks

    - T382 version of CFS for hurricane season prediction

    - Analysis of tropical storm statistics and performance

    - Impact of dynamic input on the NOAA HSO

NOAA 2013 Hurricane Season Outlooks

Season and Activity Type	Atlantic Outlook	E. Pacific Outlook
Chance Above Normal	70%	10%
Chance Near Normal	25%	35%
Chance Below Normal	5%	55%
Named Storms (NS)	13-20	11-16
Hurricanes (H)	7-11	5-8
Major Hurricanes (MH)	3-6	1-4
ACE (% Median)	120%-205%	60%-105%

On May 23, NOAA released the 2013 Outlooks. We are predicting an above average year for the Atlantic and a below average year for the Eastern Pacific.

Model Summary: May 2013 Atlantic Outlook

Model	Named Storms	Hurricanes	Major Hurricanes	ACE (% Median)
CPC Regression:	14-18 (16)	7-9 (8)	3-4.5 (3.75)	140-170 (155)
CPC Binning : Nino 3.4+SSTA	7.9-21.5 (14.7)	4.2-11.5 (7.85)	2.1-5.9 (4)	69-217 (143)
CPC Binning ENSO+SSTA	10.1-21 (15.55)	5.2-11.7 (8.45)	2.8-5.9 (4.35)	106-229 (167)
CFS: Hi-Res T-382 (bias corrected)	14.4-17.4 (15.9)	5.2-11.2 (8.2)		119-206 (163)
CFS V2 Hybrid: 1	11-15 (13)	6-8 (7)	3-4 (3.5)	103-156 (130)
CFS V2 Hybrid: 2	12-16 (14)	6-9 (7.5)	3-4 (3.5)	112-169 (141)
CFS V2 Hybrid: 3	12-16 (14)	6-9 (7.5)	3-4 (3.5)	110-170 (140)
GFDL Hybrid		6-11 (8.4)		
ECMWF:	7.3-14.5 (10.9)	4.1-10.1 (7.1)		64-141 (103)
EUROSIP:	7.6-14.4 (11)			
UKMET				
Guidance Mean	10.7-17.1 (13.9)	5.5-9.9 (7.8)	2.8-4.7 (3.8)	103-182 (143)

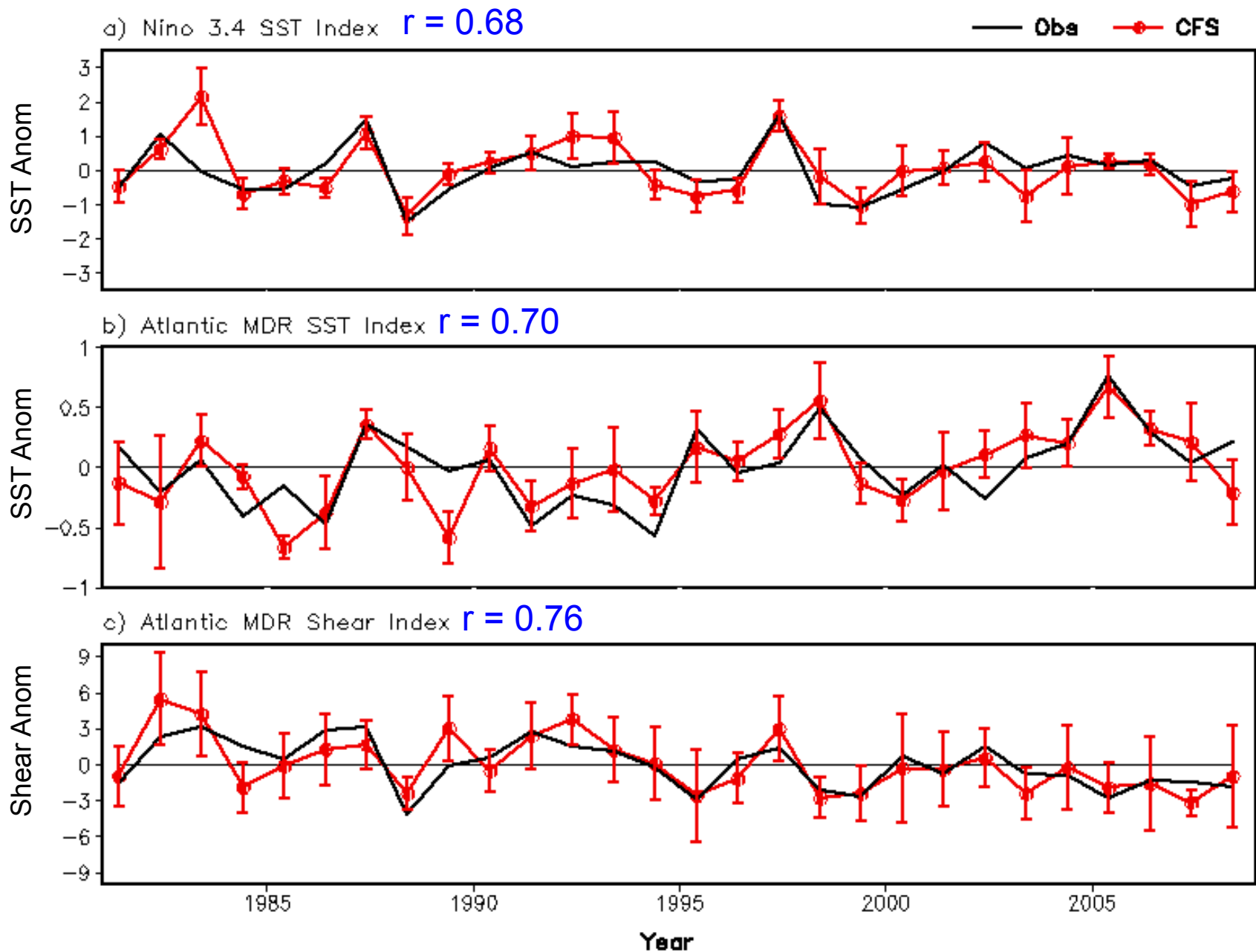# Dynamic Hurricane Season Prediction with the T382 CFS

The T382 CFS Hindcast Experiments

- Experimental hurricane season prediction project initiated as an internal Climate Testbed (CTB) project in 2007 as a collaborative effort between the NCEP CPC and EMC

- AGCM - 2007 operational NCEP GFS in T382/L64 resolution
  LSM - Noah LSM
  OGCM - GFDL MOM3

- Historical case study performed for 1981-2008: All runs initialized with NCEP/DOE R2 and NCEP GODAS.
  Initial conditions at 00Z, April 19-23. Forecasts extend to December 1. Output every 6 hours.

- Tropical cyclone detection and tracking method based on Carmago and Zebiak (2002)
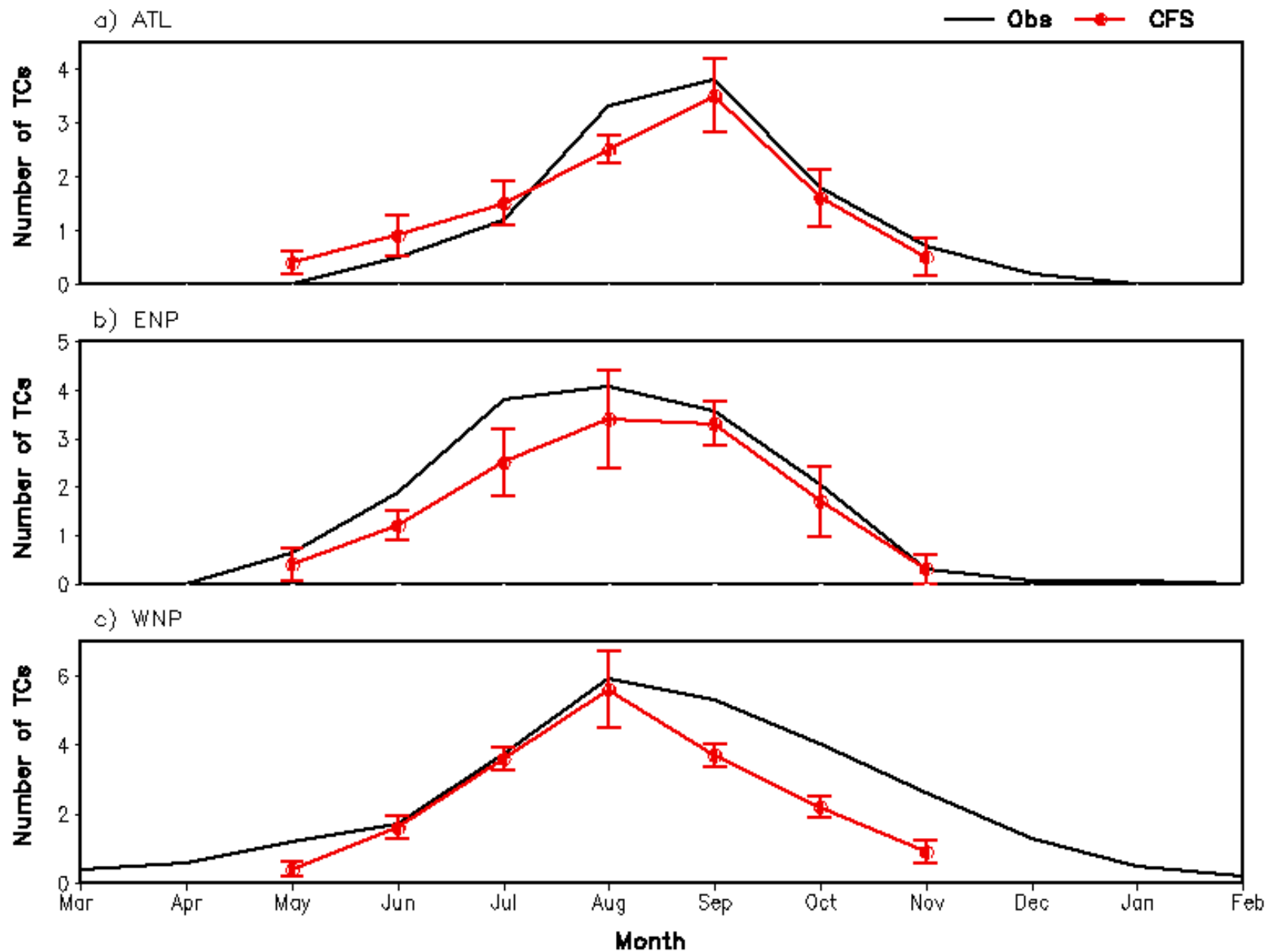
Detection & Tracking Method

- 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 CFS at T382, created using 5-member hindcasts for 1981-2008
- Observations from the HURDAT and JTWC Best Track Datasets
- Tropical depressions and subtropical storms are not included in storm counts.

T382 CFS – Indices for JJAS

a) Nino 3.4 SST Index r = 0.68

b) Atlantic MDR SST Index r = 0.70

c) Atlantic MDR Shear Index r = 0.76

T382 CFS – Seasonal Cycle of TCs

Interannual Variability
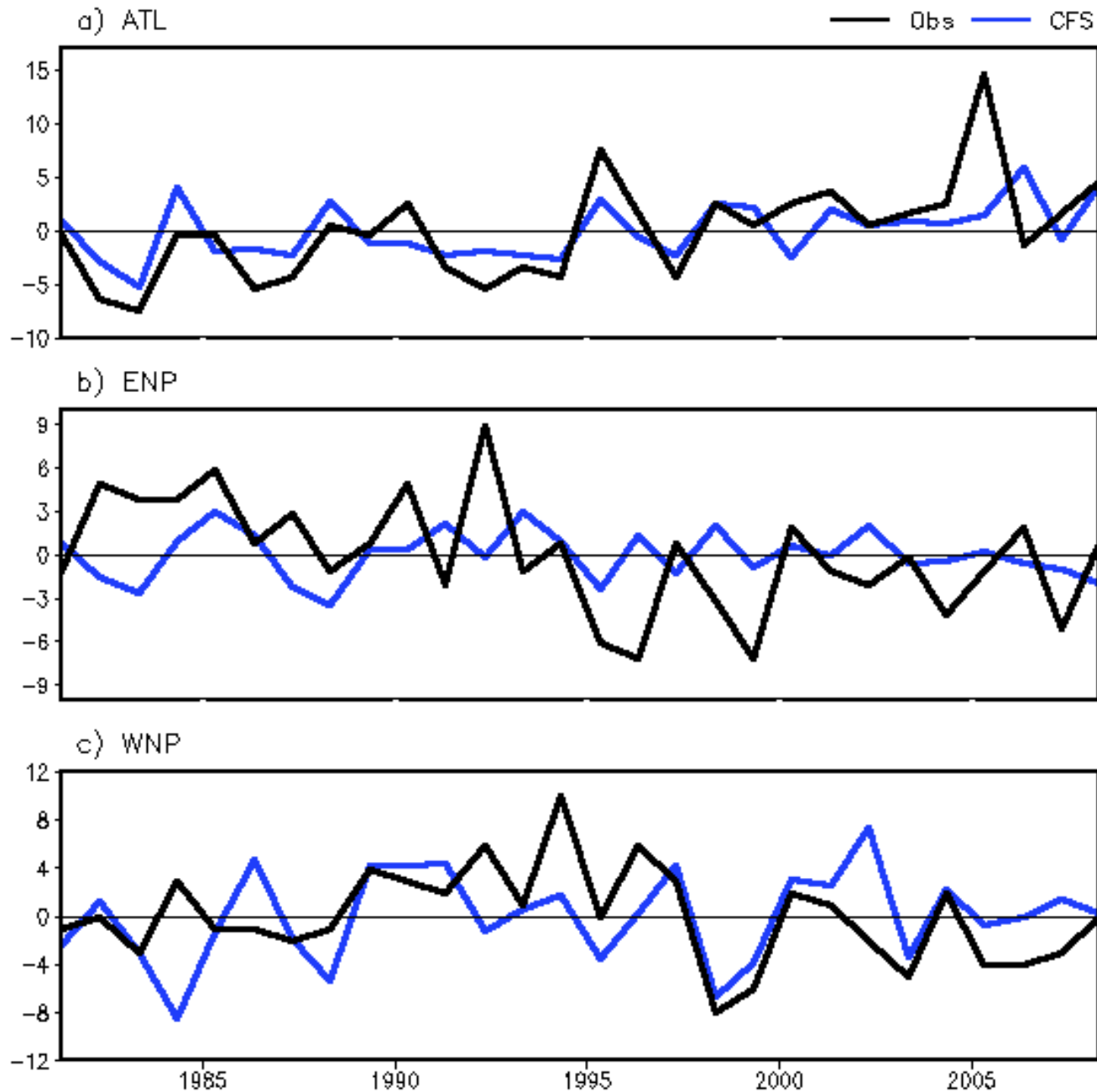
a) ATL

b) ENP

c) WNP

Obs — CFS

Spearman Rank Correlation

r=0.63

r=-0.07

r=0.43

* Bold = significant

CFS Hurricane Season Prediction for the 2009 – 2012 Seasons

Past Forecasts and Verification; ATL

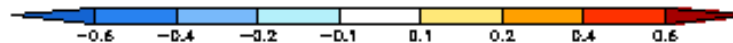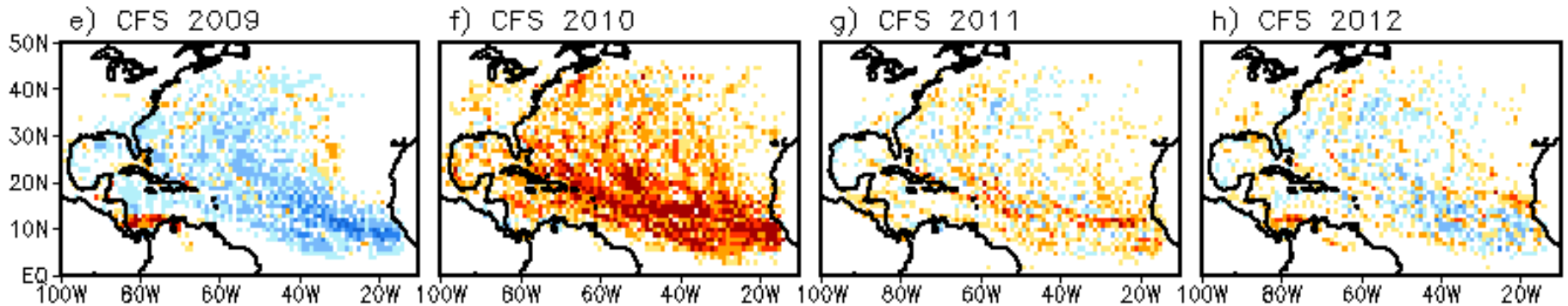|	Atlantic Basin	Tropical Storms	Hurricanes	ACE Index (% of Median)
2009	Ensemble	7.9	5.1	82.8
	Range	6 - 10	4 - 6	61 - 104
	Verification	9	3	57
2010	Ensemble	22.0	13	262.3
	Range	19 - 25	10 - 16	212 - 312
	Verification	19	12	185
2011	Ensemble	14.4	7.5	144.6
	Range	11 - 18	5 - 10	100 - 189
	Verification	19	7	134
2012	Ensemble	12.9	6.2	124.4
	Range	11 - 15	4 – 8	89 - 160
	Verification	19	10	149

Past Forecasts and Verification; ENP

	ENP Basin	Tropical Storms	Hurricanes	ACE Index (% of Median)
2009	Ensemble	16.4	8.1	97.0
	Range	15 – 18	7 – 9	74 – 120
	Verification	17	7	99.3
2010	Ensemble	15.4	7.1	75.4
	Range	12 – 19	6 – 8	52 – 99
	Verification	7	3	29
2011	Ensemble	16.1	9.0	99.1
	Range	14 – 18	7 – 11	75 – 123
	Verification	11	10	94
2012	Ensemble	17.0	9.9	117.5
	Range	15 – 19	8 – 12	86 – 149
	Verification	17	10	78

Track Prediction (anomalous storm day density for CFS)

Observed Actual Tracks

a) Best Track 2009 b) Best Track 2010 c) Best Track 2011 d) Best Track 2012
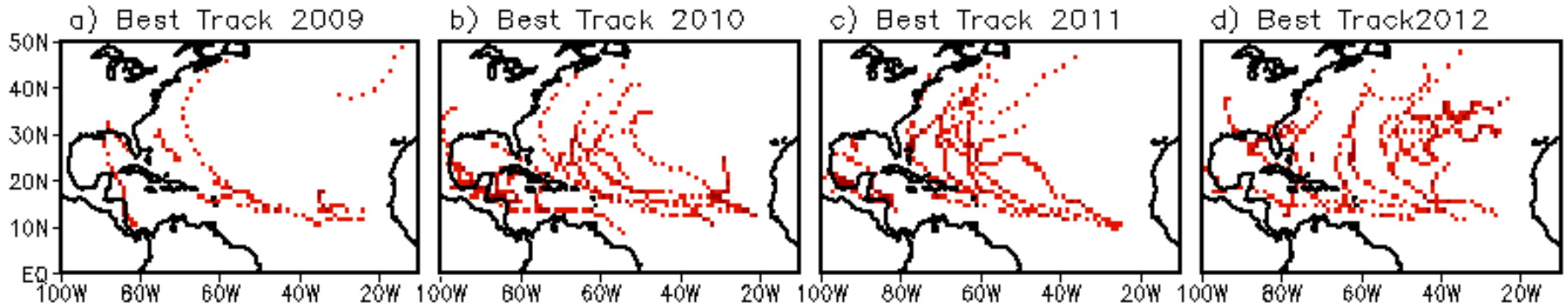
Anomalous Storm Day Density from CFS Forecasts
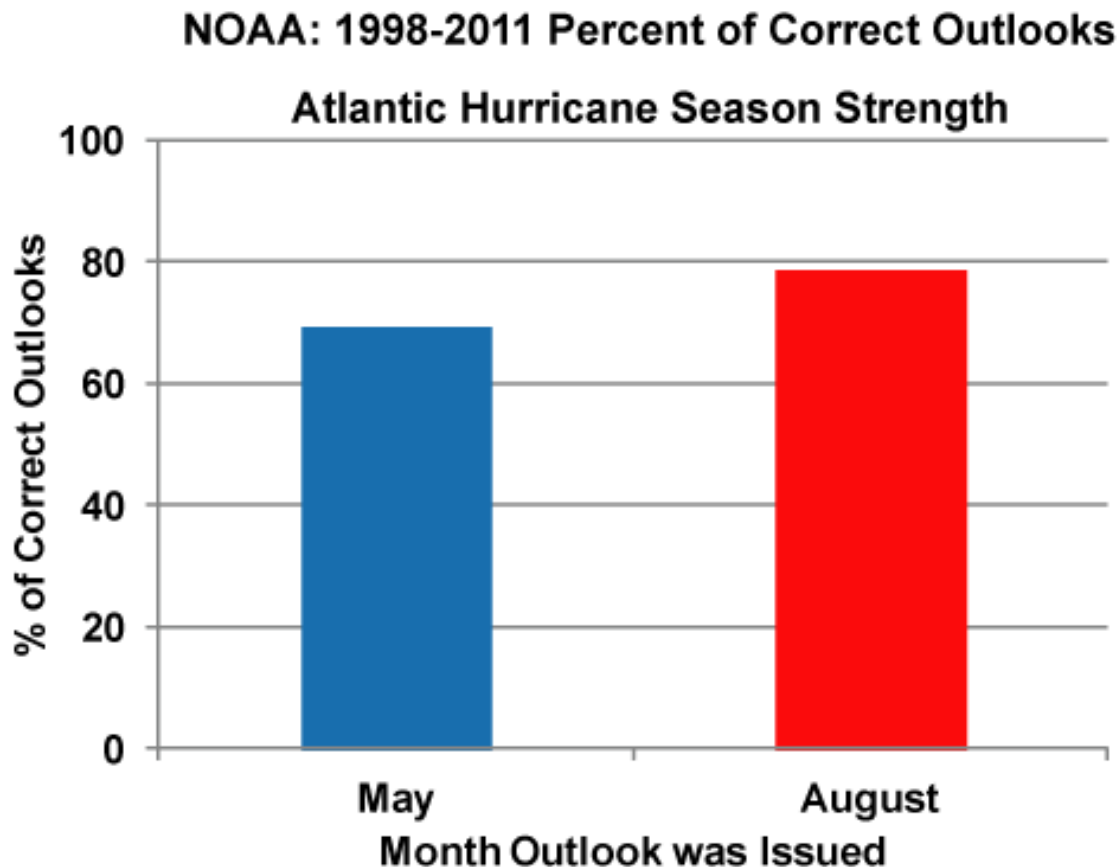

e) CFS 2009 f) CFS 2010 g) CFS 2011 h) CFS 2012

Impact of Dynamic Prediction Input on the NOAA Atlantic Hurricane Season Outlook Verifications

Verification for Hurricane Season Strength
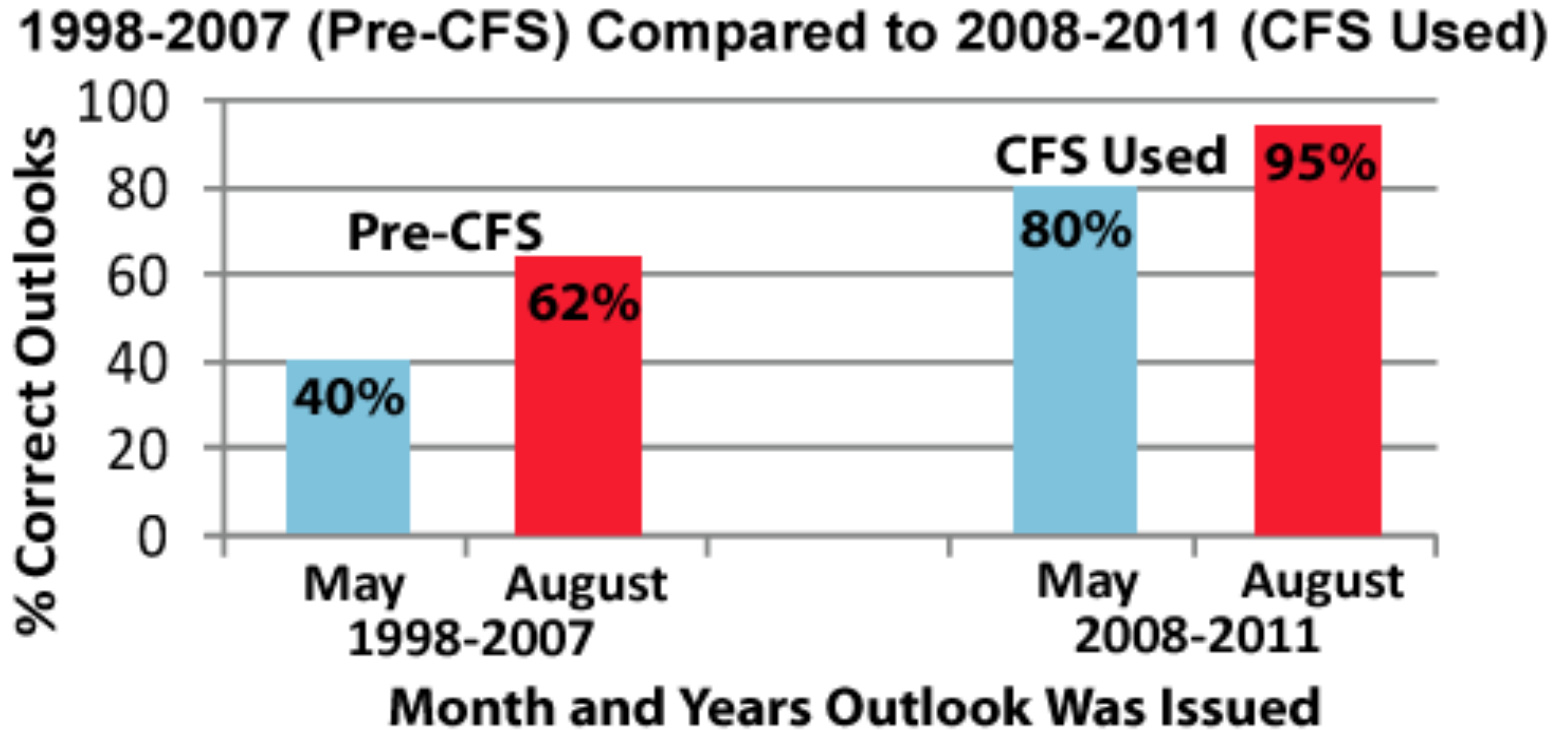

NOAA: 1998-2011 Percent of Correct Outlooks

Atlantic Hurricane Season Strength

NOAA's Atlantic hurricane season outlooks issued in May have correctly predicted the season strength (Above-, near-, or below-normal) 70% of the time. Outlooks issued in August were correct 79% of the time.

Atlantic Outlook Verification

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

Summary

➤ CFS in T382 resolution exhibits robust climatological seasonal cycle of tropical cyclones over three NH basins.

➤ Warming trend and intensification of hurricane activity in the Atlantic basin captured in the CFS hindcasts.

➤ Fair level of skill in predicting interannual variability of seasonal storm activities for the Atlantic and West. N. Pacific basins.

➤ Addition of dynamical prediction tools has contributed considerably to much improved HSO performance since 2008.

➤ Currently exploring ways to utilize track predictions for landfall probability distribution

➤ Future plans include an upgrade of the hurricane season prediction system to T574 (~25 km) or higher resolution by 2015 and usage of the NOAA NMME forecast system.