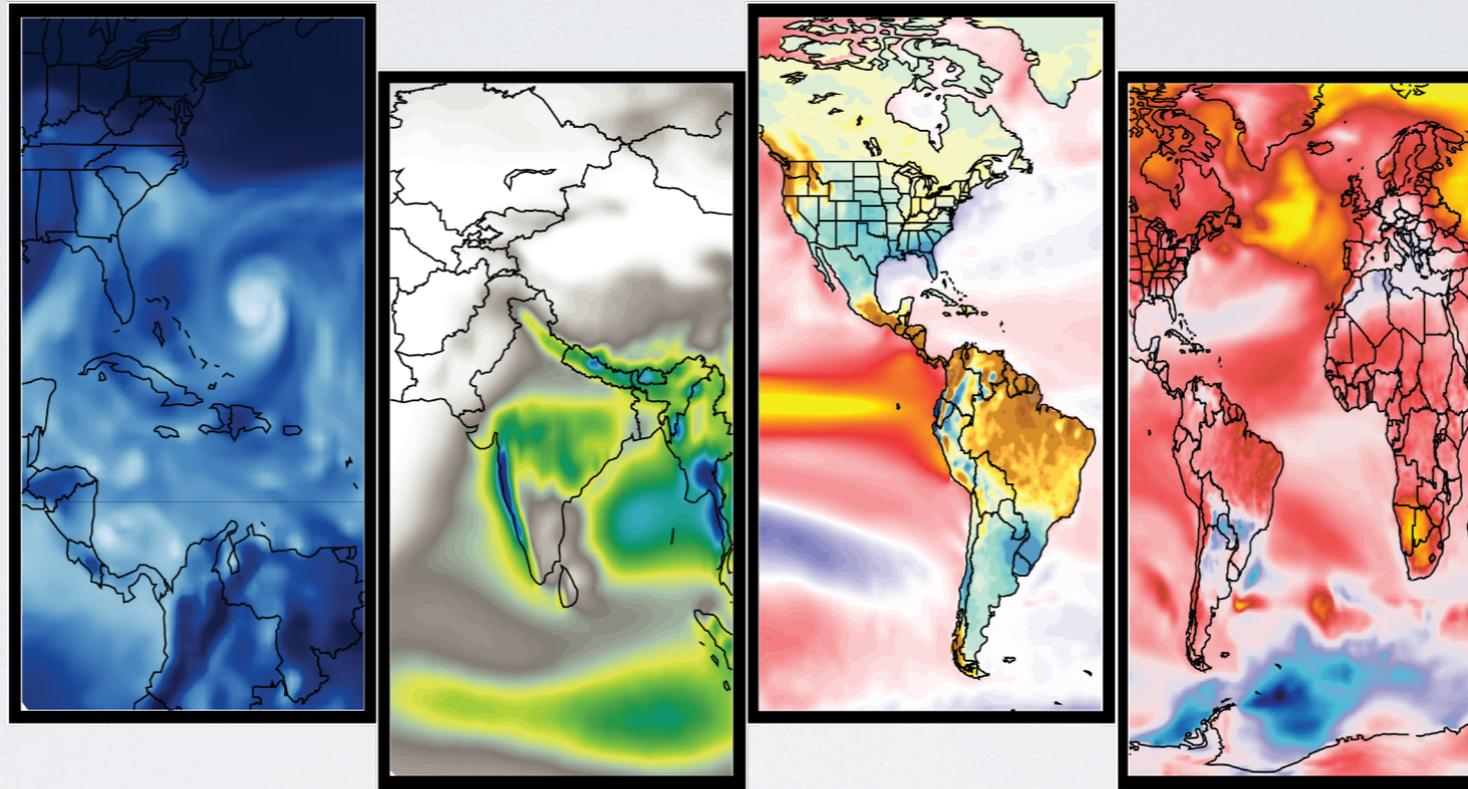


Towards Seasonal Predictions of Regional Hurricane Activity

NOAA/GFDL Climate Variations and Predictability Group

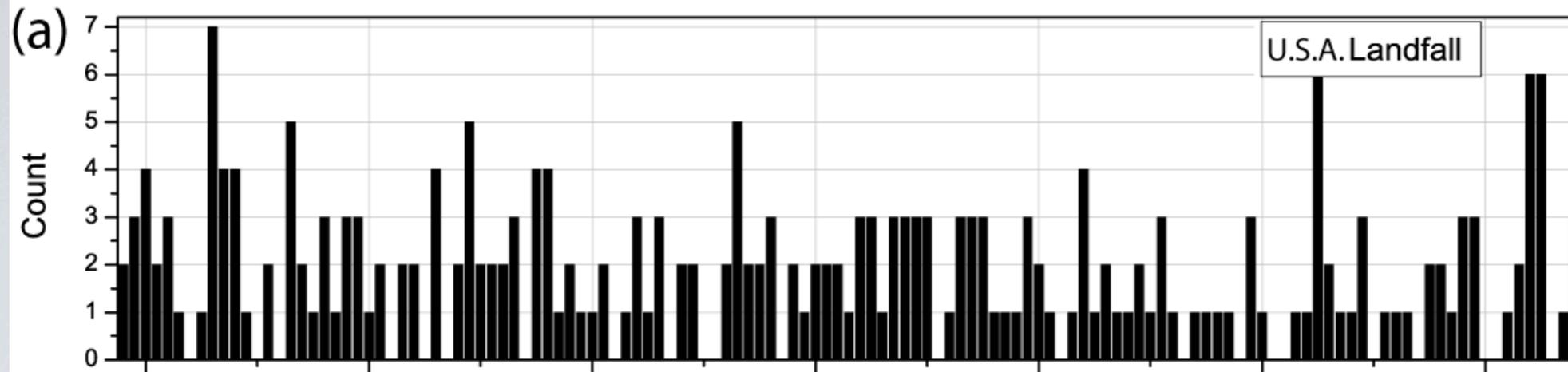


Hypothesis: Enhanced resolution & corrected large-scale climate improve simulation and prediction of regional climate & extremes.

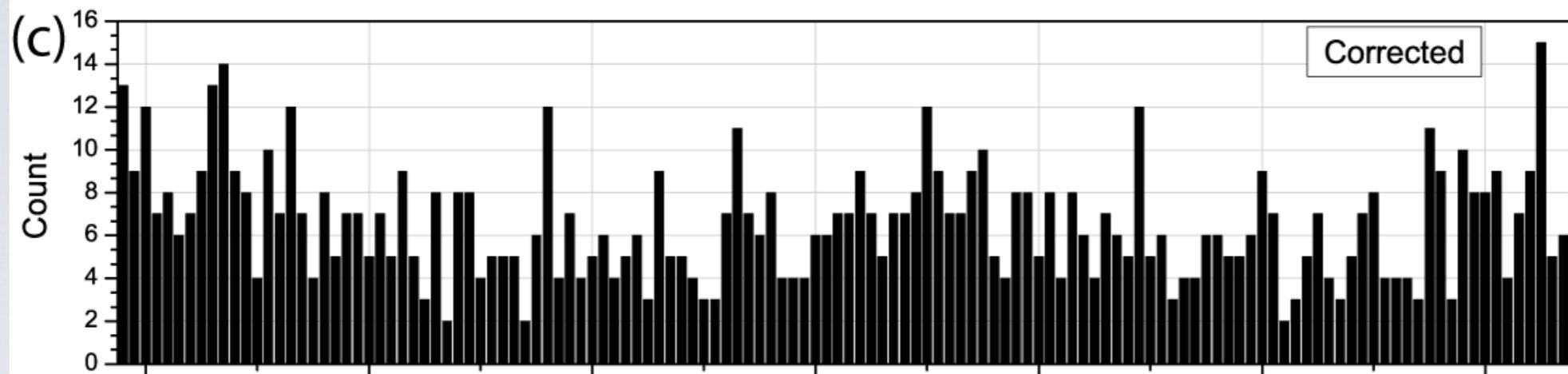
Practical Goal: Build a intraseasonal to multi-decadal forecasting systems to:

- Yield improved forecasts of large-scale climate
- Enable forecasts of regional climate and extremes

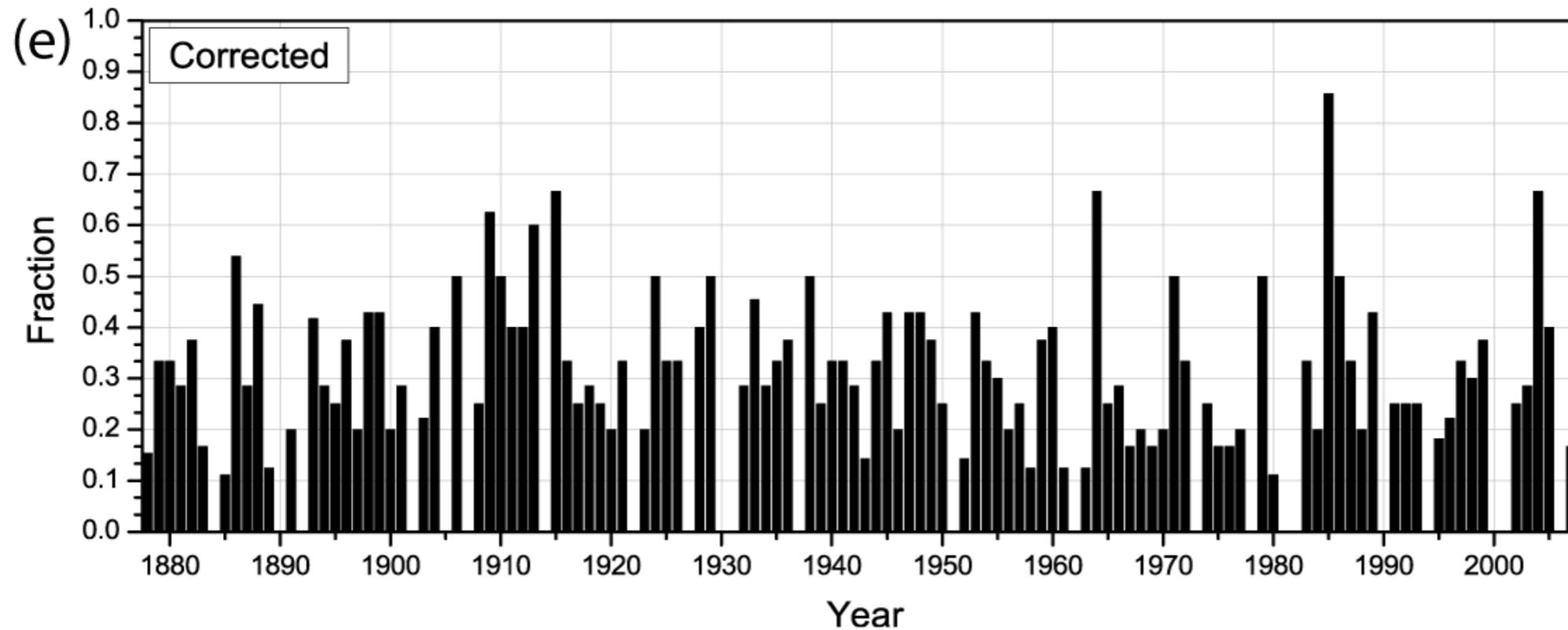
Seasonal hurricane counts



U.S. Landfalling
Hurricanes



Basinwide
Hurricanes



Fraction of
Basinwide
Hurricanes
Making U.S.
Landfall

Hybrid Statistical-Dynamical, based on two SST indices, show skill in single GCM and 2-GCM predictions

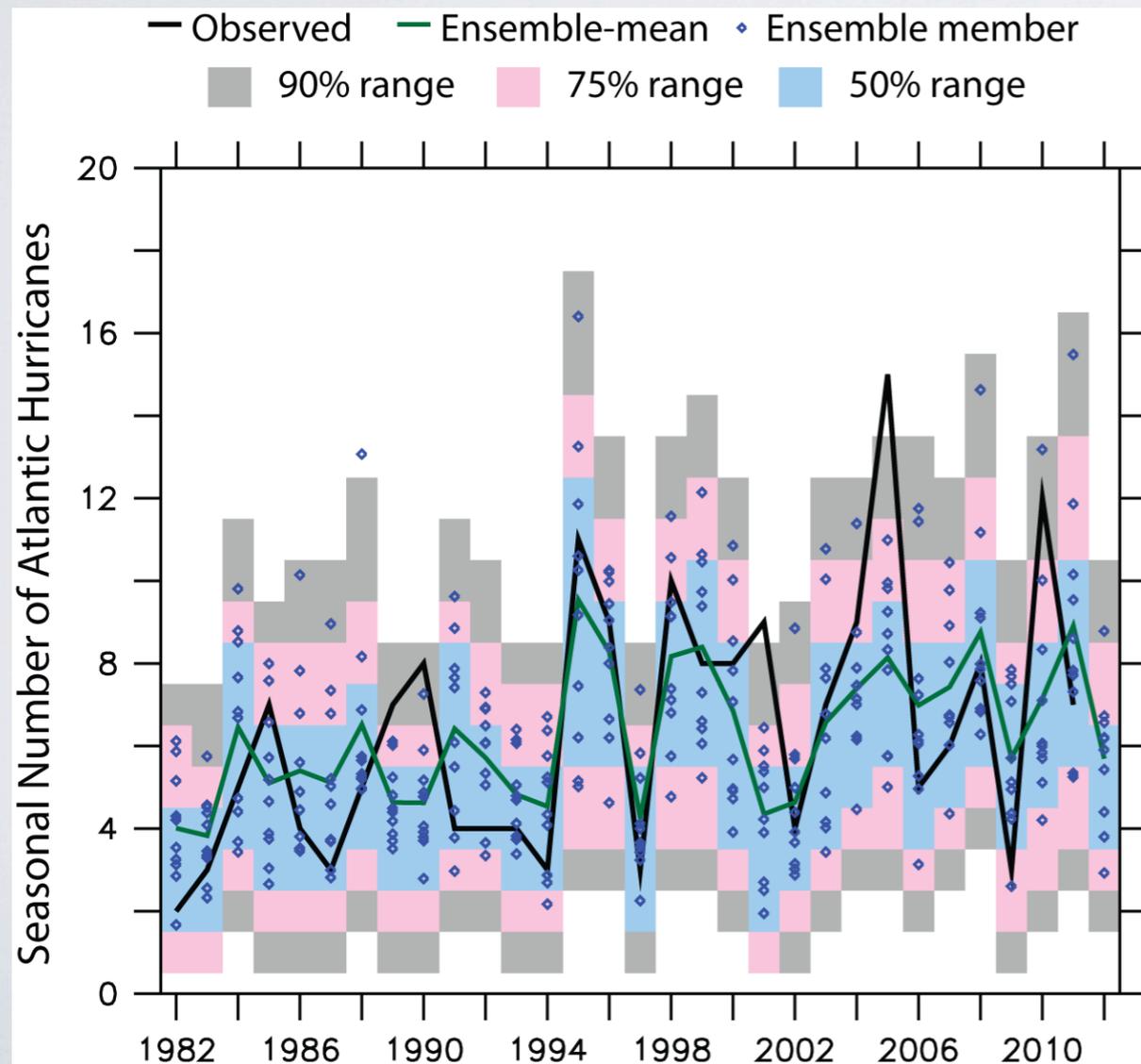
April & onward forecasts fed to NOAA Seasonal Outlook Team

Hi-Res AGCM in many different climates. Count storms.

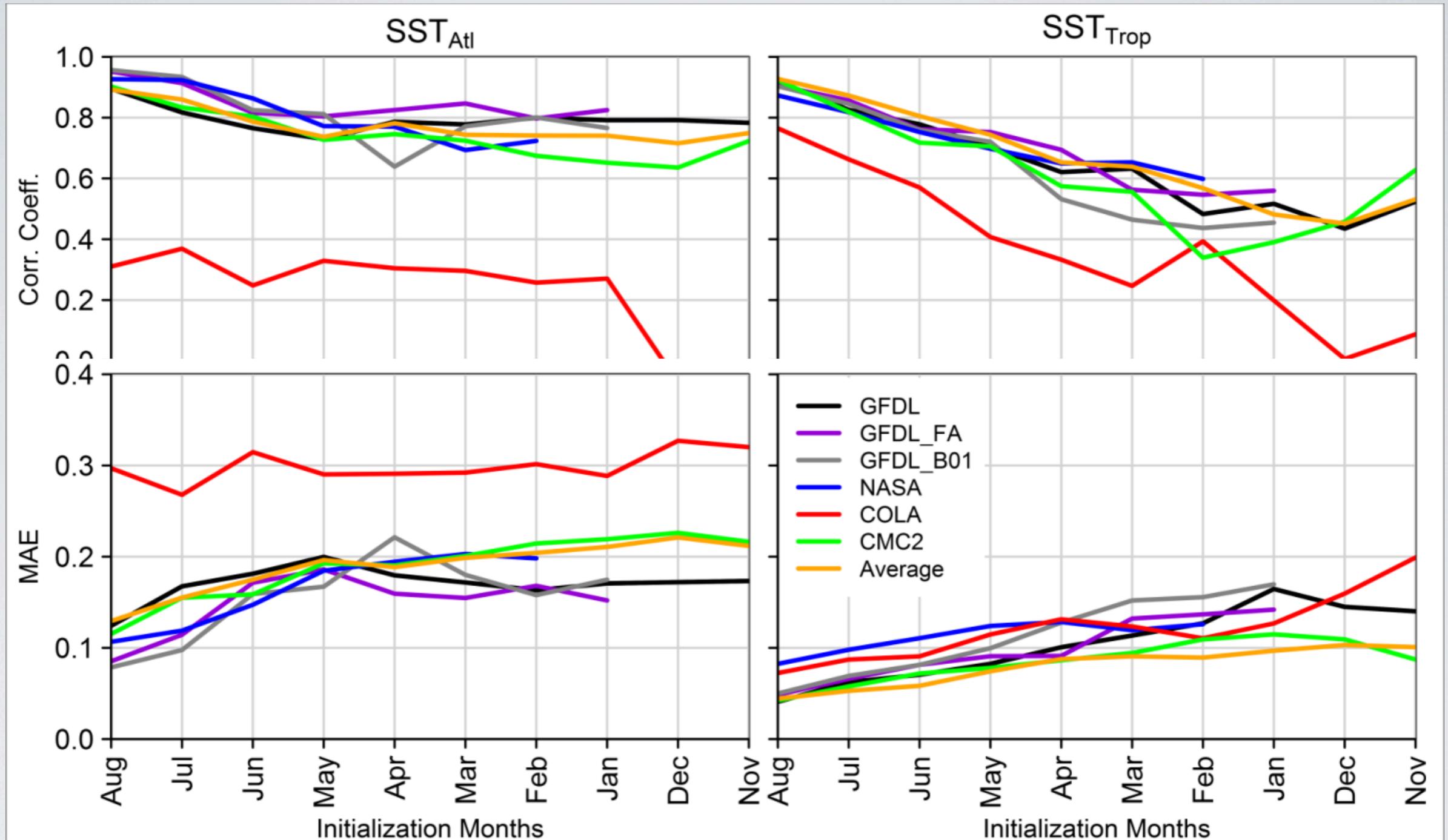
Build statistical model of the response of hurricanes in HiRAM

Use initialized coupled model to forecast future values of SST

Initialized January: $r=0.66$

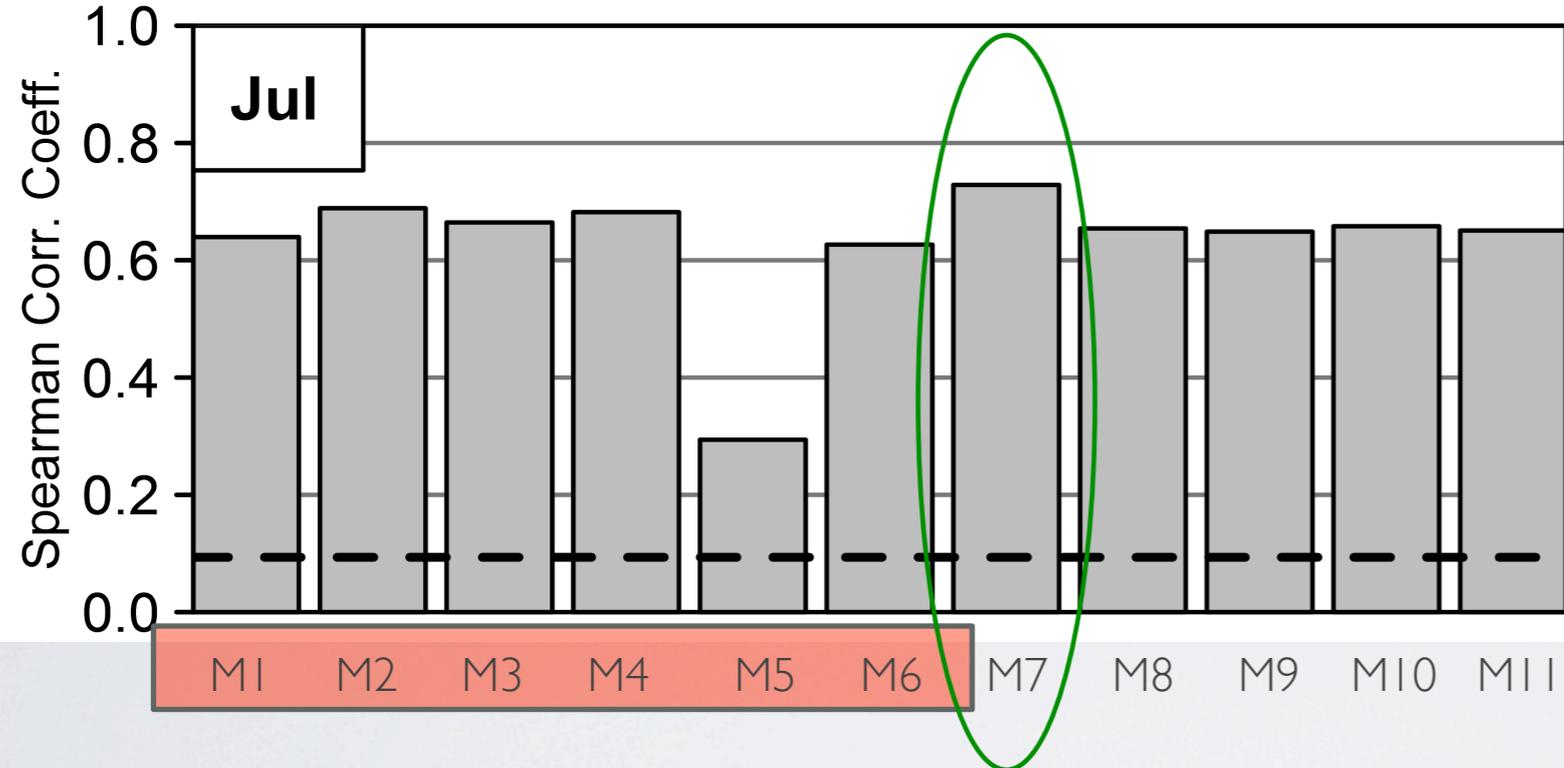


NMME Models Exhibit Skill in Predictions of SST Indices

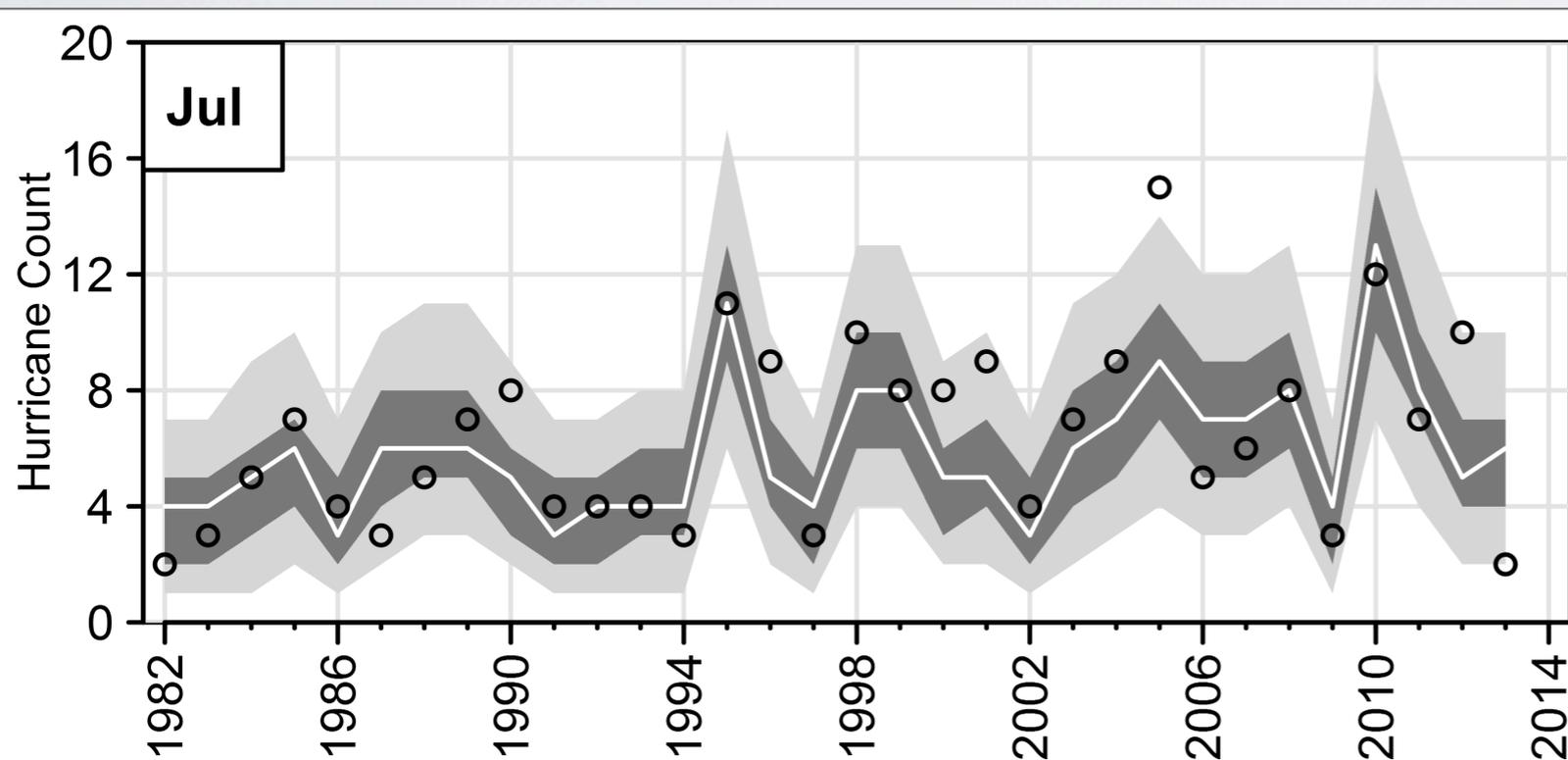


For predictions of NA Seasonal Hurricane Frequency Multi-model average more consistently skillful than models

Beda Luitel, G. Villarini, et al. (2015, in prep.)



“worst” model still valuable
hard to beat “equal weight”



- M01 = GFDL
- M02 = GFDL-B01
- M03 = GFDL-FA
- M04 = NASA
- M05 = COLA
- M06 = CMC2

M07 = Equal Weight

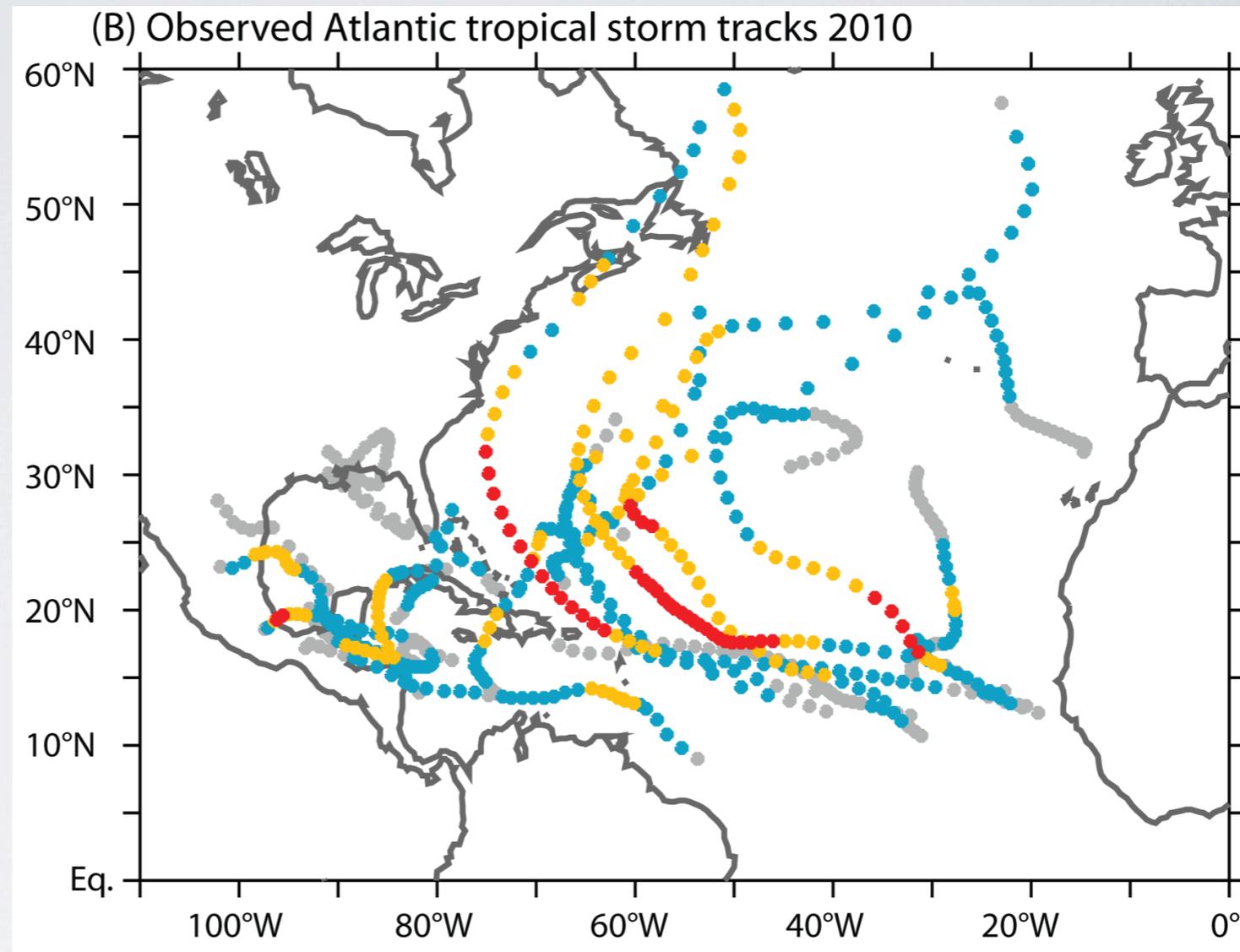
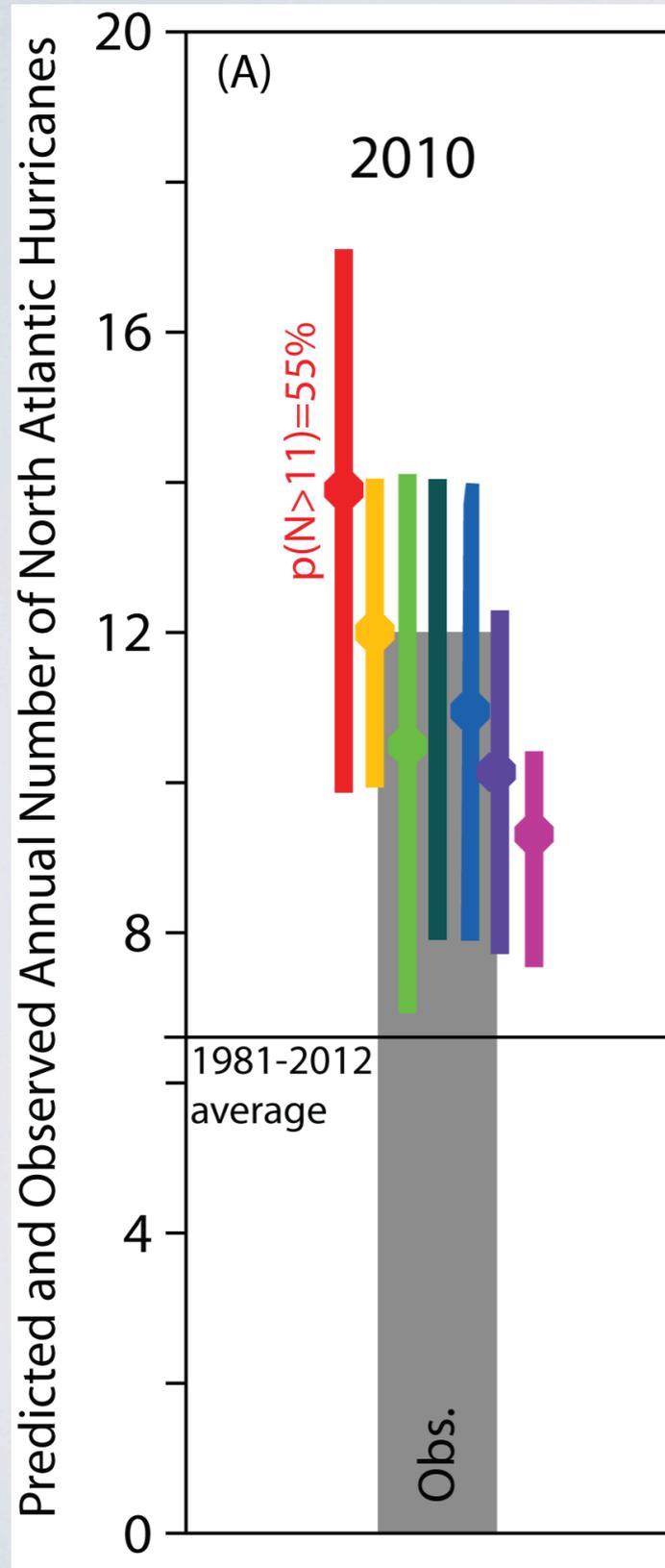
M08 = Weighted

M09 = Equal Weight NOCOLA

M10 = Weighted NOCOLA

M11 = Empirical

Correct predictions of basin-wide active 2010 but not of U.S. landfall absence



Can we reliably predict statistics of storms more regionally than “basin-wide” number?



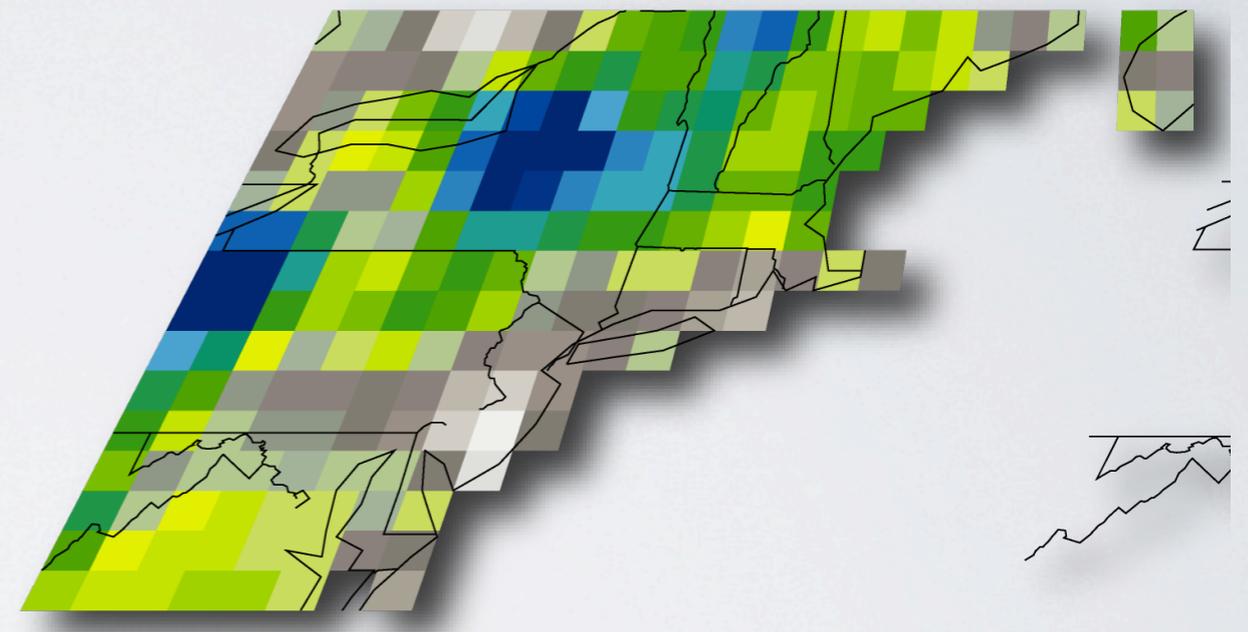
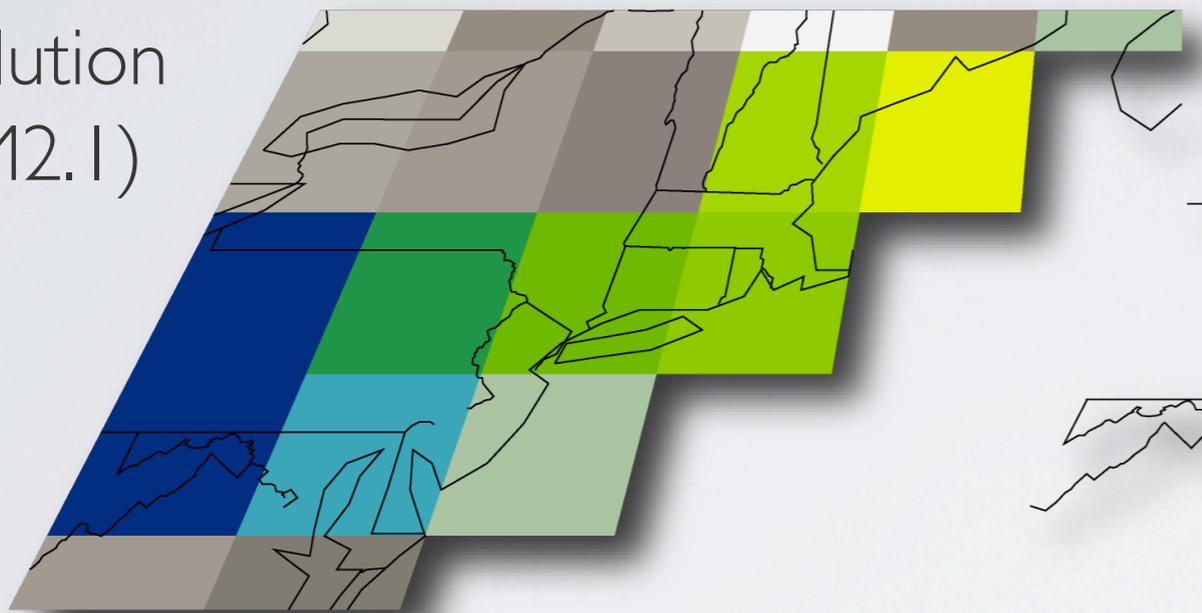
GFDL FLOR: Experimental high-resolution coupled seasonal to decadal prediction system

Goal: Build a seasonal to decadal forecasting system to:
Yield improved forecasts of large-scale climate
Enable forecasts of regional climate and extremes

Precipitation in Northeast USA

High resolution
(CM2.5-FLOR)

Medium
resolution
(CM2.1)



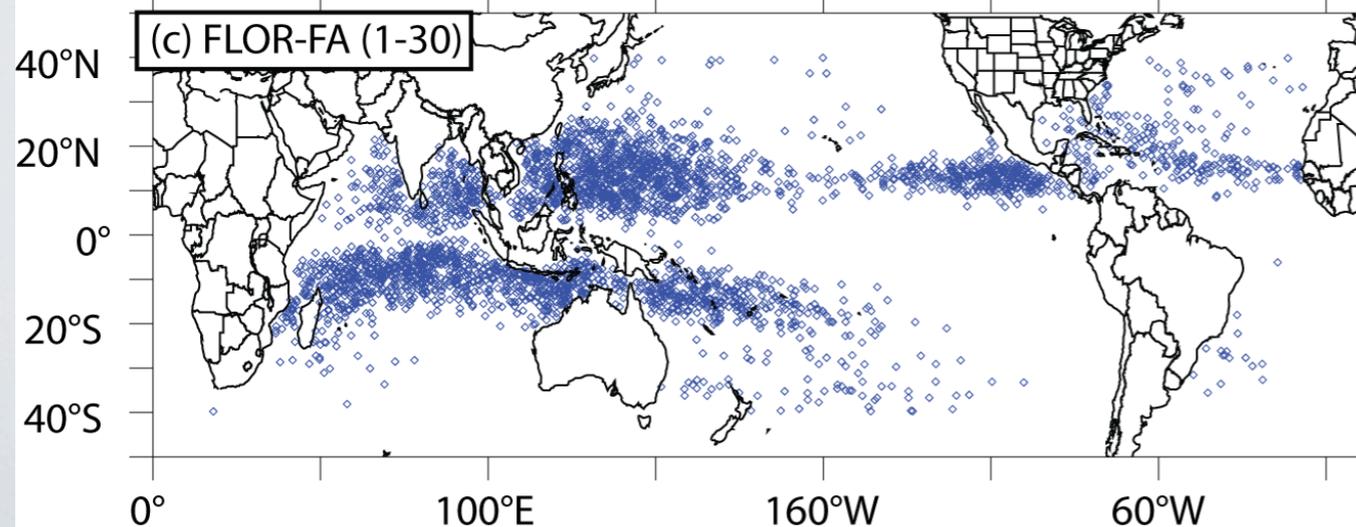
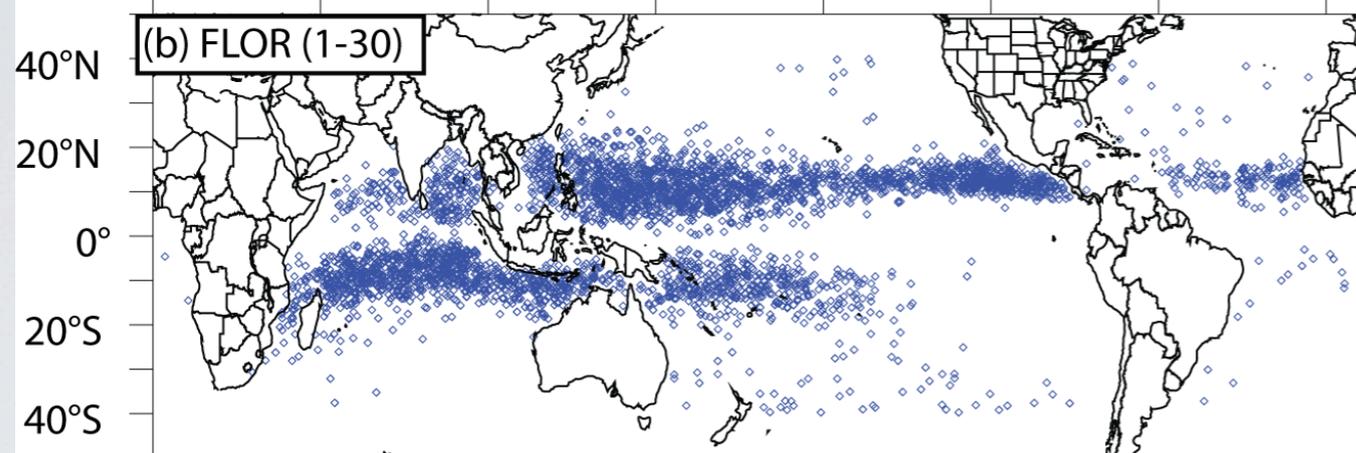
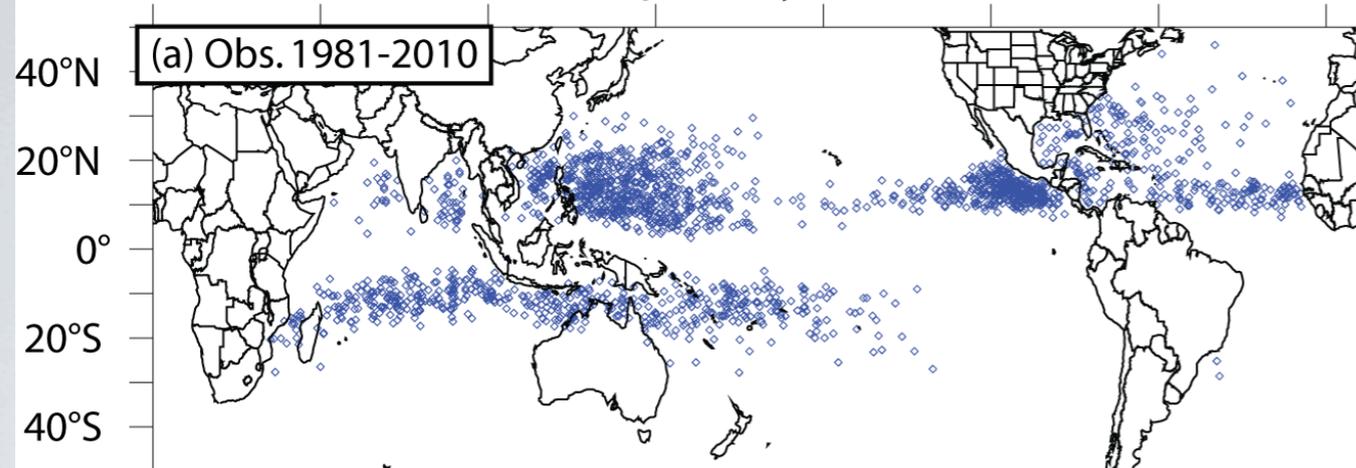
Delworth et al. (2012), Vecchi et al. (2014)

Modified version of CM2.5 (Delworth et al. 2012):

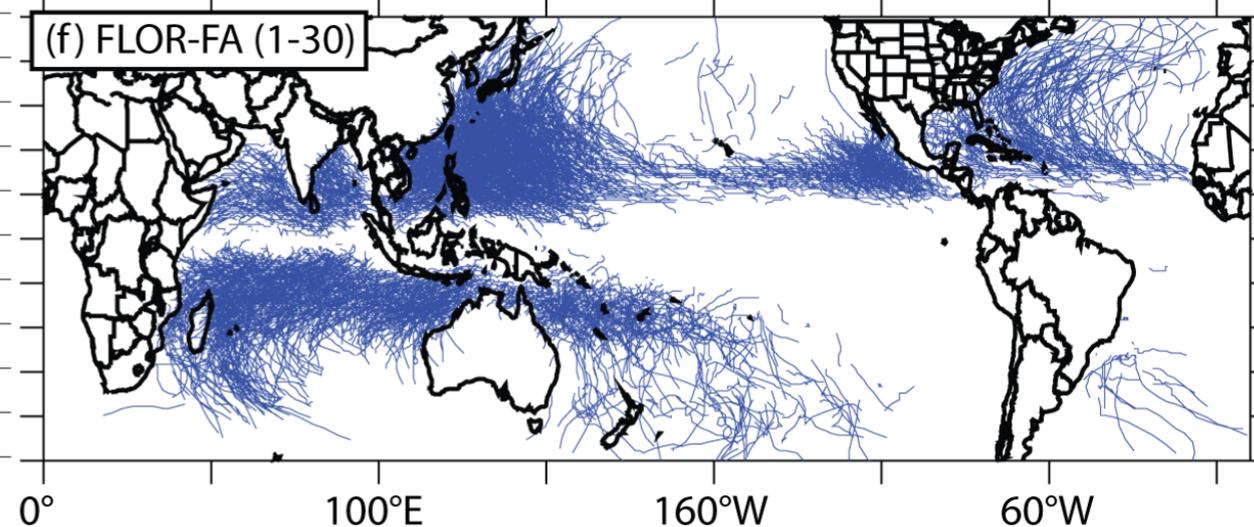
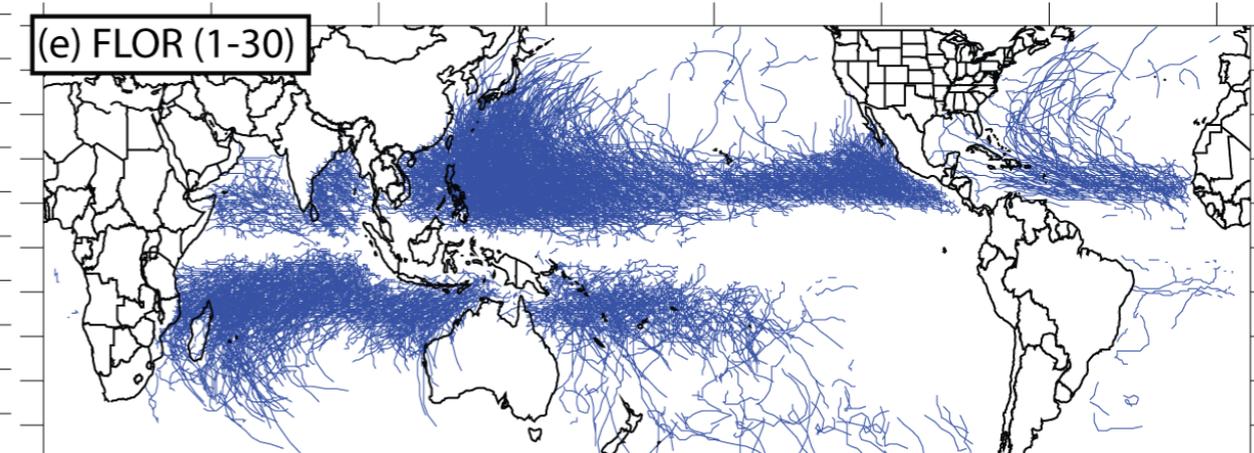
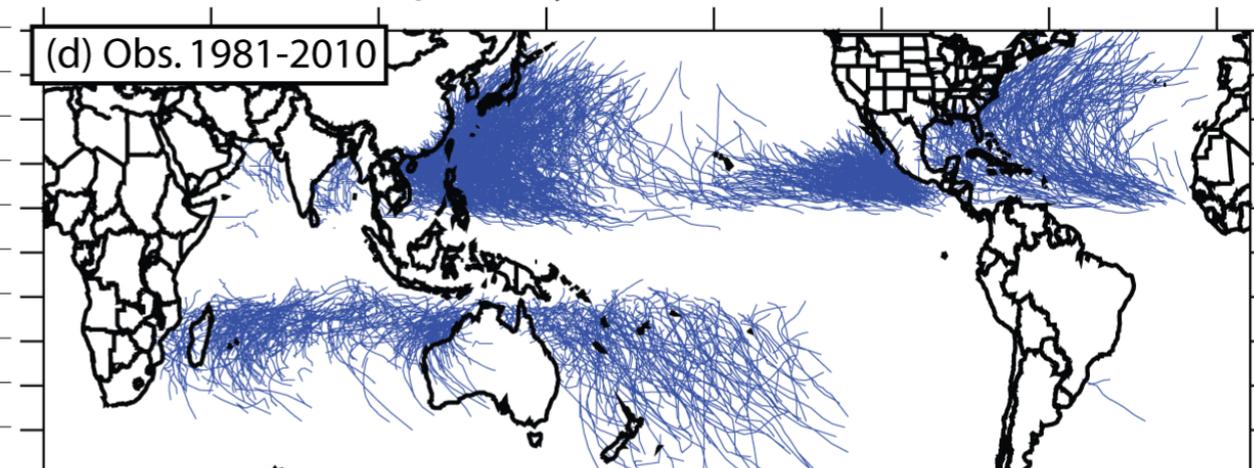
- 50km cubed-sphere atmosphere
 - 1° ocean/sea ice (low res enables prediction work)
- ~15-18 years per day allows multi-century integrations.
Contributed to NMME from March 2014.

Artificially correcting climatological SSTs through flux adjustment improves simulation (and prediction) of TC tracks

Location of Tropical Cyclone Genesis

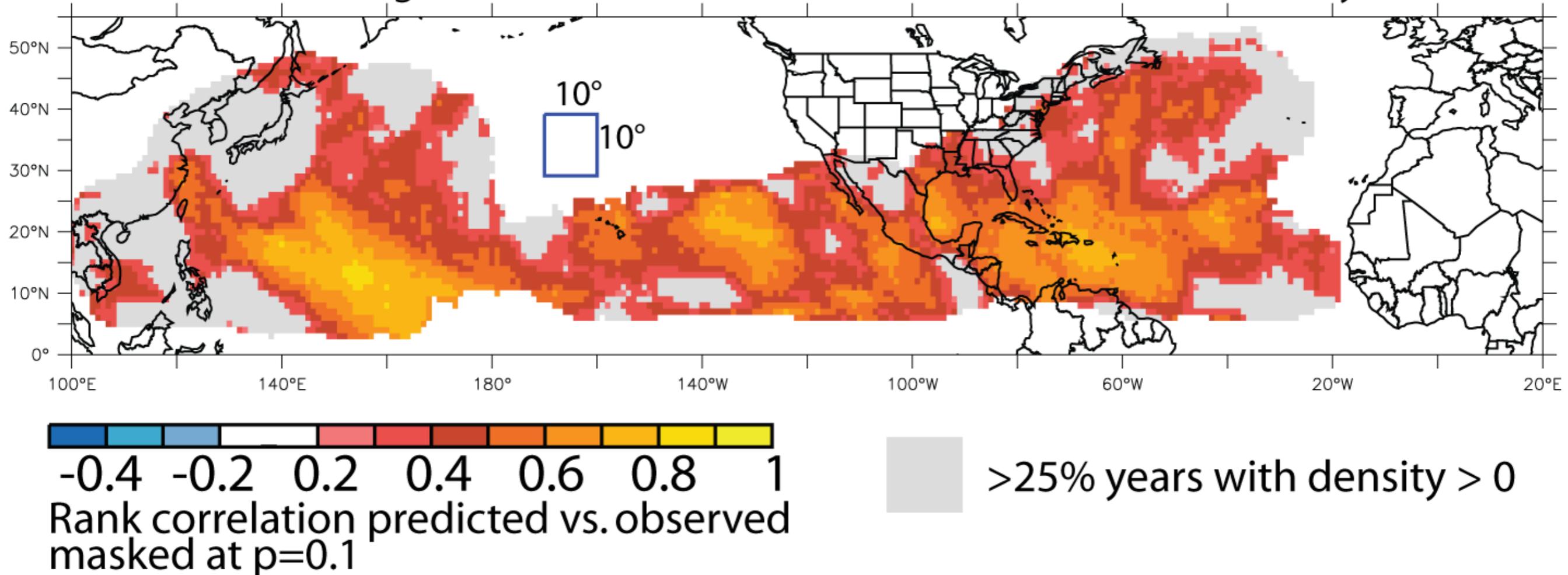


Tropical Cyclone Track



Can we reliably predict statistics of storms more regionally than “basin-wide” number?

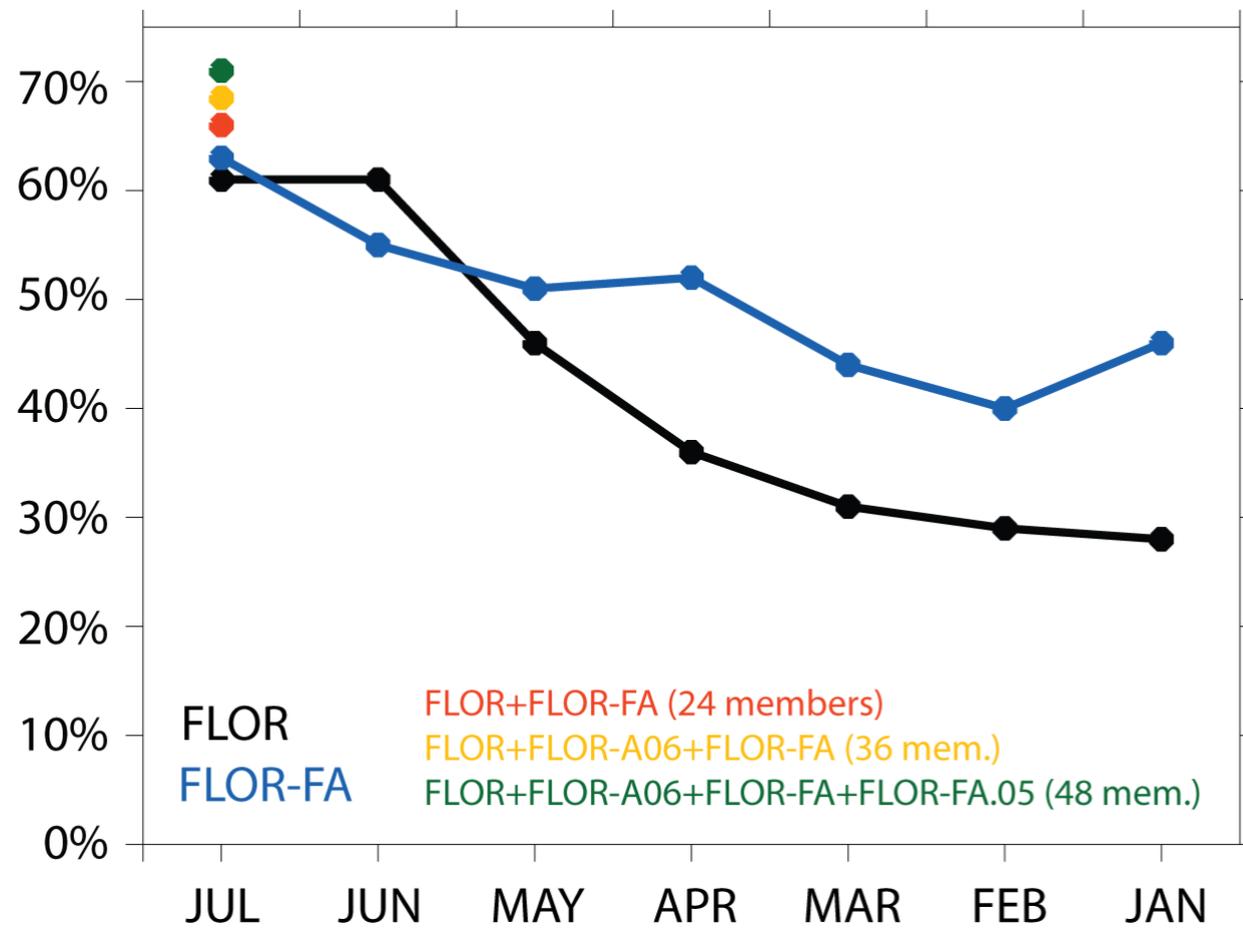
48-Member Average FLOR, FLOR-FA, FLOR-A06, FLOR-FA.05 Initialized 1-July



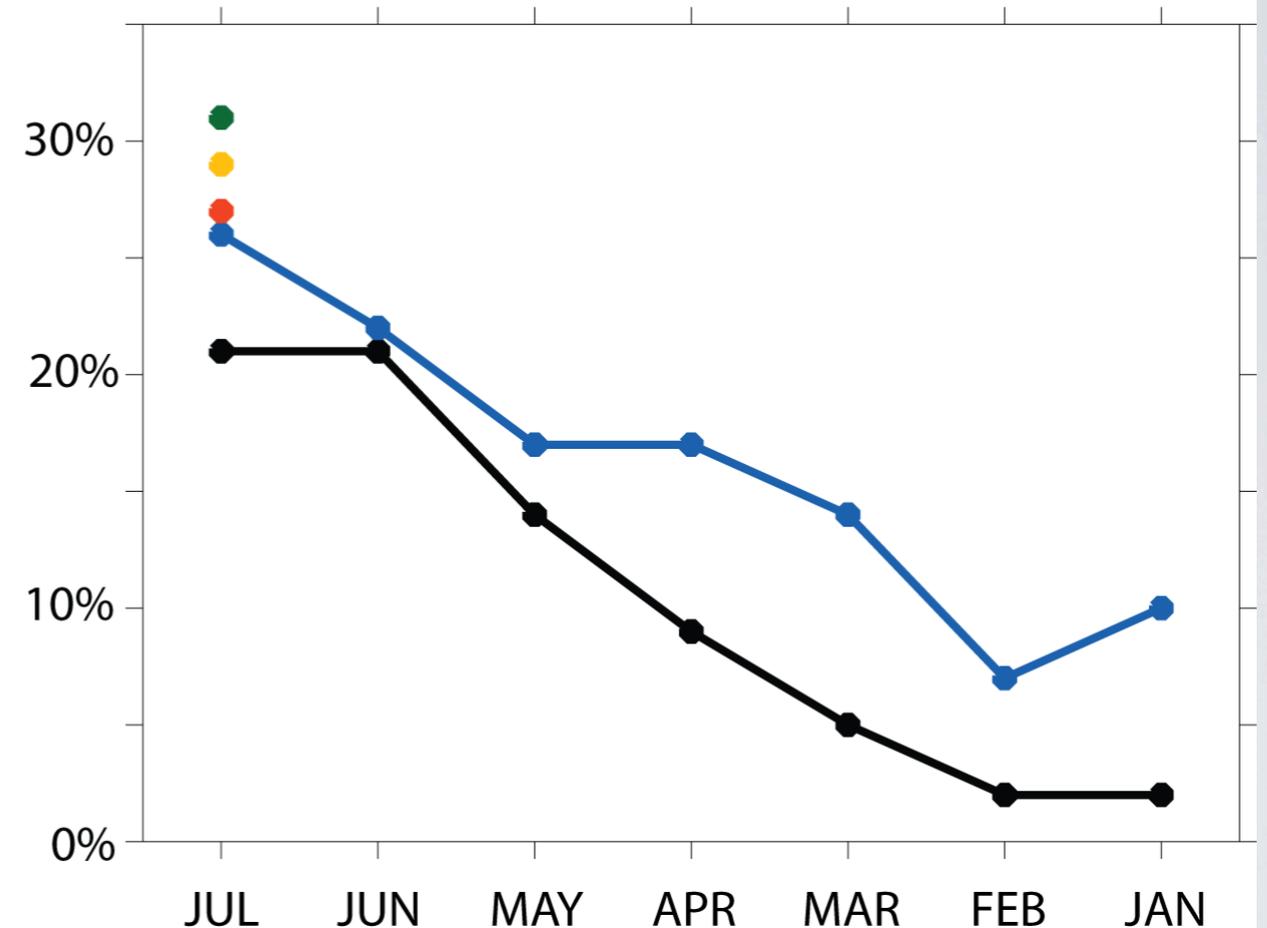
Shaded: Can experimental FLOR forecasts distinguish years with many and few storms passing within $10^\circ \times 10^\circ$ of a point.

FLOR-FA outperforms FLOR at predictions of regional (and basinwide) TC activity – particularly at long leads

(a) Percentage of TC areas with significant rank correlation

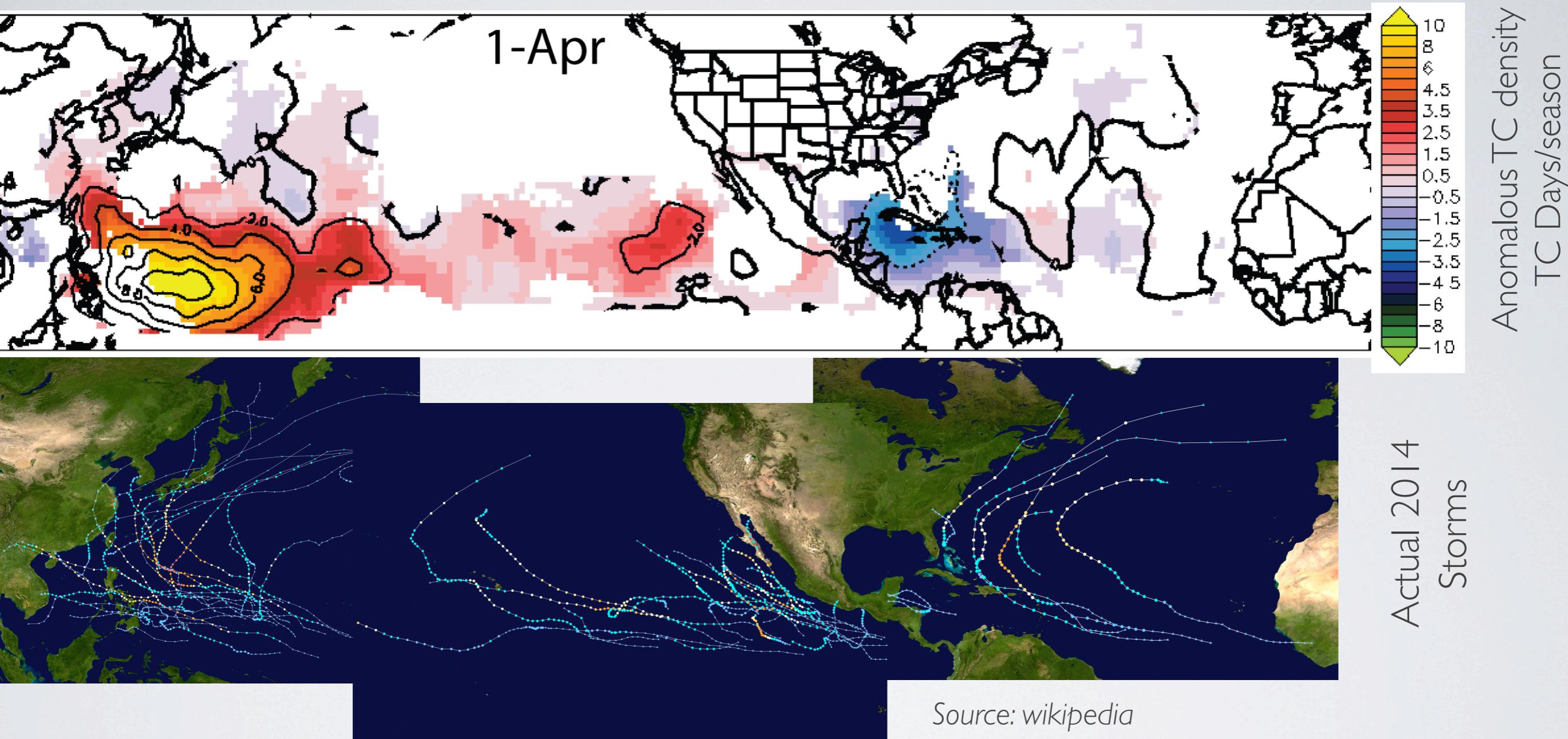


(b) Percentage of TC areas with rank correlation > 0.5



***EXPERIMENTAL RESEARCH PRODUCT – NOT AN OFFICIAL OUTLOOK ***

Experimental 2014 TC density forecasts



Forecasts of 2014 TC density anomaly with GFDL-FLOR-HAD13 initialized 1-April-2014 and 1-July 2014.

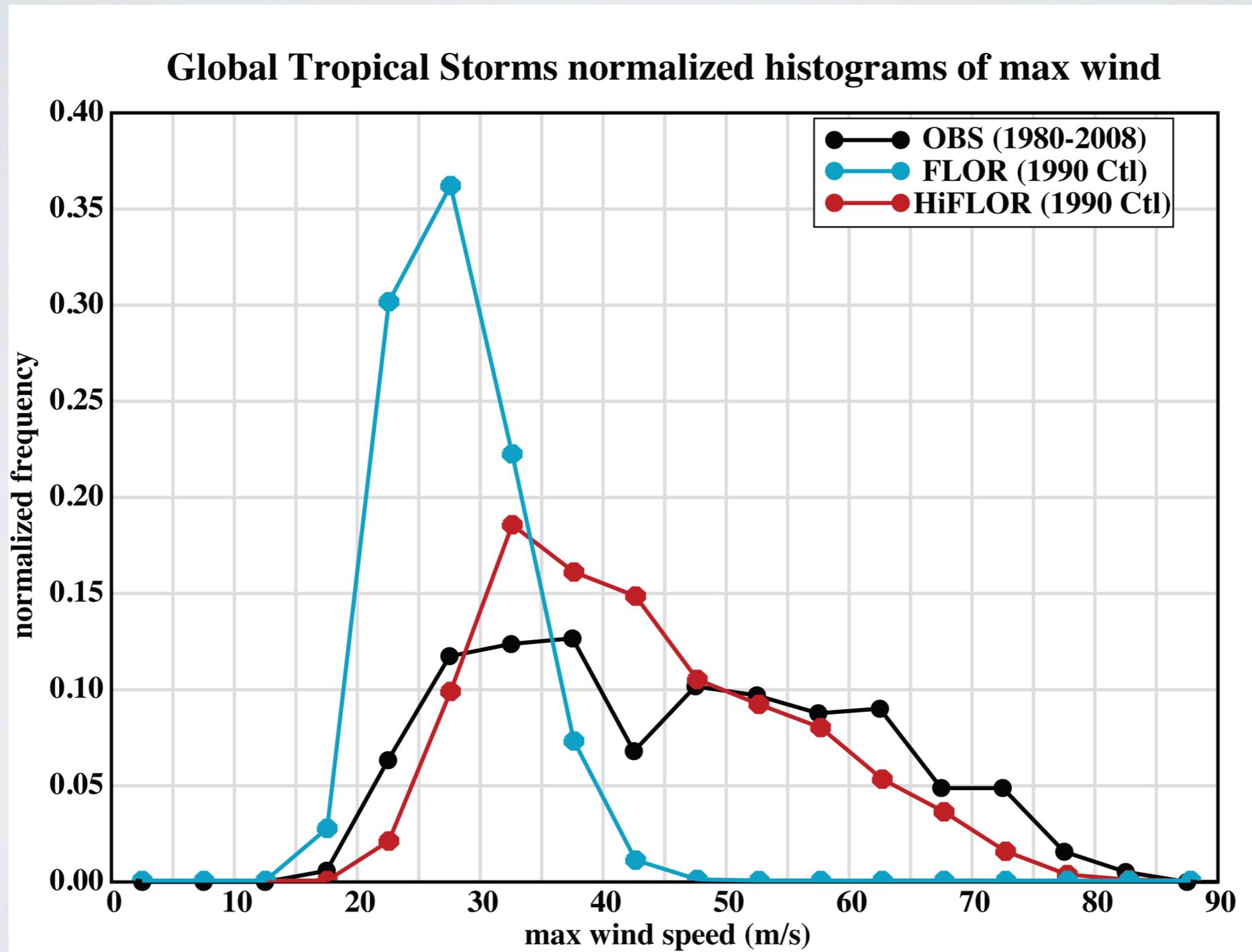
Contour: all values

Shade: locations with significant retrospective correlation

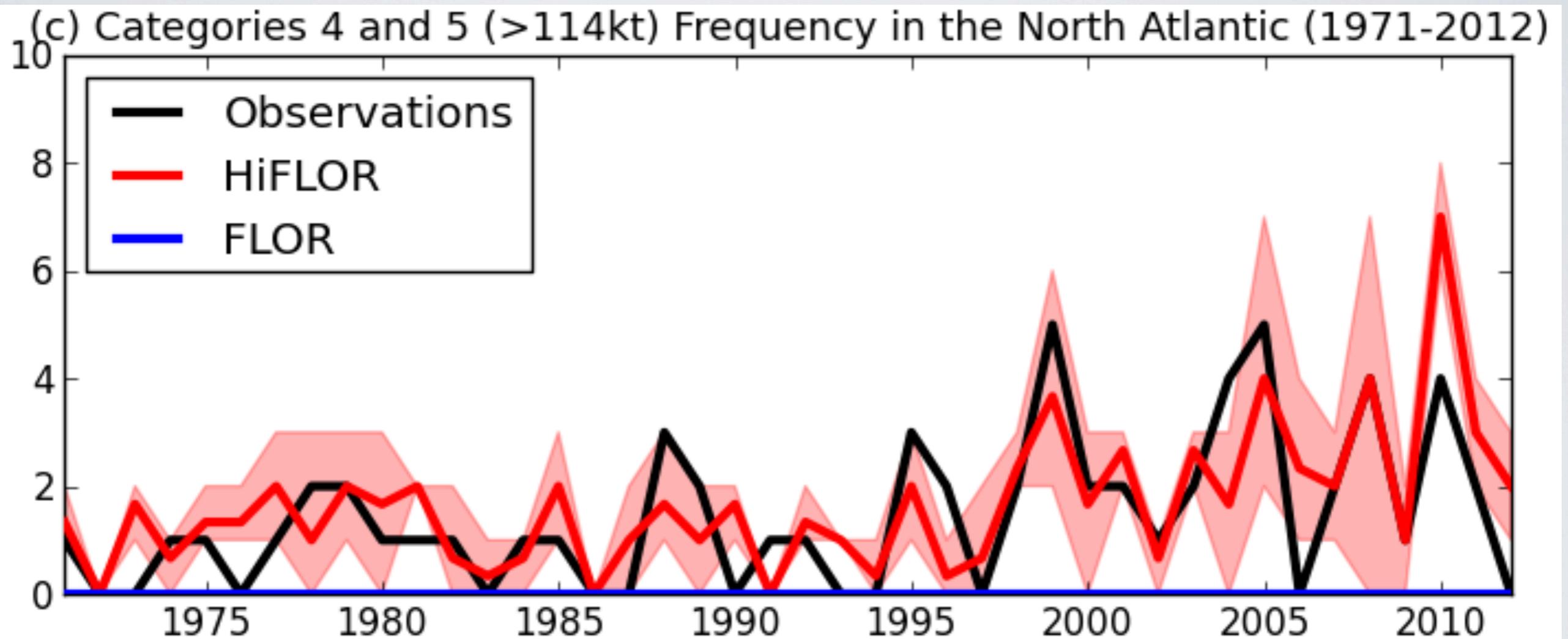
(based on Vecchi et al. 2014, J. Clim.)

Most impactful hurricanes tend to be strongest.

Need prediction models that can capture them. New prototype model (“GFDL-HiFLOR”, first run May 2014) able to simulate Cat. 4-5s



HiFLOR prototype NOAA-GFDL prediction model recovers
Cat. 4-5 history...experimental predictions encouraging...

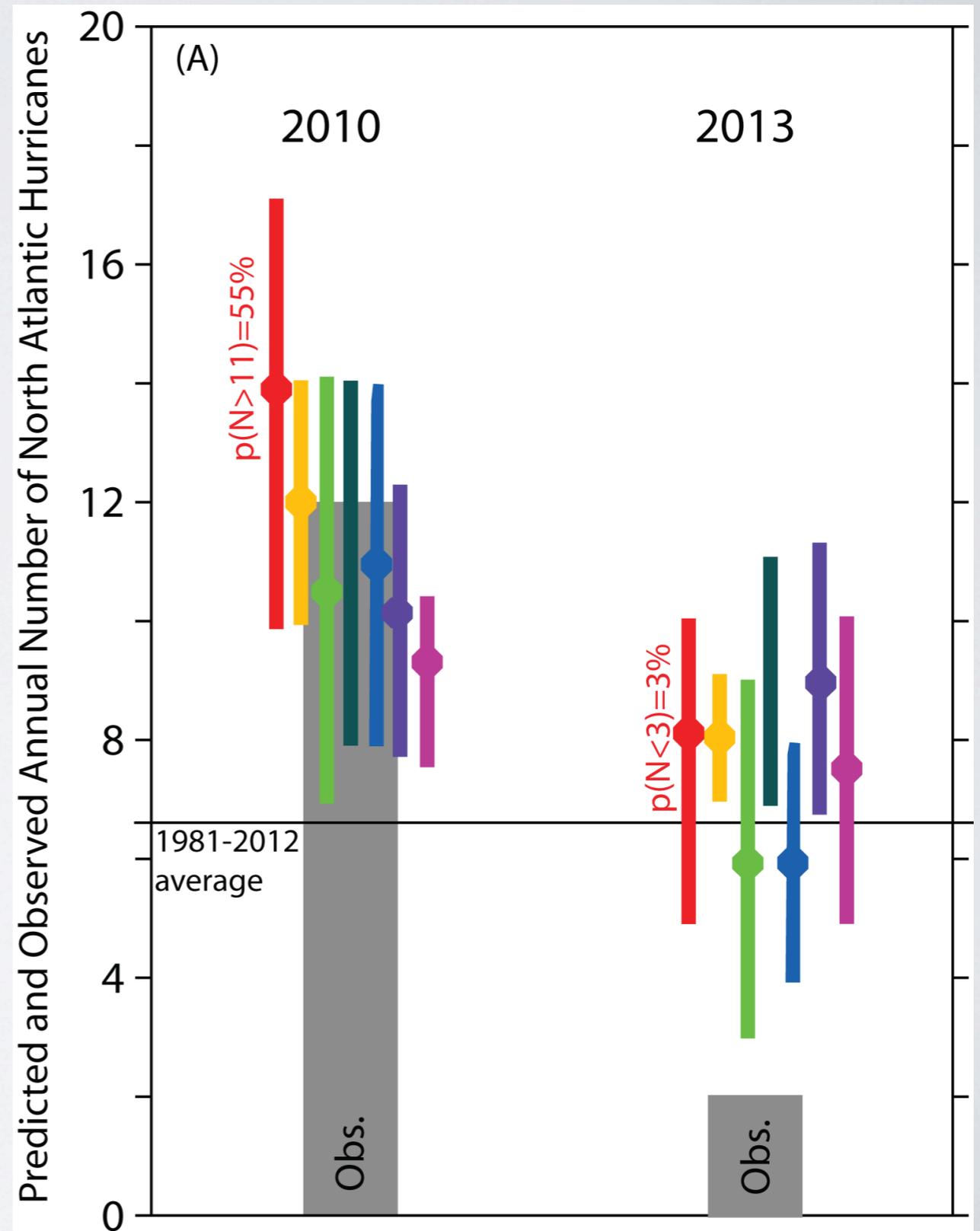


Summary

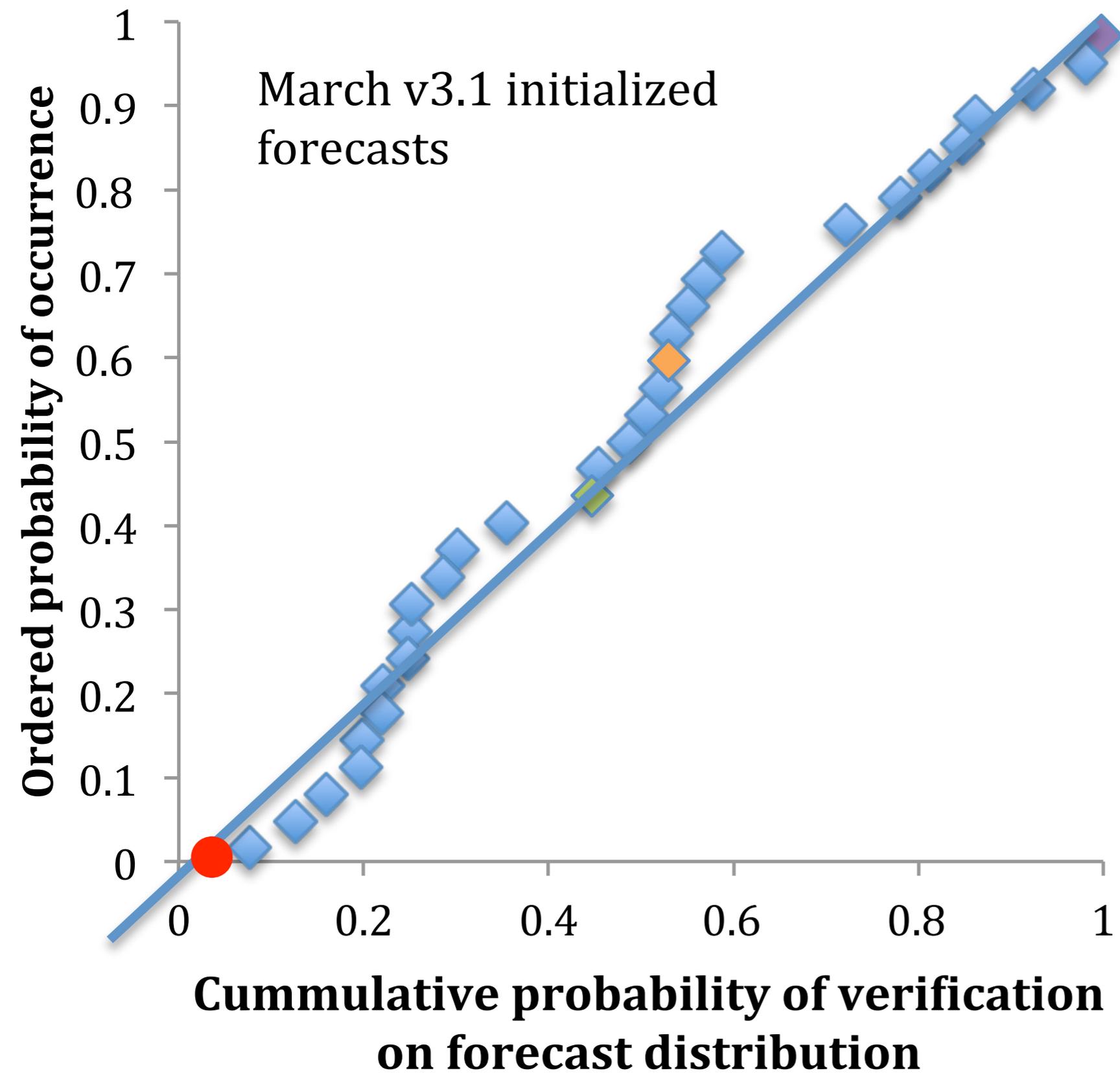
- Multi-model ensemble yields improved predictions of basinwide Atlantic hurricane frequency
- Increased atmospheric and land resolution:
Improved forecasts of large-scale climate
Enable forecasts of regional climate and extremes
- Skillful seasonal predictions of TC activity at regional scales appear feasible
Large (many 10s) ensembles appear desirable
- Flux adjustment improves simulation and seasonal prediction of regional climate and extremes.

Probabilistic forecasts are necessary

- Climate system is chaotic: even the “best” prediction system conceivable will not be able to precisely predict every upcoming season.
- If predictions are *reliable*, even things deemed unlikely will sometimes happen.
- Most useful way to communicate predictions depends on application.



Even though 2013 has poor deterministic skill:
Prediction PDF appears relatively well calibrated



Blue: prior to publication of method
Colors: post-publication (2010-2012)
● 2013

Make PDF, not mode, of TC activity the target

Update of Vecchi et al. (2011)