

Multi-year predictions of North Atlantic hurricane activity

Initial results and challenges

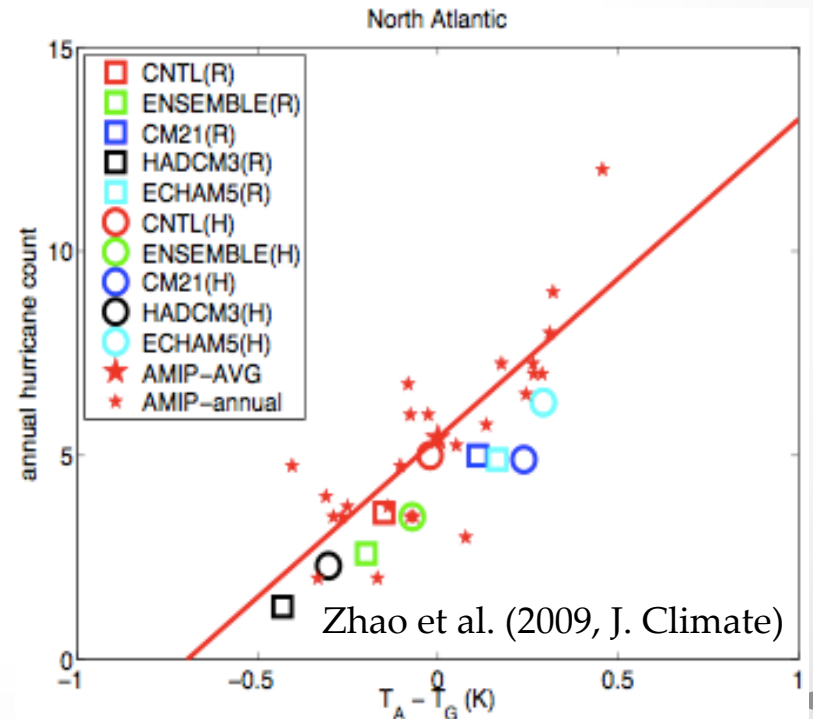
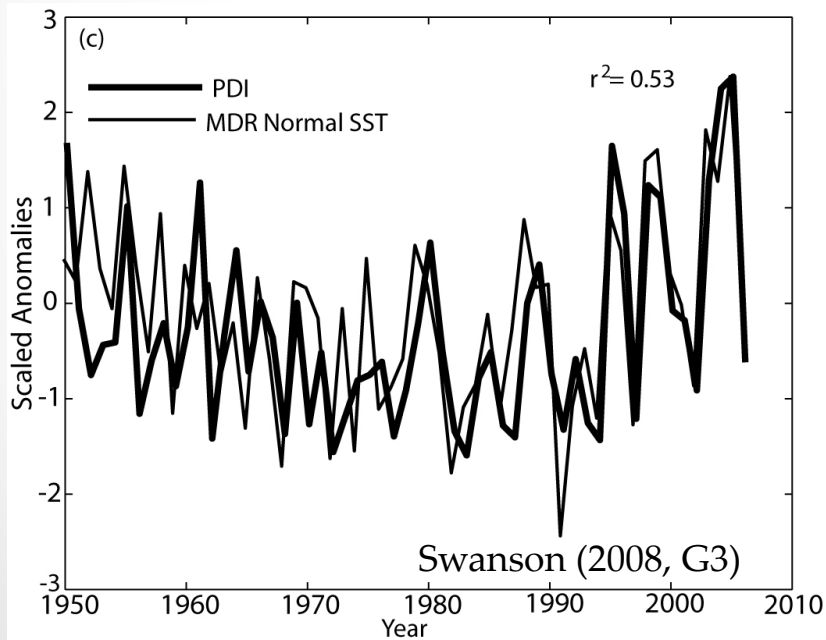
Gabriel Vecchi
NOAA/GFDL

Statistical Hurricane Model

Predictors: **Atlantic and Tropical-mean SST.**

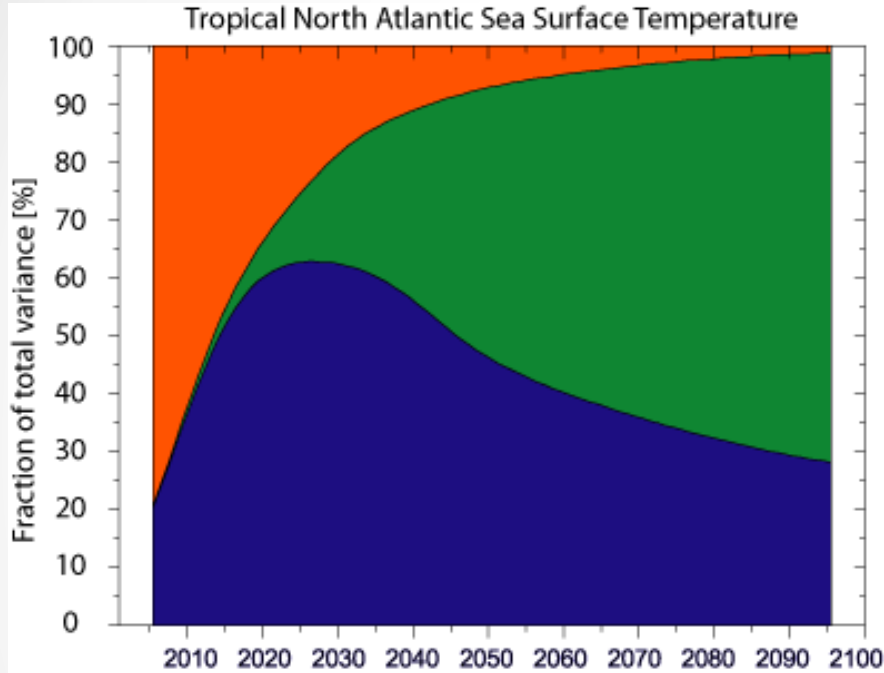
Motivation is Atlantic minus Tropical (“Relative”) SSTA, which:

- explains much of past observed hurricane activity (e.g., Swanson 2008, Vecchi et al. 2008, Villarini et al. 2009,2010,)
- explains inter-model spread of high-res dynamical AGCM projections (e.g., Zhao et al. 2009, 2010, Vecchi et al. 2011)
- predictor/driver of large-scale conditions impacting hurricanes (e.g., potential intensity, shear, etc) (e.g., Latif et al. 2007, Vecchi and Soden 2007, Vecchi et al. 2011)
- can be readily computed from multiple models (e.g., Villarini et al. 2011, Vecchi et al 2011)

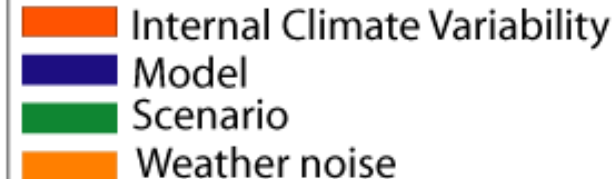
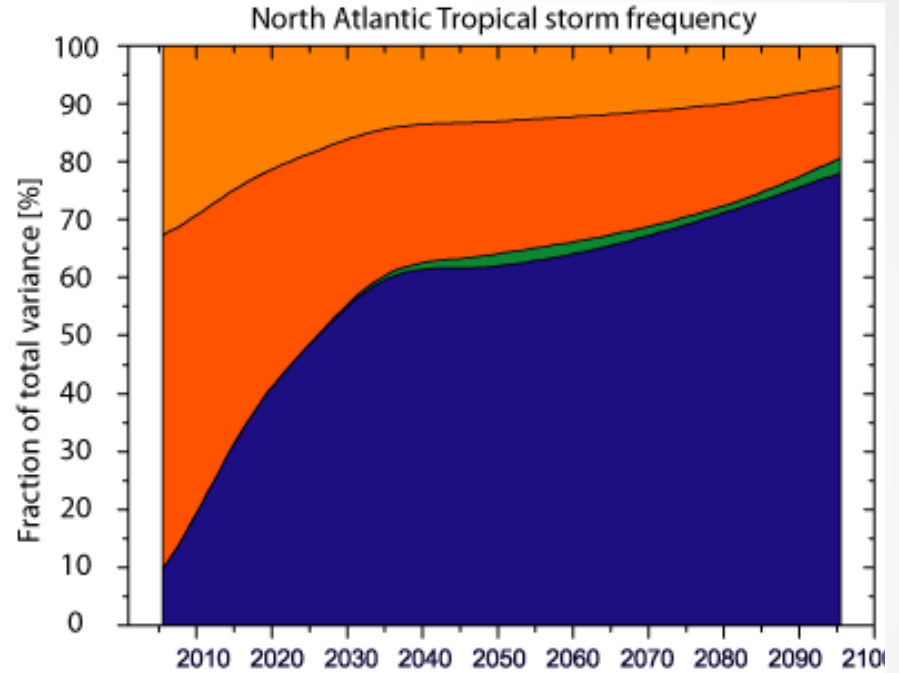


Apply Stat Hurr Model to CMIP3 GCMs

Analysis after Hawkins and Sutton (2009, BAMS)

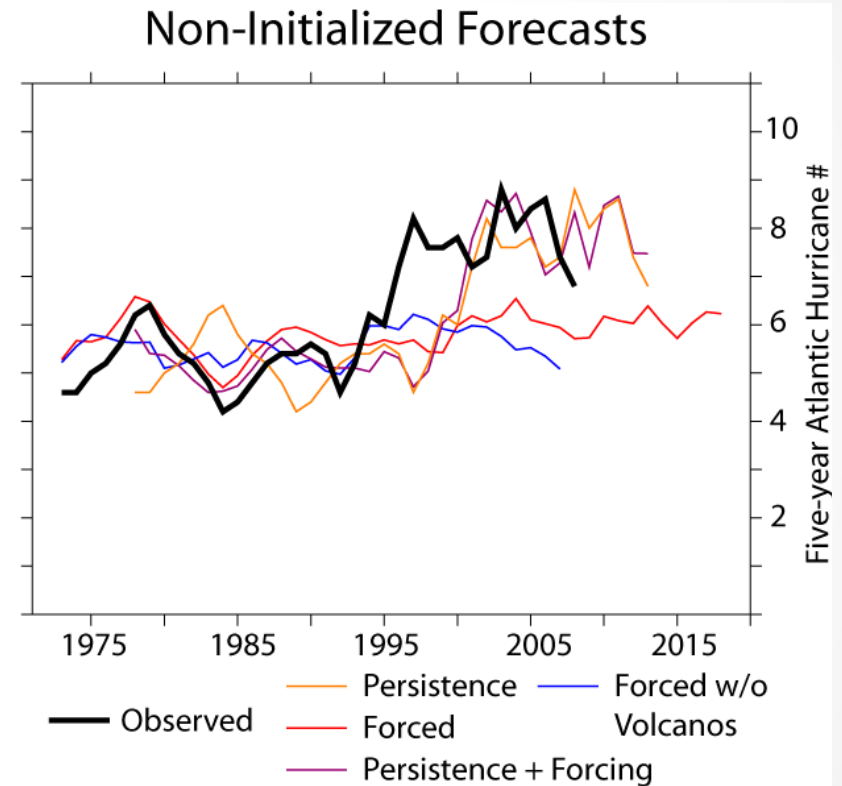
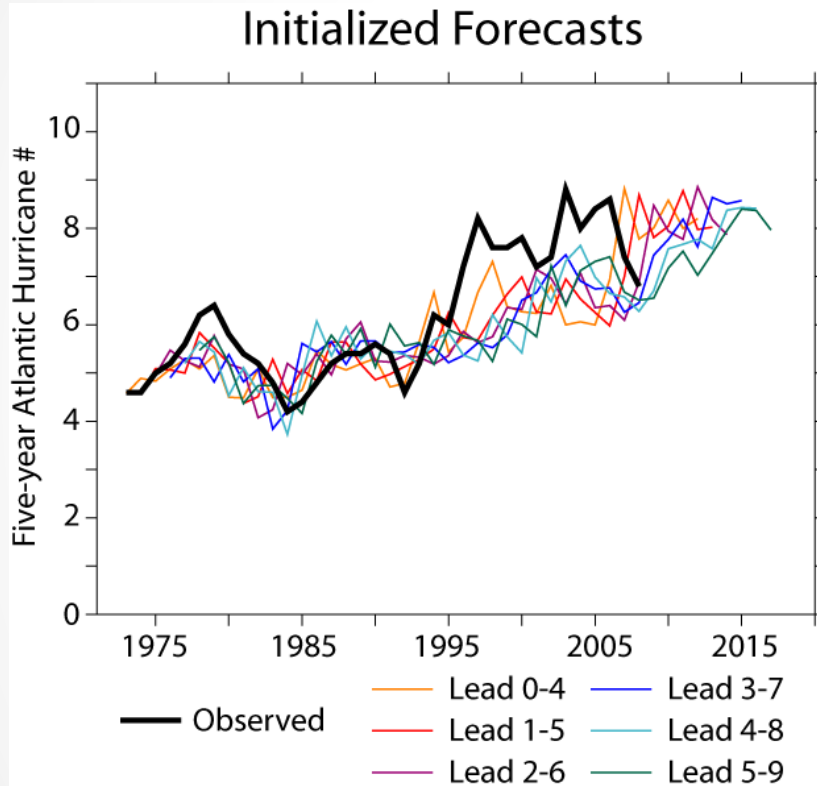


Fractional Contribution to total projection spread in decadal means



Apply Stat. Hurr. Model to Prototype

GFDL-CM2.1 CMIP5 Decadal Predictions



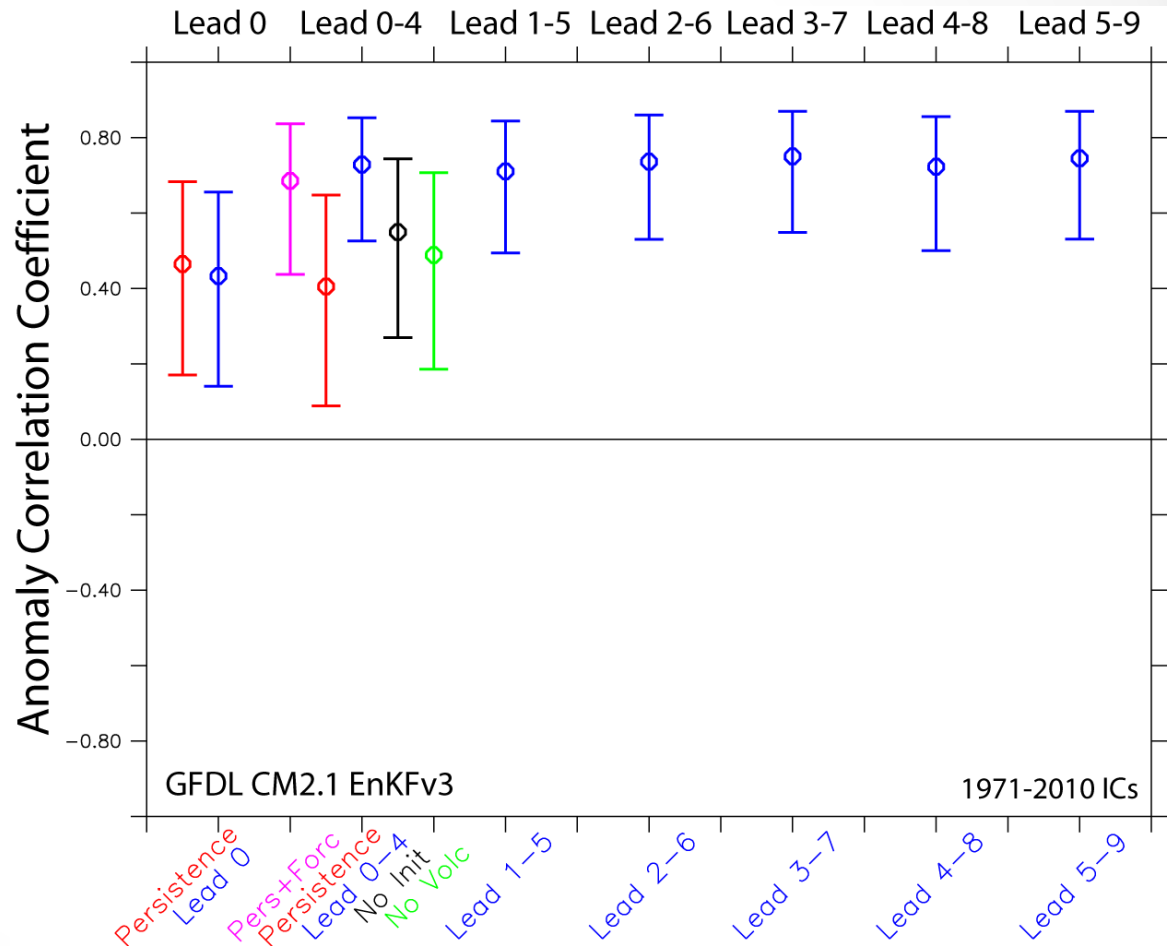
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GFDL-CM2.1 CMIP5 Decadal Predictions

$p=0.05$ confidence int.
using Fisher's Z Test

Assume all forecasts
and verifications are
independent

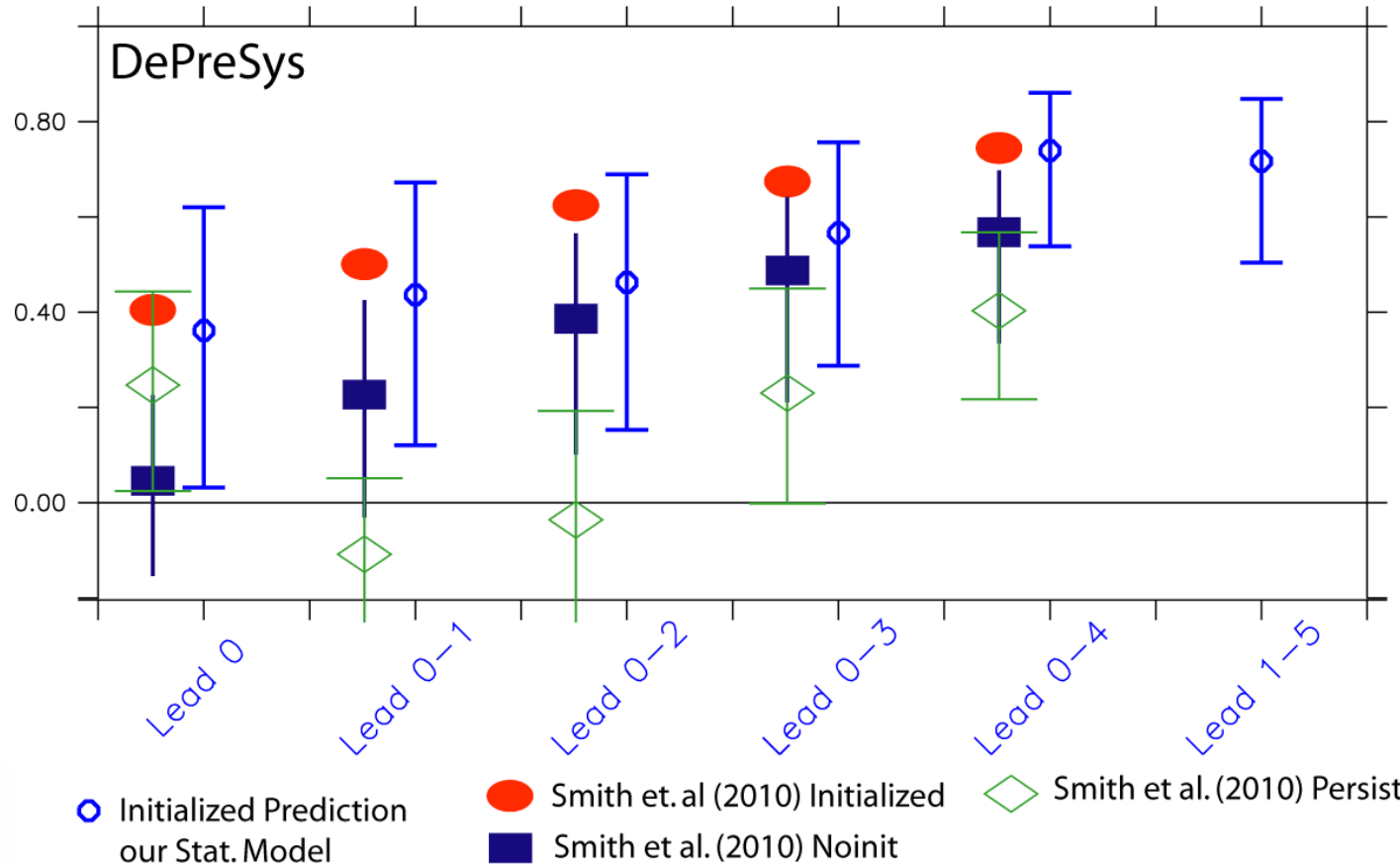
*At face value, suggest
initialized decadal
hurricane forecast skill
exceeds null, persistent
and forced forecasts.*



Apply Stat. Hurr. Model to DePreSys.v2

CMIP5 Decadal Predictions

Correlation of GCM-based predictions and observed hurricane counts



$p=0.05$ confidence int.
using Fisher's Z Test

Assume all forecasts and verifications are independent

Simple statistical model recovers basic Smith et al. (2010) results, including width of confidence intervals.

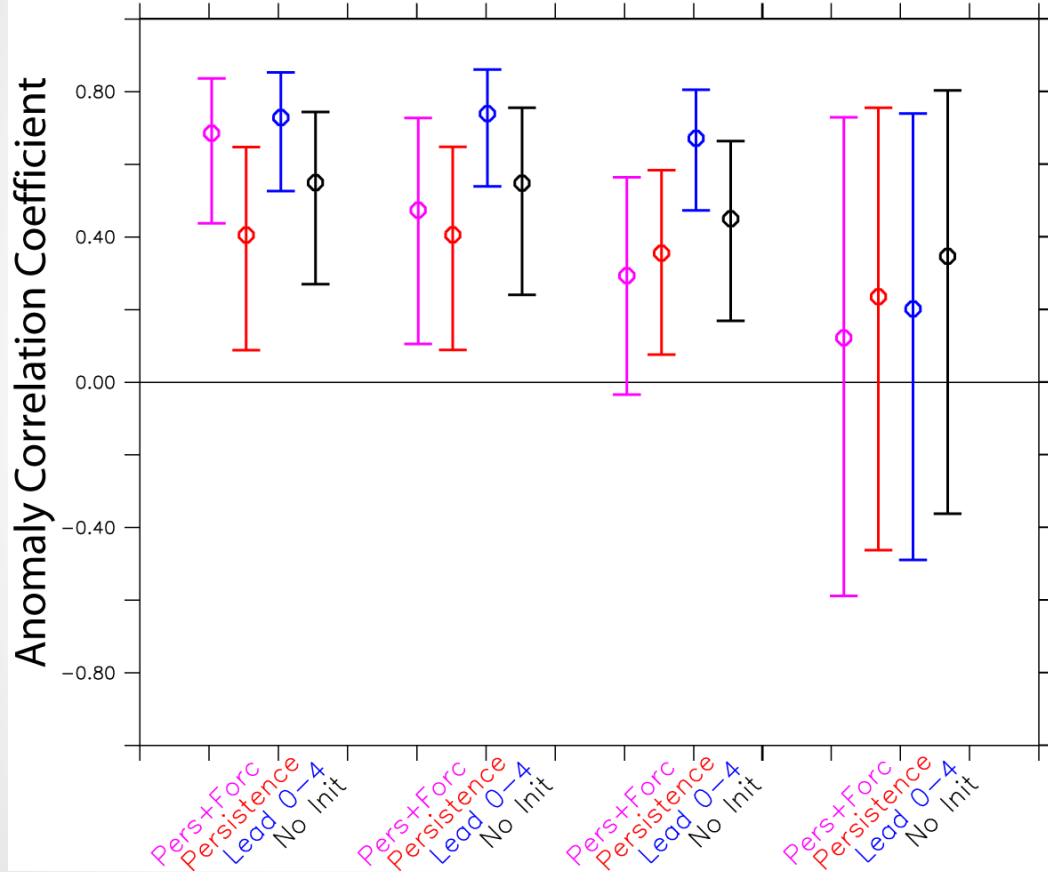
Apply Stat. Hurr. Model to CMIP5 Predictions

Five Year Atlantic Hurricane Count Predictions

GFDL CM2.1
EnKFv3
1971-2010 ICs

DePreSys.v2
1971-2005 ICs
1960-2005 ICs

CCCMA
1960-2005 ICs



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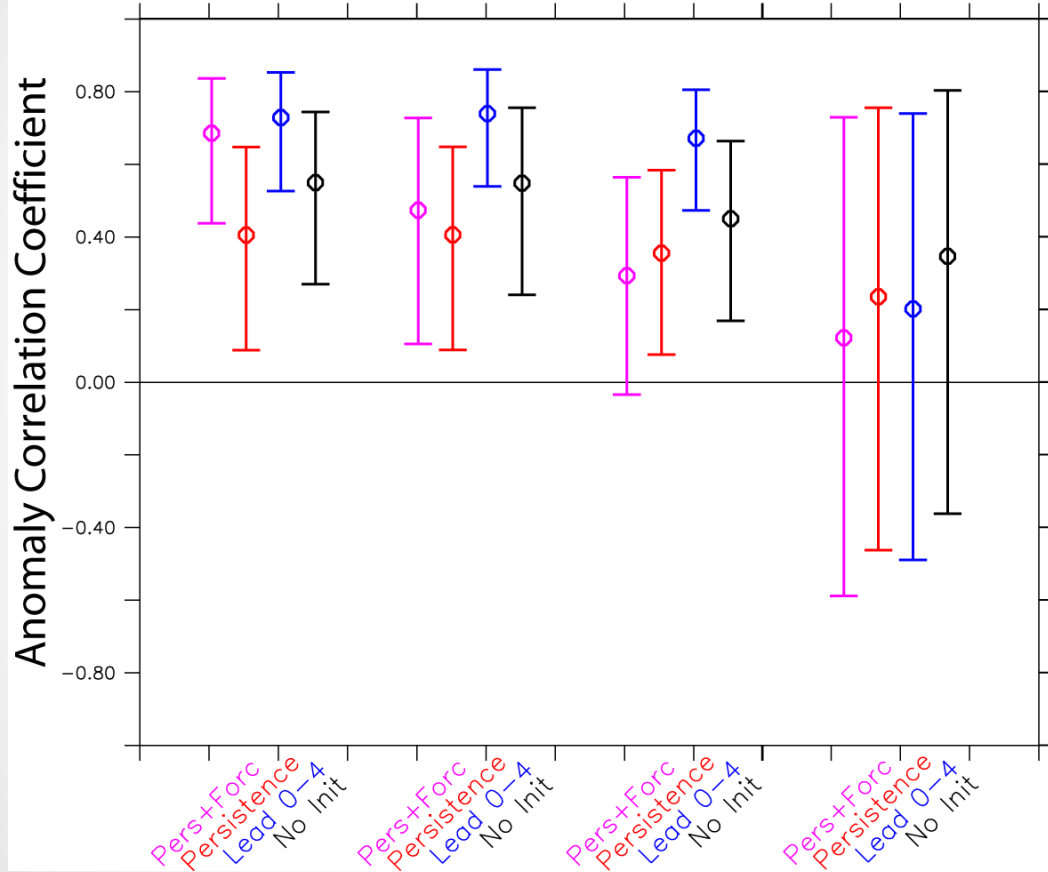
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Assumption of independence invalid for both forecasts and obs.

Apply Stat. Hurr. Model to CMIP5 Predictions

Five Year Atlantic Hurricane Count Predictions

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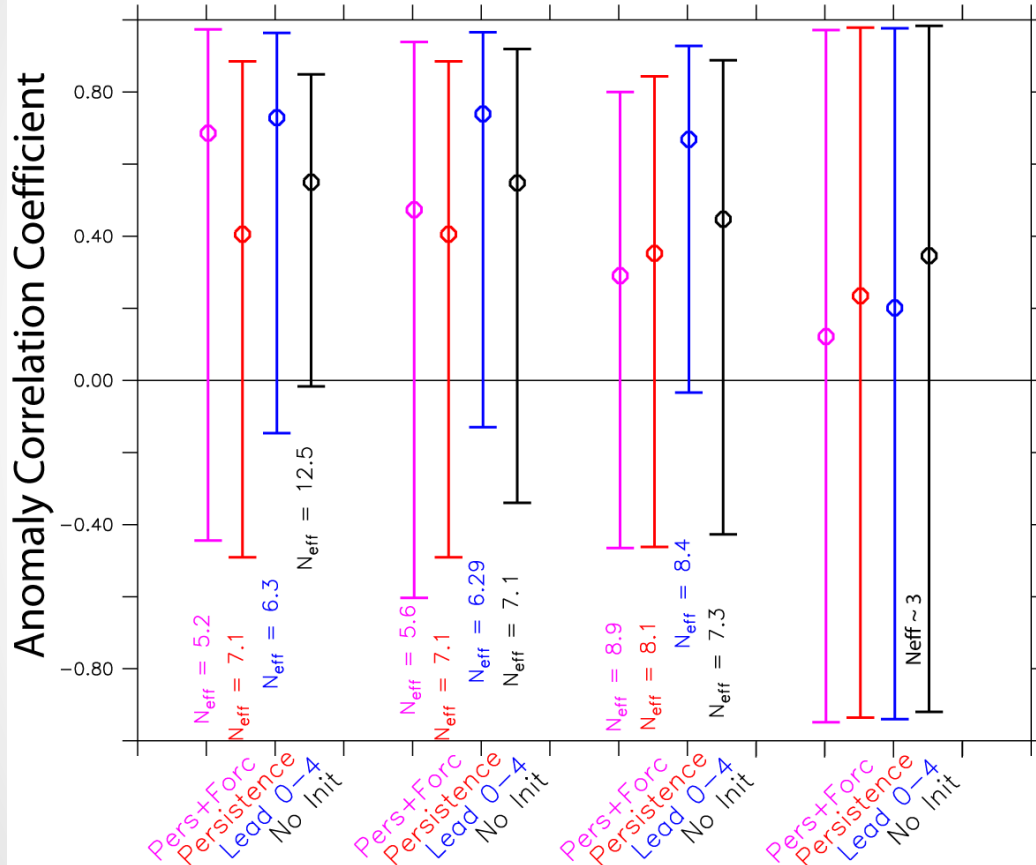
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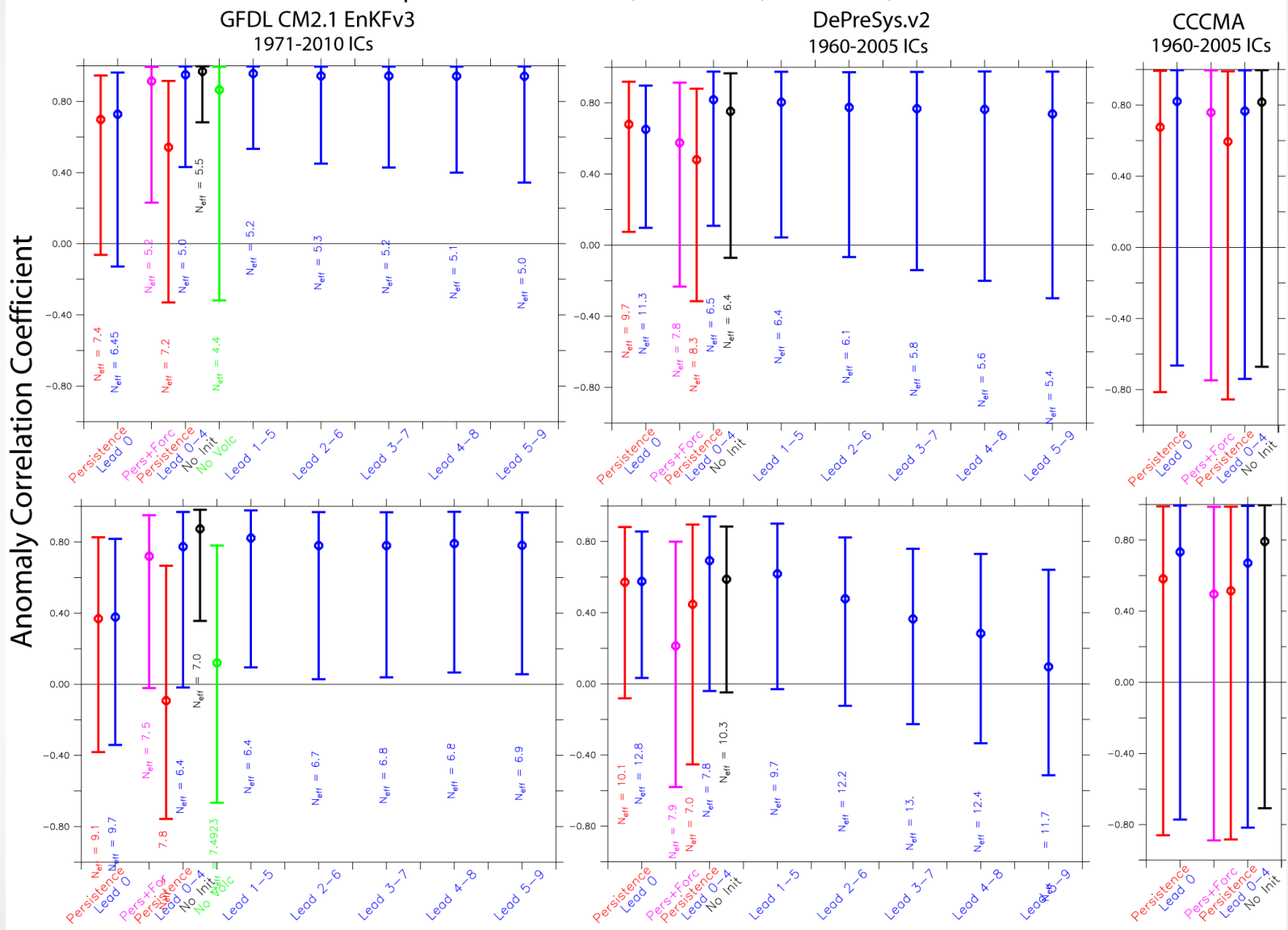


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Correct DoF for autocorrelation based on Bretherton et al. (1999, JC)

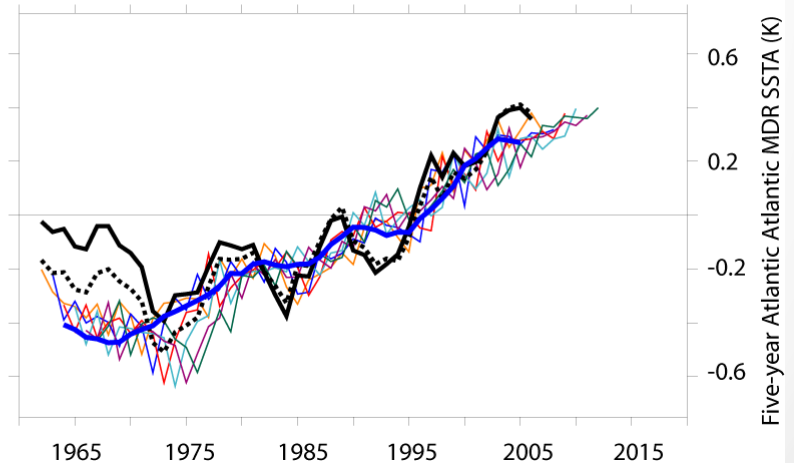
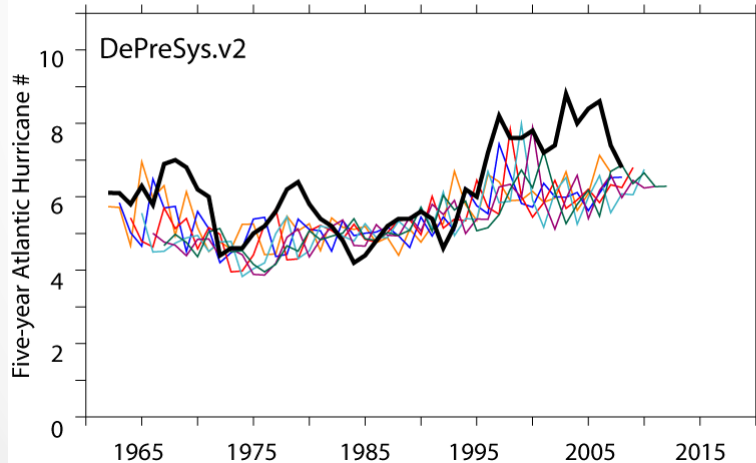
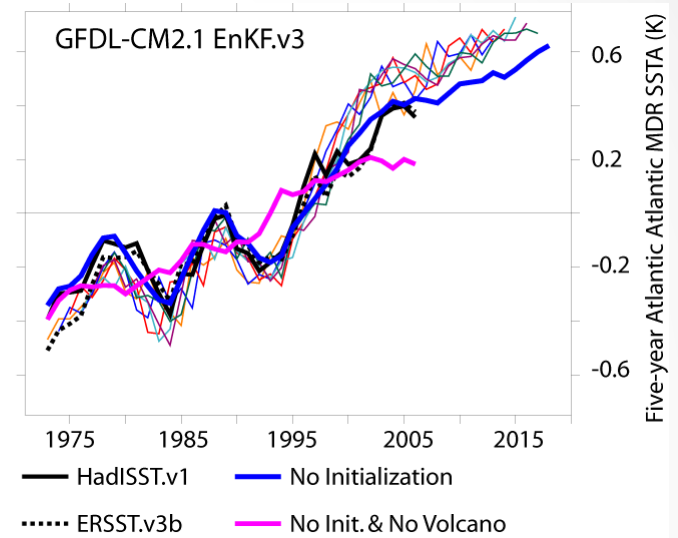
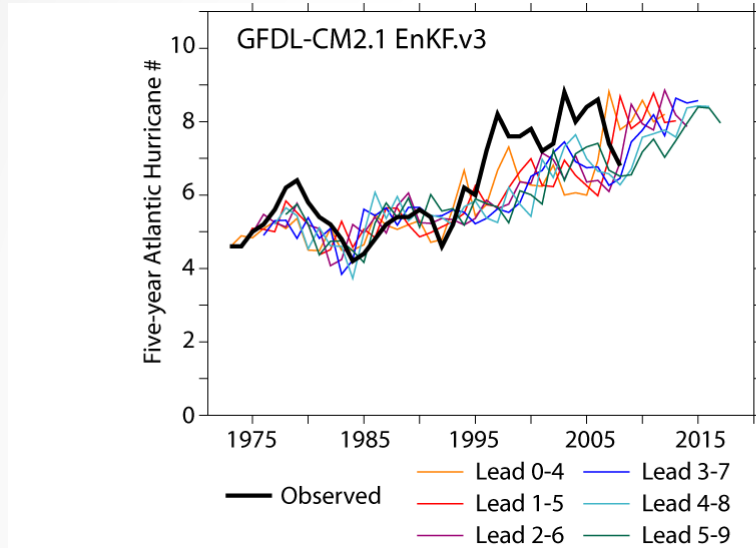
Multi-year Predictions of Atlantic MDR SSTA

Five Year Tropical North Atlantic (80°W-20°W, 10°N-25°N) SSTA Predictions



Detrended Five Year Tropical North Atlantic (80°W-20°W, 10°N-25°N) SSTA Predictions

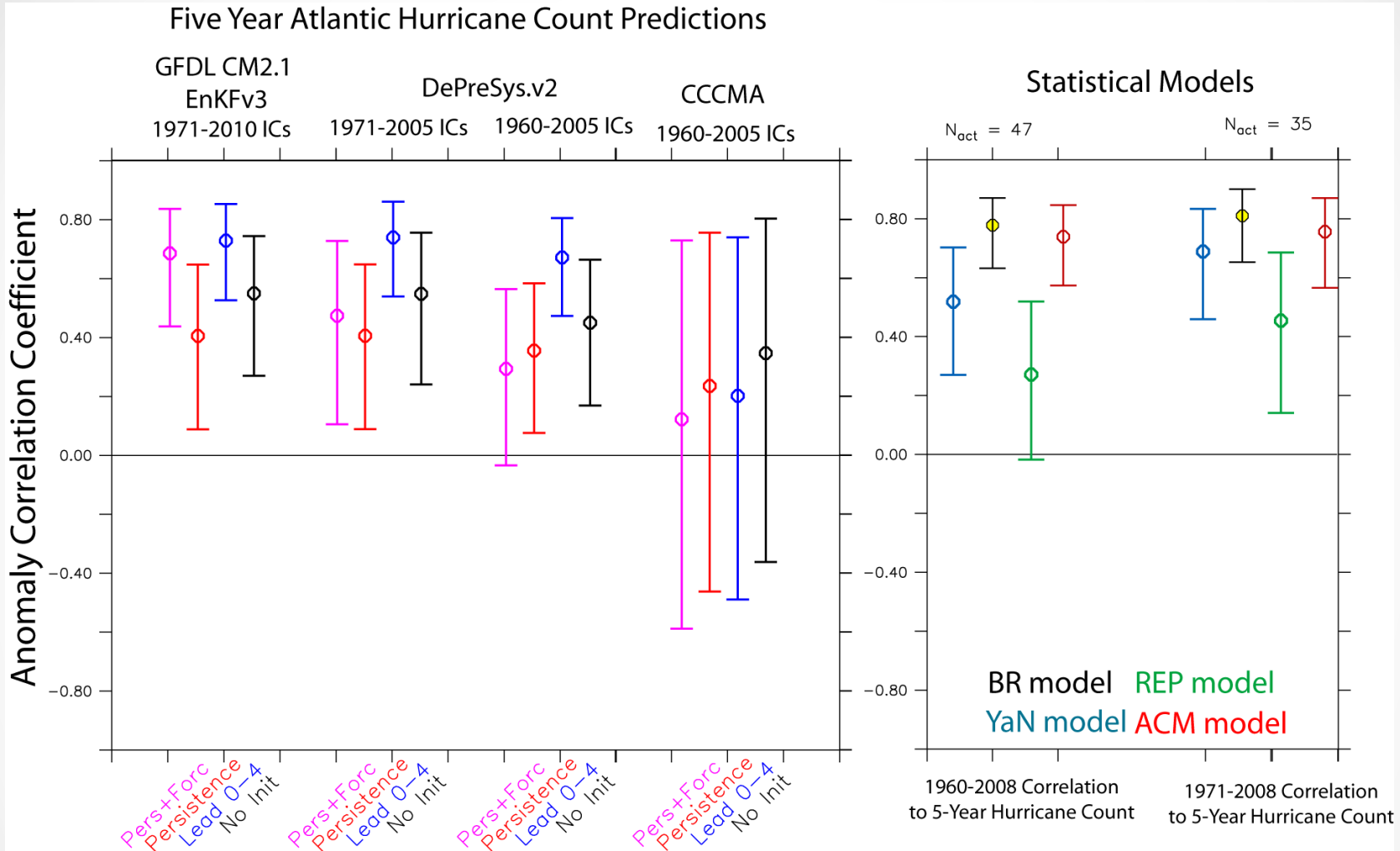
Volcanoes behind enhanced MDR SSTA skill in CM2.1 relative DePreSys



Summary

- High nominal skill in retrospective initialized predictions, but little significant
- Very reduced degrees of freedom from high autocorrelation (e.g., 35 \rightarrow \sim 6-7, 49 \rightarrow \sim 8-9)
- Not accounting for autocorrelation leads to severe overestimates of statistical significance
- None of the retrospective hurricane forecasts are significantly different from zero (or uninitialized/persistence)
- Skill in retrospective forecasts of MDR SSTA largely due to forcing, with volcanoes playing a big role
- Many of these factors likely to hold for other quantities

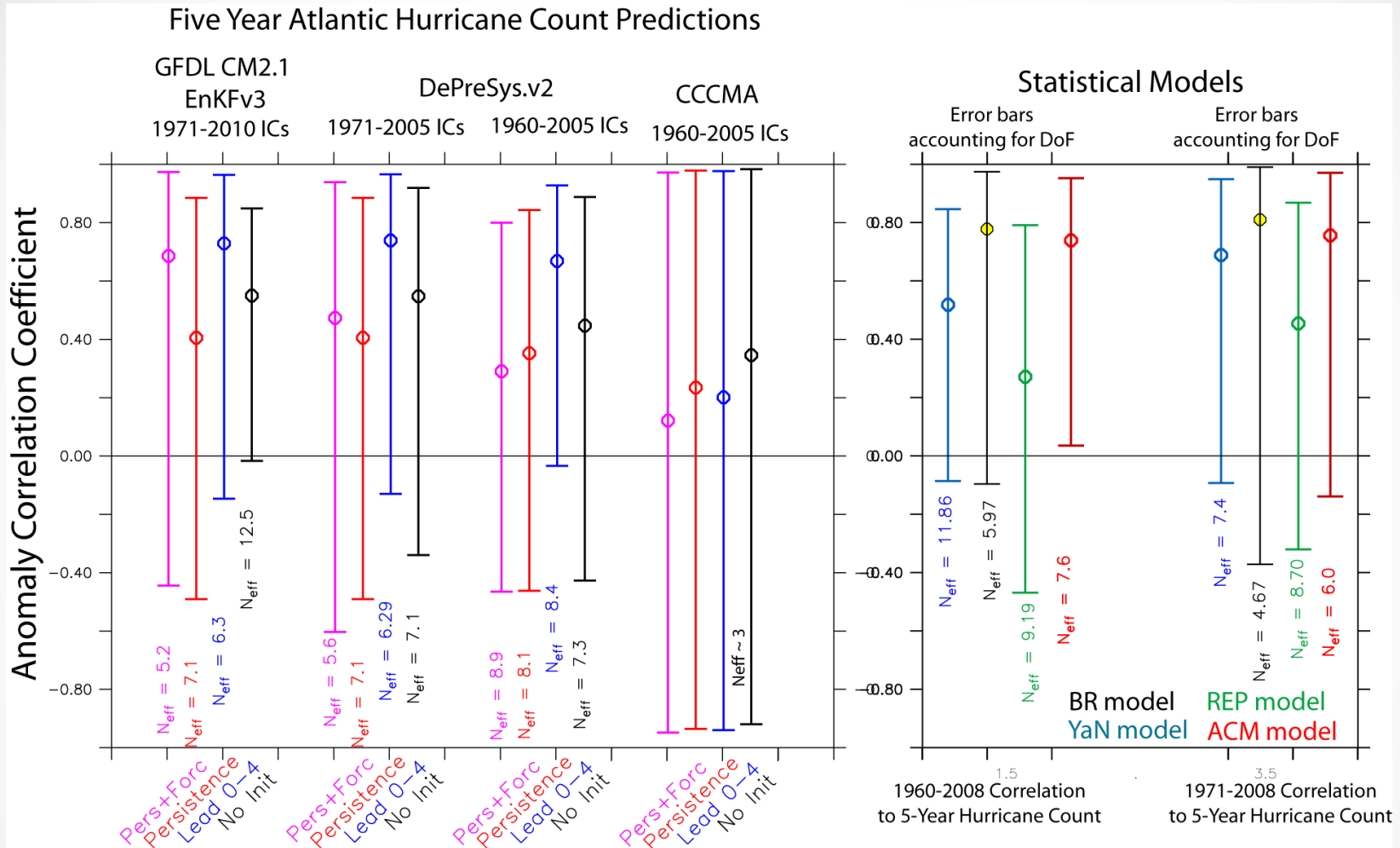
Apply Stat. Hurr. Model to CMIP5 Predictions



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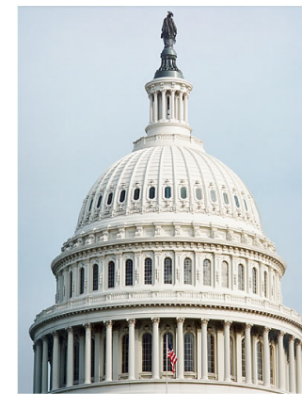
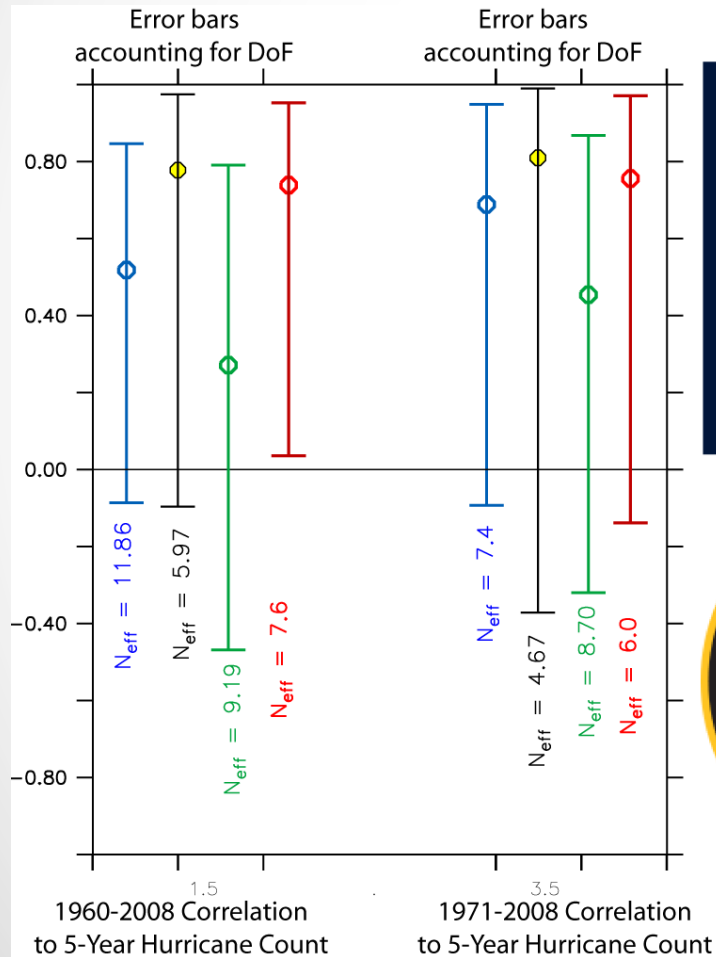


Assumption of independence invalid for both forecasts and obs.
 Correct DoF for autocorrelation based on Bretherton et al. (1999, JC)

Vecchi, Delworth, Dixon, Doi, Msadek,
 Rosati and Villarini (2011, in preparation)

We need to account for DoF correctly: “statistical models” were not serious

They were the first three timeseries of data I tried, thinking they would be both “red” and silly.



Winning percentage of NY Yankees

Years since Boston Bruins last Stanley Cup win

Number of Republican Senators in US Congress

-1 times Years since AC Milan won Scudetto