Climate Forecast Applications Network (CFAN)

Forecast of 2018 Atlantic Hurricane Activity

June 1, 2018

Summary

CFAN's June seasonal forecast of 2018 North Atlantic hurricane activity is based on current ocean-atmosphere anomalies that show historical skill as indicators of total hurricanes, numbers of major hurricanes (Category 3 or greater), accumulated cyclone energy (ACE), and the number of hurricanes making landfalls in the continental U.S. Our current forecasts predict below-normal activity in 2018: 4 hurricanes, 1 to 2 major hurricanes, total ACE of 63, and 0 to 1 US landfalls.

Introduction

Seasonal hurricane activity in the North Atlantic varies substantially from year to year with changing ocean-atmosphere conditions on regional to global scales. North Atlantic hurricane totals and accumulated cyclone energy (ACE) are especially responsive to regional sea-surface temperatures (SSTs) and related atmospheric circulation anomalies in tropical areas of the North Atlantic and the far eastern Pacific. Greater hurricane frequency is favored by warm SSTs in the tropical Atlantic and Caribbean Sea, which tend to enhance atmospheric convection, low-level convergence of moisture and latent heat energy, and tropical cyclone formation and intensification. Additional contributing factors include cool surface waters in the eastern tropical Pacific, a primary component of La Niña conditions that reduce upper-tropospheric wind shear, which inhibits hurricane development.

Opposite Atlantic and Pacific SST influences are reflected by patterns of correlation between July-August-September (JAS) seasonal SST means with annual indices of North Atlantic hurricane totals and ACE (Figs. 1A, 1B). Negative correlations in the eastern Pacific are strongest in areas north of the equator just west of Central America, while positive relationships prevail over the Caribbean Sea and much of the tropical North Atlantic.

Since the beginning of 2018, the tropical North Atlantic has undergone pronounced cooling (Fig. 1D), leading to negative SST anomalies of -0.5° to -1°C in recent May observations (Fig. 1C). By contrast, warming in the northeastern tropical Pacific (Fig. 1D) has contributed to a steady erosion of cool winter La Niña conditions, and an impending reversal toward El Niño is suggested by the emergence of slightly positive SST anomalies in May (Fig. 1C).

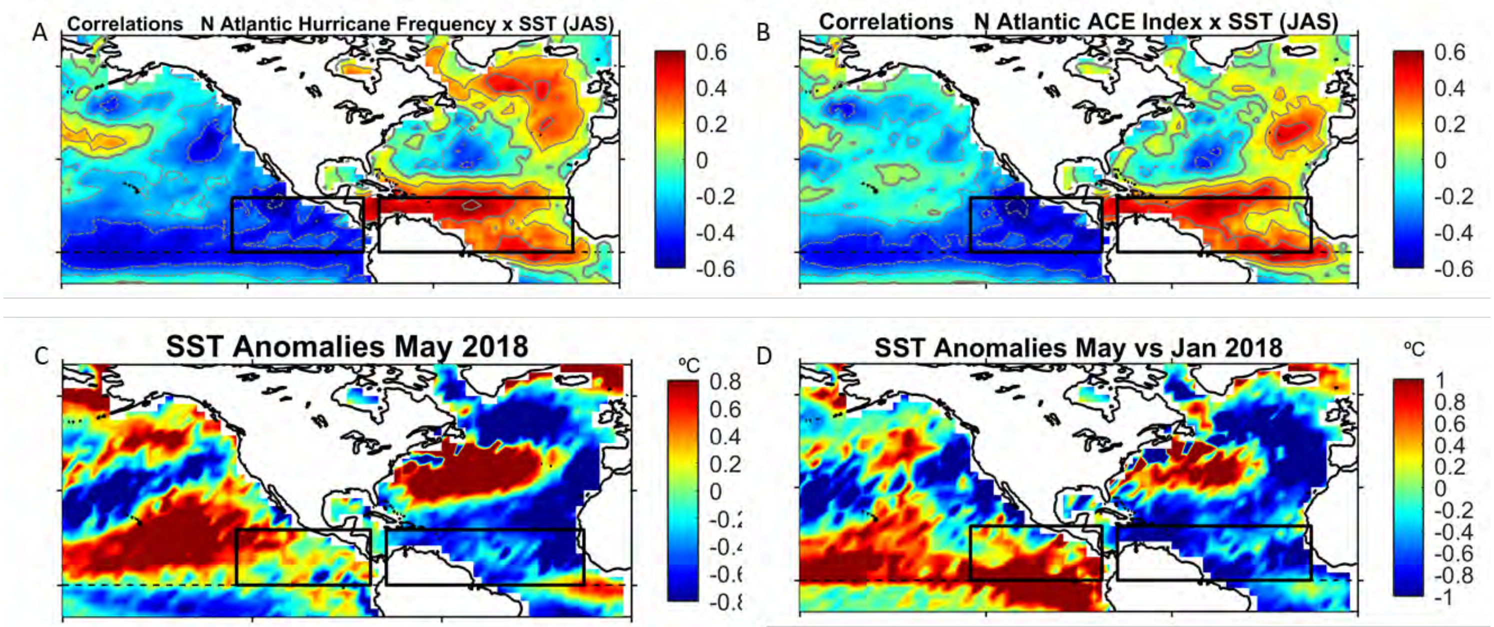

Figure 1. Sea surface temperature (SST) relationships to North Atlantic hurricanes and 2018 anomalies and trends. A. July-Aug-Sept (JAS) SST correlations with North Atlantic hurricane frequencies (1995-2017). B. JAS SST correlations with North Atlantic accumulated cyclone energy (ACE). C. SST anomalies, May 2018. D. SST anomaly changes from January to May 2018. Boxes depict areas of strong SST influence on North Atlantic hurricanes.

SST anomalies and trends during early 2018 are illustrated in Figure 2 for the tropical Pacific and North Atlantic areas outlined in Figure 1. Temperature anomalies and trajectories in both areas suggest the likelihood of low hurricane activity in 2018. Comparable early-year (January to May) SST trends in 2009 and 2002, were followed by low levels of North Atlantic ACE (53, 67) and hurricane frequencies (3, 4), in contrast to the highly active season last year in 2017 (ACE 226, and 10 North Atlantic hurricanes).

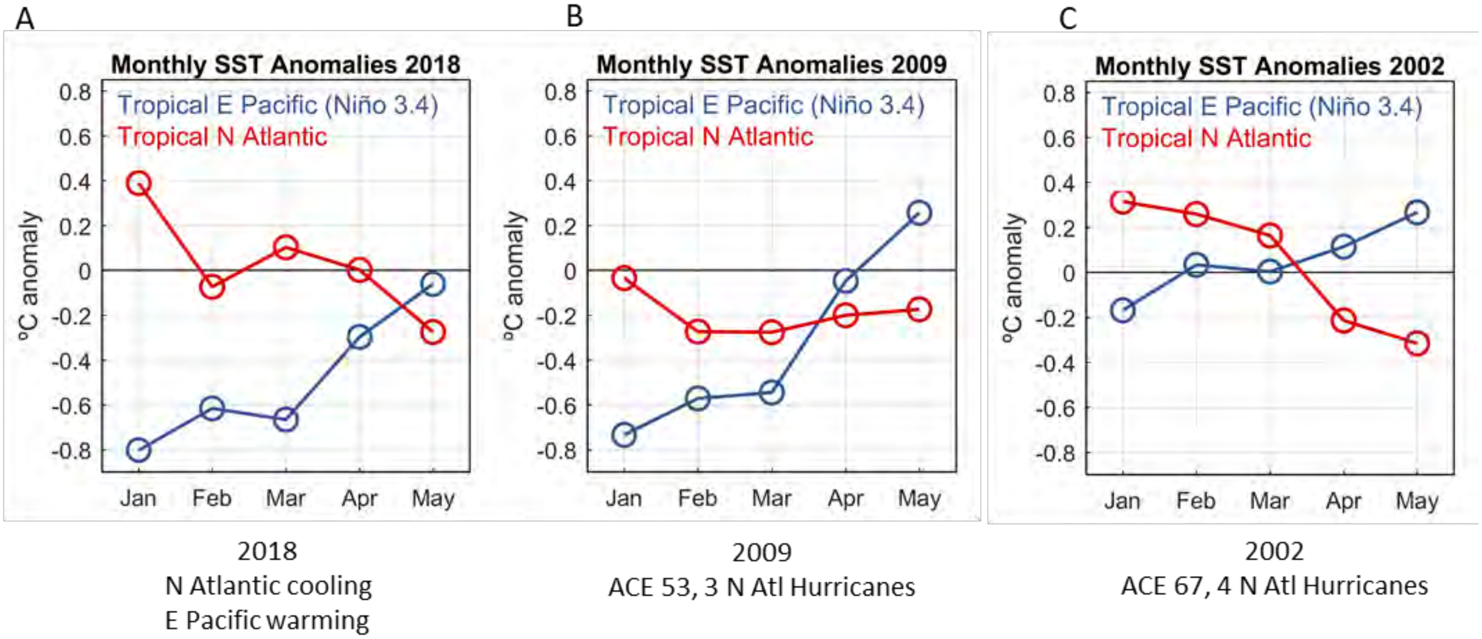

Figure 2. Monthly January-May SST anomalies in the eastern tropical Pacific and the tropical North Atlantic in 2018 (A), 2009 (B), and 2002 (C). SST indices reflect areas depicted by boxes in Fig. 1.

Strong hurricane activity is also responsive to spring (April-May) North Atlantic patterns of atmospheric sea-level pressure (SLP) and near-surface 1000 hPa winds, with higher hurricane totals consistently following conditions of high subpolar SLP around Iceland and Greenland, and low tropical-subtropical SLP and weak northeasterly trade winds, as reflected by SLP and wind correlations depicted in Figure 3A that correspond to the negative phase of the North Atlantic Oscillation (NAO) pattern. Recent April-May anomalies reflect high SLP and strong trade winds in the low-latitude North Atlantic, atmospheric patterns largely responsible for cool tropical surface conditions that provide further indications of low hurricane activity in 2018.

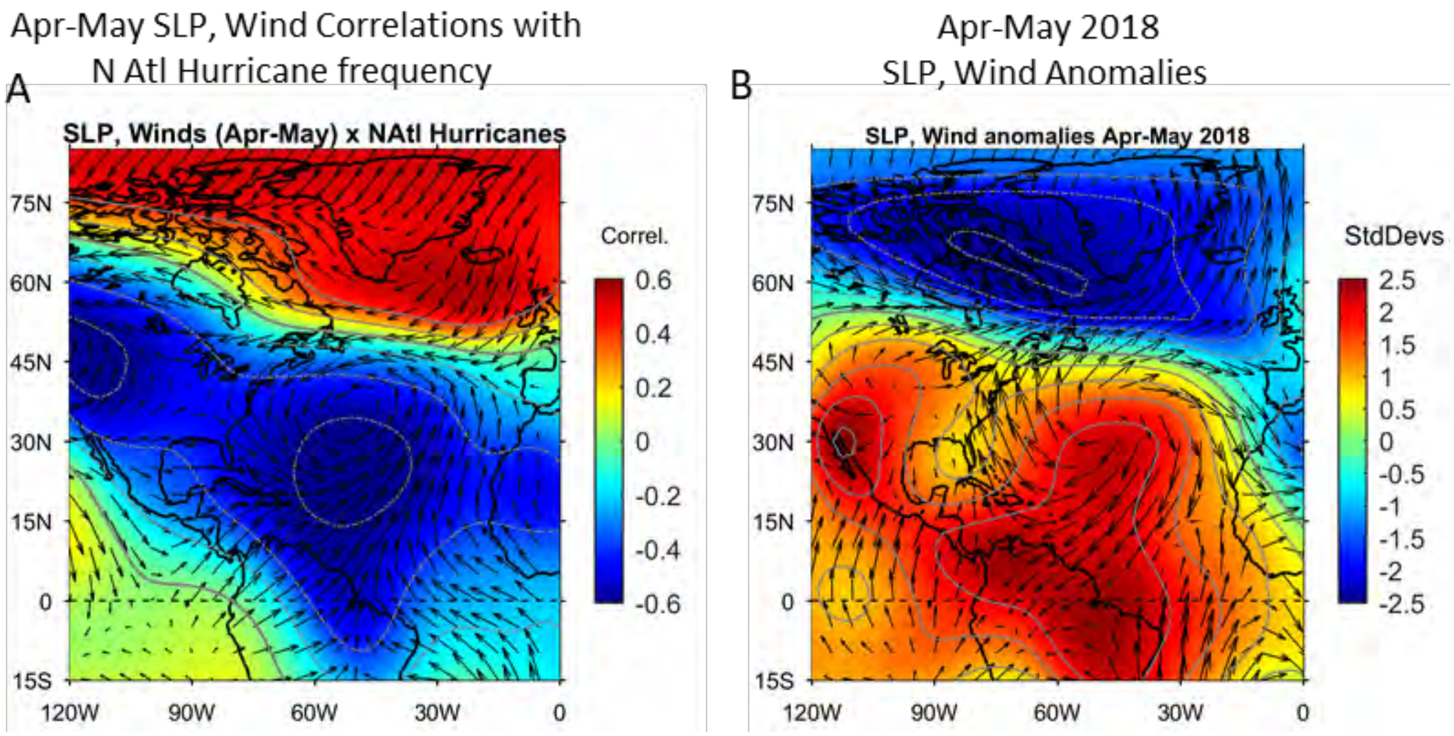

Figure 3. April-May North Atlantic atmospheric relationships to hurricane frequencies and 2018 anomalies. A.Correlations of April-May means of atmospheric sea-level pressure (SLP, shading) and near-surface 1000 hPa winds (vectors) with North Atlantic hurricane totals (1995-2017). B. April-May 2018 SLP and wind anomalies (normalized).

Predictors

Regional SSTs in the tropics affect hurricane activity largely through impacts on vertical and horizonal motions in the overlying atmosphere. However, significant relationships between North Atlantic hurricane totals and zonal (westerly) winds extend nearly throughout the global equatorial belt from the surface through the lower stratosphere, reflecting the involvement of global-scale circulation processes (Figure 4). Hurricane totals respond positively to anomalous westerly near-surface flow over equatorial South America and the Indo-Pacific and strong easterly flow over the Pacific, patterns characteristic of La Niña conditions and related intensification of the Pacific Walker circulation. Significant, largely opposite relationships are observed in upper-tropospheric zonal flow (150-300 hPa), while significant correlations in the lower stratosphere (50-70 hPa) suggest connections to global-scale processes of the Quasi-biennial Oscillation (QBO).

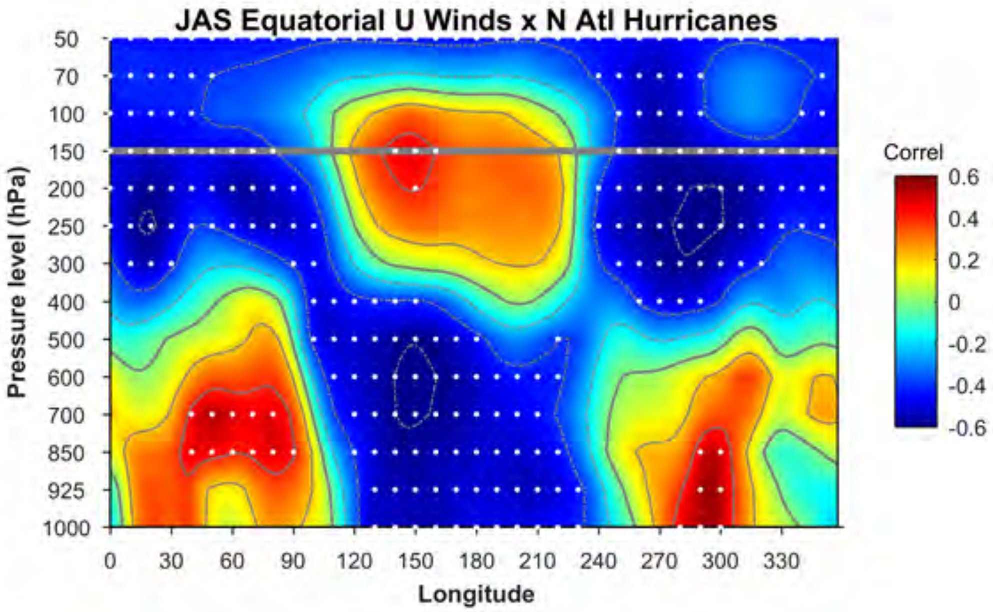

Figure 4. July-September equatorial zonal U (westerly) wind correlations with simultaneous North Atlantic hurricane totals (1995-2017). Correlations are plotted for the global equatorial belt (5°N-5°S) from near-surface (1000 hPa) to lower-stratospheric levels (50 hPa), with the troposphere-stratosphere tropopause boundary approximated by the horizontal line at 150 hPa. Positive low-level correlations (red) at 270-300° longitude correspond to areas over tropical South America. Negative low-level values (blue) from 120°-240° correspond to the equatorial Pacific, and positive low-level values from 30°-90°correspond to areas over the Indian Ocean. White markers denote statistically-significant ($p < 0.05$) correlations of magnitude >0.4.

Our hurricane forecast models are based on the recent expression of global equatorial U-wind anomalies that display strong historical relationships to hurricane indices. Historical hurricane-wind correlations and 2018 projections are based on models developed independently from three overlapping time periods (1995-2017, 2002-2017 and 2008-2017), in order to account for changing relationships and most recent circulation influences throughout the most recent warm phase of the Atlantic Multidecadal Oscillation (AMO), which began in 1995. Atmospheric predictors are based on hurricane-correlated equatorial wind patterns, such as those illustrated in Fig. 4, but during the March-April-May (MAM) spring window preceding the North Atlantic hurricane season that coincides approximately with the late-summer months from July through October.

Example predictor patterns are illustrated in Figure 5, which shows MAM U-wind correlations with North Atlantic hurricane totals (Fig. 5A) and 2018 MAM anomalies (Fig. 5B). Recent U-wind anomalies project largely oppositely (spatial correlation $r = -0.5$) on global MAM wind patterns preceding higher hurricane totals, most notably in critical areas above the eastern Pacific and Atlantic (240+ longitude). Here, upper- and lower-tropospheric wind anomalies are consistent with anomalous atmospheric subsidence over the tropical North Atlantic, conditions that tend to persist through summer, and currently foreshadow suppressed convection and reduced late-summer hurricane activity. Regression-based forecast estimates were developed from six different forecast models for North Atlantic hurricane totals, major hurricanes, ACE, and US landfalls, based on three different model training periods (noted above) and two spatial domains (troposphere and troposphere + stratosphere).

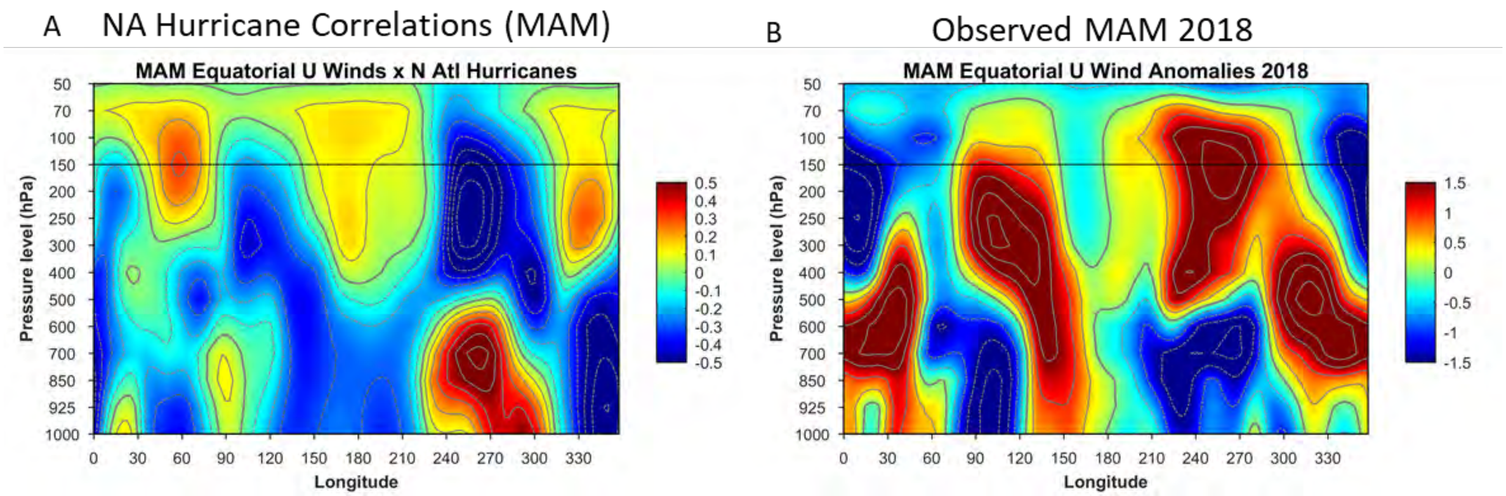

Figure 5. Global MAM equatorial zonal wind correlations with North Atlantic hurricanes, and 2018 wind anomalies. A. MAM correlations (2002-2017), mapped by longitude and height from 1000 hPa (near-surface) to 50 hPa (stratosphere). B. MAM 2018 anomalies, which depicts global features generally opposite (r = -0.5) those preceding higher hurricane totals.

Model-based forecasts and uncertainties (standard deviations), along with observed 1995-2017 index means are summarized in Table 1.

Table 1. 2018 Hurricane index forecast estimates (model means), uncertainties (model standard deviations, N=6), and 1995-2017 hurricane index averages.

Index	2018 Fcst	Std Dev	1995-2017
North Atlantic Hurricanes	4.3	2.0	7.5
Major Hurricanes (Cat. 3-5)	1.6	0.8	3.5
North Atlantic ACE	63	21	132.5
US Hurricane Landfalls	0.4	0.3	1.7

Historical model hindcast time series and 2018 forecast estimates are compared with observed hurricane series in Figure 6.

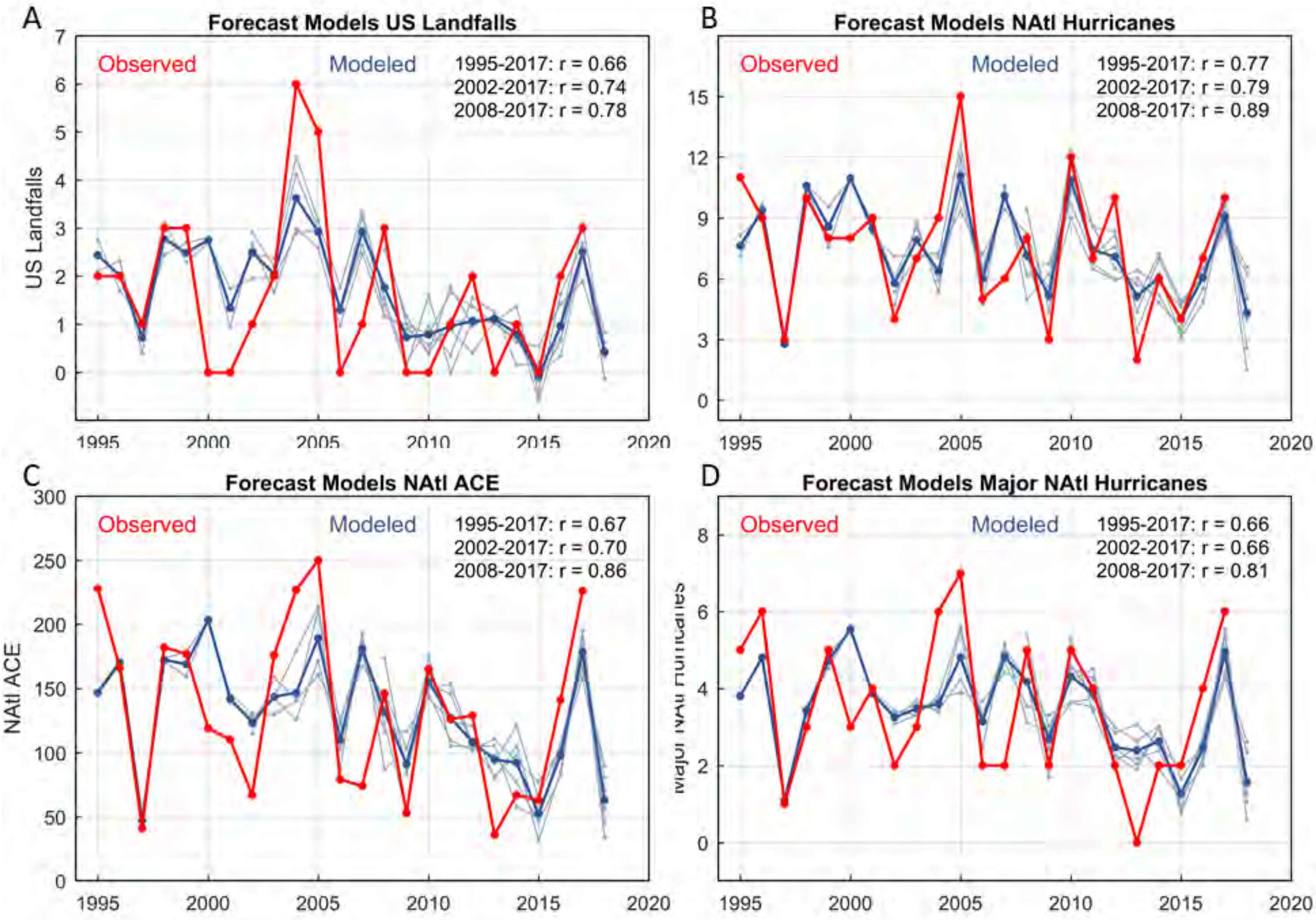

Figure 6. Model hindcast hurricane estimates (blue) and observed historical metrics (red). Fine gray lines depict individual model estimates (6), and blue lines reflect model means. A. US hurricane landfalls. B. North Atlantic hurricanes. C. North Atlantic ACE. D. North Atlantic major hurricanes (category 3-5).

All models point to low hurricane activity in 2018. Comparisons of model hindcasts and past conditions (Fig. 6) show that strong underestimates are limited primarily to the historically-extreme hurricane seasons of 2004 and 2005. We find that many aspects of current ocean-atmosphere conditions are consistent with low hurricane activity in 2018.

However unexpected outcomes cannot be ruled out, and we estimate the probability of exceptionally high activity (ACE > 200) in 2018 to be very low.

Further information about CFAN's forecasts

Further information about CFAN's tropical forecast products – TropiCast – can be found at https://www.cfanclimate.net/products-tropical-cyclones.

Summary reports are issued publicly. The technical forecast reports are available only to subscribers.

About CFAN

Climate Forecast Applications Network (CFAN) develops innovative forecast tools that give longer and more accurate warnings of extreme weather events, so clients can better prepare and recover. CFAN's staff applies the latest research to a wide range of customer challenges, helping businesses and government around the world. Our advanced prediction tools provide clients with the confidence to make complex and difficult decisions about weather risks.

CFAN was founded in 2006 by Judith Curry and Peter Webster and launched under the Enterprise Innovation Institute's VentureLab program at Georgia Tech. Its research has been assisted by grants from NOAA, the Department of Energy and the Department of Defense.

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