



Forecast of 2018 Atlantic Hurricane Activity

April 5, 2018

Summary

CFAN's inaugural April seasonal forecast for Atlantic tropical cyclone activity is based on systematic interactions among ENSO, stratospheric circulations and regional North Atlantic processes. CFAN's prediction for the 2018 hurricane season Accumulated Cyclone Energy (ACE) is for 60% chance of normal season and a 40% chance of a below normal season, based on NHC classifications. The predicted ACE values of 73 [range 43 to 97] are well below average for the active period since 1995.

Introduction

North Atlantic hurricane activity varies in response to simultaneous anomalies of regional sea surface temperatures and coupled atmospheric dynamics. Greater activity is observed in connection with cool La Nina surface conditions in the far eastern tropical Pacific and contrasting warm water around the Caribbean and tropical North Atlantic. This thermal contrast promotes low-level atmospheric convergence over the North Atlantic Main Development Region, leading to enhanced convection, tropical cyclone intensification and elevated annual ACE totals.

Sea surface temperature (SST) anomalies are generated largely by regional atmospheric dynamics over several months or longer, providing advance indications of seasonal hurricane activity. However, summer ENSO (El Nino Southern Oscillation) conditions typically grow rapidly during late spring and early summer, giving limited forewarning of anomalous hurricane conditions during peak months from August to October (ASO).

At the beginning of April 2018, an ongoing La Niña event is reflected by a negative SST anomaly (-0.7°C) in the equatorial east-central Pacific Niño 3.4 region. Most current predictions for ENSO are for a transition to ENSO neutral conditions, with some models predicting transition to a weak El Nino by the end of 2018. While traditionally there has been little skill in ENSO forecasts made in spring owing to the 'spring predictability barrier', recent advances in the ECWMF Seasonal Forecast System (SEAS5) and statistical modeling are providing increasing confidence in ENSO forecasts made in Spring.

CFAN's statistical model for extended range ENSO forecasts utilizes Northern Hemisphere December to February (DJF) zonal (U) wind tendencies in the lower stratosphere that feature weak westerly flow over the Arctic and strong flow above the subtropical eastern Pacific. The current expression of conditions in DJF 2017 contribute to expectations of a tendency towards El Niño conditions by December 2018. Similar



indications are given by anomalous DJF convergence in the upper troposphere above Antarctica, and patterns of meridional (V) winds in similar areas of the Southern Hemisphere. We predict 59% probability of neutral ENSO and a 38% probability of a weak El Nino by December 2018.

CFAN's climate dynamics research shows that hurricane-related factors develop through characteristic sequences of events over 6-24 months that involve interactions among ENSO and large-scale tropospheric and stratospheric processes, including the Quasi-biennial Oscillation (QBO) of equatorial stratospheric winds. Our forecast process identifies long-lead indicators in a variety of atmospheric variables at regional and global scales.

Predictors

Our forecast method identifies precursor pattern of atmospheric circulation that display strong historical correlations with North Atlantic hurricane activity, as represented by the ACE index. Patterns are identified in a variety of atmospheric variables from the NCEP-NCAR Reanalysis data, which are analyzed separately for 17 tropospheric and stratospheric levels and several spatial scales over global and regional domains. Correlations indicate the strength and spatial structures of antecedent climate features that recurrently precede ACE anomalies. Potential predictors are subjected to statistical experiments that test forecast skill of past hurricane anomalies.

Figure 1 illustrates one atmospheric predictor pattern and compares current JFM 2018 anomalies with JFM anomalies in 2017. Figure 1A illustrates correlations of historical ACE totals with JFM near-surface (1000 hPa) atmospheric vorticity over the North Pacific and North Atlantic. High ACE totals are consistently preceded by a pattern featuring positive vorticity anomalies (cyclonic circulation tendencies) over subtropical-midlatitude ocean areas surrounding the U.S., in conjunction with contrasting negative vorticity anomalies to the south over the tropical eastern Pacific, the western equatorial Atlantic and areas of Brazil. These conditions are associated with low surface pressure and weak trade winds, which are primary mechanisms of surface warming over the tropical North Atlantic. Negative vorticity anomalies in the tropical eastern Pacific occur in conjunction with anomalous high pressure and strong northeasterly trade winds, mechanisms that favor surface cooling and La Nina-like conditions by late summer. The organized JFM vorticity pattern in 2017 (Figure 1B) is conducive to development of cool water in the eastern Pacific and warm water in the tropical Atlantic, a signature of high ACE totals.

Current JFM vorticity anomalies (Figure 1C) in the northeast Pacific exhibit the negative polarity of the ACE-favorable pattern, suggesting later development of warm El Nino-like conditions that tend to reduce low-level convergence and increase upper-level wind shear above the North Atlantic – factors that tend to suppress hurricane activity. Current Atlantic vorticity anomalies also project on the negative polarity of the ACE-favorable regional pattern; however some degree of spatial mismatch is apparent in the positions of individual cells in the Atlantic.

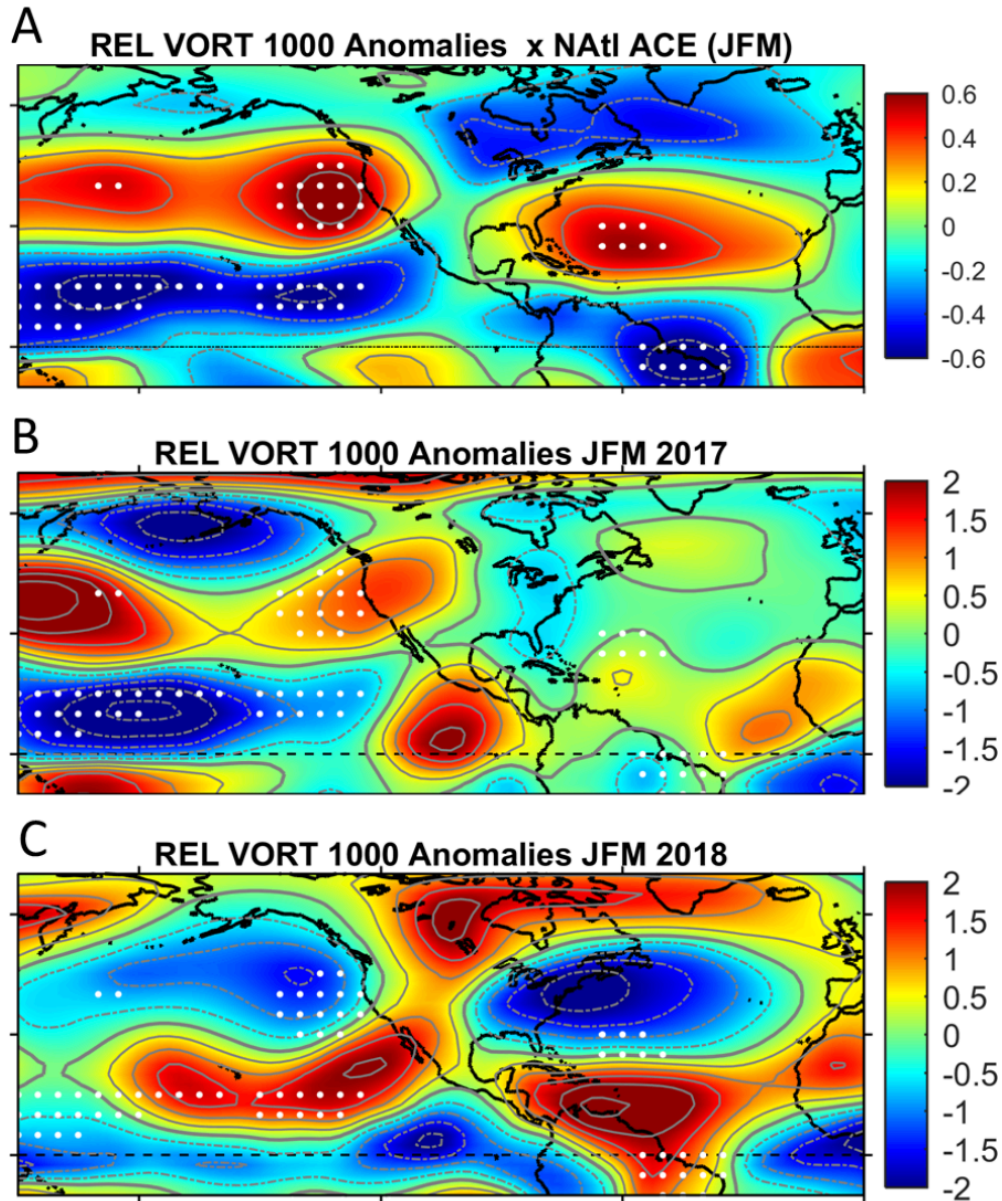


Figure 1. January-March (JFM) atmospheric precursors of North Atlantic ACE anomalies and comparisons with recent anomalies. A. ACE index correlations with JFM 1000 hPa relative vorticity. B. JFM 2017 vorticity anomalies. C. 2018 vorticity anomalies. Hatching marks areas of greatest forecast skill by local circulation anomalies, which contribute to high 2017 and low 2018 ACE forecasts.



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Predictive atmospheric patterns were also identified in zonal-mean anomalies relative vorticity (Figs. 3A, 3B) and zonal (U) winds and (Figs. 3C, 3D). These patterns include coherent circulation precursors of North Atlantic ACE that extend from the surface to the lower stratosphere through latitudes from 0° to 60°N. High ACE totals are produced by negative JFM vorticity and zonal wind anomalies at 45° to 35°N, and positive vorticity anomalies from 25°N to 10°N that represent anomalous midlatitude ridging, weak westerly winds and a shift toward stronger westerly flow and weakened upper ridges in the subtropics and tropics. The coherence of these zonal-mean anomalies suggests that ACE is driven substantially by hemisphere- to-global-scale dynamics.

ACE Index Correlations

Current Anomalies

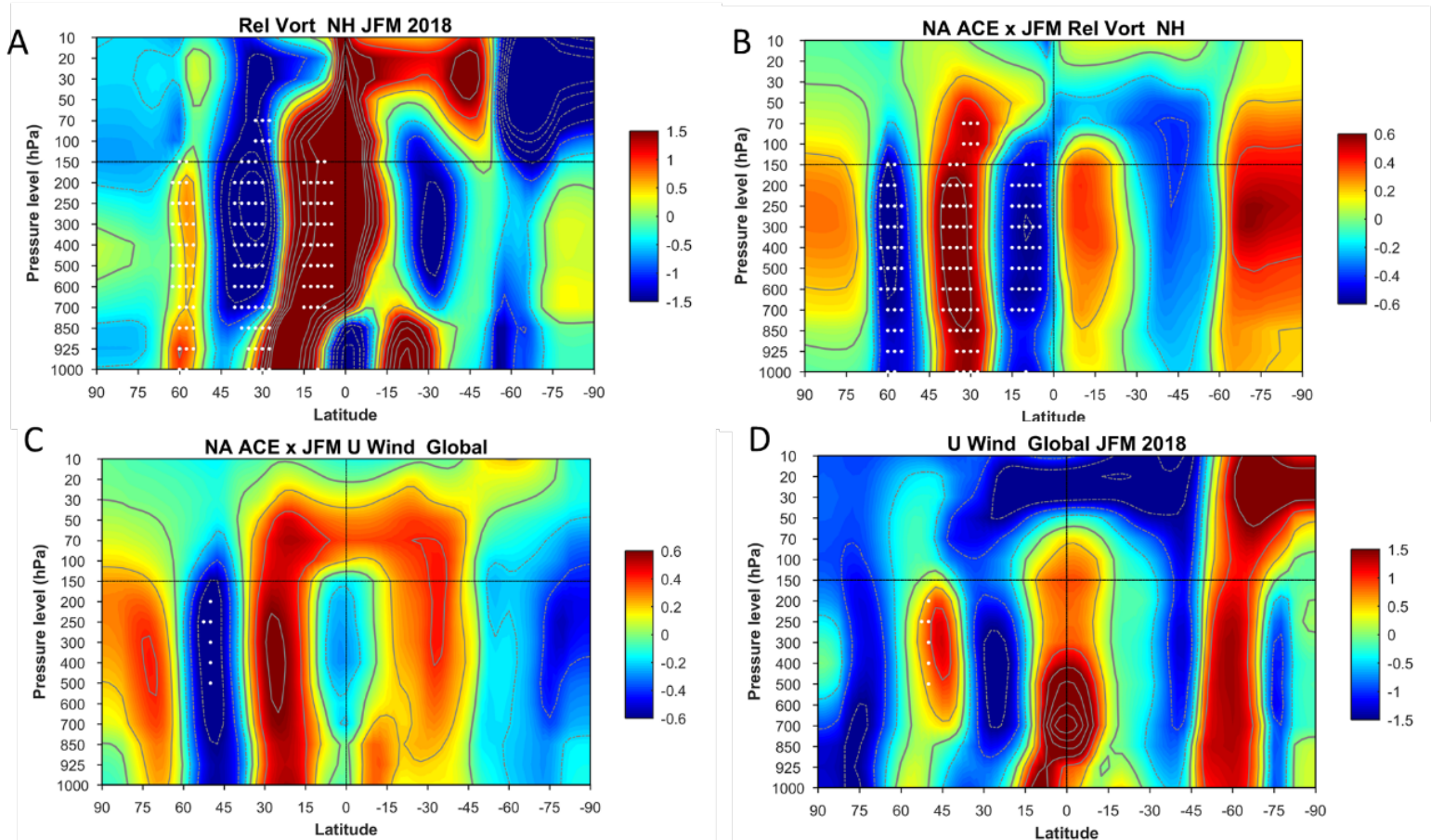


Figure 2. ACE correlations with zonal-mean atmospheric variables (JFM), mapped by latitude and height from 90N (left) to 90S (right) and 1000 hPa (near-surface, bottom) to 10 hPa in the stratosphere (top). A. ACE correlations with JFM zonal-mean relative vorticity. B. JFM 2018 relative vorticity anomalies (standard deviations). C. ACE correlations with JFM zonal-mean zonal (U) winds. D. JFM 2018 U wind anomalies. Hatching reflects locations with greatest predictive skill, which contribute to ACE forecast models.

Forecast model

A subset of the most skillful predictors is applied to the present scenario to derive quantitative forecasts. The April forecast is based on atmospheric anomalies and tendencies from January-March (JFM) 2018. Five predictive models, each based on a different atmospheric precursor pattern, form the basis for our 2018 forecasts.

Models are based on different global spatial patterns of relative vorticity at tropospheric levels of 1000, 600 and 400 hPa, and zonal-mean patterns of zonal (U) wind and relative vorticity, which contain information from the troposphere to the lower stratosphere. Annual ACE forecasts were determined from each model, based on training upon information available in other years from 1995 to 2017 (leave-one-out approach). Historical ACE estimates from individual models correlate with observations at levels of $r = 0.55$ to $r = 0.7$, while the average of the 5 model estimates, which forms the basis for the 2018 ACE forecast, correlates with historical ACE values at the level $r = 0.78$.

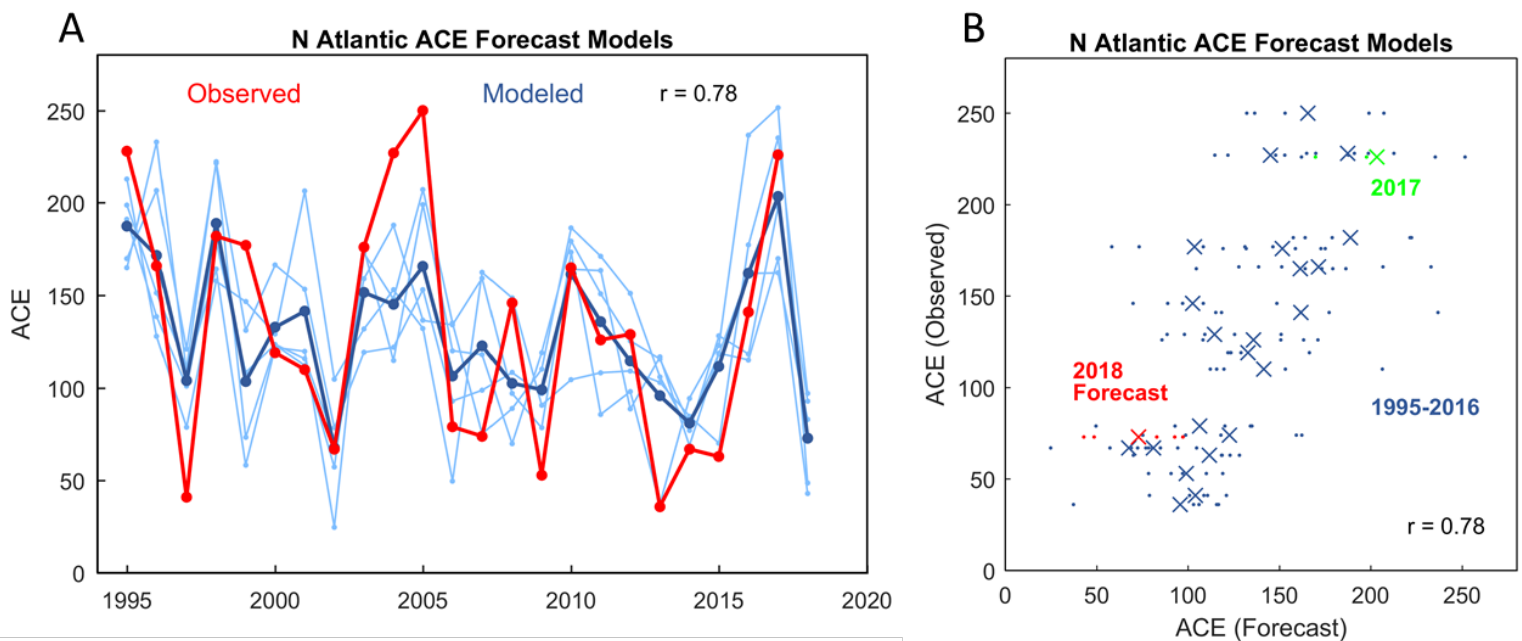


Figure 3. ACE forecasts from 5 JFM circulation-based predictive models. A. Time series of historical ACE values (red) and mean forecast of five models (blue) used for the 2018 ACE forecast (final modeled values). Individual model time series are shown in light blue. B. Scatterplot comparison of observed and modeled ACE. Blue points represent ACE forecasts produced by the five models in historical tests (1995-2016). Blue X's mark the mean forecast estimates of all five models. Green markers indicate successful historical forecasts of above-normal ACE totals in 2017 by all models (mean 203; range 162-252), compared to an observed level of 226 and a 1980-2017 mean of 133. Red markers illustrate forecast estimates for 2018 (overall estimate ACE: 73; range 43 to 97).



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The average forecast from the 5 models is for a 2018 ACE value of 73 [range 43 to 97]. The standard classification of a normal year is for ACE values between 66 and 111. CFAN's forecast is at the lower end of the normal range, with two of the five models predicting below normal ACE. This corresponds to a 60% probability of a normal season, and a 40% probability of a below normal season. Note that predicted ACE values for 2018 are well below the average value of 133 since 1995.

The Spring 2018 scenario does not have any analogues during the period 1995-2017. Previous years during this period that had ACE values below 80 are 1997, 2002, 2006, 2007, 2009, 2013, 2014 and 2015.

CFAN's April prediction, based on recent 2018 atmospheric conditions is lower than our December forecast that was based on long-lead predictors from late 2016.

CFAN's model for seasonal forecasts of Atlantic hurricane activity is based on a new approach, and hence there is not an actual forecast track record for this methodology. Confidence in our prediction for 2018 can be derived from our hindcast predictions back to 1995 and the physical plausibility of the model predictors based on our predictability analysis. However, the small sample size since 1995 (which is driven by the regime of the Atlantic Multidecadal Oscillation) limits the confidence that can be placed in the prediction model. Generally, confidence in an April forecast seasonal Atlantic hurricane activity is lower than forecasts made later in the year.

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.



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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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