Extended Range Forecast for North Atlantic Hurricane Activity in 2022

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Forecast Summary

TSR predicts that North Atlantic hurricane activity in 2022 will be near to the 1991-2020 30-year norm level in keeping with the recent years that followed two-year La Niña events. However, this outlook has large uncertainties.

The TSR (Tropical Storm Risk) extended range forecast for North Atlantic hurricane activity in 2022 anticipates a season with activity close to the 1991-2020 30-year norm level. The forecast spans the period from 1st June to 30th November 2022 and employs data through to the end of November 2021. TSR uses a new method for this extended hurricane outlook because climate teleconnection signals for the 2022 northern hemisphere summer are currently either weak or unpredictable, and because extended range forecasts for hurricane activity show little skill. This method recognises that 2020 and 2021 were moderate La Niña years and that it is rare to have three successive La Niña years. The forecast is based largely on the observed hurricane activity that occurred in two years (2001 and 2012) that immediately followed recent two-year La Niña events. In both 2001 and 2012 Atlantic hurricane activity was close to the 1991-2020 30-year mean level. In the absence of skillful forecasts for environmental fields during August-September 2022 at this ~9-month lead we suggest that this 'composite-based' forecast method is appropriate to use. We express the forecast uncertainty in terms of probability of exceedance for Accumulated Cyclone Energy (ACE) and for hurricane numbers.

North Atlantic ACE Index and System Numbers in 2022

		ACE Index	Intense Hurricanes	Hurricanes	Tropical Storms
TSR Forecast	2022	122	3	8	18
72-yr Climate Norm	1950-2021	105	2.7	6.4	12.2
30-yr Climate Norm	1991-2020	122	3.2	7.2	14.4
10-yr Climate Norm	2012-2021	125	3.1	7.3	16.8
Forecast Skill at this Lead	2003-2020	1%	4%	0%	0%

Key: ACE Index = Accumulated Cyclone Energy Index = Sum of the squares of 6-hourly maximum sustained wind speeds (in units of knots) for all systems while they are at least tropical storm strength. ACE unit = $x10^4$ $knots^2$.
Intense Hurricane = 1 minute sustained wind > 95 kts = Hurricane category 3 to 5.
Hurricane = 1 minute sustained wind > 63 kts = Hurricane category 1 to 5.
Tropical Storm = 1 minute sustained wind > 33 kts.
Forecast Skill = Percentage improvement in mean square error over running 10-year prior climate norm for the TSR publicly-released seasonal outlooks for the 19-years 2003-2021.

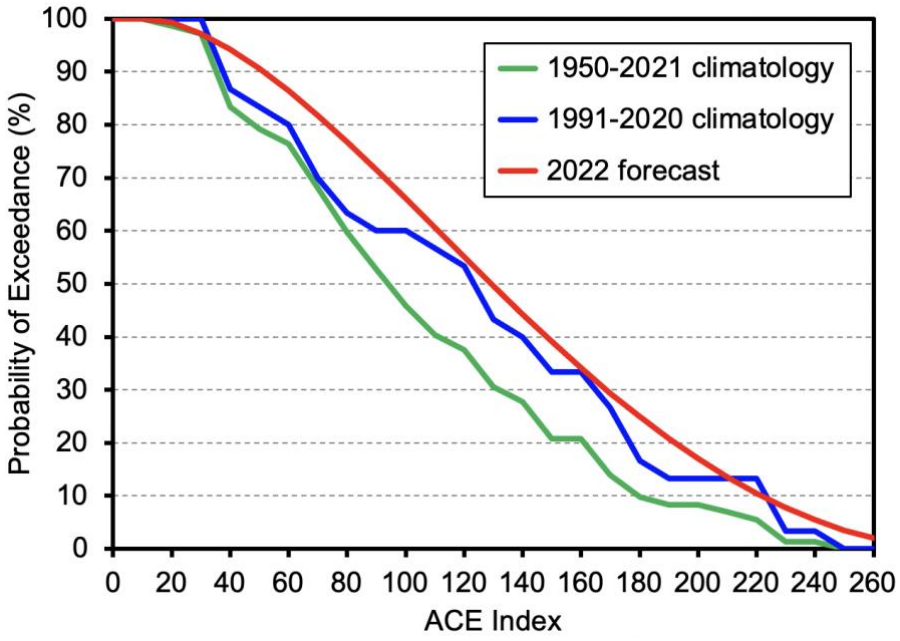
The forecast tercile probabilities (1991-2020 data) for the 2022 North Atlantic hurricane season ACE index are as follows: a 36% probability of being upper tercile (>155)), a 42% likelihood of being middle tercile (75 to 155)) and a 22% chance of being lower tercile (<75)).

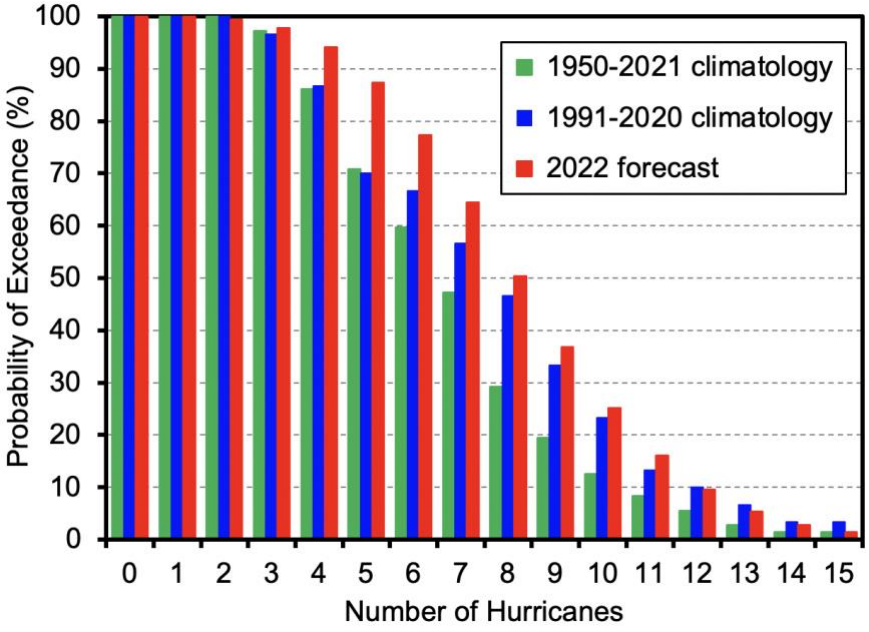
Key: Terciles = Data groupings of equal (33.3%) probability corresponding to the upper, middle and lower one-third of values for the current 30-year climate norm (1991-2020). Upper tercile = ACE value greater than 155. Middle tercile = ACE value between 75 and 155. Lower tercile = ACE value less than 75.

Forecast Probability of Exceedance Plots for the 2022 North Atlantic Hurricane Season

Seasonal outlooks for North Atlantic hurricane activity contribute to the anticipation of risk for insurance companies, other weather-sensitive businesses, and local and national governments. However, the uncertainty associated with such forecasts is often unclear. This reduces their benefit and contributes to the perception of forecast 'busts'. The robust assessment of risk requires a full and clear probabilistic quantification of forecast uncertainty with the forecast issued in terms of probability of exceedance (PoE). In this way the chance of each hurricane number/activity outcome occurring is clear for the benefit of users. Going forward TSR is including robust forecast probability of exceedance (PoE) information based on the recommendation and methodology described in Saunders et al. (2020).

The plots below display our extended range outlooks for ACE (upper panel) and for the number of hurricanes (lower panel) in terms of PoE. Each plot displays three sets of PoE data comprising the forecast PoE curve and two climatology PoE curves. The forecast PoE curves are computed using the method described in section 3 of Saunders et al. (2020) while the climatology PoE curves are computed directly from observations. The two forecast PoE plots specify the current chance that a given ACE index and/or hurricane total will be reached in 2022 and how these chances differ to climatology.





Reference: Saunders, M. A., Klotzbach, P. J., Lea, A. S. R., Schreck, C. J., & Bell, M. M. (2020). Quantifying the probability and causes of the surprisingly active 2018 North Atlantic hurricane season. *Earth and Space Science*, *7*, e2019EA000852. https://doi.org/10.1029/2019EA000852

Methodology and Key Predictor(s) for 2022

The TSR statistical seasonal hurricane forecast model divides the North Atlantic into three regions and employs separate forecast models for each region before summing the regional hurricane forecasts to obtain an overall forecast. For two of these three regions (tropical North Atlantic, and the Caribbean Sea and Gulf of Mexico) the forecast model pools different environmental fields involving August-September sea surface temperatures (SSTs) and July-September trade wind speed to select the environmental field or combination of fields which gives the highest replicated real-time skill for hurricane activity over the prior 10-year period. The nature of this process means that the details of the seasonal forecast model can vary subtly from year-to-year and also with lead time within the same year. Separate forecast models are employed to predict the July-September trade wind speed and to predict the August-September SSTs. Finally bias corrections are employed for each predictand based on the forecast model performance for that predictand over the prior 10 years.

All regressions are performed using normalized data for all variables (predictands and predictors). This ensures that the requirements of linear regression modeling are met; namely that observations are drawn from normal distributions and that regression errors are normally distributed with a mean of zero. In each case the transform distribution is determined using 1950-2019 data. Table S2 in Supporting Information in Saunders et al (2020) lists some of the statistical distributions used to transform particular data sets to a normalized distribution. Normality is assessed by using the Anderson-Darling statistical test.

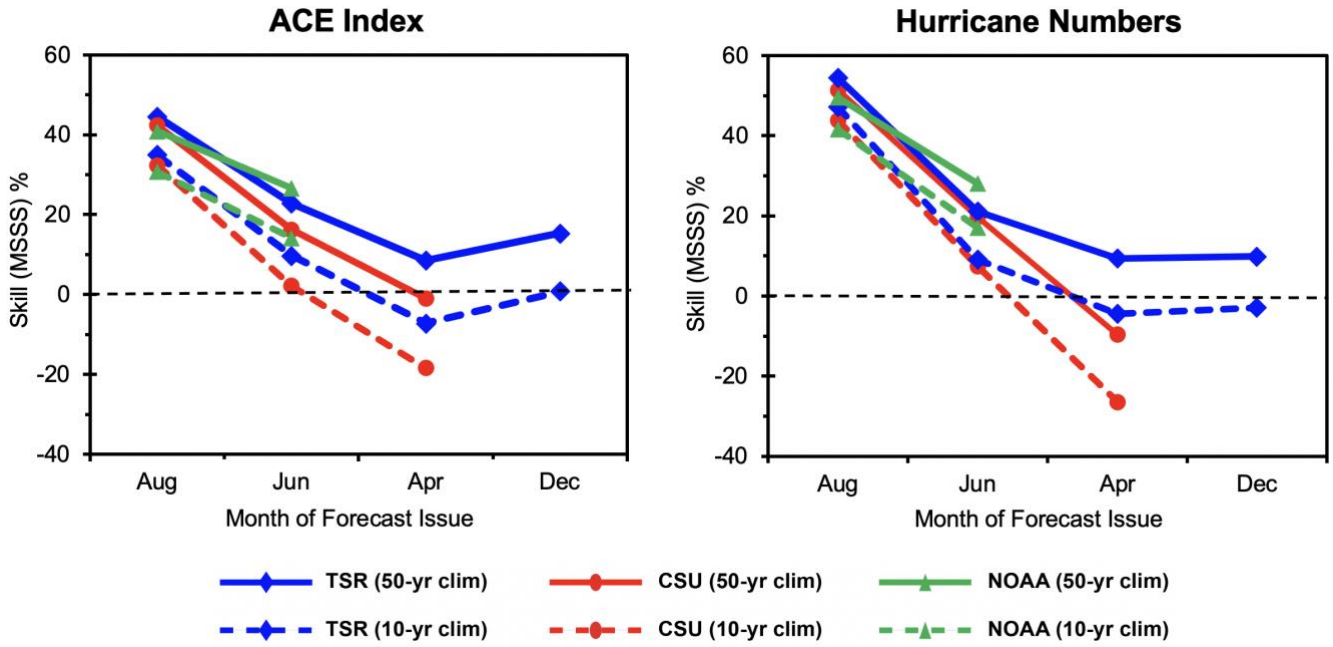
The reason why the TSR extended forecast for the 2022 Atlantic hurricane activity calls for ACE-activity close to the 1991-2020 climate norm level is our current expectation that neutral ENSO (El Niño Southern Oscillation) conditions will occur during July-August-September 2022. We consider that this is a likely scenario due to the strength of the current La Niña event and the historical tendency for the summer following a two-year La Niña event (2020 and 2021 were moderate La Niñas) to exhibit neutral ENSO conditions. Should ENSO be neutral during summer 2022 then if the North Atlantic Oscillation (NAO) in April-May-June 2022 is either in its upper or lower tercile historically the NAO may have a sizeable influence on the 2022 Atlantic hurricane activity. Unfortunately there is no skill at predicting the April-May-June 2022 NAO at this ~5 month range. It should be stressed that there are large uncertainties in our extended outlook for North Atlantic hurricane activity in 2022. These uncertainties arise in particular from uncertainties in the forecast ENSO for summer 2022 and from uncertainties about the influence of the upcoming April-May-June NAO on 2022 hurricane activity.

Precision of Seasonal Hurricane Forecasts 2003-2021 Issued Publicly

The figure on the next page displays the seasonal forecast skill for North Atlantic hurricane activity for the 19-year period between 2003 and 2021. This skill assessment uses the seasonal forecast values that were issued publicly in real-time by the three forecast centres TSR, CSU (Colorado State University) and NOAA (National Oceanic and Atmospheric Administration). Skill is displayed as a function of lead time for two measures of seasonal hurricane activity: the ACE index and basin hurricane numbers.

The Mean Square Skill Score (MSSS) is used to define the forecast skill. MSSS is the percentage improvement in mean square error over a climatology forecast. Positive skill indicates that the model performs better than climatology, while a negative skill indicates that it performs worse than climatology. Two different climatologies are used: a fixed 50-year (1951-2000) climatology and a running prior 10-year climate norm.

It should be noted that NOAA does not issue seasonal hurricane outlooks before late May and that CSU stopped providing quantitative extended-range hurricane outlooks from the prior December after 2011. It is clear there is little skill in forecasting the upcoming ACE and numbers of hurricanes from the previous December for the period 2003-2021. Skill starts to climb after April as the hurricane season approaches with moderate-to-good skill levels being achieved, on average, by early August.



Although there are mostly only small differences in skill between the three forecast centres, the TSR model has been either the near-equal best or the best performing statistical seasonal forecast model at all lead times for the period 2003-2021.

Further Information and Next Forecast

Further information about the TSR forecasts and their verifications may be obtained from the TSR web site *https://www.tropicalstormrisk.com*. We anticipate that the first TSR forecast update for the 2022 North Atlantic hurricane season will be issued on Tuesday 12th April 2022.