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North Atlantic Hurricane Season – 2020 Forecast

10 June 2020

Executive summary:

- Basin wide hurricane activity for 2020 is forecast to be higher than the mean number of storms observed between 2000-2019 (a more active period for hurricanes than the long-term average) with 17.6 storms expected in the basin relative to the mean of 15.3.
- The main development region (MDR), a region of the tropical Atlantic that extends approximately from the west coast of Africa to the western Caribbean Sea, is forecast to have the largest deviation from the 2000-2019 mean with 8 named storms expected relative to the mean of 6.
- The Gulf region is forecast to expect 4.4 named storms compared to a 2000-2019 mean of 3.7.
- Storms that form in the East Coast region have a forecast expected value lower than the 2000-2019 mean with of 5.1 storms forecast compared to the 2000-2019 mean of 5.6.
- Despite the expected increase in activity, the forecast number of U.S mainland landfalls of 4.6 is expected to be closer to the 2000-2019 mean of 4.4, reflecting the view that dominant atmospheric fluid flow and wind shear patterns could act to protect the US coastline.

Applying machine learning to better model insurance risk from hurricanes

Twelve Capital, together with machine learning climate-tech firm reask, have developed a proprietary North Atlantic hurricane seasonal forecast methodology. This moves beyond traditional basin-wide hurricane activity metrics, such as hurricane count, towards a more complete insurance risk assessment framework that incorporates a measure of regional hurricane landfall risk. The model couples statistically robust predictions with well-established physical phenomena to produce results that can be interpreted using relevant climate processes. More detail of the model methodology can be found in the Appendix.

The modelling approach allows for the direct calculation of regional (regions shown in Figure 1) storm count and landfall probability distributions as well as highlighting the associated key climate signals. Seasonal risk can then initiatively be assessed based on risk levels relative to a baseline climatological benchmark. Here the baseline is taken to be the period 2000-2019, a period which exhibited higher risk levels relative to the long term average (1970-2019, 12 named storms annually on average. Source: IBTrACS.). A marked increase in hurricane activity over the past two decades suggests a shift in baseline risk potentially driven by climate variability.

Hurricane season activity expected to be above average for 2020

With 17.6 storms expected in the basin relative to the mean of 15.3, basin wide storm activity is forecast to be higher than the mean number of storms observed between 2000 and 2019. The skewness in risk relative to the baseline view is evident in Figure 2 where the predicted risk level for basin wide storm count is clearly shifted to more extreme values.

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The 2020 forecast clearly shows, in Table 1, higher risk associated with the number of storms emanating from both the main development region (MDR; a region of the tropical Atlantic that extends approximately from the west coast of Africa to the western Caribbean Sea) and Gulf regions with lower risk along the East Coast relative the 2000-2019 mean.

The MDR is forecast to have the largest deviation from the 2000-2019 mean with 8 named storms expected relative to the mean of 6. MDR activity is a key area of focus for potential insurance risk. Hurricanes emanating from this region have more chance on intensifying over warmer sea surface temperatures and therefore have a higher impact potential.

The Gulf region is forecast to expect 4.4 named storms compared to a 2000-2019 mean of 3.7.

Storms that form in the East Coast region have a forecast expected value lower than the 2000-2019 mean with of 5.1 storms forecast compared to the 2000-2019 mean of 5.6

Figure 1: Model region classifications. Source: reask and Twelve Capital.

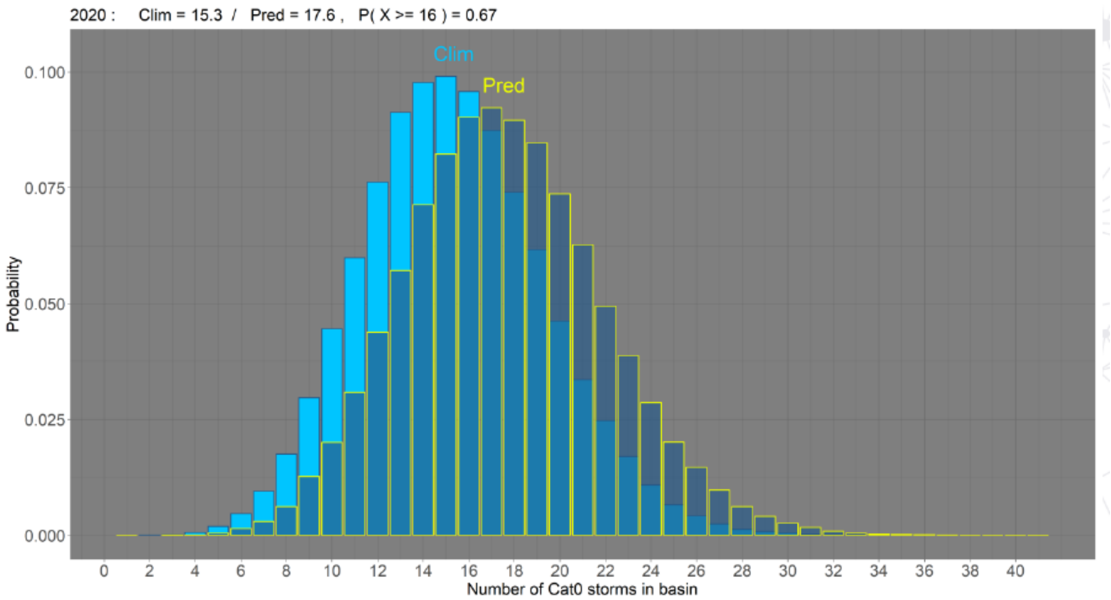

Figure 2: Comparison of the 2020 season predicted risk distribution of basin wide count with the 2000-2019 climatology. Source: reask.

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Table 1: Hurricane season 2020 forecast. The machine learning algorithm assumes continuous distributions to estimate discrete data. All figures are rounded to one decimal place. Source: reask.

Metric	Region	2020 mean forecast (% change from 2000-2019)	2000-2019 mean	Probability of exceeding mean	High confidence interval	Interval confidence
Count	North Atlantic Basin	**17.6 (+15%)**	15.3	67% (P>15)	[14-21]	64.7%
	Main Development Region	**8 (+33.3%)**	6	68% (P>6)	[5-10]	60.9%
	Gulf/West Caribbean	**4.4 (+18.9%)**	3.7	63% (P>=4)	[2-5]	64.0%
	East Coast	**5.1 (-8.9%)**	5.6	41% (P>5)	[3-6]	61.1%
Landfalls	Main Development Region	**1.4 (+7.7%)**	1.3	75% (P>=1)	[1-2]	57.7%
	Gulf/West Caribbean	**2.2 (+10%)**	2	65% (P>=2)	[1-3]	69.0%
	East Coast	**1 (-9.1%)**	1.1	61% (P>=1)	[0-1]	75.0%

Two key signals with credible predictive quality, identified via machine learning technology support the 2020 hurricane season forecast, namely North Atlantic sea surface temperatures and the West African monsoon.

Sea Surface Temperatures (SSTs)

Global anomalies of SSTs for the month of May 2020 (Figure 3) highlight two important patterns that contribute to the forecast of higher activity in the North Atlantic basin relative the 2000-2019 average:

- Anomalously warm water temperatures in the tropical Atlantic, highlighted by the yellow regions in Figure 3, are favourable for hurricane formation and intensification in the MDR, Caribbean and Gulf of Mexico regions.
- Anomalously cold water temperatures in the central/east Pacific, visible as an area of green cooler temperatures in the east pacific in Figure 3. The emergence of this “cold tongue” pattern is indicative of the current ENSO neutral phase and potential for a la Niña event in the coming months. A la Niña event during the season would create conditions more favourable for hurricane activity by reducing the vertical wind shear thereby reducing the probability that storms get “toppled over” by changes in winds with height.

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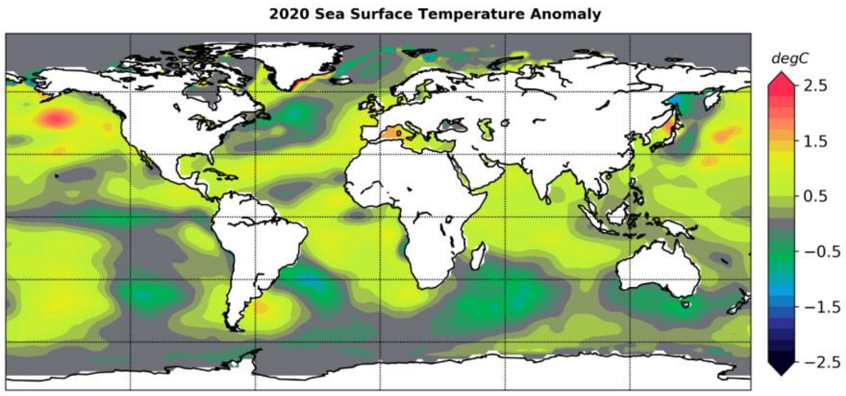

Figure 3: May anomalies in sea surface temperatures with respect to the 1979-2019 climatology. Source: reask.

West African Monsoon (WAM)

Global precipitation and convection patterns point towards an active WAM season. The dipole of strong positive and negative precipitation anomalies around West Africa (highlighted by dipole of red and green precipitation anomalies west and south of western Africa in Figure 4) could result in the potential for reduced vertical wind shear favouring activity in the main development region. An active WAM also acts to increase the frequency and intensity of African easterly waves[1] thereby creating favourable conditions for tropical cyclone genesis over the deep tropics.

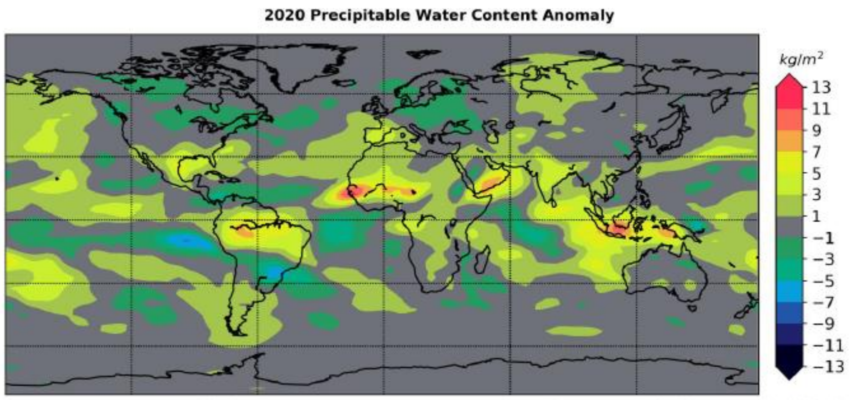

Figure 4: March - May anomalies in precipitation water content with respect to the 1979-2019 climatology. Source: reask

Forecast points to hurricane landfall risk rising more slowly than activity

Despite the predicted increase in storm activity for 2020, the forecast landfall probability is much closer to the baseline view with the departure from expected value predicted to be less than 10% for all regions.

Key predictability in landfall rate in the US suggests that the dominant atmospheric fluid flow and wind shear patterns could act to protect the US coastline. In such a scenario a large proportion of the forecast MDR systems could recurve out to sea rather than threaten the US.

[1] African Easterly Waves are waves in the atmosphere that propagate from east to west over the Sahel region of Africa and are often observed to form hurricanes as they reach the Atlantic Ocean.

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A notable analog year for that scenario is the 2010 season where the pattern of pressure and steering flow anomalies observed during August-October 2010 acted to steer MDR storms away from hitting the US mainland. Of the 19 observed named storm in 2010, 12 were hurricane strength with no hurricane strength storm making landfall with the continental United States.

The steering flow can be clearly seen by the white arrows in Figure 5 where the meridional component pushes storms northward and the zonal component pushes storms to the east thereby reducing landfall risk.

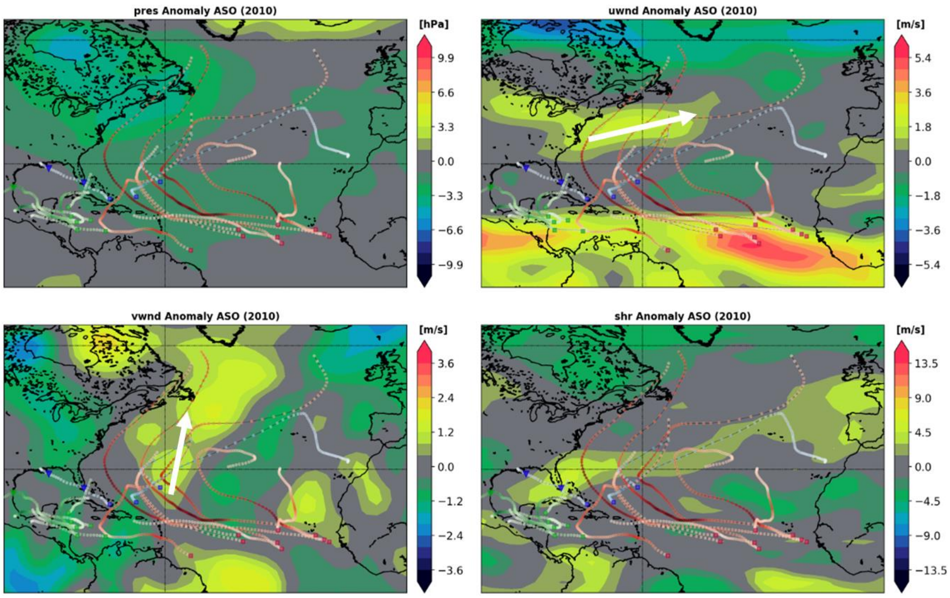

Figure 5: 2020 tropical cyclone tracks along with August-October observed anomalies of (a) sea surface pressure, (b) zonal winds, (c) meridional winds and (d) vertical wind shear. Source: reask.

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Appendix – Machine learning methodology

Machine learning (ML) techniques allow for development of algorithms directly from data without human-specified rules. In the context of understanding climate risk ML methods provide tools to automate knowledge discovery directly from global climate data (i.e. pattern extraction). The approach generates "smart" global climate predictors, using neural networks, where patterns in global climate data are automatically recognised and linked to known climate signals (Figure 6). Large datasets of potential climate predictors can be generated based on the state of the pre-season climate in spring and automatically tested for their reliability in predicting in-season hurricane activity. Predictor reliability for forecasting hurricane activity is assessed in two ways:

- Correlation to hurricane count metrics, such as basin wide numbers, regional activity and landfalls.
- Correlation to environmental conditions known to favour in-season hurricane such as anomalously warm sea surface temperatures, low environmental pressure and weak vertical wind shear (i.e. reduced change in winds with height).

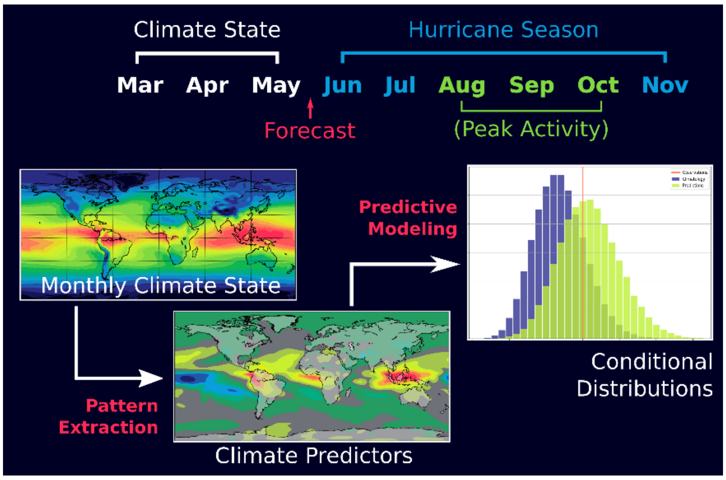

Figure 6: Seasonal hurricane forecasting timeline and machine learning (ML) based forecasting system: Key climate patterns are extracted from monthly gridded data in spring and provided as input to (or 'reask generated') ML based predictive algorithm. The system models distributions of hurricane risks conditional on the state of the climate in spring. Source: reask.

Forecast approach

The machine learning process is based on a sequence of conditional models that quantifies the probability of potentially high impact US land-falling systems such as the ones emanating from the Cape Verde / MDR region shown in Figure 7 (e.g. Hurricane Irma 2017).

- **Step 1:** Model the distribution of storm activity in the basin conditional on the state of selected spring climate predictors.
- **Step 2:** Conditional on Step 1 distributions and additional climate predictors, predict activity in three key sub-areas of the basin:
    - Cape Verde region / Main Development Region (MDR)
    - Gulf of Mexico / Caribbean
    - East coast of the US / Atlantic North.
- **Step 3:** Estimate for each of the above, the probability of US landfalls, conditional on Step 2 activity and further climate predictors.

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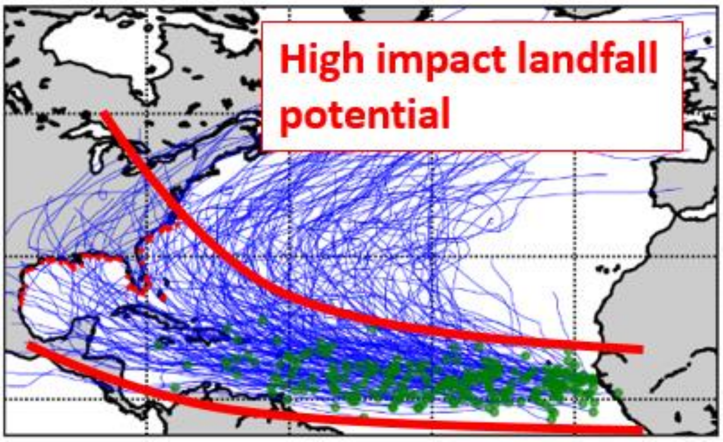

Figure 7: High impact potential storms identified from the Cape Verde/MDR region. Source: reask and Twelve Capital.

Past model performance is assessed via a ‘leave-one-out’ cross validation exercise, where we repeatedly leave out a year from the dataset used to train the algorithm and use it for independent model evaluation instead. Table 2 summarises results over the 2004-2019 period in terms of US land-falling systems originating from the Cape Verde / MDR region and highlights the strength of the approach in distinguishing high potential risk seasons such as 2004, 2008 and 2011 from those with lower threat such as 2009 or 2015.

Table 2: Leave-one-out evaluation of model’s predictions for the number of US land-falling systems issued from the Cape Verde / MDR region. Source: reask.

Season	Actual observed landfalls	Mean prediction	Probability of 0 landfalls	Probability of 1 landfall	Probability of 2 or more landfalls
2019	1	1.60	0.20	0.32	0.48
2018	1	0.77	0.48	0.34	0.18
2017	2	1.34	0.27	0.34	0.39
2016	1	1.17	0.33	0.35	0.32
2015	0	0.26	0.78	0.19	0.03
2014	0	1.08	0.36	0.35	0.29
2013	0	0.76	0.47	0.35	0.18
2012	1	1.14	0.34	0.35	0.31
2011	2	2.21	0.12	0.24	0.64
2010	0	1.26	0.3	0.35	0.35
2009	0	0.47	0.64	0.28	0.08
2008	3	2.48	0.1	0.21	0.69
2007	0	1.13	0.33	0.36	0.31
2006	1	0.97	0.38	0.37	0.25
2005	3	1.56	0.22	0.32	0.46
2004	5	3.41	0.04	0.12	0.84

Twelve Capital and reask – co-operation

Since June 2018, Twelve Capital and reask have worked closely together to further the development of hurricane forecasting tools by using machine learning. Both parties believe that advancements in technology and computing power can enhance ILS investment management.

reask is a catastrophe analytics specialist providing global solutions for tropical cyclone risk management and forecasting. reask is based in Sydney with its team of experts in risk analysis, machine learning and high performance computing. Their team has vast experience in natural catastrophe modelling having developed their expertise from previous engagements at RMS, Willis Re and other specialised firms.

Twelve Capital AG
Dufourstrasse 101
8008 Zurich, Switzerland
Phone: +41 (0)44 5000 120

Twelve Capital (UK) Ltd
Moss House, 15-16 Brook's Mews
London W1K 4DS, United Kingdom
Phone: +44 (0)203 856 6760

info@twelvecapital.com
www.twelvecapital.com

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