Forecasting the activity of the Atlantic tropical cyclone season using causal precursors of favorable conditions for tropical cyclone formation

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Tropical cyclones (TC) range among the most disastrous extreme weather events, causing substantial damages to infrastructures and regularly displacing millions of people. Global warming is expected to intensify tropical cyclones and their impacts. Although adaptation options to tropical cyclones are limited, forecasting the impact of single tropical cyclones or the intensity of a whole tropical cyclone season is of great interest. While the forecast skill of dynamical models that project the development of an existing TC has improved it remains challenging to forecast TC formations. Here we present a novel approach to forecast the number of TC formations in the Atlantic. We use a three-step approach in which we first characterize favorable conditions for TC formation. These well-known conditions are warm sea surface temperatures (SSTs) and low vertical wind shear (VWS) in the main development region (MDR). In a second step, potential drivers of these favorable conditions are identified within lagged cross correlation maps between these favorable conditions (SST and VWS in the MDR) and basic climate variables as mean sea level pressure, upper troposphere wind speeds and SSTs. Than a causal discovery algorithm is applied to identify causal precursors of favorable conditions for TC formation within the set of potential drivers. We find that low vertical wind shear is driven by warm Pacific (SSTs) while Atlantic SSTs are mostly driven by autocorrelation. With June values of these two predictors we obtain a remarkable forecast skill for the number of TC formations of the upcoming season.

The same method can also be applied at longer time scales still achieving considerable skill 9 months before the season.