ABSTRACT

Investigating the Use of Statistical Models for Projecting Future North Atlantic Tropical Cyclone Frequency

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This thesis assesses the skill of four statistical models in hindcasting North Atlantic annual tropical cyclone (TC) frequency over 1950–2008 with the aim of projecting future activity. Three of the models are motivated by operational statistical forecast schemes and are premised on standard hurricane predictors including sea surface temperatures (SSTs) and near-surface zonal winds. The fourth model uses an SST-gradient index previously proposed for Caribbean seasonal rainfall prediction. The statistical models, created from backward regression, explain 24-48% of the observed variability in 1950-2008 annual TC frequency. The future state of the predictors are extracted from the ECHAM5, HadCM3, MRI CGCM2.3.2a and MIROC3.2 GCM simulations under the Coupled Model Intercomparison Project Phase 3 (CMIP3). Models utilizing SST and near-surface wind predictors suggest significant increases in mean annual frequency by 2-8 TCs by 2070-2090, compared to a single surface wind predictor model, indicating that positive trends in SSTs under global warming have a larger relative influence on projections than changes in the variability of the surface winds. Wind-only models exhibit declines in TC frequency while the SST-gradient model yields little change relative to the present-day mean. Backward regression reapplied against the 1990-2008 period, analogous to future warmer oceanic and atmospheric state, retains only the CLLJ-type predictors, explaining up to 82% of TC frequency variability and suggesting a more dominant role for the CLLJ in a warmer climate. Projections using the new models show either a more conservative increase or a stronger decrease in frequency, consistent with a stronger CLLJ.

Keywords: Jhordanne Jonelle Patrizia Jones; North Atlantic tropical cyclones; tropical cyclone frequency; statistical modelling; future projections; Caribbean low-level jet; seasonal forecast models.