A comparison of observed and model-generated tropical cyclone climatologies using a spatial lattice

Of broad scientific and societal interest is the reliability of global climate models (GCMs) to simulate tropical cyclones (TCs) in the context of climate change. Improvements to model resolution and physics provide promising results, however uncertainty about the fidelity of model-generated to actual TCs exists. Here we present a spatial lattice approach for comparing observed and model-produced TC tracks. The methodology employs a spatial tessellation of TC basins using equal-area hexagons. Summaries of per-hexagon TC statistics are calculated for observed and modeled data and compared through a common framework. We provide comparisons for two atmospheric GCMs--the GFDL-HiRAM (global) and the FSU-COAPS model (North Atlantic). Using multiple performance metrics, we show that globally, the HiRAM generally compares well with observations; however, both models fail to reproduce the observed distribution of storms over the Gulf of Mexico.

Another advantage of this approach is that it allows us to spatially match TC and covariate data. We demonstrate this using observed and model-generated track data with sea surface temperature (SST). We employ a statistical model to estimate the limiting intensity of TCs for observations and model data, and then use a weighted regression of per-hexagon limiting intensity on SST to obtain an estimate of the sensitivity of limiting intensity to SST. Results indicate high sensitivities for observations (7.9 ± 1.19 $ms^{-1}K^{-1}$), but lower sensitivities for the models (1.8 ± 0.42 $ms^{-1}K^{-1}$). Model-generated track data from a downscaling approach provide more realistic basin-wide sensitivities, but a mismatch exists in the spatial variability of sensitivities.