Ph.D. Defense Announcement
Jhordanne Jones
July 28, 2021 at 9:00 a.m.

Jhordanne Jones
Ph.D. Defense

Wednesday, July 28, 2021
9:00 a.m.

Defense
Virtual (full Zoom link below)

Post Defense Meeting
Riehl Conference Room (211 ACRC)

Committee:
Michael Bell (Adviser)
Philip Klotzbach (Co-adviser)
Elizabeth Barnes
Eric Maloney
Gregory Florant (Biology)

An Examination of the Large-Scale Drivers of North Atlantic Vertical Wind Shear and Seasonal Tropical Cyclone Variability

This dissertation characterizes and examines the large-scale sources of variability driving tropical North Atlantic deep-layer vertical wind shear (VWS). VWS is a key variable for the seasonal prediction of tropical cyclone (TC) activity and can be used to assess the source of predictability within a given season. Part 1 of the dissertation examines tropical versus subtropical impacts on TC activity by considering large-scale influences on boreal summer tropical zonal VWS variability, a key predictor of seasonal TC activity. Through an empirical orthogonal function analysis, I show that subtropical anticyclonic wave breaking (AWB) activity drives the second mode of variability in tropical zonal VWS, while El Niño-Southern Oscillation (ENSO) primarily drives the leading mode of tropical zonal VWS variability. Linear regressions of the four leading principal components against tropical North Atlantic zonal VWS and accumulated cyclone energy show that, while the leading mode holds much of the regression strength, some improvement can be achieved with the addition of the second and third modes. Furthermore, an index of AWB-associated VWS anomalies, a proxy for AWB impacts on the large-scale environment, may be a better indicator of summertime VWS anomalies. The utilization of this index may be used to better understand AWB's contribution to seasonal TC activity.

Part 2 shows that predictors representing the environmental impacts of subtropical AWB on seasonal TC activity improve the skill of extended-range seasonal forecasts of TC activity. There is a significant correlation between boreal winter and boreal summer AWB activity via AWB-forced phases of the quasi-stationary North Atlantic Oscillation (NAO). Years with above-normal boreal summer AWB activity over the North Atlantic region also show above-normal AWB activity in the preceding boreal winter that forces a positive phase of the NAO that persists through the spring. These conditions are sustained by continued AWB throughout the year, particularly when ENSO plays less of a role at forcing the large-scale circulation. While individual AWB events are synoptic and nonlinear with little predictability beyond 8-10 days, the strong dynamical connection between winter and summer wave breaking lends enough persistence to AWB activity to allow for predictability of its potential impacts on TC activity. We find that the winter-summer relationship improves the skill of extended-range seasonal forecasts from as early as an April lead time, particularly for years when wave breaking has played a crucial role in suppressing TC development.

Part 3 characterizes VWS variability within the Community Earth System Model version 1 Large Ensemble (CESM1-LE). The 35 historical runs of the CESM1-LE provide substantially larger samples of the environment and various large-scale drivers than the ERA5 reanalysis that spans 1979 to present. Firstly, ENSO is shown to be the leading mode of tropical Atlantic variability and explains most, if not all, of the structured variance. Secondly, while the CESM1-LE shows robust physical representations of known climate phenomena, their relationships with tropical Atlantic VWS remain marginal except for ENSO. Eigenanalysis applied to the CESM1-LE shows that the principal components are ill-defined and gives no distinct pattern for non-ENSO associated large-scale drivers. Thirdly, composite analyses show that despite the narrow range of VWS variability associated with non-ENSO large-scale drivers, their individual contribution to VWS is noticeably stronger during ENSO-neutral conditions as represented by the large ensemble.

Topic: Ph.D. Defense: Jhordanne Jones
Time: Jul 28, 2021 09:00 AM Mountain Time (US and Canada)

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