M.S. Defense Announcement
Wei-Ting Hsiao
Wednesday, September 8 at 10:30 a.m. MT

Wei-Ting Hsiao
M.S. Defense

September 8, 2021
10:30 a.m. MT

Defense
ATS Large Classroom (101 ATS) or in Zoom (full meeting information below)

Post Defense Meeting
Riehl Conference Room (211 ACRC)

Committee:
Eric Maloney (Adviser)
Elizabeth Barnes (Co-adviser)
Nathaniel Mueller (Ecosystem Science and Sustainability)

The Impact of Tropical Intraseasonal Variability on Subseasonal-to-Seasonal Predictability

Subseasonal-to-seasonal (S2S) timescales have been identified as a gap in weather forecast skill at 2 weeks to 2 months lead times. This timescale is set by midlatitude synoptic predictability limits, and sits between the typical weather timescale and the longer annual to interannual periods that may have skill due to knowledge of low-frequency phenomena such as El Niño-Southern Oscillation (ENSO). Previous studies have shown that tropical intraseasonal variability serves as an important source of S2S predictability in the midlatitudes based on a linear Rossby wave theory. The theory suggests that consistent weather patterns are excited by tropical divergence and associated teleconnections to the extratropics on S2S timescales that influence predictability. However, those physical processes that provide sources of S2S forecast skill have yet to be fully characterized. This thesis examines aspects of tropical intraseasonal variability that are important for S2S prediction, including how tropical intraseasonal variability has changed with warming over the last century and how the misrepresentation of such variability in a weather forecast model leads to errors in midlatitude precipitation S2S forecast.

In the first part of this thesis, three reanalyses datasets (ERA5, MERRA-2, and ERA 20-C) are examined to quantify the amplitude changes in a dominant mode of intraseasonal tropical variability, the Madden-Julian oscillation (MJO), over the last century. MJO-associated precipitation and vertical velocity amplitude are found to exhibit a complex evolution over the observational record, where the precipitation has larger increases than the vertical velocity. A decrease in the ratio of MJO circulation to precipitation anomaly amplitude is detected over the observational period. Tropical weak temperature gradient theory is used to show that this decrease is consistent with the change in tropical dry static stability that has occurred under climate warming. The weakening MJO circulation per unit precipitation over the past century may has modified associated teleconnections and has implications to S2S prediction in the tropics and midlatitudes.

In the second part of the thesis, emphasis is placed on understanding S2S precipitation forecast errors for the western United States (U.S.) in an operational weather model. A set of hindcasts during boreal winter, where the tropics are nudged toward reanalysis, is compared to hindcasts without nudging. The western U.S. precipitation forecasts are found to improve with nudging at 3-4 week lead times. Using a multivariate k-means clustering method, hindcasts are grouped by their initial states and one cluster that exhibits an initially strong Aleutian Low is found to provide better forecast

improvement. The improvement originates from the poor representation in the non-nudged hindcasts of the destructive interference between (1) the anomalous Aleutian Low and (2) the teleconnection pattern generated by certain phases of the MJO during non-cold ENSO conditions. These results suggest that improving the simulation of tropical intraseasonal precipitation during the early MJO phases under non-cold ENSO may lead to better 3-4 week precipitation forecasts in the western U.S.

Topic: M.S. Defense: Wei-Ting Hsiao
Time: Sep 8, 2021 10:30 AM Mountain Time (US and Canada)

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