UNIVERSITY of HAWAI'I MĀNOA

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Ph.D. Dissertation Defense Announcement

SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY

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Ph.D. Dissertation Title:

The predictability of anomalous interannual boreal summer Arctic sea ice patterns

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Abstract:

There is an abundance of interest in the anomalous year-to-year melting patterns of summer sea ice but ongoing prediction efforts have been a struggle because the factors controlling interannual sea ice variability remain unresolved. Dynamical and statistical modeling techniques incorrectly predict annual minimum sea ice extents and historical simulations of CMIP 5 models fail to represent the magnitude and timing of summer interannual variability in the Arctic. The models underestimate the interannual variability along the Arctic sea ice margins and over predict the magnitude and in the dormant inner core. These shortcomings indicate a new approach may be appropriate.

While the Arctic Oscillation may be the dominant mode of climate variability shaping sea ice patterns, additional remote forcings have been found. Widespread summer Arctic sea ice anomalies are shaped by wind-forced sea ice transport modulated by unique monsoon-Arctic Rossby wave trains. The anomalous dipole behavior between East Asian and Western North Pacific monsoon rainfall induces a meridional wave train, which propagates poleward into the Arctic and influences sea ice patterns with a single barotropic circulation center. An eastward propagating circumglobal wave train, bounded by the subtropical jet, is excited by anomalous Indian summer monsoon rainfall and produces a barotropic dipole circulation pattern, which drives distinct sea ice patterns later in the summer. The combined influences of the two remote Asian monsoon variations throughout the summer induce a sea ice melt pattern in which the North Atlantic-European Arctic contrasts the Siberian-North American Arctic and are comparable in magnitude to the leading interannual mode of sea ice variability.

A new prediction approach utilizing a Physical-Empirical model, which has been previously applied to monsoon rainfall and other climatological phenomena, is applied to anomalous interannual sea ice pattern prediction during the annual minimum extent. The newly discovered monsoon-driven sea ice connections are used to establish predictors of Asian Summer Monsoon rainfall early in the year, in addition to other physically meaningful predictors to independently predict each interannual mode during the end of the Arctic melt period. Using stepwise regressions to develop models relating the predictors to the first four leading sea ice modes, which account for nearly 60% of the variance, exhibits high skill in replicating historical ice concentrations along the Arctic periphery.