Evaluating the Contribution of Ocean Variables in an Updated Markov Model for Antarctic Sea Ice Predictability

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With its large seasonal and interannual variability, Antarctic sea ice greatly affects surface energy balances in the atmosphere and ocean by changing surface albedo, salt injection, and insolation between the air-sea interface. Therefore, long- range forecasts of Antarctic sea ice are very much in demand, not only because of the potential importance of sea ice in the global climate, but also for the practical purpose of exploring the Antarctic continent. Chen and Yuan (2004) used 20 years of satellite observed sea ice concentration (SIC) data and reanalysis of atmospheric variables such as air temperature, geopotential height, and winds, to develop a linear Markov model for predicting Antarctic sea ice at the seasonal timescale with some skill. Now, satellite observations have accumulated for 40+ years, providing more information for developing robust statistical models. Moreover, there are ocean variables that are believed to play a role in SIC predictability, such as upper ocean heat content (OHC) and sea surface temperature (SST). Our study aims to re-develop the Markov model with an updated time series of sea ice and atmospheric variables and evaluate if the inclusion of ocean variables improves model skill. We first examine the correlation between SIC variability and OHC/SST variability in the Southern ocean. Our results show that contrary to our expectations, SST is more strongly correlated with SIC than OHC in the Antarctic region. Therefore, we introduce SST as a new model predictor. Markov models are then developed in the MEOF space using SIC, atmospheric, and ocean variables. Based on cross-validation experiments, we found that models with SST showed improved skill compared to models with only atmospheric variables. Eastern hemisphere prediction skill improved, which was lacking in the previous model. Our results therefore suggest that the inclusion of the ocean's impact improves Antarctic sea ice predictability using statistical methods. Further trials are needed to select the parameters for a model with the best prediction skill.