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Forecast skill of autumn snow for European winter climate during the 20th century: A multi member seasonal prediction experiment

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As the leading climate mode to explain wintertime climate variability over Europe, the North Atlantic Oscillation (NAO) has been extensively studied over the last decades. Recently, studies highlighted the state of the Northern Hemispheric cryosphere as possible predictor for the wintertime NAO (Cohen et al. 2014). Although several studies could find seasonal prediction skill in reanalysis data (Orsolini et al. 2016, Duville et al. 2017,Han & Sun 2018), experiments with ocean-atmosphere general circulation models (AOGCMs) still show conflicting results (Furtado et al. 2015, Handorf et al. 2015, Francis 2017, Gastineau et al. 2017).

Here we use two kinds ECMWF seasonal prediction ensembles starting with November initial conditions taken from the long-term reanalysis ERA-20C and forecasting the following three winter months. Besides the 110-year ensemble of 50 members representing internal variability of the atmosphere, we investigate a second ensemble of 20 members where initial conditions are split between low and high snow cover years for the Northern Hemisphere. We compare two recently used Eurasian snow cover indices for their skill in predicting winter climate for the European continent. Analyzing the two forecast experiments, we found that prediction runs starting with high snow index values in November result in significantly more negative NAO states in the following winter (DJF), which in turn modulates near surface temperatures. We track the atmospheric anomalies triggered by the high snow index through the tropo- and stratosphere as well as for the individual winter months to provide a physical explanation for the formation of this particular climate state.