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Autumn Arctic predictors and predictions for winter marine cold air outbreaks over the Barents Sea

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The air temperature over Arctic sea ice can fall strongly below 0°C, while for adjacent areas of open water, sea surface temperature remains close to freezing. This creates a strong temperature gradient across the sea ice edge. Transports of cold air masses from the sea ice toward open ocean water, known as marine cold air outbreaks (MCAOs), modify vertical stability of the atmospheric column and thus can create conditions favorable for the formation of hazardous maritime cyclones (polar lows), which pose risks to marine and coastal infrastructure and society. For marine management, MCAO predictions would be highly beneficial. Previous studies analyze the genesis of MCAOs, while predictability and large-scale drivers of MCAOs remain poorly understood.

We investigate (i) the ability of the Earth System Model from the Max-Planck Institute for Meteorology (MPI-ESM) to predict MCAOs at a seasonal timescale and (ii) options to improve predictability of MCAOs through their large-scale drivers. To identify MCAO preconditions, we utilize the atmospheric reanalysis ERA-Interim using lagged cross-correlation analysis, composite analysis, and causal effect network (CEN).

Our results show that the MPI-ESM has high prediction skill for MCAOs over the Barents Sea (BS), Greenland-Iceland-Norwegian Seas and the Labrador Sea for about 2-2.5 weeks ahead starting from the November and February initial conditions. This holds for the prediction skill analyzed from daily model output. For MCAO properties such as extreme MCAO values occurring during a month, or the frequency of MCAO events per month, we find high prediction skill for up to a month ahead. Whereas the lagged cross-correlation analysis indicates a relationship between September and October atmospheric circulation and sea ice conditions with November BS-MCAOs, the CEN identifies the causal link only from the Arctic sea ice cover.

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