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Marine cold air outbreaks in Fram Strait – General increase in March and a special case in 2020

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Marine Cold Air Outbreaks (MCAOs) are common features above the open water surfaces of the Nordic Seas. They are characterized by marked vertical temperature gradients, which typically persist over several days, and strongly shape air-sea heat exchanges, convection, weather and boundary layer characteristics in the affected region. Based on the novel ERA-5 reanalysis product, we are analyzing climatological and recent aspects of MCAOs in the Fram Strait region of the North Atlantic, which is a “hot spot” particularly during winter and early spring. MCAOs in Fram Strait occur preferably when persistent low pressure systems occupy Northern Scandinavia and the Barents/Kara Sea, which exerts strong zonal pressure gradients across Fram Strait. Based on the vertical gradients of potential temperature, occurrence frequencies of MCAOs of different strengths are investigated. It is found that MCAOs of moderate strength occur at an average of 7-9 days per month between December and March, while especially strong MCAOs occur at an average of 1-3 days in that time. Regarding the former, March is the only month for which a significant trend of +1.7 days/month/decade was found over the 1979-2020 period. While regional MCAO expression is dependent on both the relative location of the ice edge and on the atmospheric circulation, MCAO increase in Fram Strait in March can be explained mainly with the latter and the associated zonal pressure gradient.

February and March 2020 serve as examples of particularly strong and persistent MCAOs in Fram Strait. The record-breaking strong polar vortex at that time, which had received global attention in the media and literature, had left its associated footprint in near surface and tropospheric circulation fields, hence providing anomalous northerly flow across the ice edge in Fram Strait. While this clearly shaped MCAOs in Fram Strait, associated anomalies were also observed in the North Atlantic Sea Ice edge, and were even detected in upper air profiles and sea ice conditions on Svalbard.

For the detailed study of such northerly advection events, atmospheric data gathered during the year-long MOSAiC expedition 2019/2020 in the central Arctic are expected to provide valuable information in the upstream direction of the anomalies in Fram Strait.