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The past and future of flow blocking around Greenland: connections between extremes

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Atmospheric flow blocking can be defined as a quasi-stationary center of high pressure that deflects traveling cyclones from their usual storm tracks. Over Greenland, flow blocking can result in a large-scale reversal of the meridional geopotential height gradient. Blocking often produces a strong equatorward deflection of polar air on the eastern flank of the anticyclone, and for Europe, blocking over or near Greenland can lead to severe cold episodes in winter and severe droughts and heat waves in summer. Moreover, because blocking is associated with an amplification of the meridional flow structure, it can be connected to extremes in poleward moisture transport. When these temperature and moisture extremes occur over Greenland itself, they exert significant stresses on the surface ice sheet. For these reasons, it is important to examine atmospheric blocking, both historically and in future climates.

There have been many metrics created to identify and quantify atmospheric flow blocking. Here, we use one such metric, the Greenland Blocking Index (GBI), to examine atmospheric flow blocking over and around Greenland and link that blocking to moisture transport. Moisture transport was calculated at each grid point in the ERA-Interim reanalysis using the integrated vapor transport (IVT) method applied between 200 and 1000 hPa. The GBI was calculated daily for the period 1948-present by averaging the 500-hPa height field in the NCEP/NCAR reanalysis over 80°E-20°E and 60°N-80°N. An IVT index was calculated from 1980-present by averaging IVT at each grid point over a North Atlantic region encompassing Greenland (85°E-15°E and 55°N-80°N). Both GBI and IVT were also examined in the historical NCAR CESM run of the Climate Model Intercomparison Project 6 (CMIP6), but over a much longer time record (1850-2015). In both datasets, extreme instances of blocking and IVT were examined at the 90th, 95th, 97th, and 99th percentiles, for both summer (JJA) and winter (DJF) seasons. Blocking frequency was found to increase in the latter half of the period in both datasets and over both time records. Moreover, a time lag was found between the instances of extreme blocking events and above-average IVT: high moisture transport more frequently preceeded instances of extreme blocking than lagged after it (by an average of 3 days). Implications of these results for Greenland ice mass balance will be explored in the presentation.