The Critical Role of Euro-Atlantic Blocking in Promoting Snowfall in Central Greenland

Claire Pettersen[1,2], Stephanie A. Henderson[3], Kyle S. Mattingly[2], Ralf Bennartz[2,4], and Melissa L. Breeden[5,6]

[1]Climate and Space Sciences and Engineering, University of Michigan, Ann Arbor, MI, USA
[2]Space Science and Engineering Center, University of Wisconsin – Madison, Madison, WI, USA
[3]Department of Atmospheric and Oceanic Sciences, University of Wisconsin – Madison, Madison, WI, USA
[4]Vanderbilt University, Nashville, TN, USA
[5]NOAA Physical Sciences Laboratory, Boulder, CO, USA
[6]Cooperative Institute for Research in the Environmental Sciences, University of Colorado Boulder, Boulder, CO, USA

The Greenland Ice Sheet (GrIS) is losing mass at an increasing rate yet mass gain from snowfall still exceeds the loss attributed to surface melt processes on an annual basis. This work assesses the relationship between persistent atmospheric blocking across the Euro-Atlantic region and enhanced precipitation processes over the central GrIS during June-August and September-November. Results show that the vast majority of snowfall events in central GrIS coincide with Euro-Atlantic blocking. During June-August, snowfall events are produced primarily by mixed-phase clouds (88%) and are linked to a persistent blocking anticyclone over southern Greenland (84%). The blocking anticyclone slowly advects warm, moist air masses into western and southern Greenland, with positive temperature and water vapor anomalies that intensify over the central GrIS. A zonal integrated water vapor transport pattern south of Greenland indicates a southern shift of the North Atlantic storm track associated with the high-latitude blocking. In contrast, snowfall events during September-November are largely produced by ice-phase clouds (85%) and are associated with a blocking anticyclone over the Nordic Seas and blocked flow over northern Europe (78%). The blocking anticyclone deflects the westerly North Atlantic storm track poleward and enables the rapid transport of warm, moist air masses up the steep southeastern edge of the GrIS, with positive temperature and water vapor anomalies to the east and southeast of Greenland. These results emphasize the critical role of Euro-Atlantic blocking in promoting snowfall processes over the central GrIS and the importance of accurate representation of blocking in climate model projections.