Atmospheric River Impacts on the Greenland Ice Sheet

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Among the most pressing consequences of recent climate warming is the acceleration of mass loss from the Greenland ice sheet (GrIS), which contributes directly to sea level rise and alters fluxes of mass and energy through the global ocean-atmosphere-cryosphere system. Several major GrIS melt events in recent years have coincided with intense poleward moisture transport by atmospheric rivers (ARs), suggesting that these events act as substantial poleward energy fluxes that play an important role in Arctic warming. ARs may affect the GrIS energy budget through the greenhouse effect of water vapor, the release of latent heat by condensation (both locally and upstream within poleward-moving air masses), and the radiative effects of clouds. These impacts of ARs on the GrIS are important to examine because both theoretical and model-based studies predict that atmospheric moisture transport to the Northern Hemisphere high latitudes will increase in a warming climate.

Previous research on the role of ARs in Arctic climate has either consisted of case studies of a few moisture transport events affecting the GrIS or has examined the effects of poleward moisture flux on Arctic sea ice. This study provides the first long-term analysis of temporal trends in ARs affecting the GrIS and their effects on GrIS energy balance and mass loss. ARs are identified in fields of integrated vapor transport (IVT) from ERA-Interim and MERRA-2 reanalyses using both a conventional feature-based “threshold” method [e.g., *Lavers and Villarini*, 2015; *Guan and Waliser*, 2015] as well as a self-organizing map (SOM) classification (Figure 1). Temporal trends in these AR events are examined, and the sensitivity of trends to the choice of threshold- or SOM-based AR identification is assessed. AR effects on GrIS melt, downwelling longwave radiation, and cloud properties are then analyzed using data from the ERA-Interim and MERRA-2 reanalyses, MEaSUREs daily Greenland surface melt data from the National Snow and Ice Data Center, the Modèle Atmosphérique Régional (MAR) regional climate model, and MODIS cloud products.

References

Guan, B., and D. E. Waliser (2015), Detection of atmospheric rivers: Evaluation and application of an algorithm for global studies, *J. Geophys. Res. Atmos.*, *120*(24), 12514–12535, doi:10.1002/2015JD024257.

Lavers, D. A., and G. Villarini (2015), The contribution of atmospheric rivers to precipitation in Europe and the United States, *J. Hydrol.*, *522*, 382–390, doi:10.1016/j.jhydrol.2014.12.010.

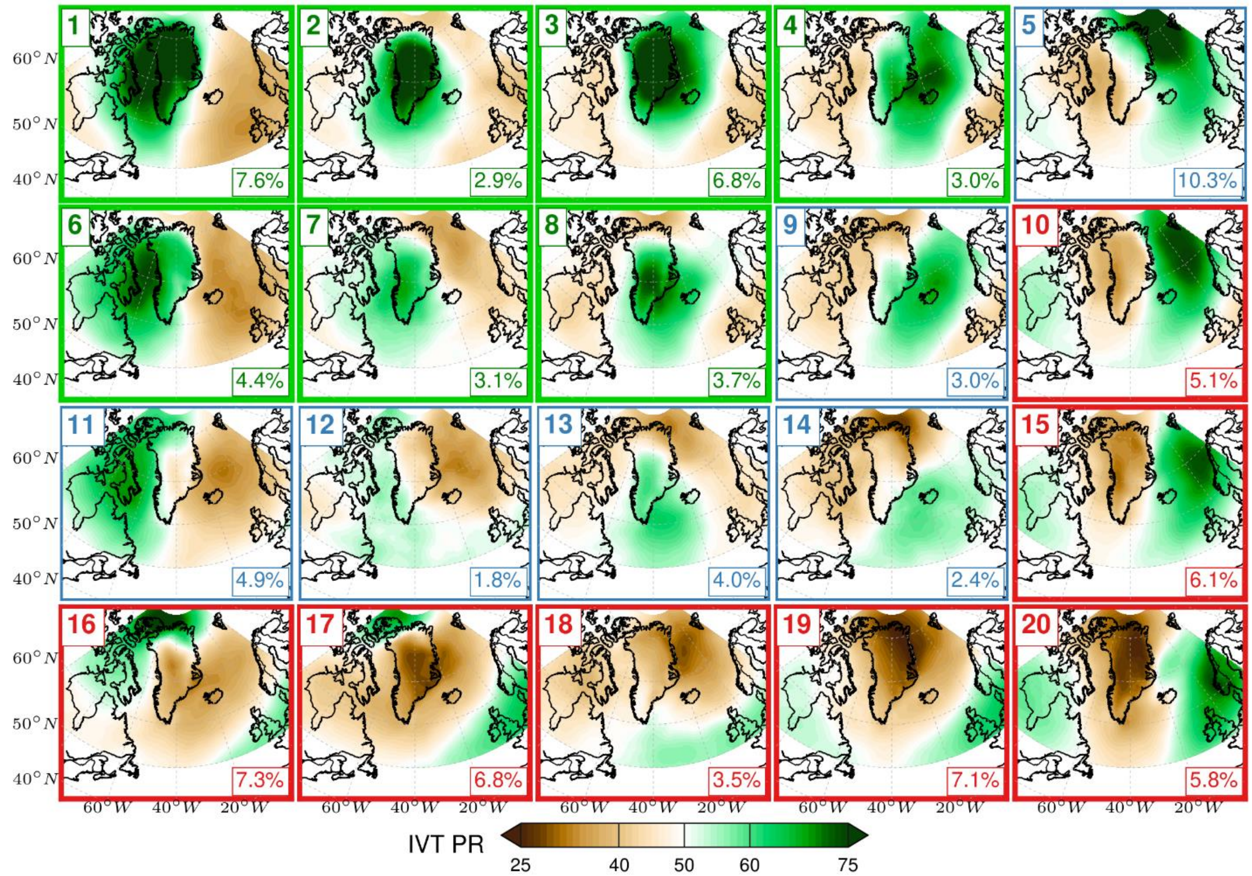

Figure 1. Composite mean IVT percentile rank for 20 nodes identified using a SOM classification applied to daily mean IVT data from ERA-Interim reanalysis during 1979–2015. Numbers in bottom right of each panel are the percentage of days during 1979–2015 when the IVT pattern most closely matched the given SOM node. Color-coding of panels indicates nodes that have been subjectively characterized as “moist” (green), “neutral” (blue), and “dry” (red) with respect to moisture transport over the GrIS.