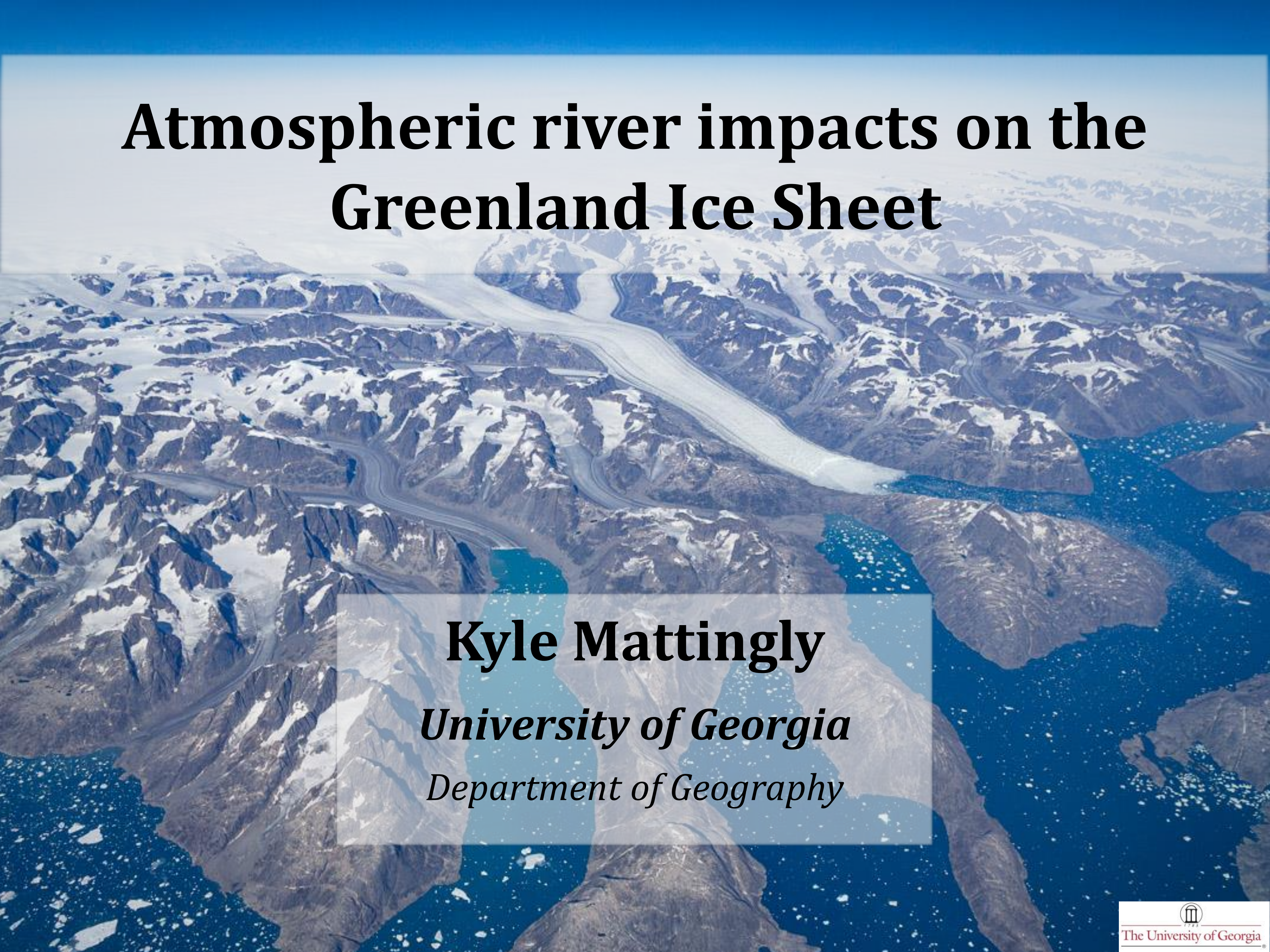


Atmospheric river impacts on the Greenland Ice Sheet

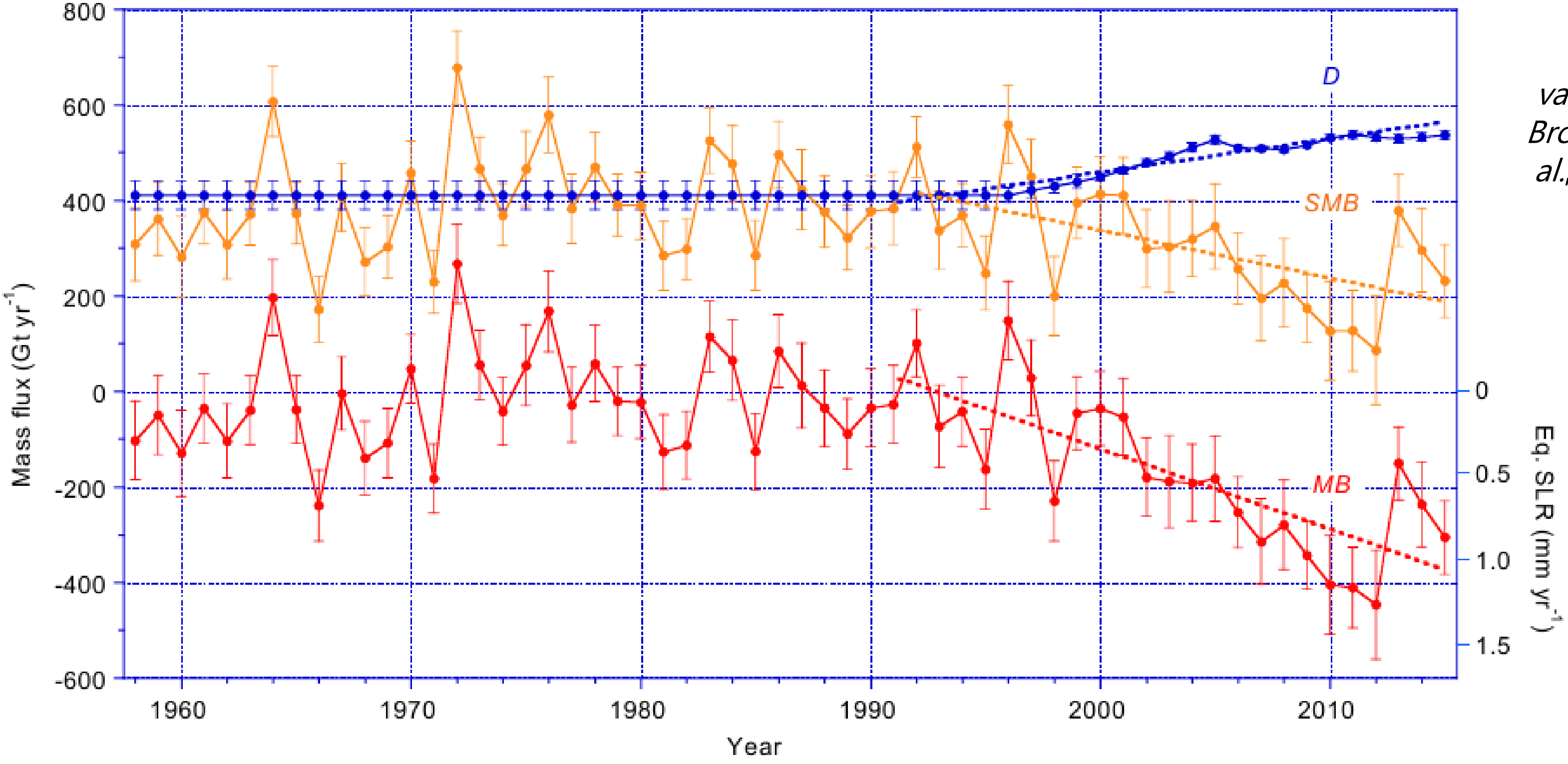
Kyle Mattingly

University of Georgia

Department of Geography

The Greenland Ice Sheet (GrIS)

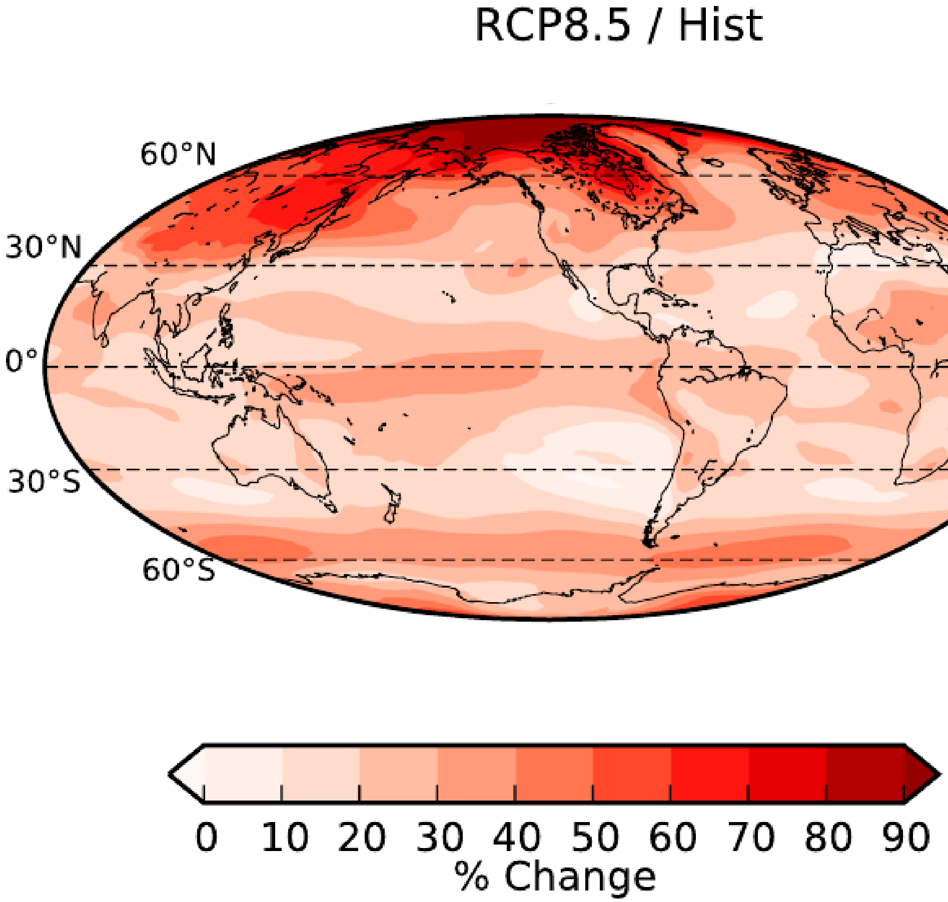
- Enough ice to cause ~21 ft. sea level rise (~8–25 mm since 1900)
- Accelerating ice mass loss (especially since ~2000)
- Mass loss occurs through (1) negative surface mass balance (SMB) and (2) ice discharge at grounding line



van den Broeke et al., 2016

Projected moisture transport changes

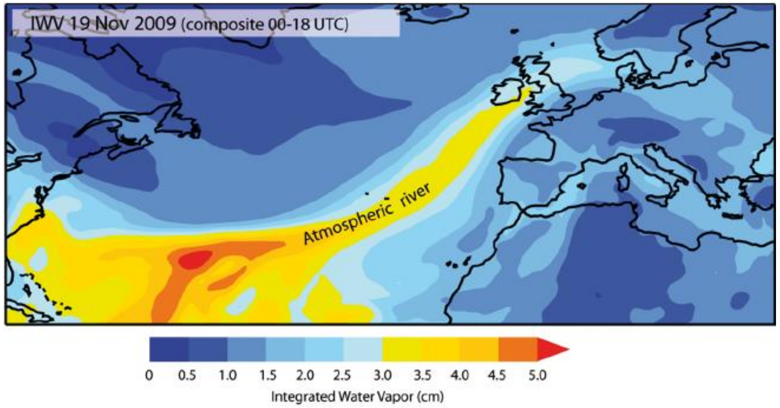
- Theoretical and model studies predict **increasing poleward moisture transport** in a warming climate
    - No corresponding increase in dry static energy transport
- Supported by observations of Arctic moistening trend



Lavers et al., 2015: % change in DJF mean horizontal vapor transport during 2073–2099 under RCP 8.5

Atmospheric Rivers influencing melt?

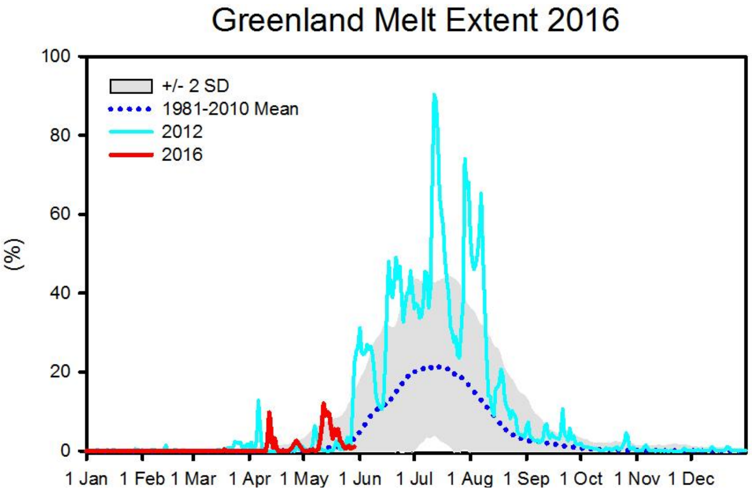
- A major fraction (> 60%) of N.H. poleward moisture transport occurs in atmospheric rivers
- ARs affected GrIS just prior to two anomalous melt events: July 2012 and April 2016



Gimeno et al., 2014

July 2012

Nghiem et al., 2012

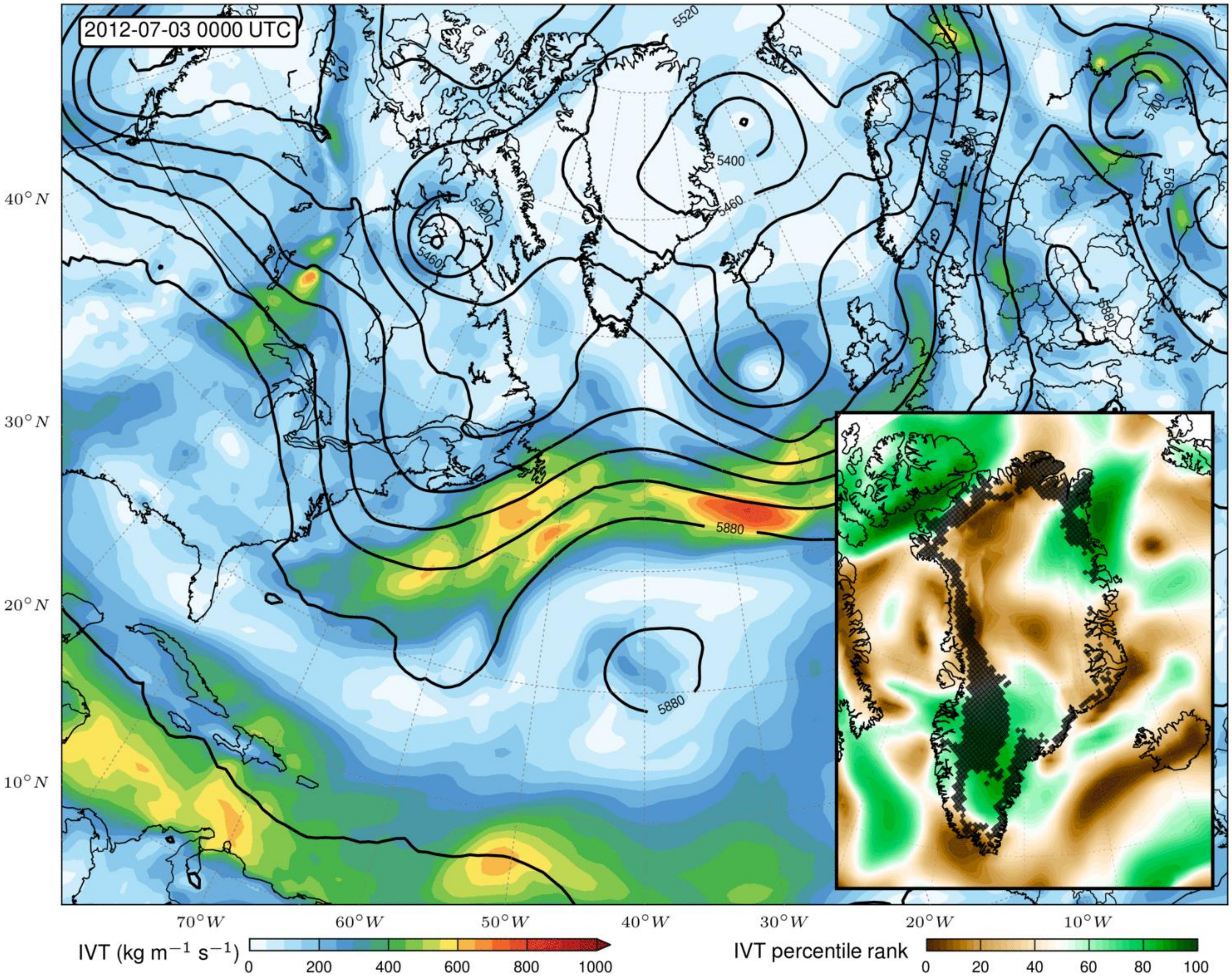


Thomas Mote, University of Georgia

April 2016

NSIDC (http://nsidc.org/greenland-today/2016/04/early-start-to-greenland-ice-sheet-melt-season/)

July 2012 AR (MERRA-2)

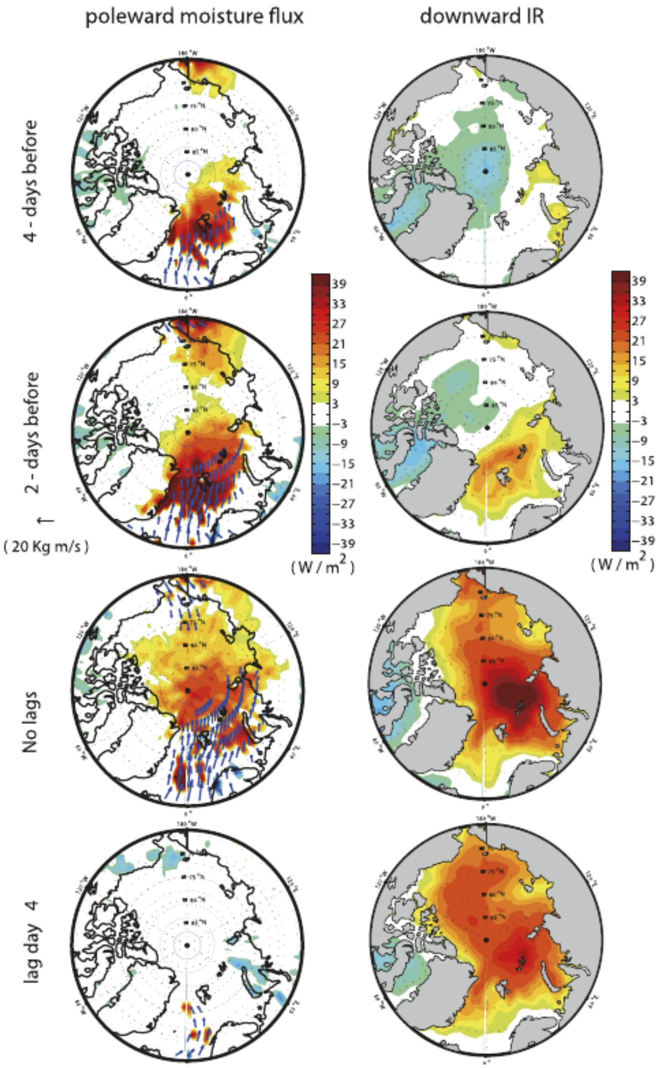


Moisture transport effects on GrIS?

1. Latent heat release
2. Greenhouse effect of water vapor
3. Enhanced cloud cover (increases LW↓)
4. Precipitation (liquid and solid)

Many studies show enhanced LW↓ over Arctic Ocean during poleward moisture fluxes

Fausto et al., 2016: turbulent fluxes of latent / sensible heat increased in importance during July 2012 GrIS melt



Park et al., 2015

Research objectives

Analyze trends in water vapor transport to GrIS, using both self-organizing maps (SOMs) and threshold-based AR detection method

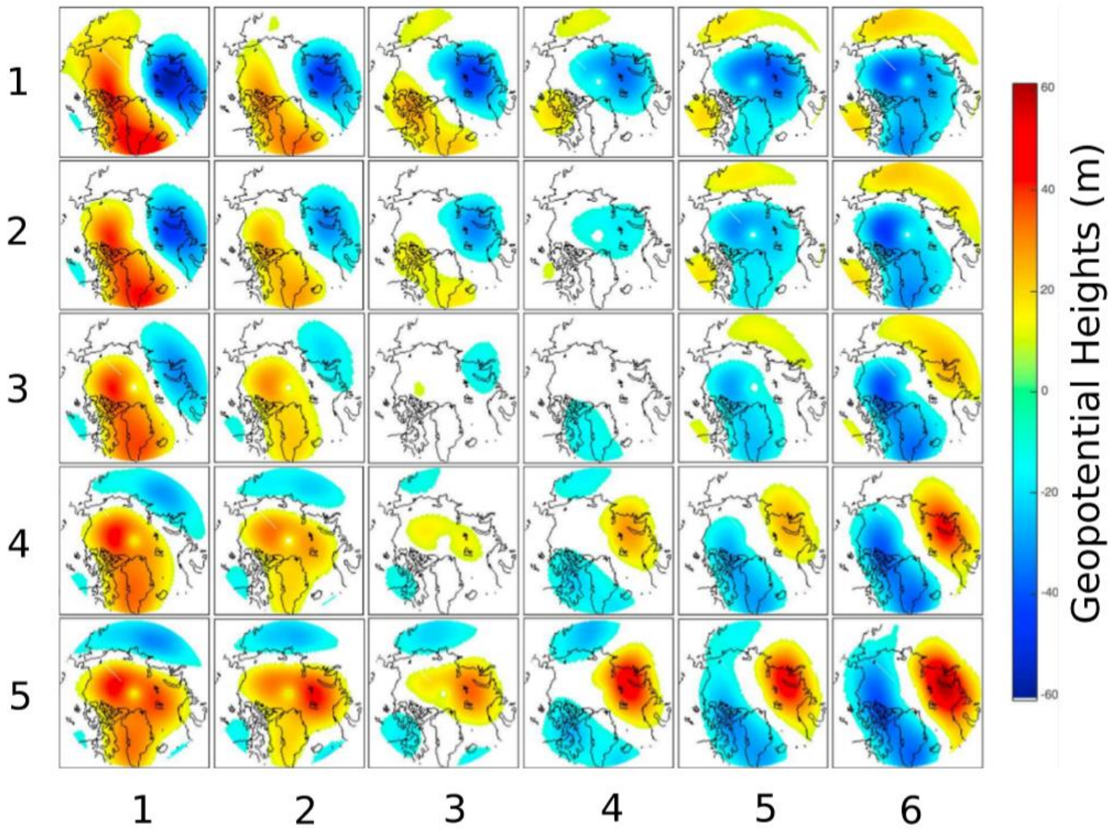
- Has water vapor transport to GrIS been increasing along with melt?
- *How does poleward moisture transport affect GrIS energy budget and cloud properties?*

Self-organizing map (SOM) method

SOMs are used to simplify large datasets into representative “nodes” (e.g., synoptic atmospheric patterns)

Classifying synoptic patterns of Integrated Vapor Transport (IVT) climatological percentile rank (PR)

IVT PR calculated from MERRA-2 and ERA-Interim reanalyses



Mioduszewski et al., 2016

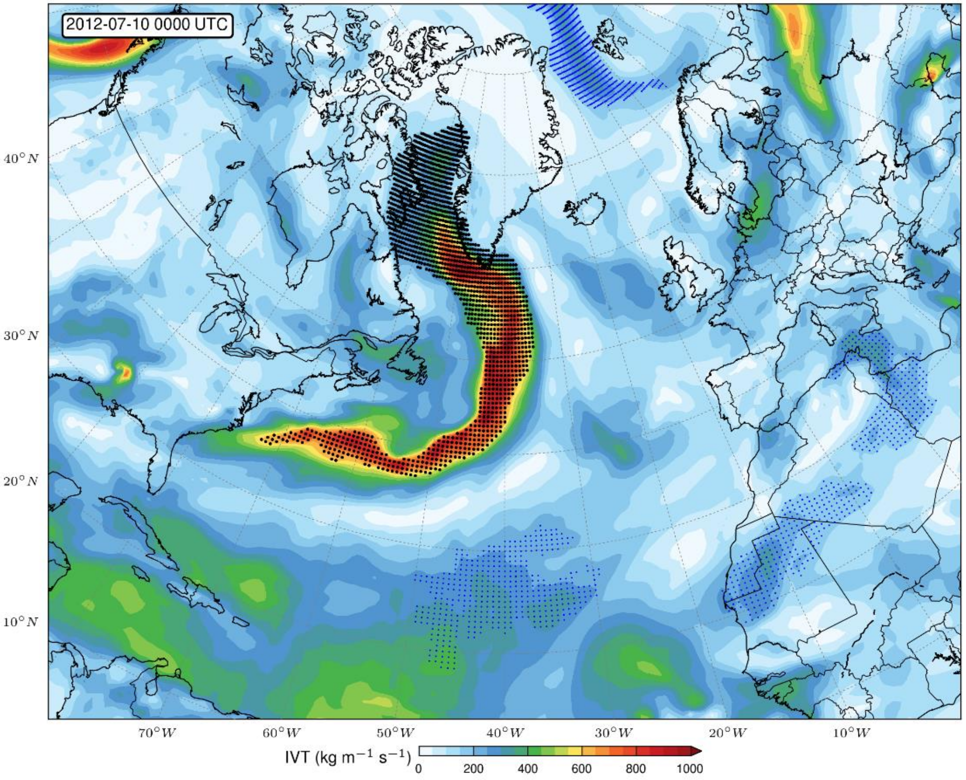
Threshold AR detection method

Study domain: North Atlantic Ocean (10°–90°N, 100°W–20°E)

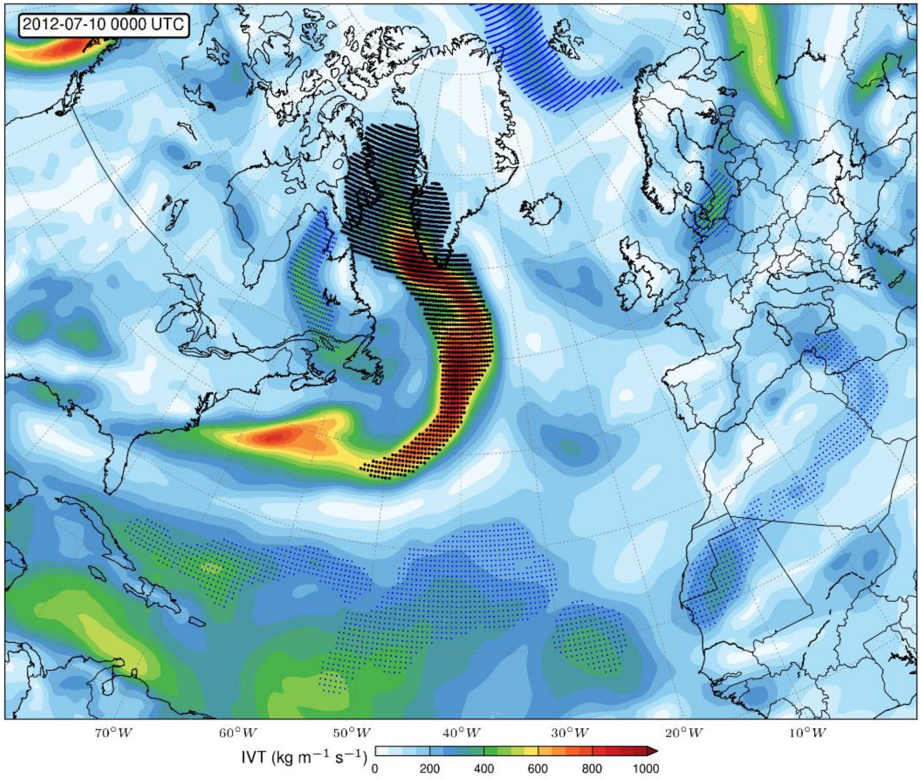
Features with **IVT PR > 85** & **IVT ≥ 150 kg m^{-1} s^{-1}**:

- Length (furthest distance b/w any 2 perimeter pts) > 2000 km
- Mean low-level (1000–700 hPa) v-wind within feature must be poleward (> 0 m s^{-1})
- Not an east-to-west oriented tropical / subtropical moisture plume
  - If centroid of feature is south of 35°N, mean u-wind must be > 2 m s^{-1}

Threshold AR detection method

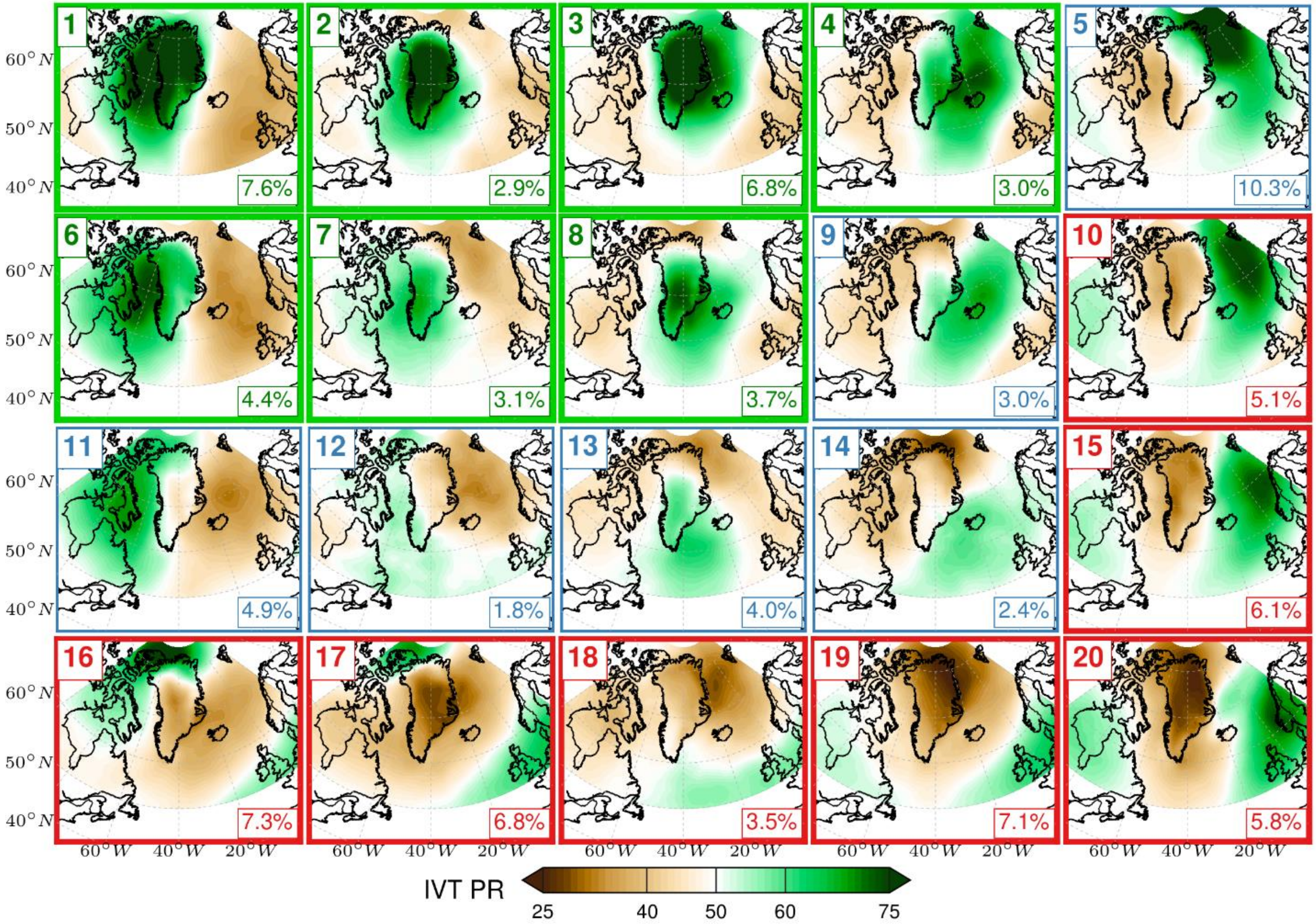


MERRA-2

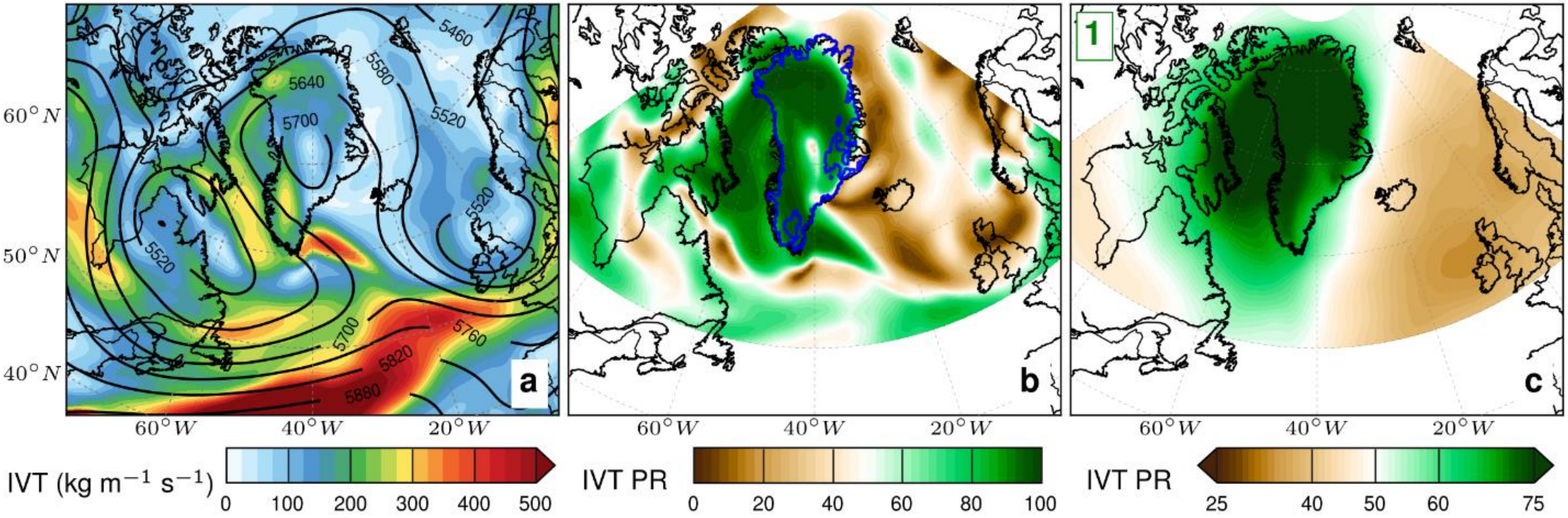


ERA-Interim

SOM composite: ERA-Interim



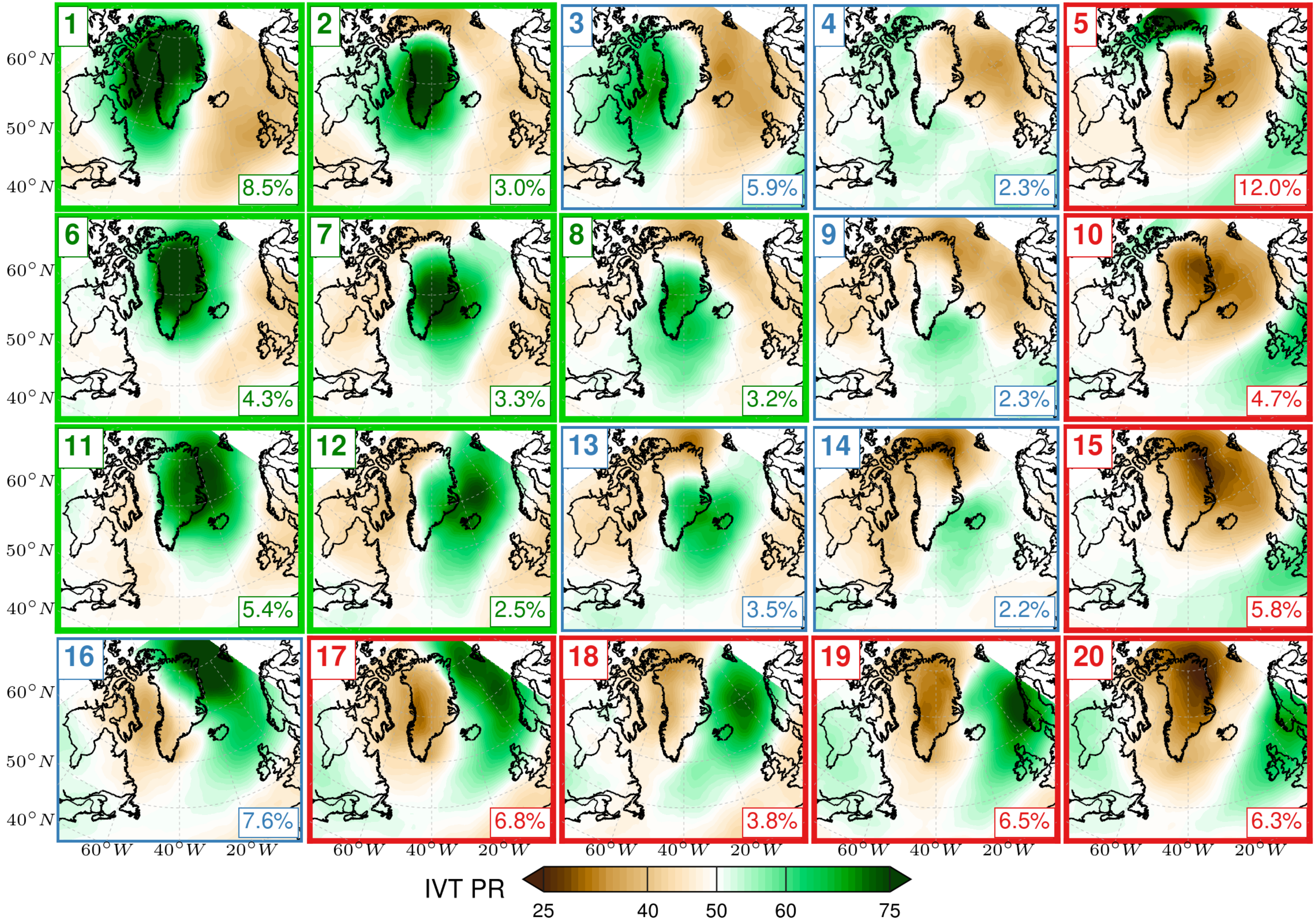
SOM composite: ERA-Interim



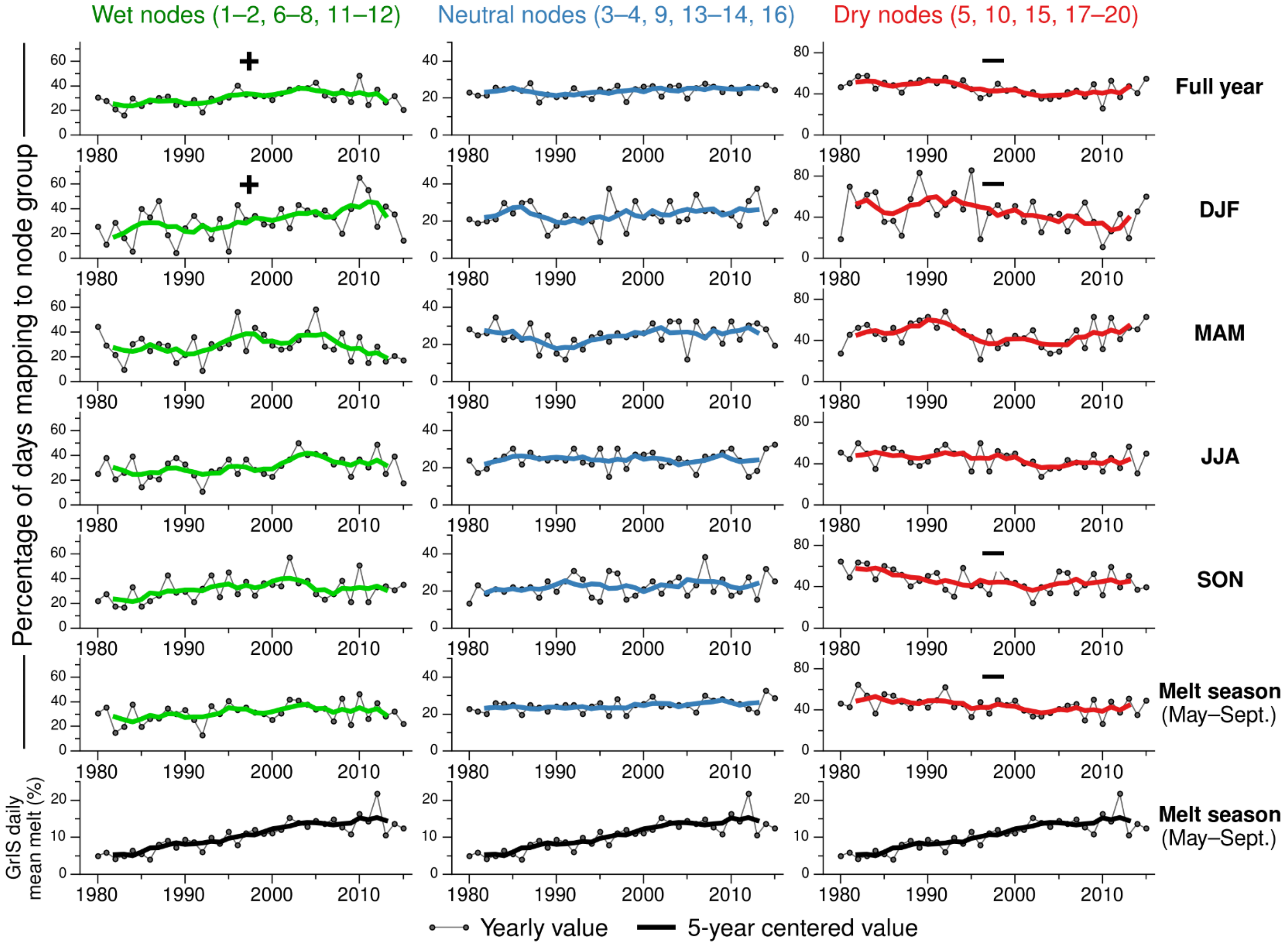
11 July 2012 (daily mean)

SOM node 1

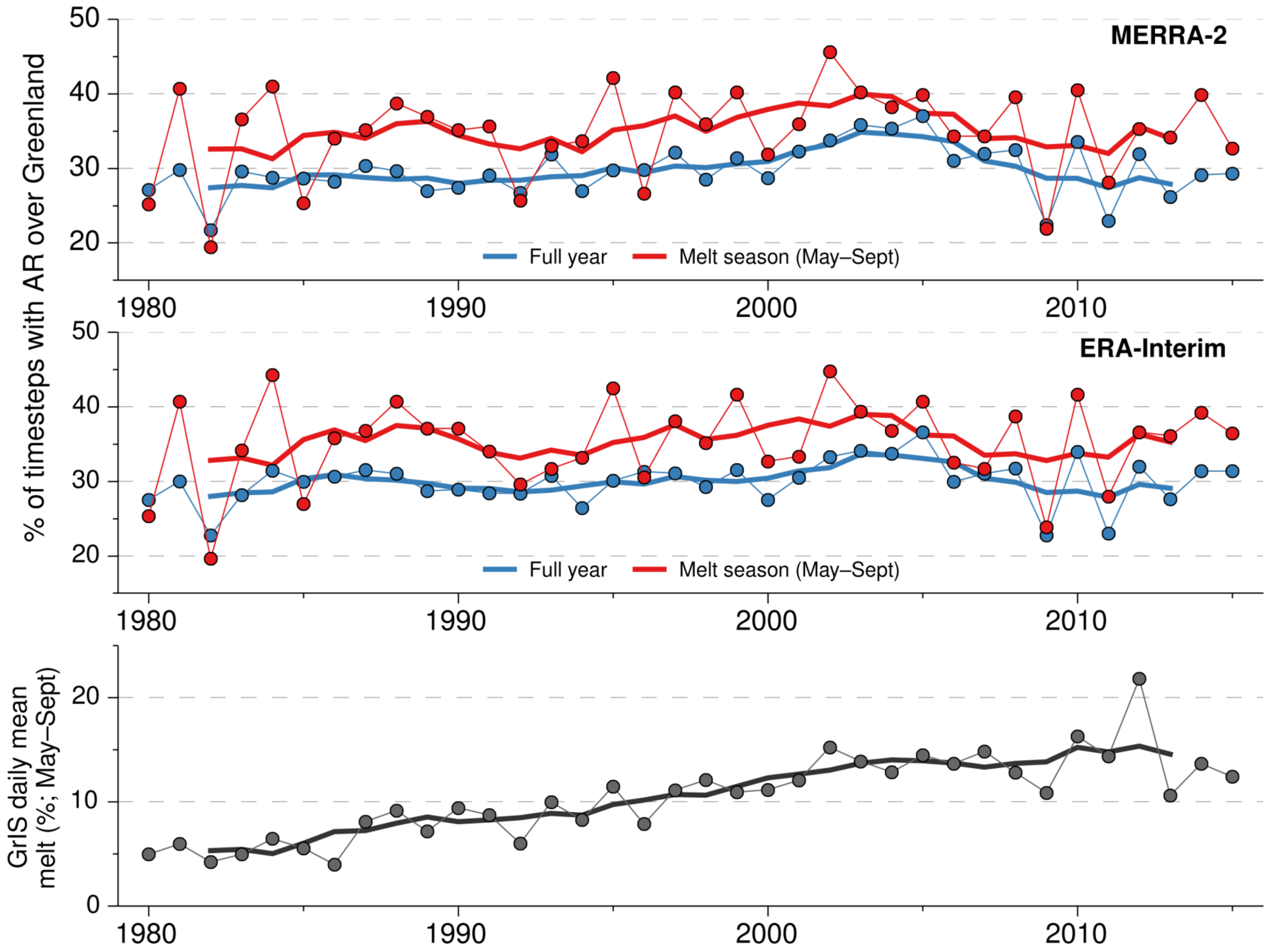
SOM composite: MERRA-2



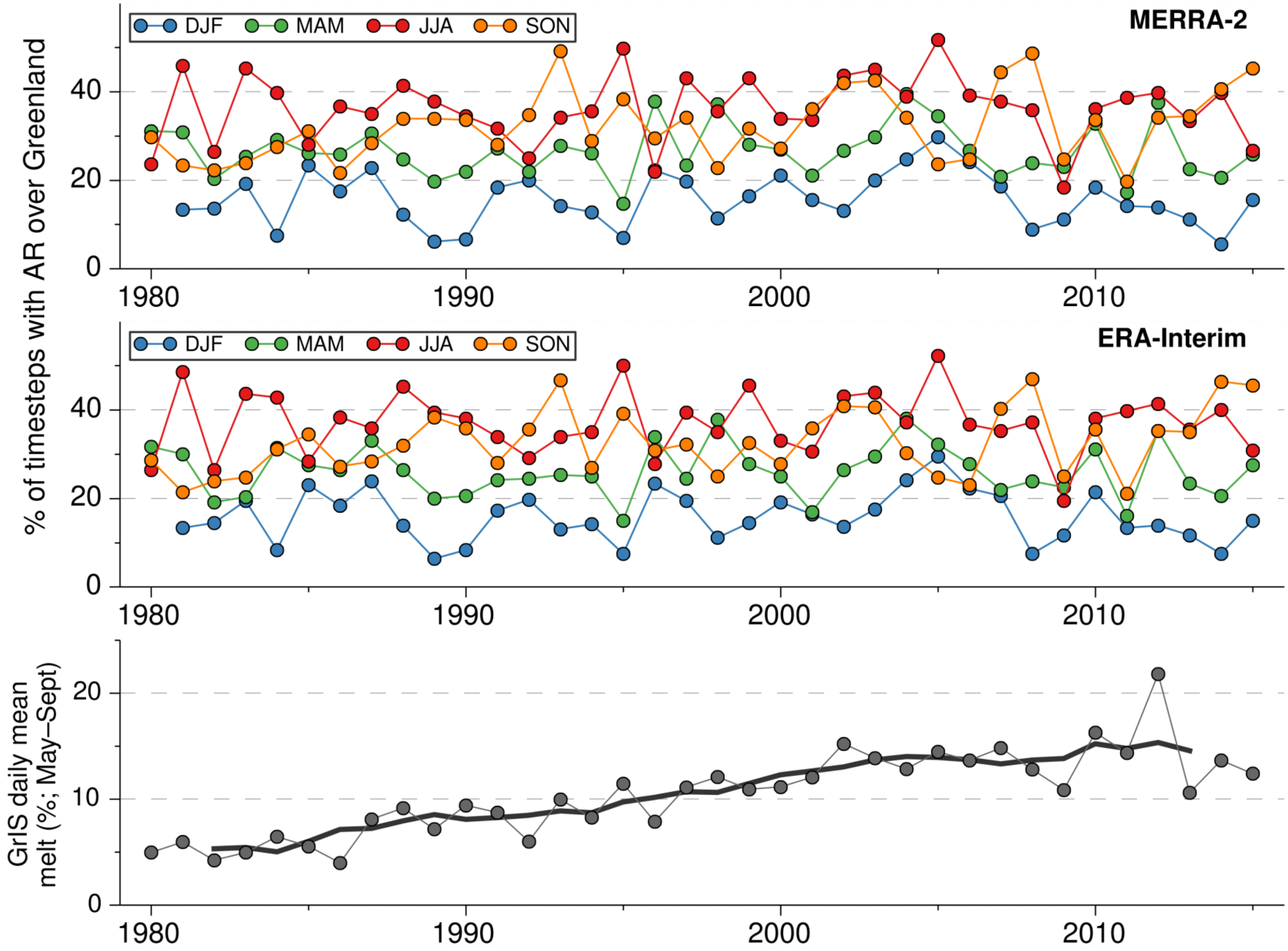
SOM node trends: MERRA-2



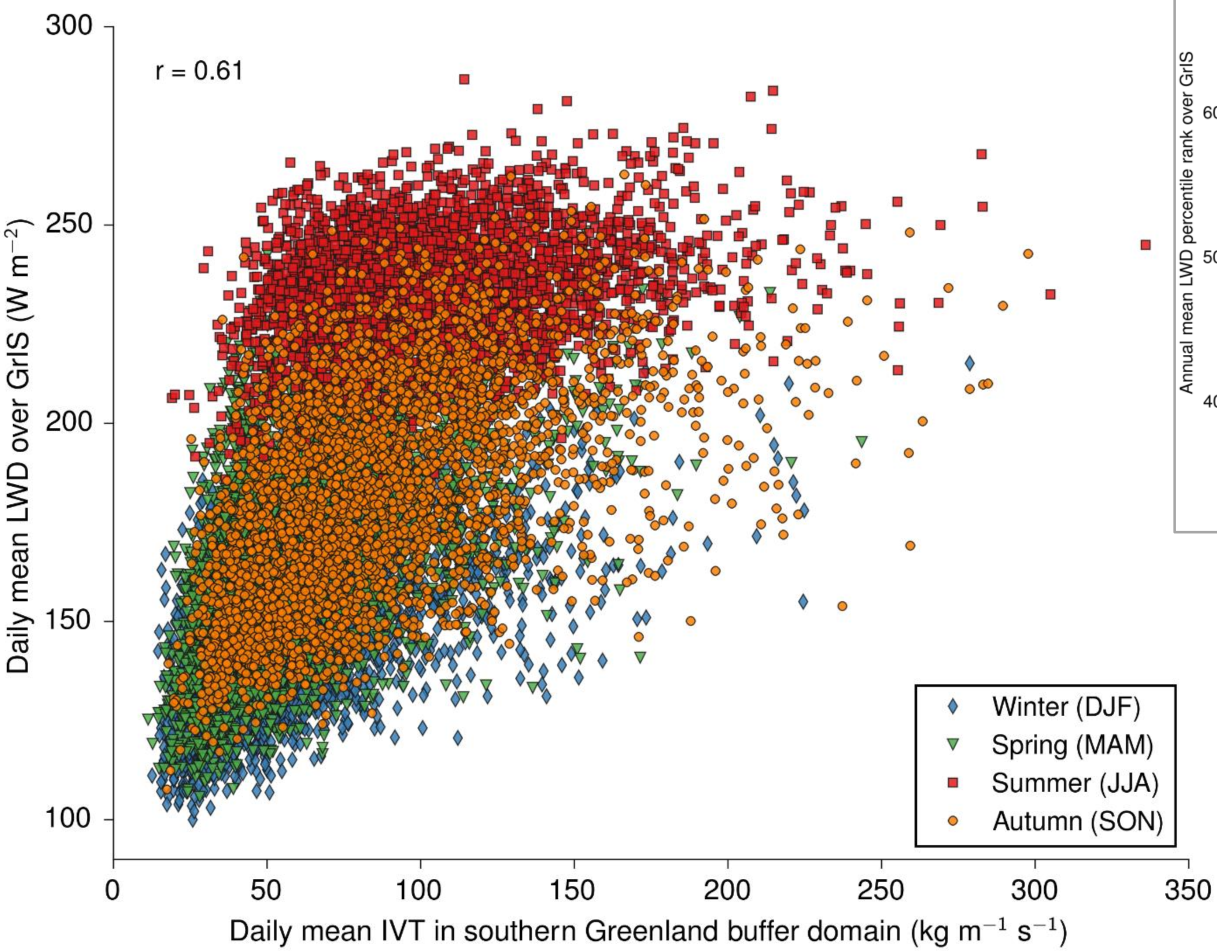
Trends in ARs affecting Greenland

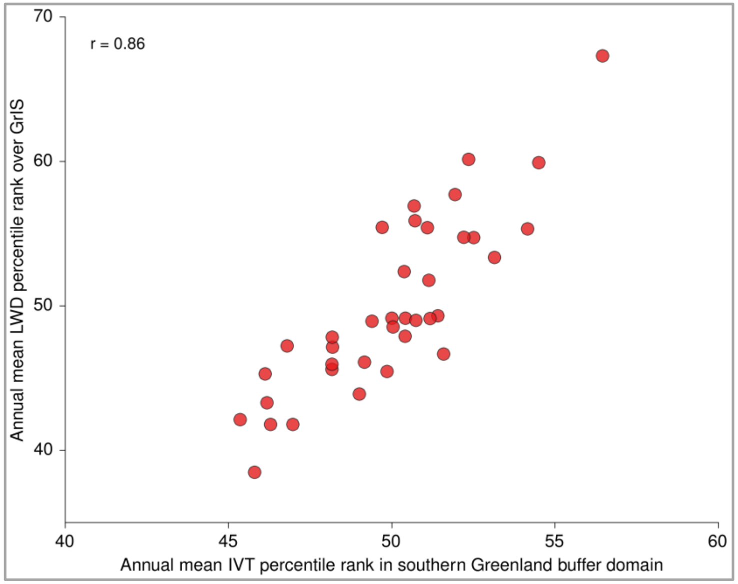


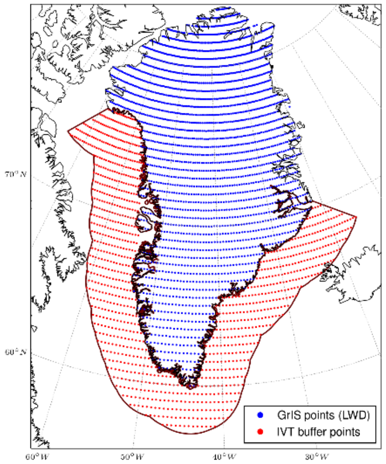
Trends in ARs affecting Greenland



IVT vs downwelling LWR (ERA-Interim)







Conclusions and future work

SOM results show clear trend toward more “moist” synoptic patterns, coinciding with increasing GrIS melt

No clear trend in frequency of ARs over Greenland

Future work:

- Further analyze AR trends:
  - AR intensity trends, impact of AR timing
  - Refine AR algorithm
- Impacts of moisture transport on GrIS SMB and energy budget
  - SOM- and AR-based analysis

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