Constructing a Synoptic Climatology of Greenland Surface Ice-Melt Events using Self-Organizing Maps

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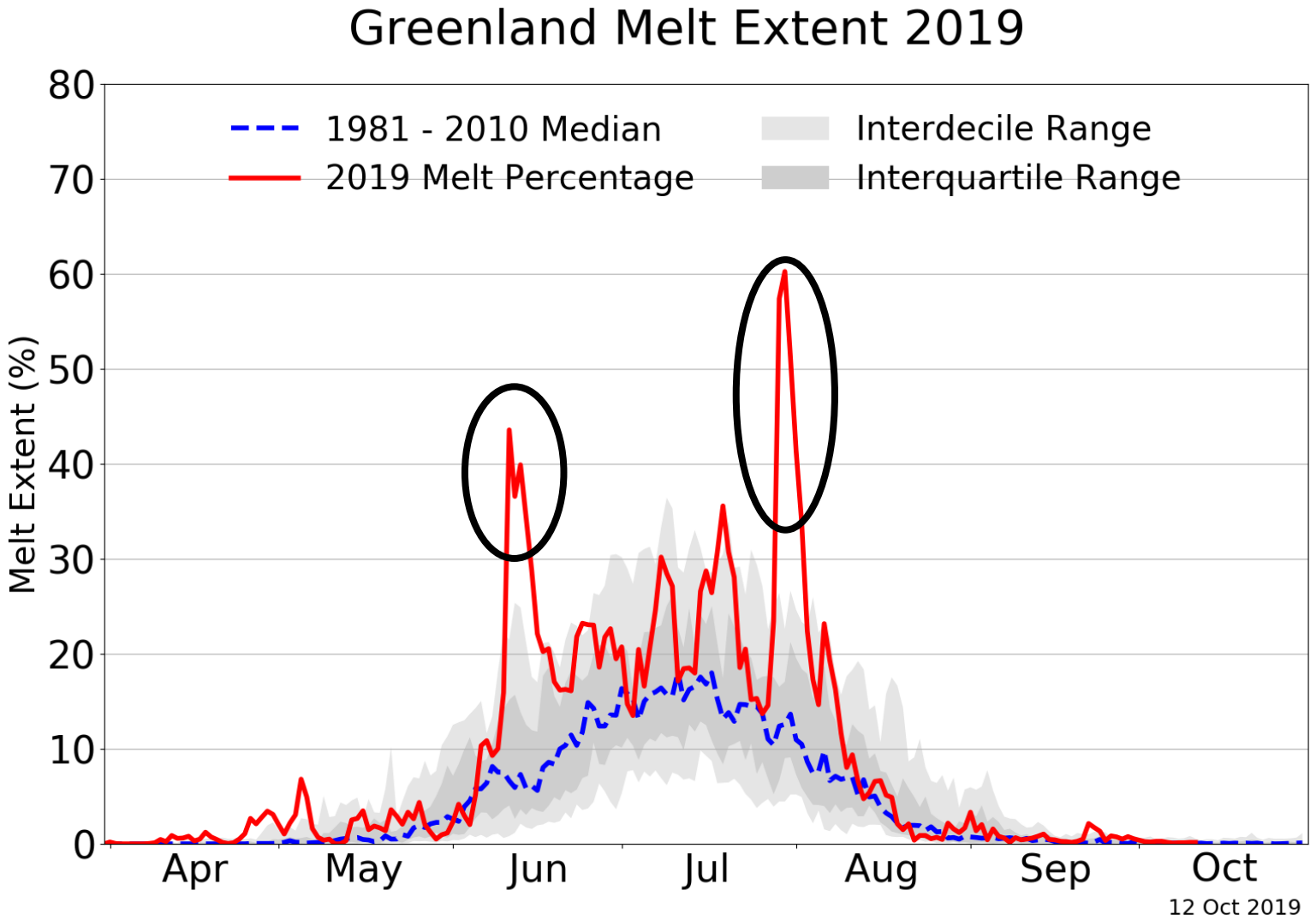
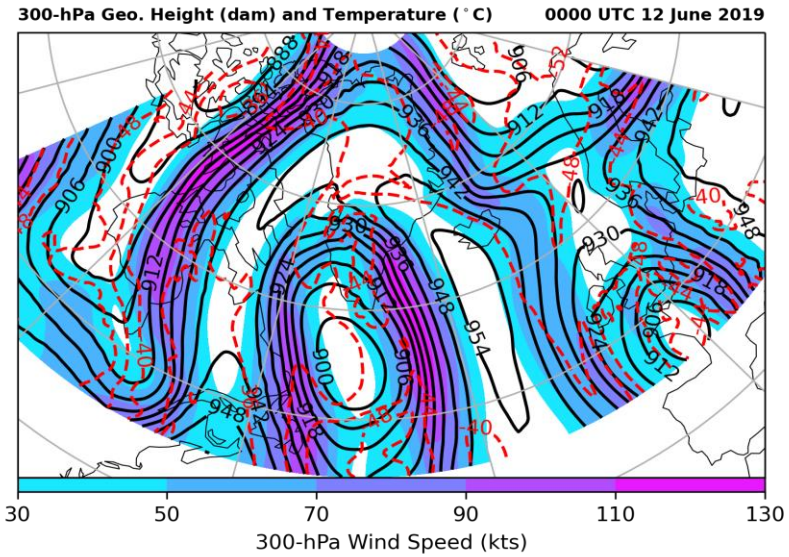
Motivation

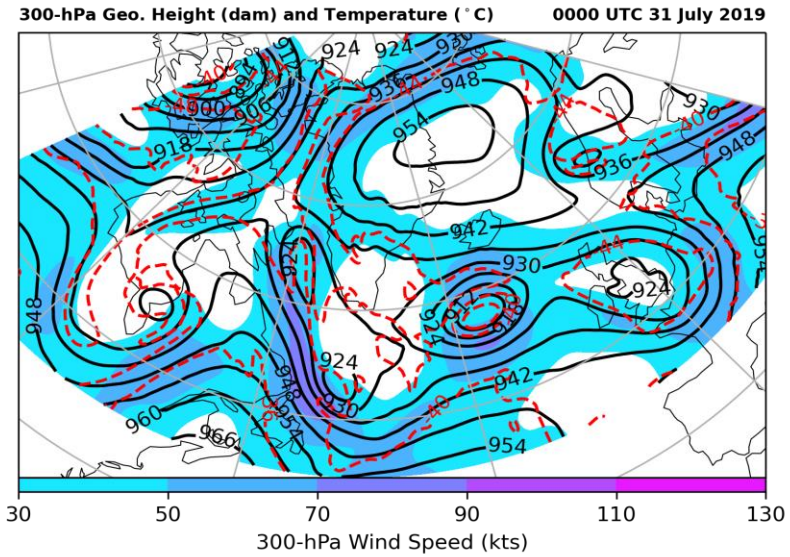


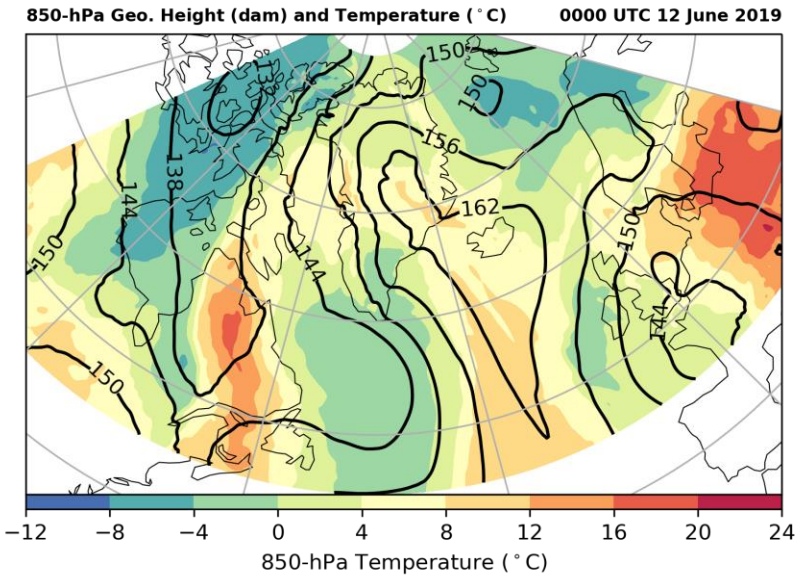
NSIDC / Thomas Mote, University of Georgia

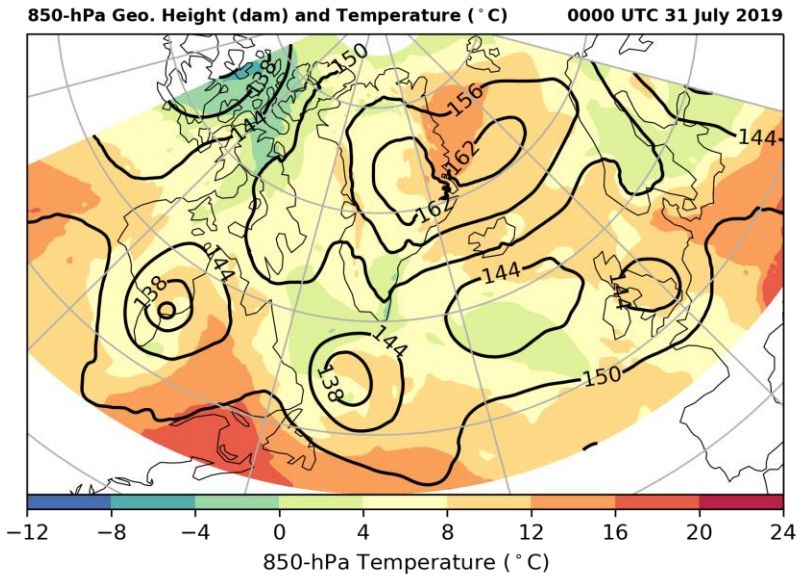
Source: NSIDC/Thomas Mote, University of Georgia;
http://nsidc.org/greenland-today/

Motivation


300-hPa Geo. Height (dam) and Temperature (°C)
0000 UTC 12 June 2019
30
50
70
90
110
130
300-hPa Wind Speed (kts)


300-hPa Geo. Height (dam) and Temperature (°C)
0000 UTC 31 July 2019
30
50
70
90
110
130
300-hPa Wind Speed (kts)


850-hPa Geo. Height (dam) and Temperature (°C)
0000 UTC 12 June 2019
−12
−8
−4
0
4
8
12
16
20
24
850-hPa Temperature (°C)


850-hPa Geo. Height (dam) and Temperature (°C)
0000 UTC 31 July 2019
−12
−8
−4
0
4
8
12
16
20
24
850-hPa Temperature (°C)

Data and Methods

- Parcel trajectories are generated using LAGRANTO (Wernli and Davies 1997; Sprenger and Wernli 2005) in order to explore the connection between the 31 July–1 August 2019 Greenland surface ice-melt event and the preceding late July European heat wave

- This study utilizes self-organizing maps (SOMs), a type of artificial neural network that clusters data points into various nodes according to the similarity between the data points, in order to classify synoptic flow patterns that contribute to Greenland surface ice-melt events

- 0.25° resolution ERA5 data regridded to 1° resolution are used for the April–October 1979–2019 time period

- Days are selected during the aforementioned time period where Greenland surface ice melt is at or above the 90th percentile compared to climatology according to the National Snow and Ice Data Center

Data and Methods

- 500-hPa geopotential height data are entered into the SOMs algorithm independently where the Greenland surface ice-melt event criterion is met to construct one-variable SOM analyses

- 700-hPa geopotential height and integrated water vapor transport (IVT) data are entered into the SOMs algorithm where the Greenland surface ice-melt event criterion is met to construct two-variable SOM analyses

- A 4 x 3 SOM size is chosen to display the full range of variability in the synoptic flow patterns

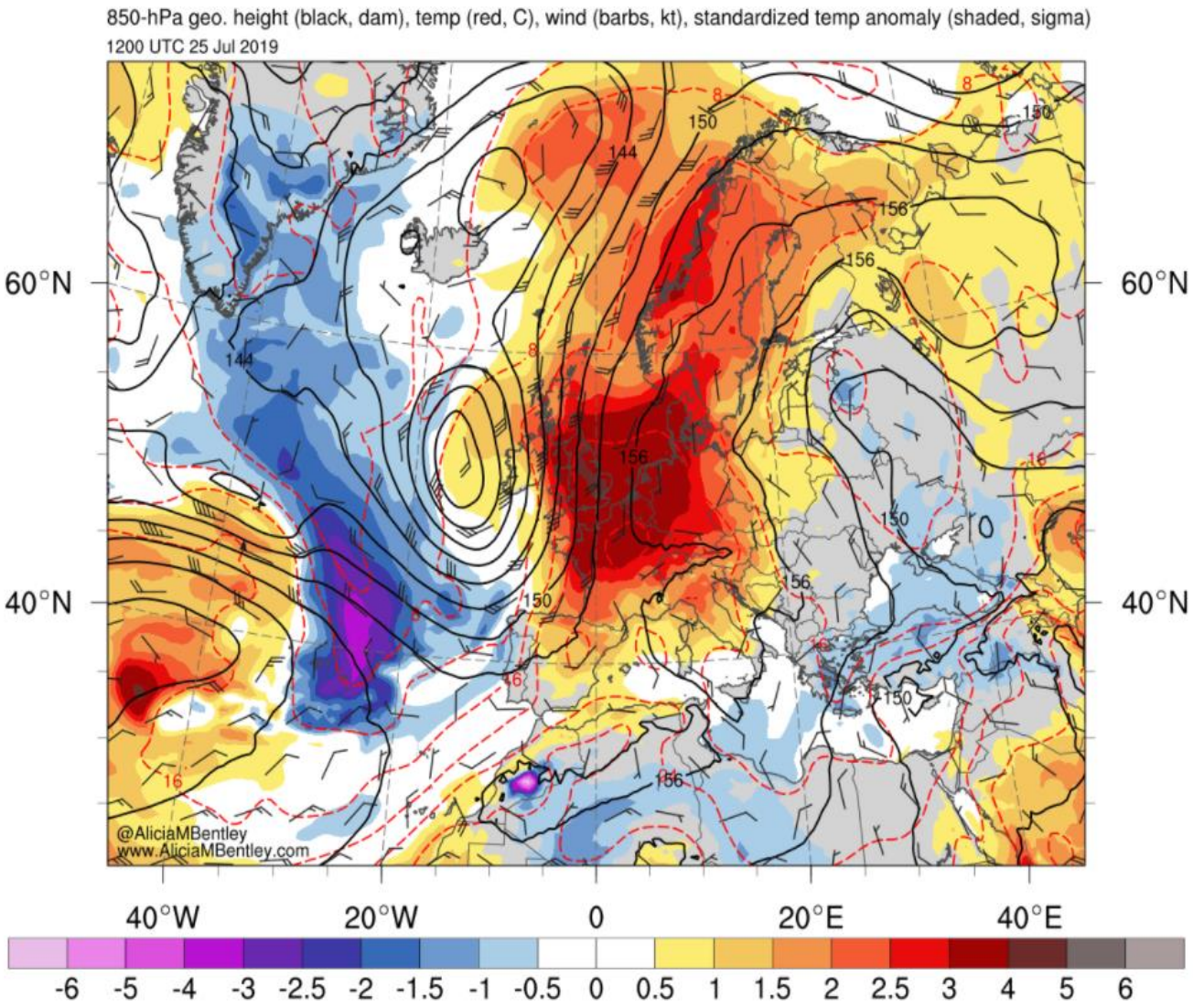
- The averages of the aforementioned variables are calculated for each node produced by the SOMs algorithms over a Greenland domain

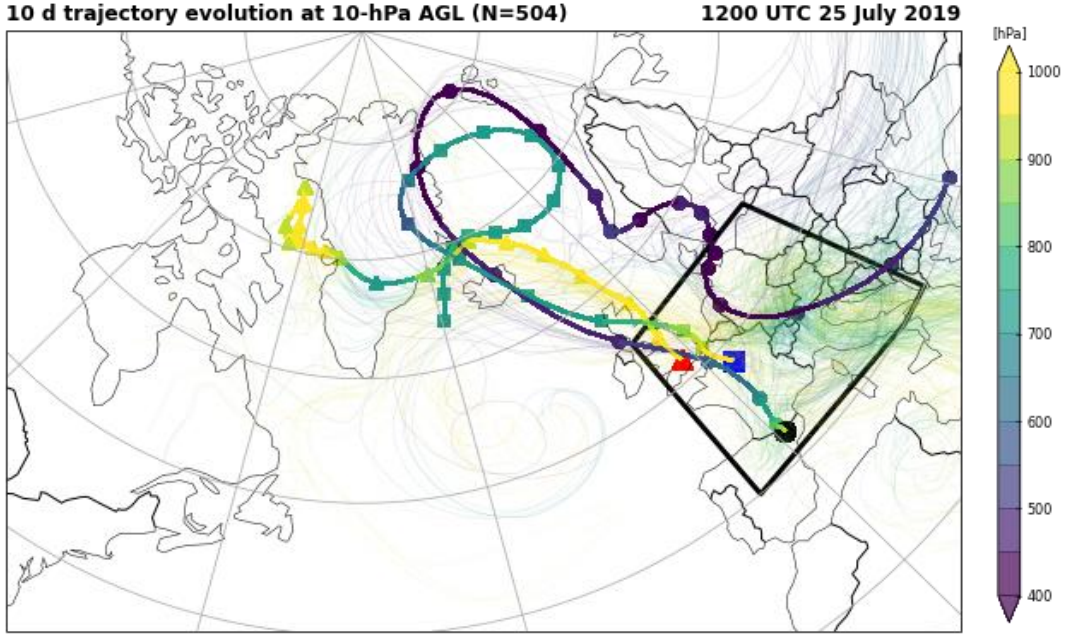
Connection to Midlatitude Heat Waves

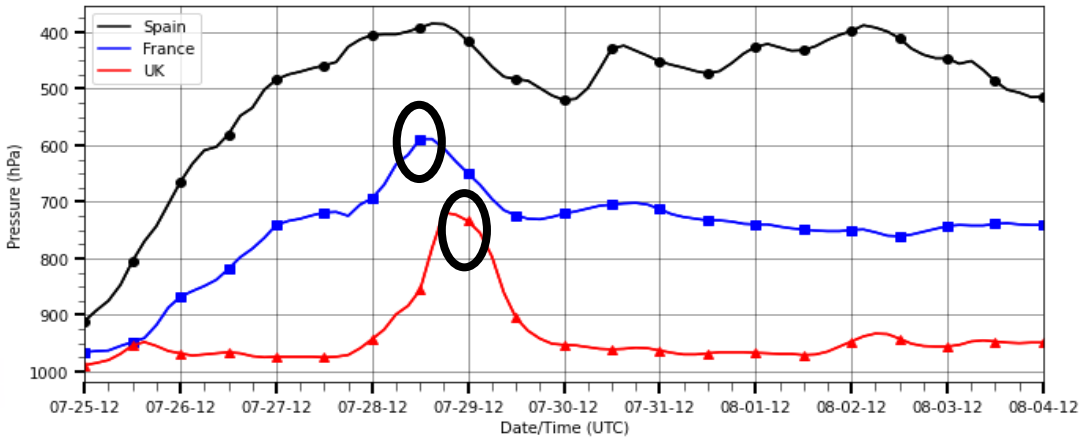
Eulerian Perspective

1200 UTC 25 July

Lagrangian Perspective

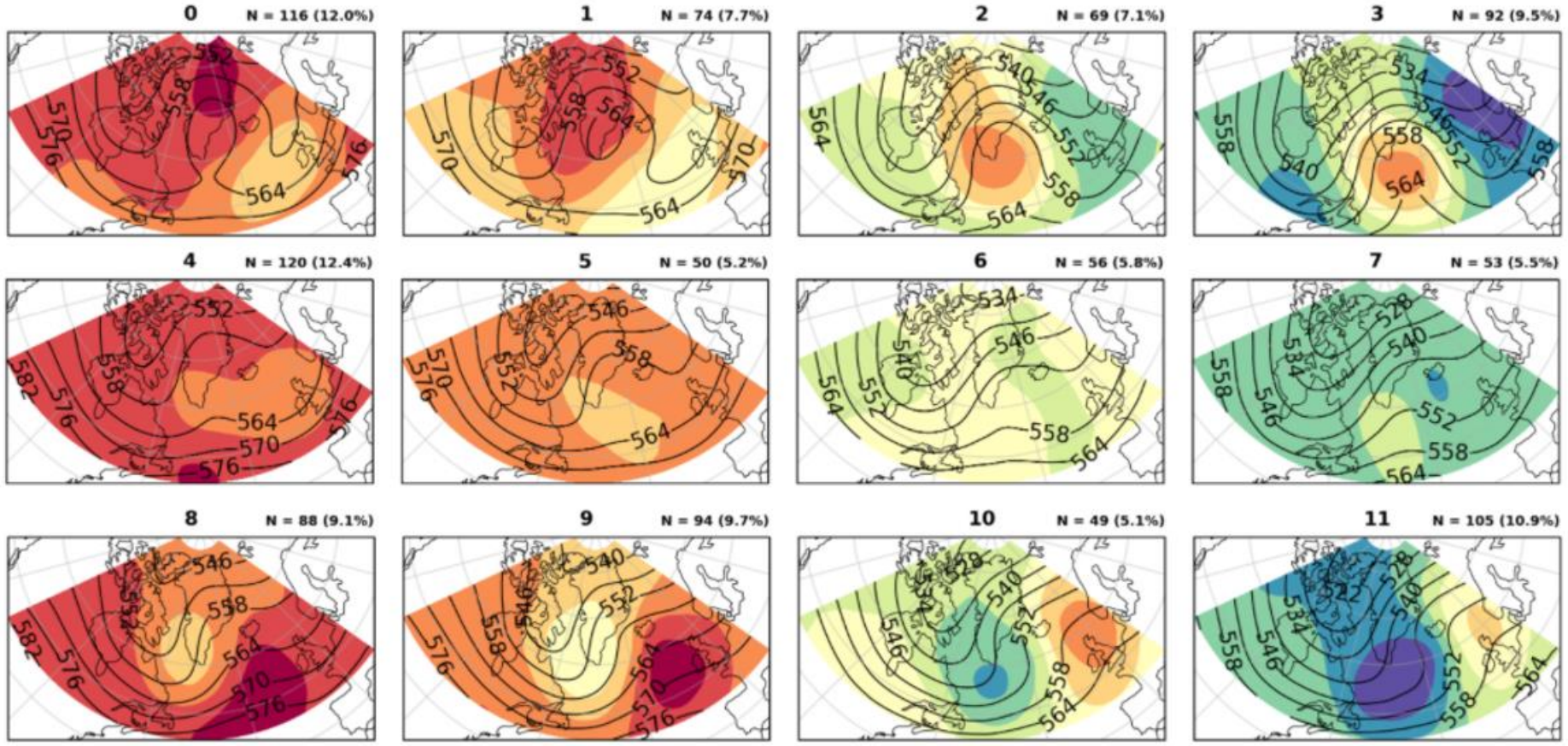




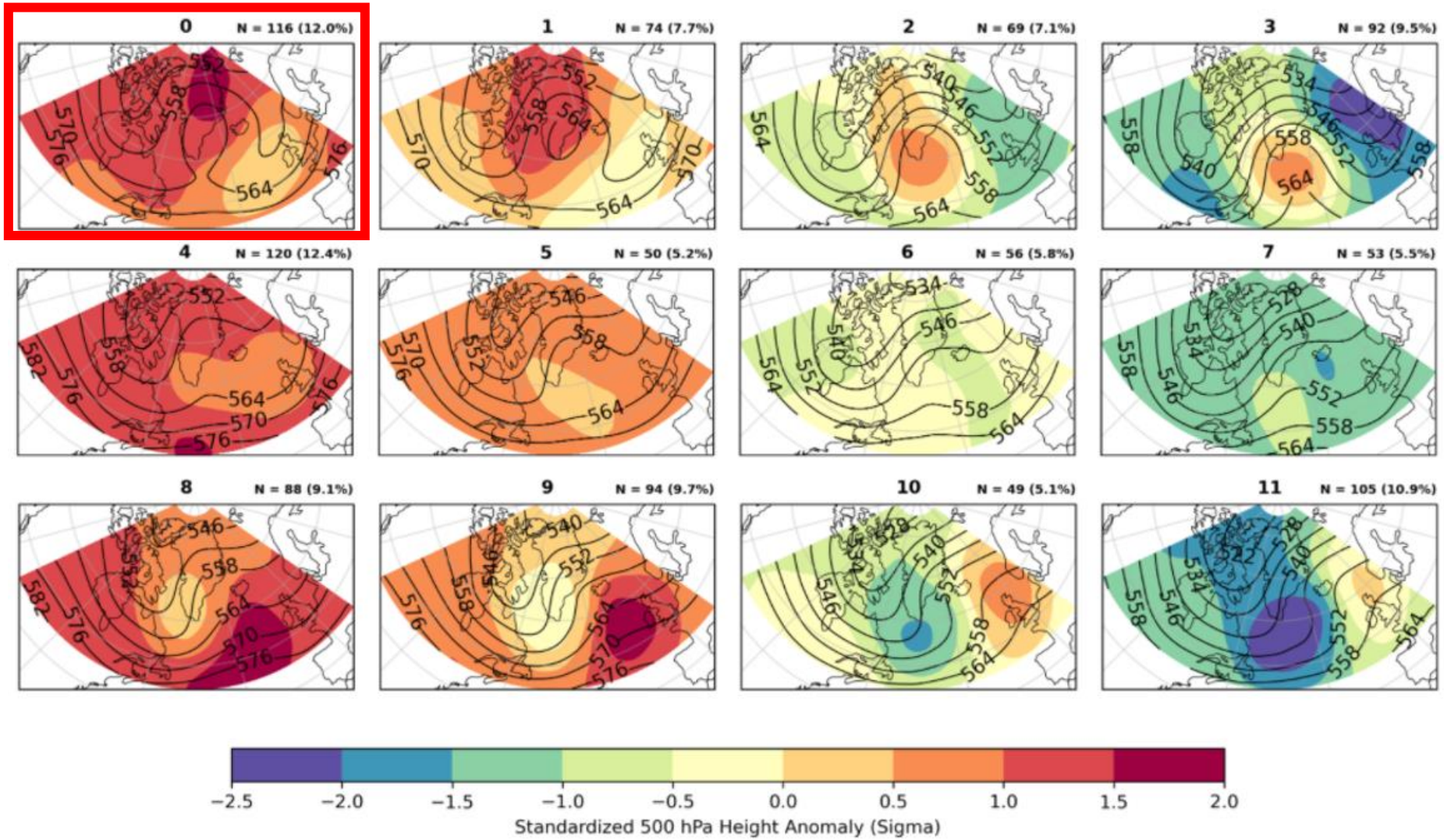


One-Variable SOMs

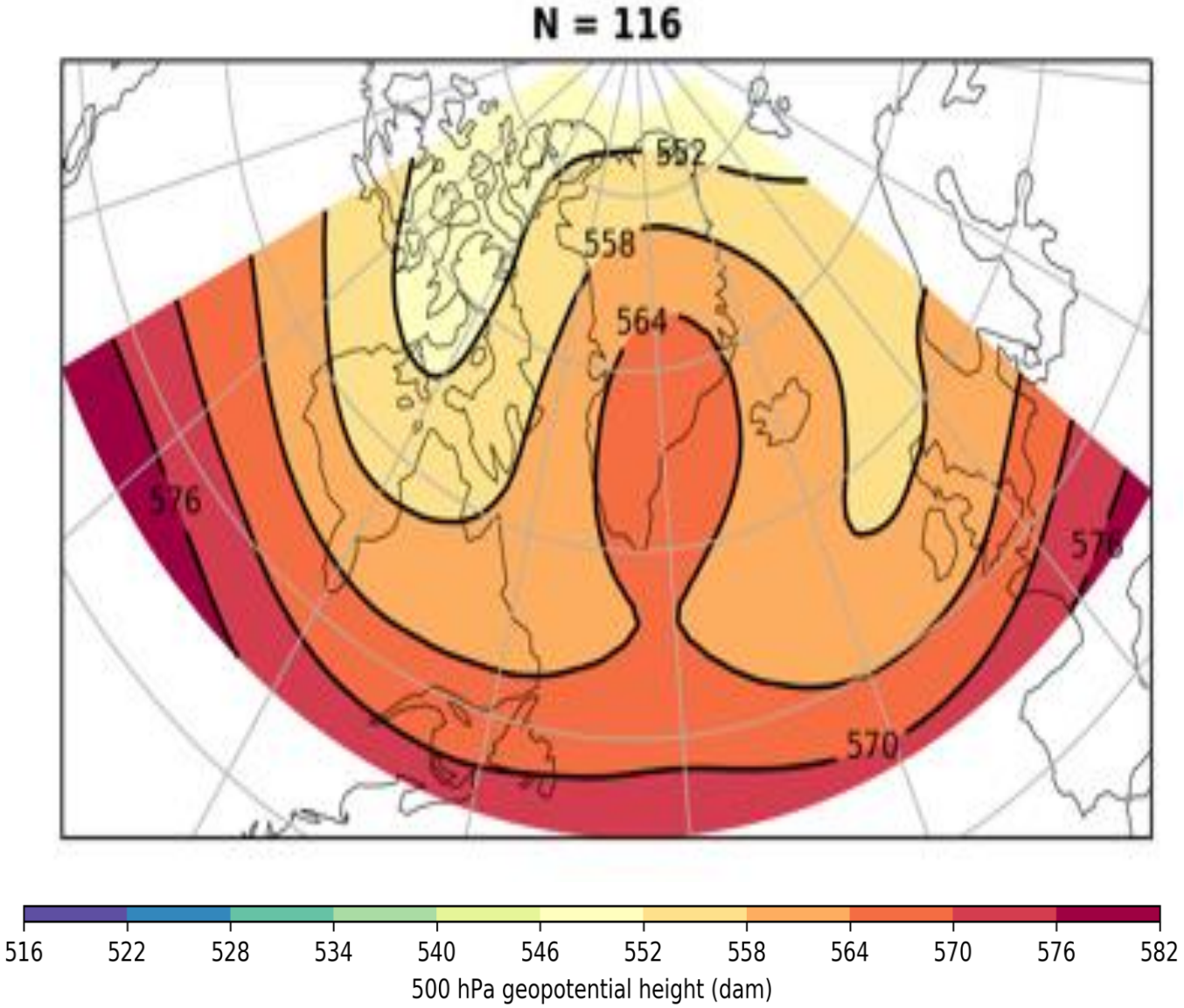
500-hPa Geopotential Height (dam)



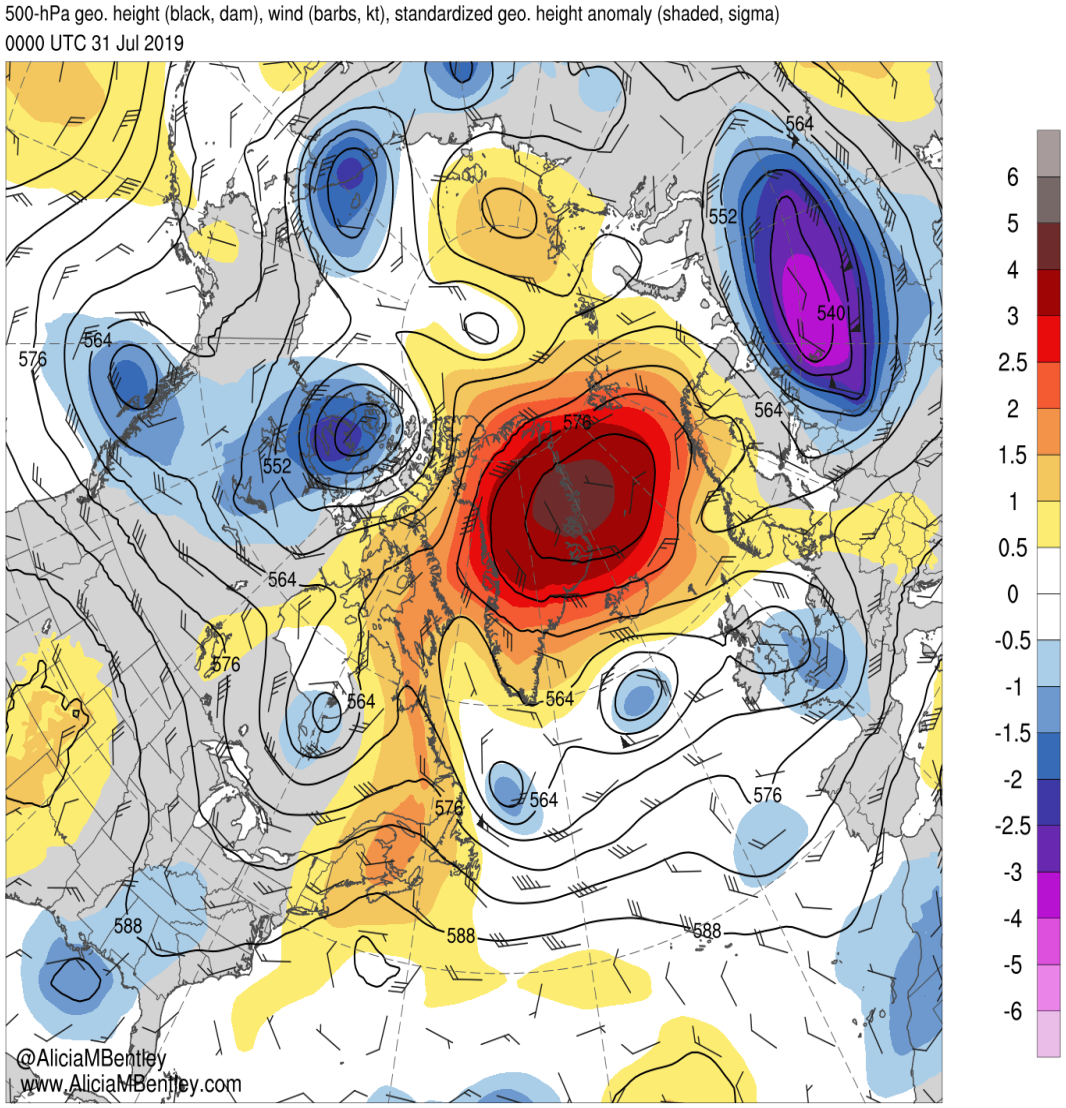
One-Variable SOMs



One-Variable SOMs

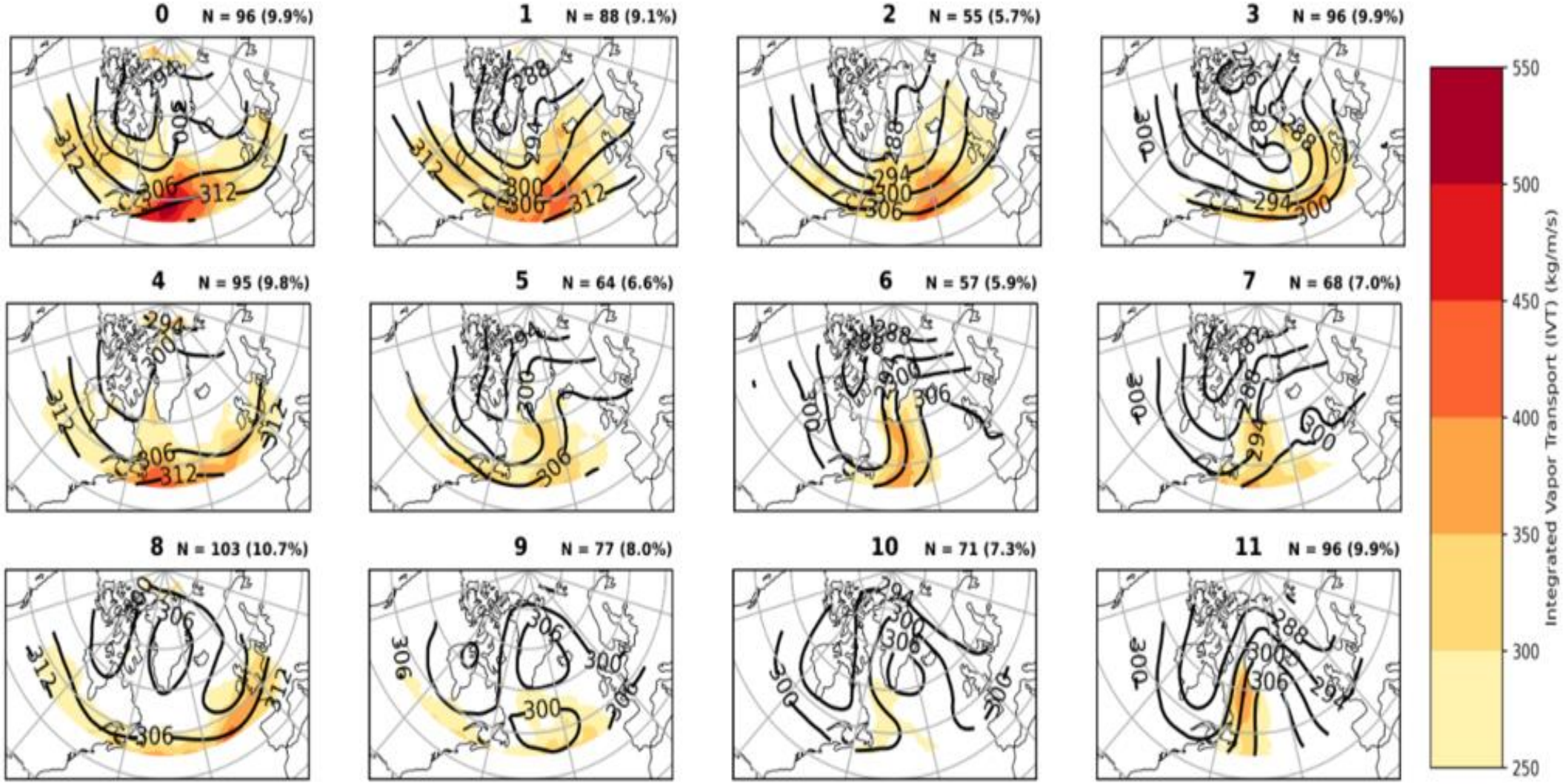


0000 UTC 31 July



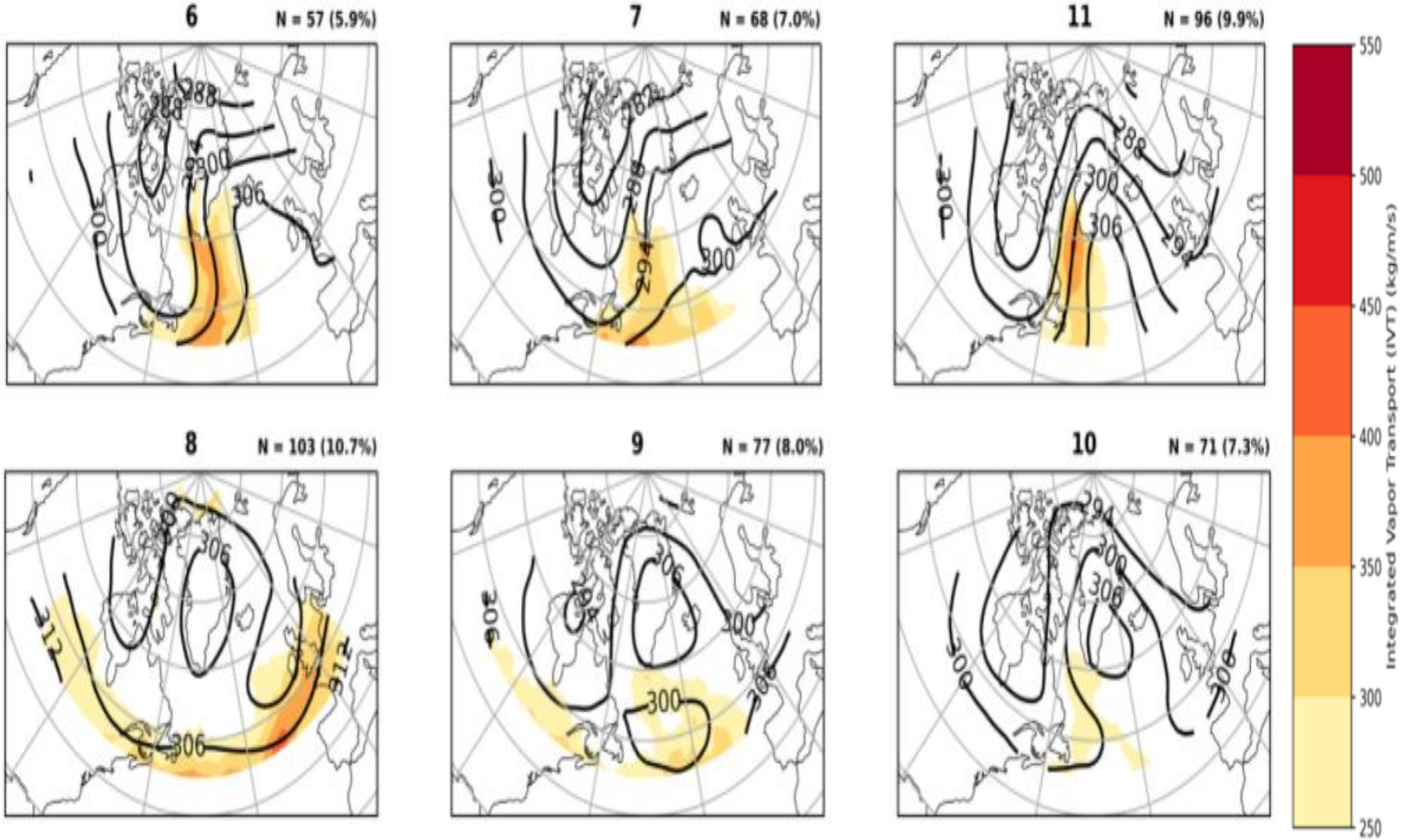
Two-Variable SOMs

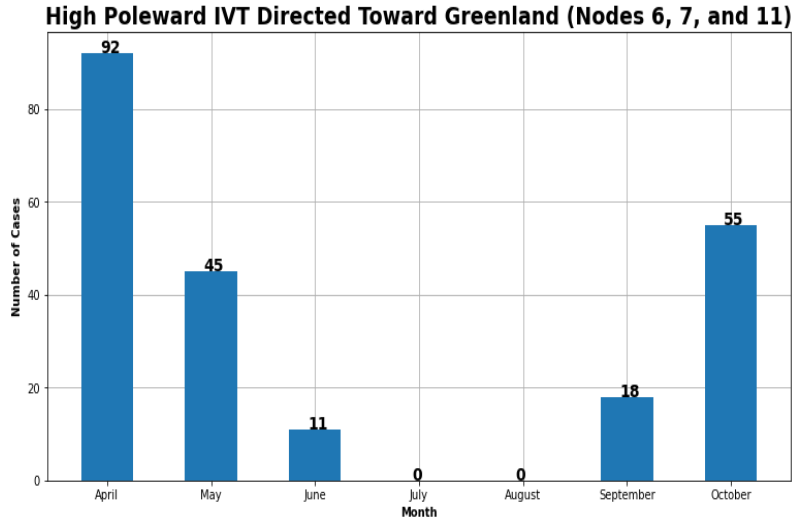
700-hPa Geopotential Height (dam) and IVT (kg m^{-1} s^{-1})

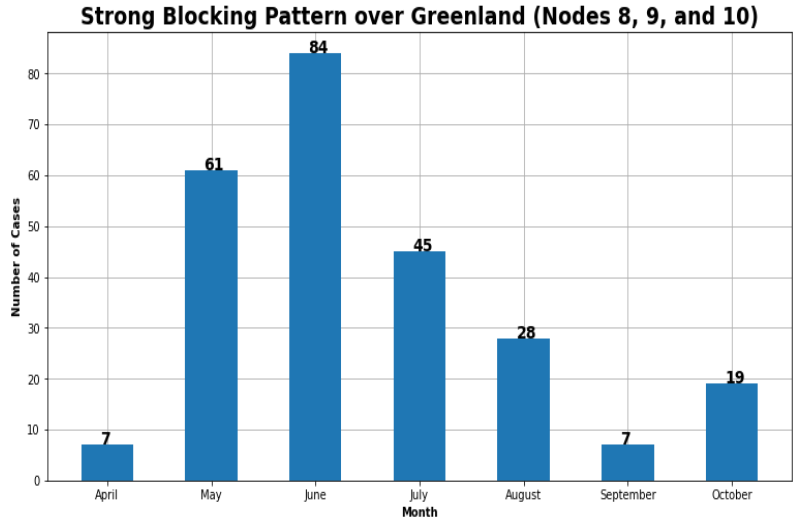


Two-Variable SOMs & Seasonal Analysis

700-hPa Geopotential Height (dam) and IVT (kg m^{-1} s^{-1})







Conclusions

- **Parcel trajectories establish that the anomalously warm low-level air mass over Europe on 25 July was able to reach Greenland subsequently, which may have been associated with the development and intensification of the Greenland blocking anticyclone on 31 July**

- **The SOMs algorithms identify three main types of synoptic flow patterns during Greenland surface ice-melt events:**
  - **A strong ridge over Greenland**
  - **A positively tilted trough of varying strength upstream of Greenland**
  - **A strong negatively tilted trough upstream of Greenland**

Conclusions

- **Nodes that show the highest poleward IVT directed toward Greenland tend to have a deep trough over eastern North America, while nodes that have little IVT directed toward Greenland tend to have a strong blocking pattern over Greenland**

- **Greenland summer ice-melt events tend to occur in conjunction with a strong blocking pattern over Greenland, while major Greenland spring and autumn ice-melt events tend to occur in conjunction with high poleward IVT directed toward Greenland**