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Atmospheric conditions over West Greenland in 2017

By

Boris Cisewski, Thünen Institute of Sea Fisheries, Germany

Abstract

An overview of the atmospheric conditions over West Greenland in 2017 is presented. In winter 2016/2017, the NAO index was positive (+1.47) for the fourth consecutive winter. The annual mean air temperature at Nuuk weather station in West Greenland was -0.8°C in 2017, which was 0.6°C above the long-term mean (1981-2010). The current report is restricted on the meteorological conditions because the ICES/NAFO oceanographic sections across Fyllas Bank and Cape Desolation had to be abandoned due to severe weather conditions in autumn 2017.

Introduction

The water mass circulation off Greenland comprises three main currents (Fig. 1): Irminger Current (IC), West Greenland (WGC) and East Greenland Currents (EGC). The EGC transports ice and cold low-salinity Surface Polar Water (SPW) to the south along the eastern coast of Greenland. On the inner shelf the East Greenland Coastal Current (EGCC), predominantly a bifurcated branch of the EGC, transports cold fresh Polar Water southward near the shelf break (Sutherland and Pickart, 2008). The IC is the northward flowing component of the North Atlantic subpolar gyre. It transports relatively warm water that mixes with colder water transported by the EGC from the Arctic Ocean. Fig. 2 reveals warm and salty Atlantic Waters flowing northward along the Reykjanes Ridge. South of the Denmark Strait (DS) the current bifurcates. While a smaller branch continues northward through the DS to form the Icelandic Irminger Current, the bulk of the current recirculates to the south and transports salty and warm ISW southward along the eastern continental slope of Greenland. South of Greenland both currents bifurcate and spread northward as a single jet of the West Greenland Current (WGC). The WGC carries the water northward and consists of two components: a cold and fresh inshore component, which is a mixture of the SPW and melt water, and a saltier and warmer ISW offshore component. The WGC transports water into the Labrador Sea, and hence is important for Labrador Sea Water formation, which is an essential element of the Atlantic Meridional Overturning Circulation. The dynamics of the current is monitored yearly in autumn at two standard ICES/NAFO oceanographic sections across the slope off West Greenland. However, in autumn 2017, the Cape Desolation and Fyllas Bank Sections had to be abandoned due to severe weather conditions.

Materials and Methods

The German groundfish survey off Greenland has been conducted since 1981, aiming at monitoring groundfish stocks, cod and redfish in particular. The monitoring is carried out by the Thünen-Institute of Sea Fisheries (TI-SF) and reveals significant interannual and long-term variability of both components of the WGC. Hydrographic profiles were collected with a Sea-Bird 911plus CTD attached to a 12-bottle water sampler. The hydrographic database consisted of 35 hydrographic stations sampled between October 21 and November 9, 2017, from R/V *Walther Herwig III*. Study area and station locations are shown in Figure 3.
The sea level pressure (SLP) and its anomalies during the winter months (December through March) were taken from NCEP/NCAR Reanalysis data available from the NOAA-CIRES Climate Diagnostics Centre (http://www.cdc.noaa.gov/). To describe the pattern of SLP over the North Atlantic, Hurrell's winter (December through March) station based index of the North-Atlantic Oscillation was used (Hurrell, 1995). This index based on the difference of normalized sea level pressure (SLP) between Lisbon, Portugal and Reykjavik, Iceland since 1864 and is available at https://climatedataguide.ucar.edu/climate-data/hurrell-north-atlantic-oscillation-nao-index-station-based. Air temperature at Nuuk station (Table 1) on the western coast of Greenland was used to characterize the atmospheric conditions in 2017 (Cappelen, 2018). The climatological mean of this time series was referenced to 1981-2010. Information about sea surface temperature anomalies was provided by NOAA/ESRL Physical Science Division, Boulder, Colorado, based on objective interpolation product (NOAA OI SST, Reynolds et al., 2002).

Results and Discussion

The variability of the atmospheric conditions over Greenland and the Labrador Sea is driven by the large scale atmospheric circulation over the North Atlantic, which is normally described in terms of the North Atlantic Oscillation (NAO). During a positive NAO strong northwest winds bring cold air from the North American continent and cause negative anomalies of the air temperatures over Greenland, Labrador Sea and Baffin Bay (Hurrell and Deser, 2010). During a negative NAO, the westerlies slacken and the weather is normally milder over the whole region. In winter 2016/2017, the NAO index was positive (+1.47) for the fourth consecutive winter, the first such positive run since the 1992-1995 (Fig. 4). Figure 5a shows the winter sea level pressure (SLP) averaged over 30 years (1981-2010), mainly dominated by the Iceland Low and the Azores High. Both, the Icelandic Low and the Azores High were strengthening resulting in an increased pressure difference over the North Atlantic sector than normal during winter 2016/2017 (Figure 5b). The anomaly in sea level pressure reveals not a typical NAO pattern with the high pressure anomaly shifted east and centred over the North Sea. (Figure 5c). Air temperature at Nuuk was used to characterize the atmospheric conditions in 2017. Annual and monthly mean values were obtained from the Danish Meteorological Institute (Figures 6 and 7). The resulting annual mean temperature at Nuuk was -0.8°C in 2017, which was 0.6°C above the long-term mean (1981-2010) (Figure 7). The annual sea surface temperature (NOAA OI SST) anomalies for 2017 indicate positive anomalies in the Northwestern Atlantic with highest values occurring northeast of Iceland and along the coast of East Greenland (Figure 8), whereas negative anomalies were observed in the central area of the North Atlantic.

Table 1 Details on the times series, analyzed in this study.

Name	Lat (°N)	Lon (°W)	Type	Source
Nuuk (4250)[1]	64.17	51.75	Weather station	DMI
Nuuk airport (4254)[1]	64.20	51.68	Weather station	DMI

[1] In recent years, Nuuk air temperature was taken from the Nuuk airport synop station 04254 due to a failure on Nuuk synop station 04250 (Cappelen, 2013).

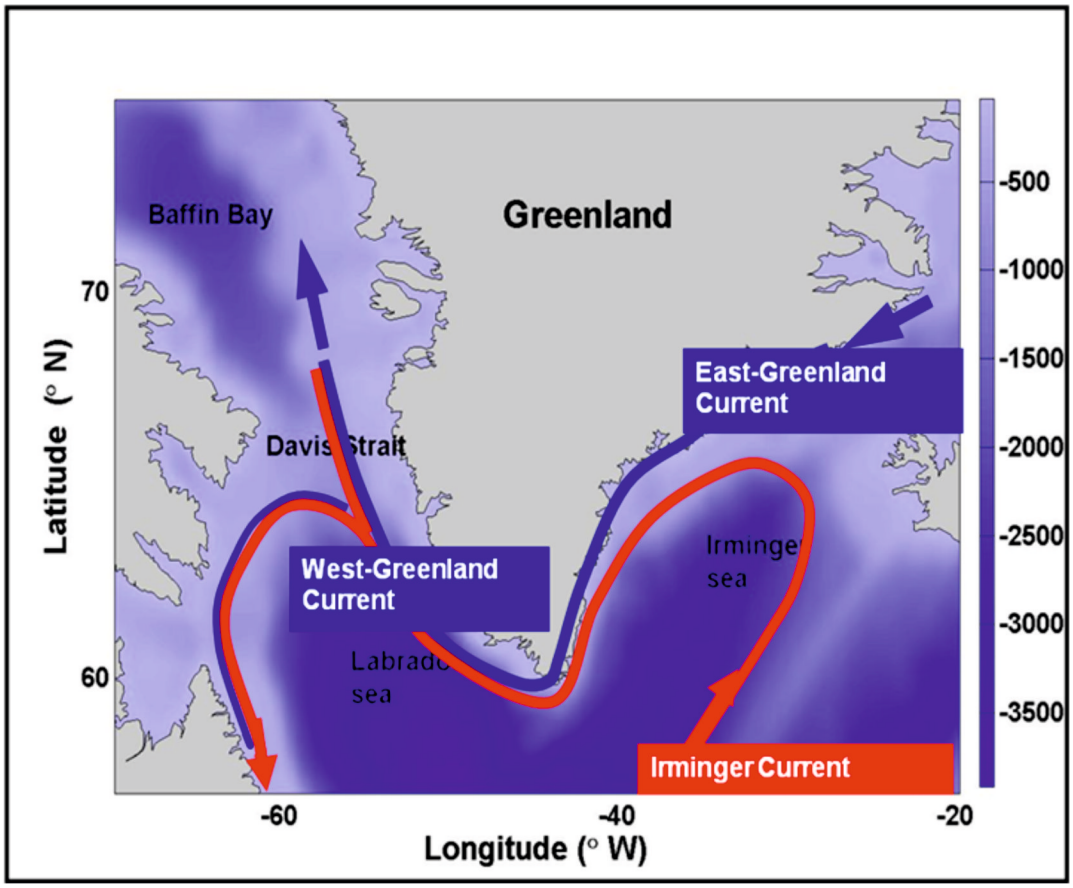

Fig. 1 Scheme of the upper ocean circulation in the study area. Red and blue curves show the trajectories of warm Irminger Sea Water and cold Surface Polar Water, respectively.

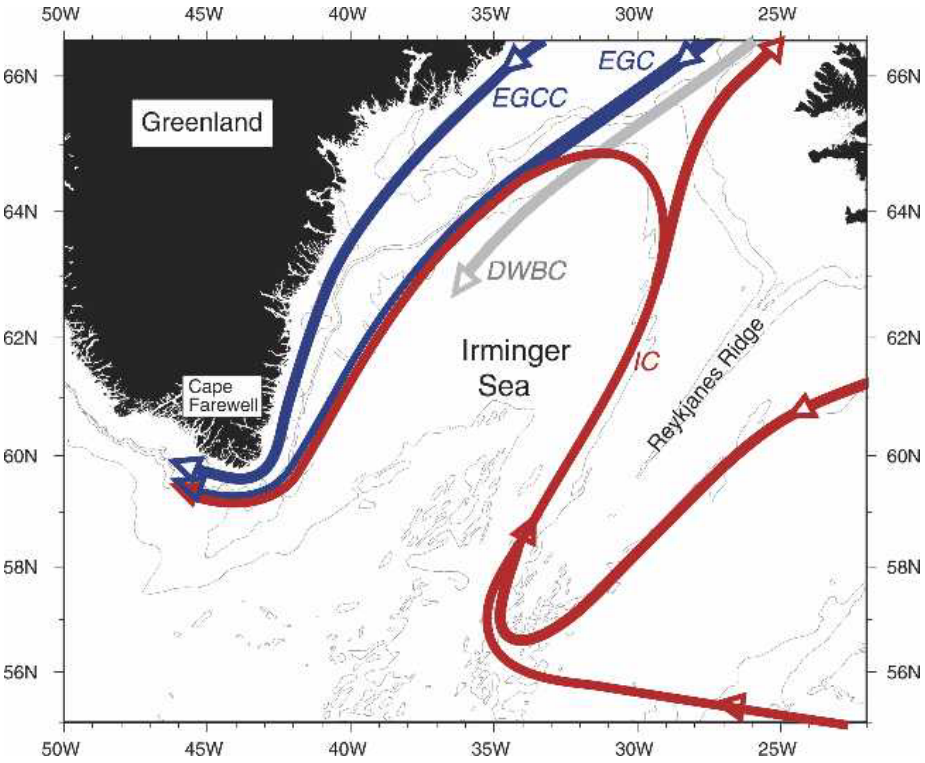

Fig. 2 Schematic of the boundary currents of the Irminger Sea (depicted from Pickart et al., 2005)

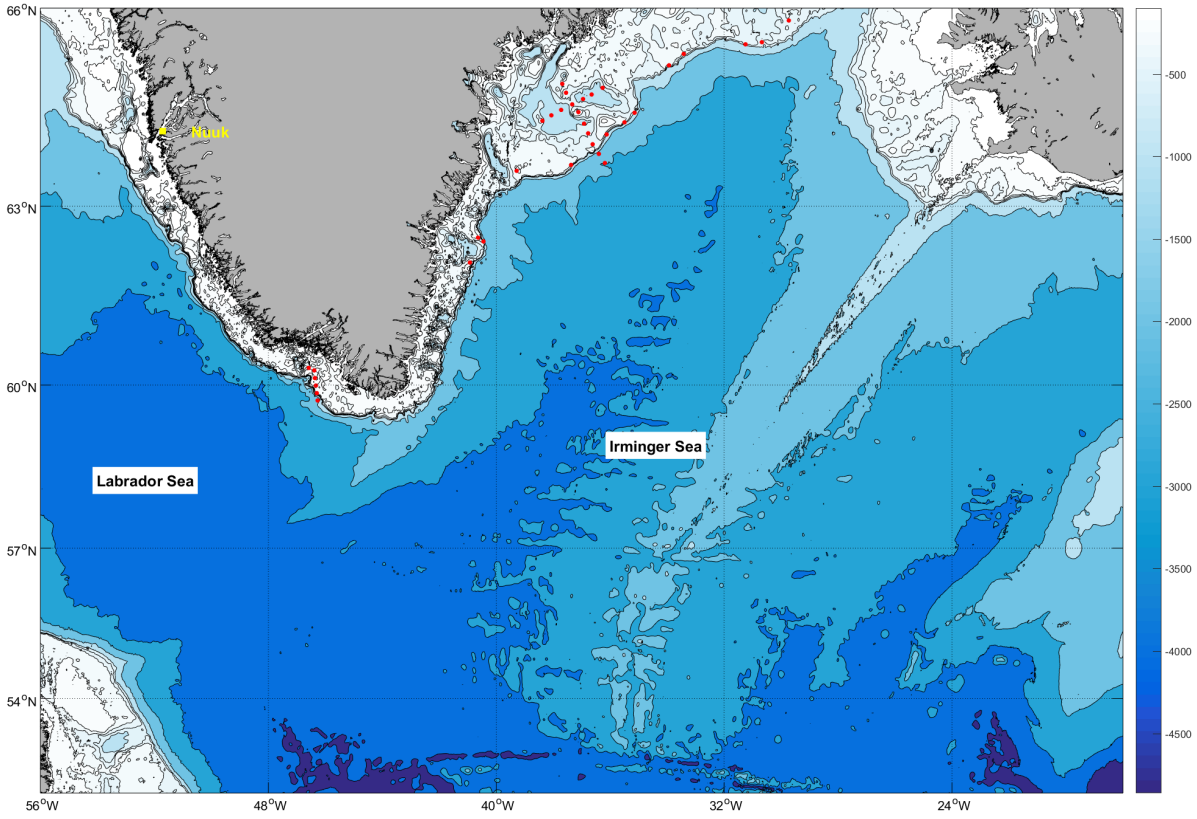

Fig. 3 Map and bathymetry of the study region. Meteorological station location is shown in yellow. Red dots show the location of the CTD stations, conducted during the survey in 2017. The Fyllas Bank Section and the Cape Desolation Section had to be abandoned due to severe weather conditions (geographic coordinates are given in table 1).

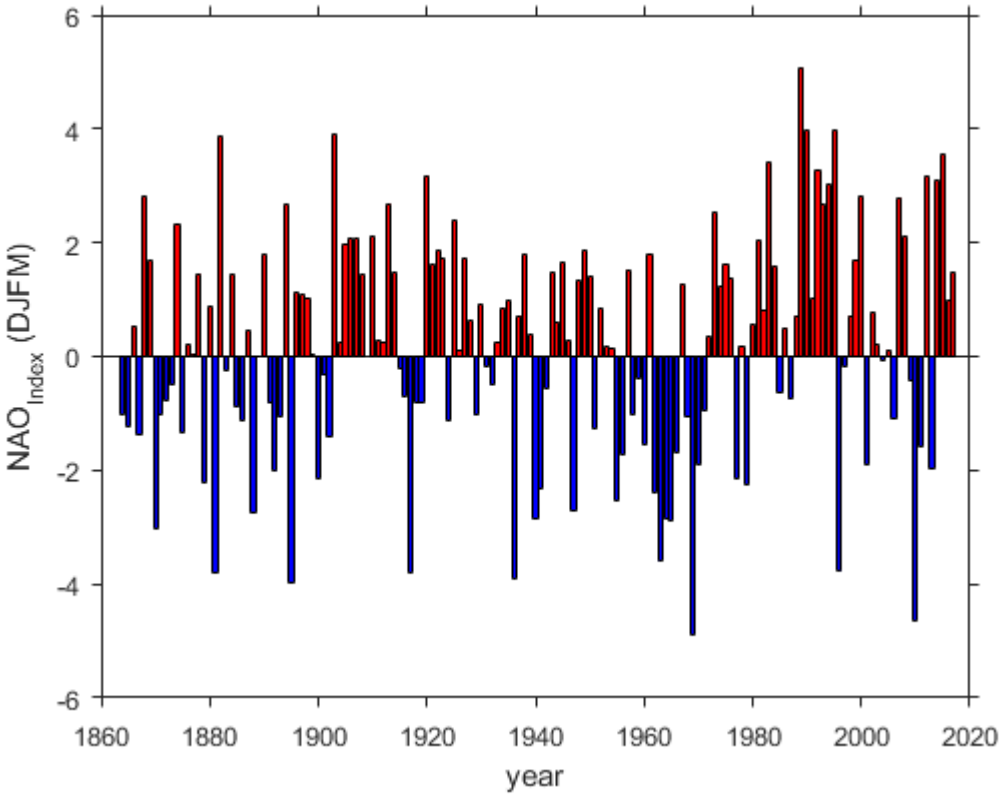

Fig. 4 The Hurrell winter (DJFM) NAO index. Data source: https://climatedataguide.ucar.edu/climate-data/hurrell-north-atlantic-oscillation-nao-index-station-based

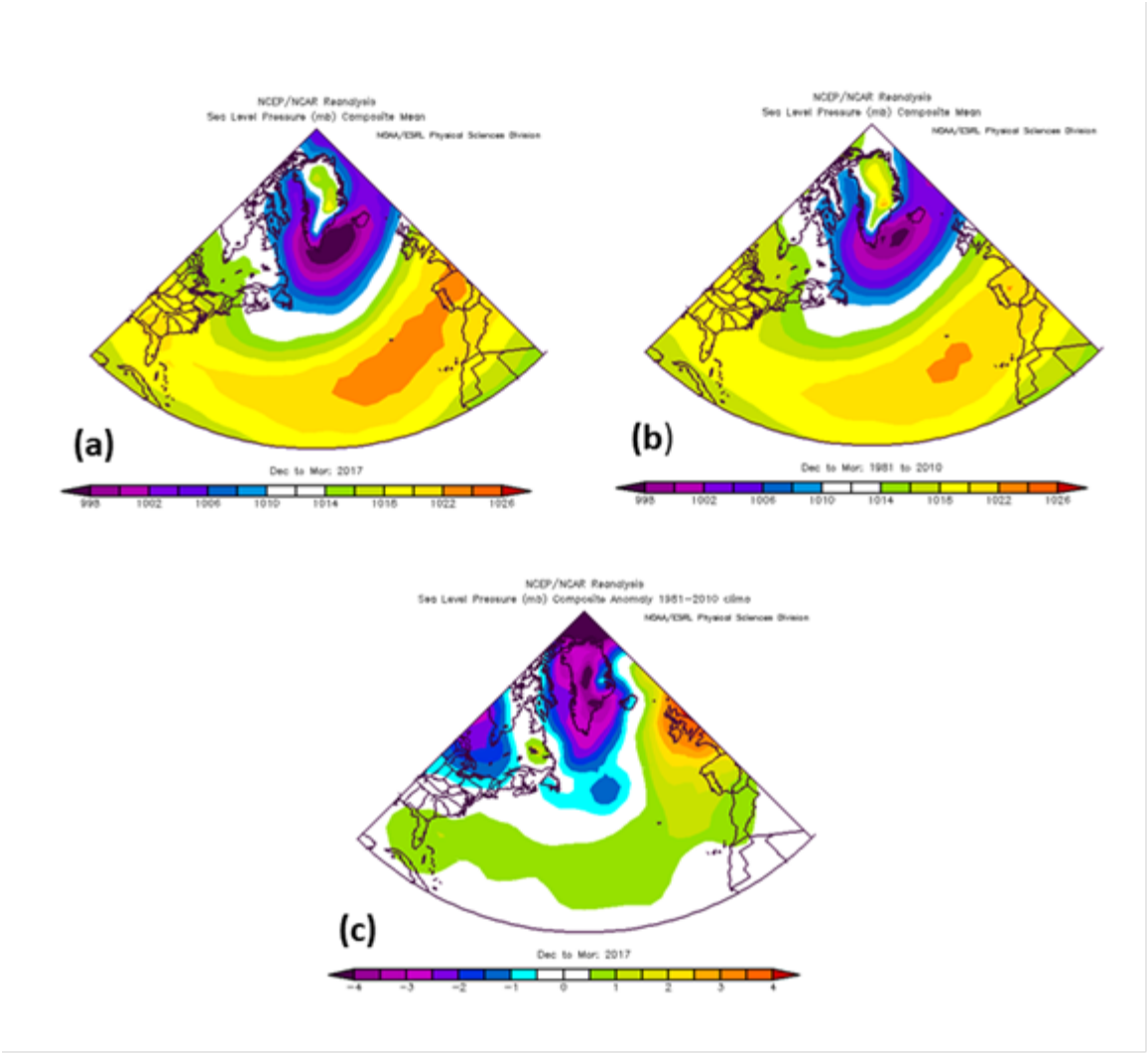

Fig. 5 Maps of winter 1981-2010 (DJFM) mean sea level pressure (SLP) **(a)**, winter 2017 SLP **(b)**, and resulting SLP anomaly **(c)** over the North Atlantic. *Images are provided by the NOAA/ESRL Physical Science Division, Boulder, Colorado*

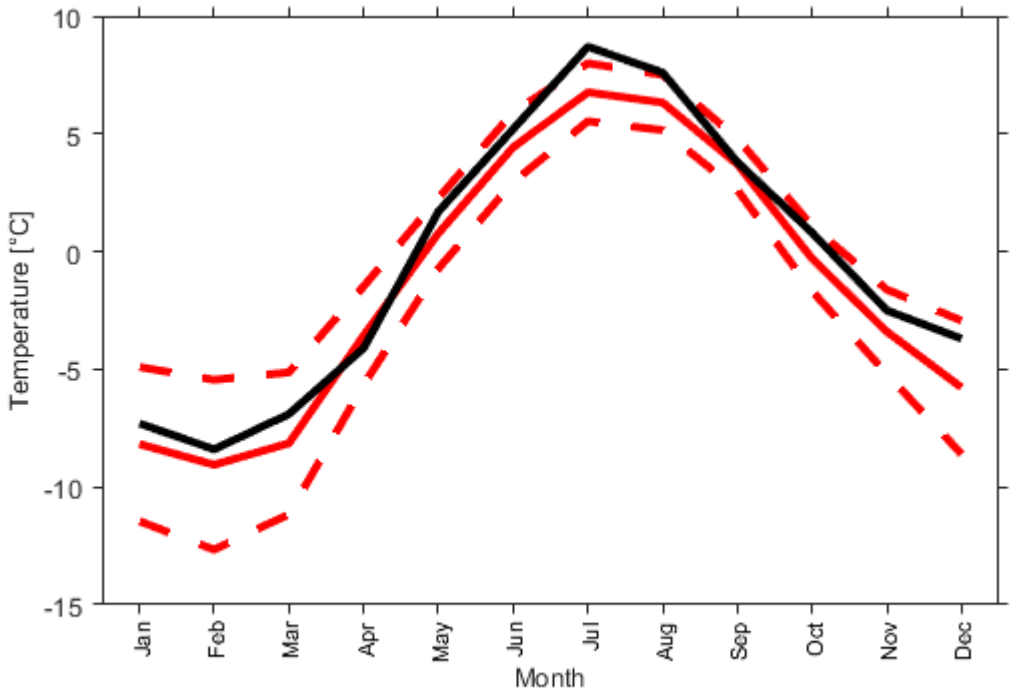

Fig. 6 Monthly mean air temperature at Nuuk station in 2017 (black line), long-term monthly mean temperature (red solid line) and one standard deviation (red dashed lines) are shown. Reference period is 1981 to 2010. Data source: Danish Meteorological Institute (DMI)

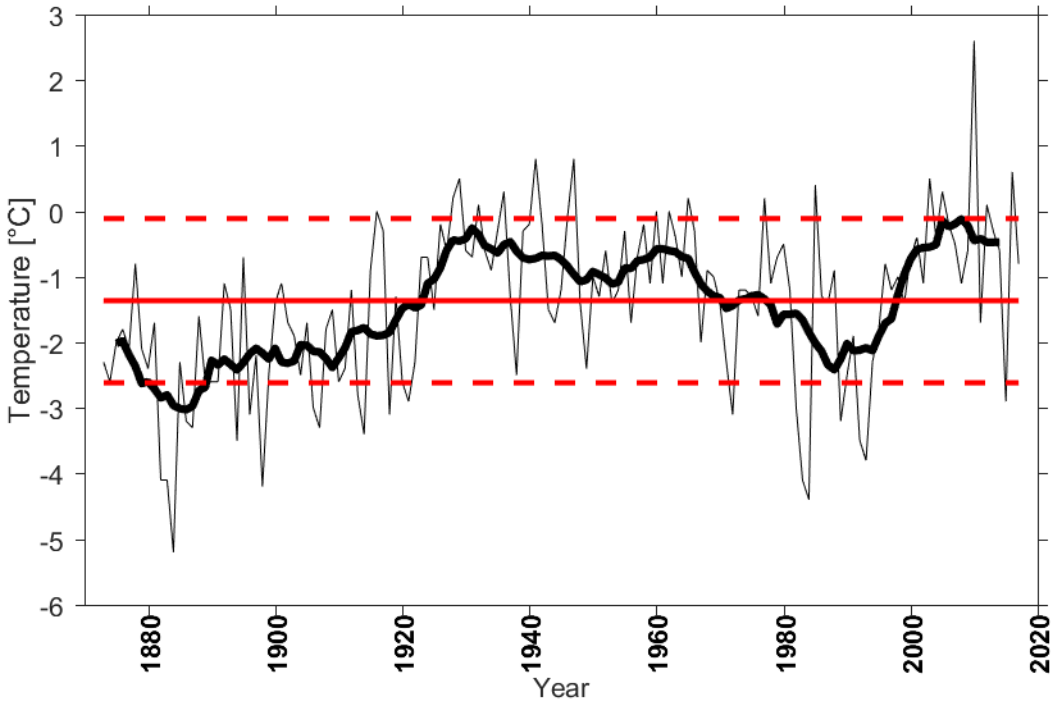

Fig. 7 Annual mean air temperature at Nuuk station. Thick black line shows the 5-year smoothed data. Red solid line indicates the long-term mean temperature, referenced to 1981-2010. Dashed red lines mark corresponding standard deviations. Data source: Danish Meteorological Institute (DMI)

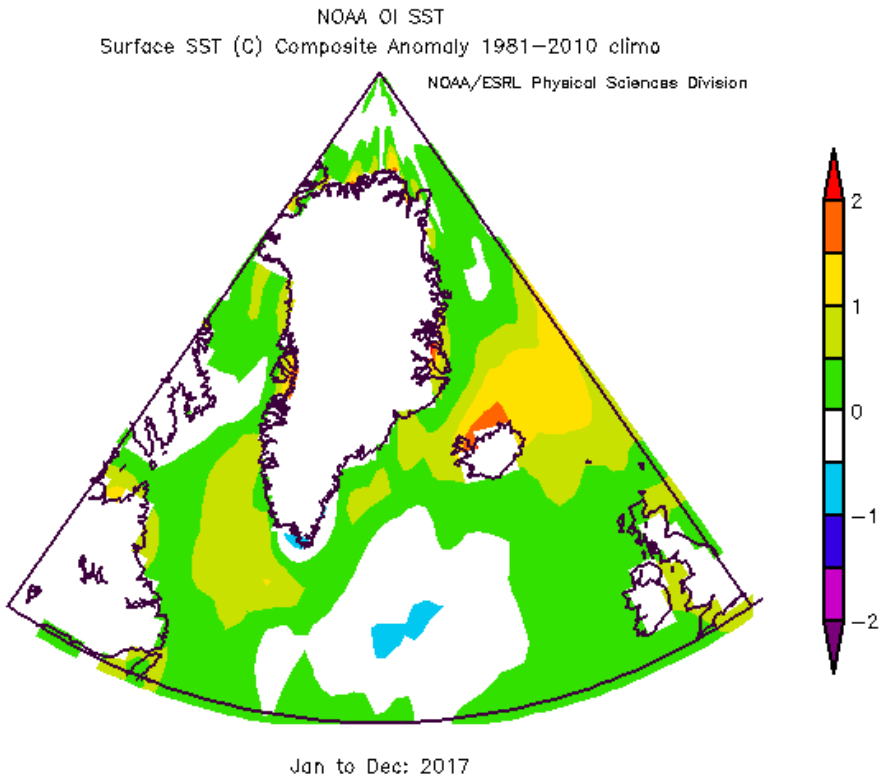

Fig. 8 Map of 2017 annual sea surface temperature (NOAA OI SST) anomalies in the study region. The long-term mean corresponds to 1981-2010. *Image is provided by the NOAA/ESRL Physical Science Division, Boulder, Colorado*

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