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Report on hydrographic conditions off Southwest Greenland June/July 2016

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Abstract

Hydrographic conditions were monitored at all 10 hydrographic standard sections and stations in June/July 2016 across the continental shelf off West Greenland. Three offshore stations have been chosen to document changes in hydrographic conditions off Southwest Greenland. The coastal water showed temperatures above the long-term mean and south of the Sisimiut section they were high above normal. After some years with a relative fresh subpolar mode water mass, salinity have returned to values higher than normal as observed within the past 15 years.

Introduction

The West Greenland Current carries water northward along the West Greenland continental slope and consists of three components: a cold, fresh and surface near inshore surface component referred to as Coastal Water (CW), a saltier, warmer and deeper offshore component referred to as Subpolar Mode Water (SPMW) and freshwater runoff from Greenland. The West Greenland Current is part of the cyclonic Subpolar Gyre and thus subject to hydrographic variations at different time-scales associated with variability of the gyre, local and regional atmospheric conditions. Hydrographic conditions are monitored at 10 hydrographic sections in June/July across the continental shelf off West Greenland (Figure 1). Three offshore stations have been chosen to document changes in hydrographic conditions off Southwest Greenland.

Materials and Methods

The 2016 standard hydrographic cruises were carried out by the Greenland Institute of Natural Resources (GINR) onboard RV Paamiut during the period 10 June to 4 July and onboard the Danish naval ship Tulugaq during the period 13 July to 27 July 2016. Observations were carried out on the following standard stations (Figure 1):

RV Paamiut sections:

Sisimiut (Holsteinsborg) St. 1–5
Aasiaat (Egedesminde) St. 1–7
Kangerluk (Disko fjord) St. 1–4
Nuussuaq St. 1–5
Upernavik St. 1–5

Tulugaq sections:

Cape Farewell St. 1-5
Cape Desolation St. 1-5
Paamiut St. 1-5
Fyllas Banke St. 1-5
Maniitsoq St. 1-5
Sisimiut St. 0-5

Hydrographic data were collected by a SBE 25plus onboard RV Paamiut, whereas it was collected by a SBE 19plus onboard Tulugaq. The instruments were respectively pre- and post-cruise calibrated by the manufacturer. The collected data were averaged to 1 m vertical bins.

Results and Discussion

West Greenland usually experiences warmer than typical conditions when the North Atlantic Oscillation (NAO) index is negative. The highest annual mean air temperature ever reported for Nuuk occurred in 2010 with a strongly negative NAO. In 2016, Hurrell station-based winter NAO (DJFM) index was weakly positive (0.98). This was reflected in the annual mean air temperature at the Nuuk weather station in 2016 (0.5°C), which was 1.9°C above the long-term mean (1981-2010), and warmer than the previous 5 years (Cappelen, 2017).

Average water properties between 0 and 50 m depth at Fyllas Banke Station 4 (FB4) in June/July are used to monitor the variability of the Coastal Water (CW) component of the West Greenland Current (Figure 2). After a temperature drop in 2015, the temperature in 2016 experienced a significant increase to levels which have not been observed since the start of the 1980´s; with temperatures 2.12°C higher than the long-term mean (1981–2010, T_{mean}=1.69°C). Conversely, the salinity of the CW stopped its positive trend, which started around 1970. In 2016 salinity was 0.29 below its long-term mean (S_{mean}=33.27).

Average water properties between 0 and 40 m depth at Fyllas Banke Station 2 (FB2) in June/July have previously been used to monitor the variability of the sea surface waters off West Greenland (Figure 3). Though the two stations (FB2 and FB4) should tell the same story, they do not. After a negative temperature trend between 2005 and 2015, the temperature in 2016 experienced a significant increase to levels which have not been observed since mid 2000´s; with temperatures 1.94°C higher than the long-term mean (1981–2010, T_{mean}=1.90°C). The salinity of the sea surface layer continued its slightly negative trend, which started around 1970. In 2016, salinity was 0.49 below its long-term mean (S_{mean}=33.42).

Note that the late occupation of the southern standard sections in 2016 might have biased the temperatures and salinities values presented in Figure 2 and 3 towards warmer and fresher conditions. During the construction of the temperature depth average values for FB2 in Figure 3 the convention is to subtract 1°C from the depth average value if the station is occupied in July.

The short-term variability that take place at FB2 (0-40 m) and FB4 (0-50 m) are illustrated for two occupation in 2016:

		T_{mean}	S_{mean}
13 May 2016:			
	FB2	0.77	33.47
	FB4	0.56	33.37
22 July 2016:			
	FB2	4.84	32.93
	FB4	3.81	32.98

Temperature and salinity of the SPMW component of the West Greenland Current started to increase towards the end of the 1990s (Figure 4), coinciding with changes in the Subpolar Gyre where warm and saline water from the Subtropical Gyre entered the Subpolar Gyre. At the end of July 2016, water temperature in the 75–

200 m layer at Cape Desolation Station 3 (KD3) was 5.17°C and salinity was 34.94, i.e. 0.52°C and 0.06 above the long-term mean (1992-2010) respectively.

SPMW referred to by others as Atlantic Water or Irminger Sea Water and with salinity greater than 34.95, were observed at stations on the Cape Farewell, Cape Desolation and Paamiut section off the west coast off Greenland in July 2016 (Figure 5). Waters with salinities in the range 34.88 to 34.95 could be followed from the Cape Farewell section in the south (59°N) to the Maniitsoq section in the north at 65°N. North of the Maniitsoq section, the SPMW core becomes gradually colder and fresher with distance. Core properties of the SPMW at Upernavik section (~73°N) measured at Upernavik 5 300 m depth to 2.79°C and 34.45 potential temperature and salinity respectively. Similar levels were found the two previously years at 264 m depth at Upernavik station 4, potential temperature and salinity were 2.86°C and 34.36 in 2015; compared with 2.57°C and 34.33 in 2014 respectively.

The highest temperature observed off the west coast off Greenland during the measuring campaigns in June/July 2016 was at the Cape Desolation section in the subsurface SPMW mass. This water mass is associated with the subduction processes which occur in the area around Cape Farewell when SPMW leaves the Irminger Sea and enters the Labrador Sea.

The lowest temperature observed off the west coast off Greenland during the measuring campaigns in June/July 2016 was north of the Sisimiut section and was associated with Baffin Bay Polar Water (BBPW).

Acknowledgements

I/we would like to thank the crew of Tulugaq and RV Paamiut.

Reference:

Cappelen, J. (2017): Greenland - DMI Historical Climate Data Collection 1784-2016, DMI Report No. 17-04.

Fig. 1. Position of the hydrographic stations occupied off West Greenland during two cruises in June/July 2016. FB4 (located at the continental slope) and FB2 (located over the continental shelf).

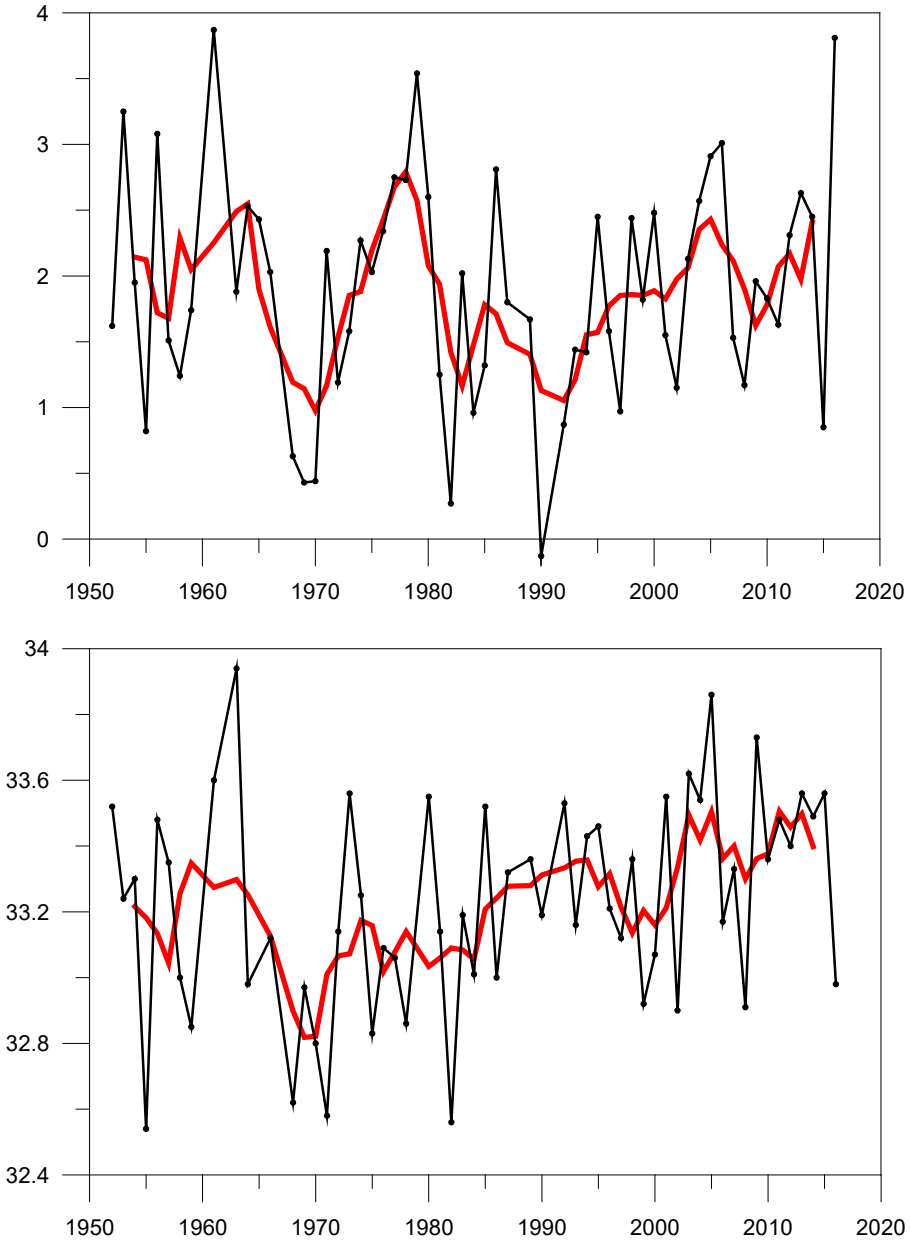

Fig. 2. Time series of mean potential temperature (°C, top) and salinity (bottom) from the Fyllas Banke continental slope (station 4, 0–50 m) with measurements in June/July for the period 1952–2016. The red curves are 5 year running mean. The temperature has not been subtracted one °C in order to compensate for the late sampling time (see text).

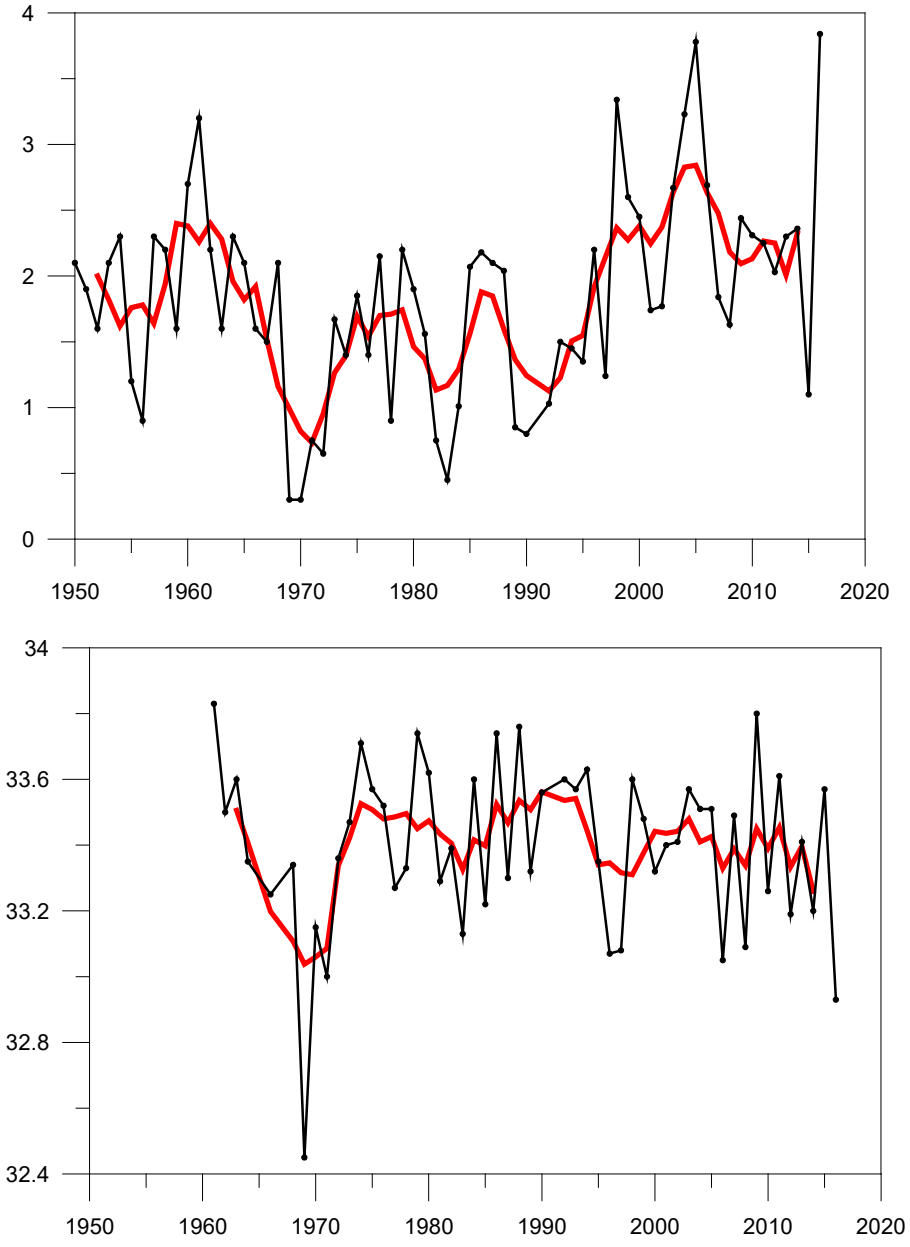

Fig. 3. Time series of mean potential temperature (°C, top) and salinity (bottom) from the Fyllas Banke continental shelf (station 2, 0–40 m) with measurements in June/July for the period 1950–2016. The red curves are 5 year running mean. The temperature has been subtracted one °C in order to compensate for the late sampling time (see text).

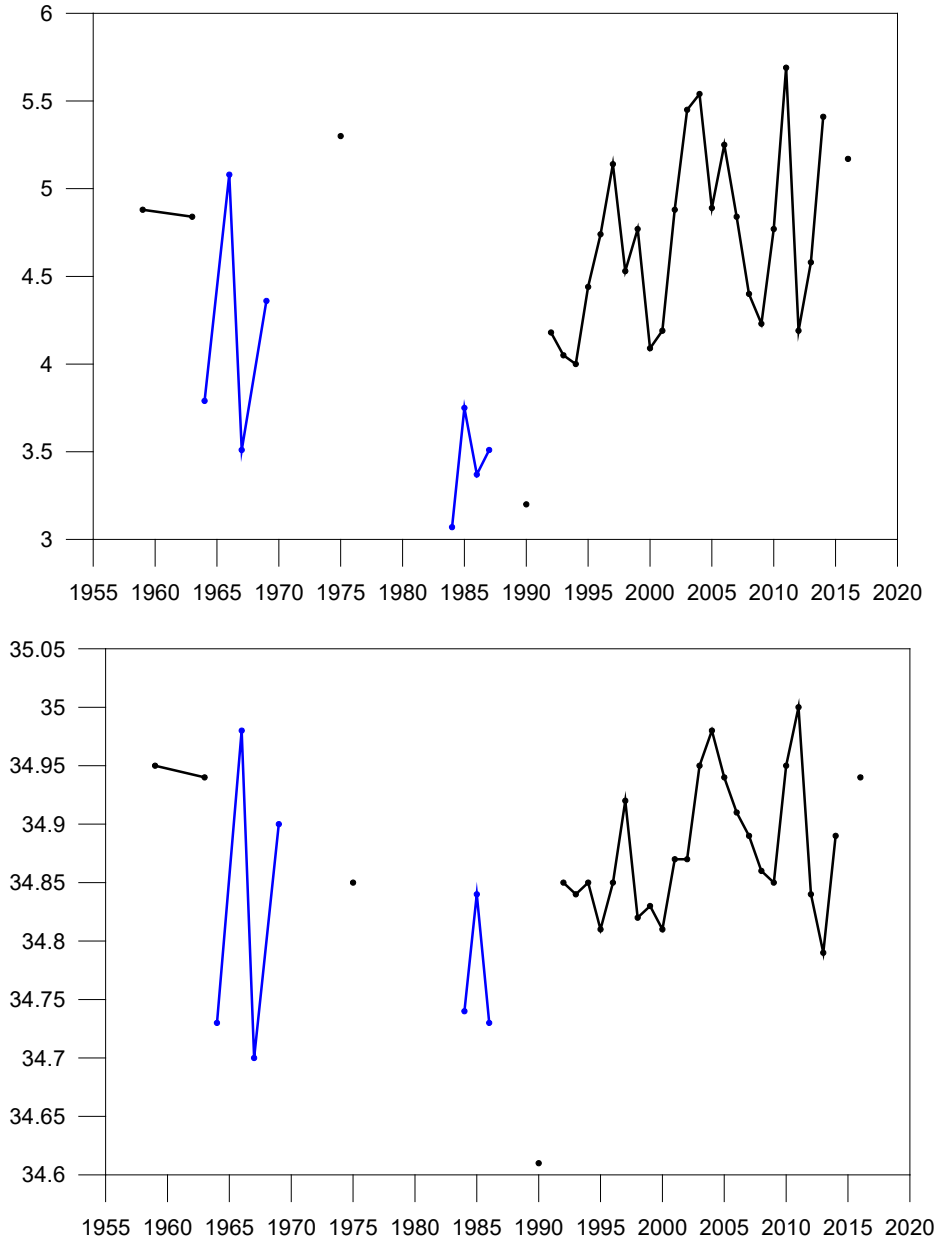

Fig. 4. Mean potential temperature (°C, top) and salinity (bottom) for the depth range 75-200 m at Cape Desolation 3 (60.47°N, 50°W) June/July 1959-2016. Blue colors indicate observations obtained early in April.

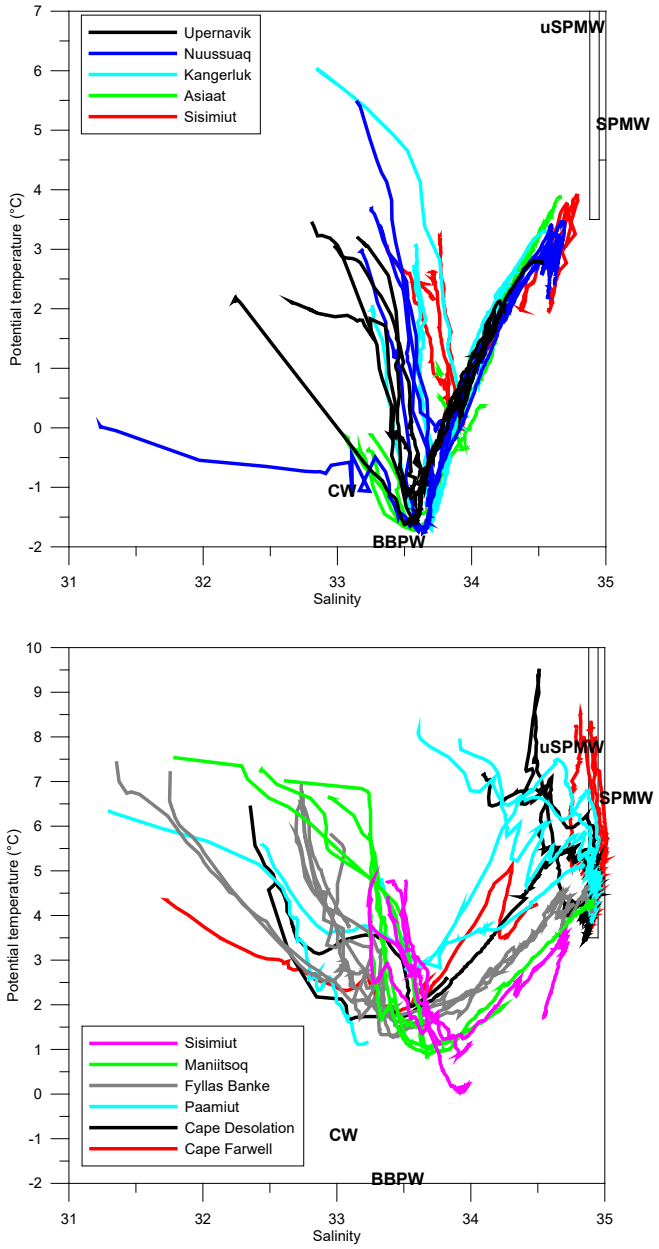

Fig. 5. Potential temperature - salinity diagrams showing every station occupied along the West Greenland continental shelf and slope during the June/July GINR surveys in 2016. Stations are color coded with respect sections (see Figure legends and Figure 1). Also indicated are water masses meet in the region: Coastal Water (CW), Subpolar Mode Water (SPMW), upper Subpolar Mode Water (upper SPMW), and Baffin Bay Polar Water (BBPW). Note the four surface point with salinity below 31 are not shown for two stations on the Maniitsoq section.