

### Key Points:

- The regional southern freshwater source transported northward along the Greenland west coast did not enter Baffin Bay during summer 2016
- North of Davis Strait, warm deep Subpolar Mode Water may enter the deep silled fjords unobstructed
- Baffin Bay Polar Water is observed on the Southwest Greenland coast as far south as 64°N suggesting a seasonal southward coastal current

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# An Updated View on Water Masses on the pan-West Greenland Continental Shelf and Their Link to Proglacial Fjords

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**Abstract** The accelerated melt of the Greenland Ice Sheet has been linked to a sudden increase in the presence of warm subsurface coastal water in west Greenland. Yet pathways of warm coastal water along the entire west Greenland coast have remained largely unstudied. Here we present the first, near-synoptic hydrographic observations at both the continental slope and fjord entrances of the west Greenland coastal system from Cape Farewell (59°N) to Melville Bay (75°N) in summer 2016. We observed a distinct north-south division in the water mass distribution in west Greenland, approximately partitioned by the northern part of Davis Strait, and a division between the continental slope and fjord entrances. Waters from the regional southern freshwater source with origin in the East Greenland Current that rounds Cape Farewell are not observed to enter Baffin Bay. The regional heat source transported by the West Greenland Current is blocked by Southwest Greenland Coastal Water in the south but the deep connections in the north allow warm deep Subpolar Mode Water to enter fjords. Furthermore, we observed cold and relative saline Baffin Bay Polar Water over the inner part of the banks, periodically reaching as far south as 64°N, suggesting the presence of an undescribed southward current at the Southwest Greenland continental shelf.

## 1. Introduction

Glaciers are currently losing mass at substantial rates, and the most rapid changes occur at marine-terminating glaciers (Gardner et al., 2013), which may be grounded hundreds of meters below sea level at the head of fjords (Howat & Eddy, 2011; Straneo & Heimbach, 2013). The accelerated discharge through these glaciers is regarded as a key component of the rapid mass loss from the Greenland Ice Sheet since the 1990s (Carr et al., 2017; Mouginot et al., 2019; Wood et al., 2018).

Recent studies have either focused on the hydrographic conditions on the coast or in fjords and their links to these changes. Few studies, however, have covered the links between the coastal system and fjords with marine-terminating glaciers (Carroll et al., 2018; Gladish et al., 2015; Mortensen et al., 2018; Straneo et al., 2013). Distinct seasonal hydrographic differences are observed between the coast and outer and inner fjords (Mortensen et al., 2018). Here we focus on the pan-shelf/coast distribution of water masses, their interaction, and links to proglacial fjords.

The west Greenland coastal system is part of a larger system consisting of Baffin Bay, Davis Strait, and the Labrador Sea. A hypothetical, but generally accepted, description of the large-scale circulation system in this region was provided more than a century ago (Nansen, 1912). The general distribution of water masses is set by two major currents: the West Greenland Current (WGC) and the Baffin Island Current (BIC). The WGC transports warm and saline water from the North Atlantic northward along the west Greenland continental slope. Variations in temperature of this water mass have been linked to variations in submarine melt rates of the Greenland Ice Sheet (Holland et al., 2008; Khazendar et al., 2019; Motyka et al., 2011; Rignot et al., 2010). The BIC transports cold and fresher water from the Arctic Ocean southward along the Baffin Island continental slope. It is the interactions between these two currents that determine the distribution of water masses within the region. The general description of the circulation system in Baffin Bay and Davis Strait is still disputable; it is largely supported by numerical models (Castro de la Guardia et al., 2015), but in situ observations are sparse (Cuny et al., 2005; Curry et al., 2014; Lin et al., 2018; Münchow et al., 2015; Myers

et al., 2009; Rykova et al., 2015; Tang et al., 2004) and especially systematic *synoptic* pan-shelf measurements are few (Fenty et al., 2016). To the latter the Oceans Melting Greenland program is underway with a larger data set covering the northwest and east coast. Consequently, a generally accepted nomenclature of water masses in the region is still missing, as is a thorough description of spatial water mass distribution on this scale (Addison, 1987; Båcle et al., 2002; Curry et al., 2011; Gladish et al., 2015; Guéguen et al., 2014; Mortensen, 2015; Tomczak & Godfred, 2004).

Here we present results from a near-synoptic survey of the pan-west Greenland coastal system from the continental slope to the entrance of fjords. Using conductivity-temperature-depth (CTD) profiles, we aim to describe the spatial distribution of water masses at the west Greenland continental shelf and slope and their link to proglacial fjords from Cape Farewell (59°N) to Melville Bay (75°N) during June to August 2016. This extensive data set allows us to address the origin of the different water masses in the region, and the warm regional water masses observed at the entrances to proglacial fjords. Besides being important for our understanding of the melt of the Greenland Ice Sheet, knowledge of the spatial distribution of water masses has major implications for our understanding of the marine coastal ecosystem in west Greenland.

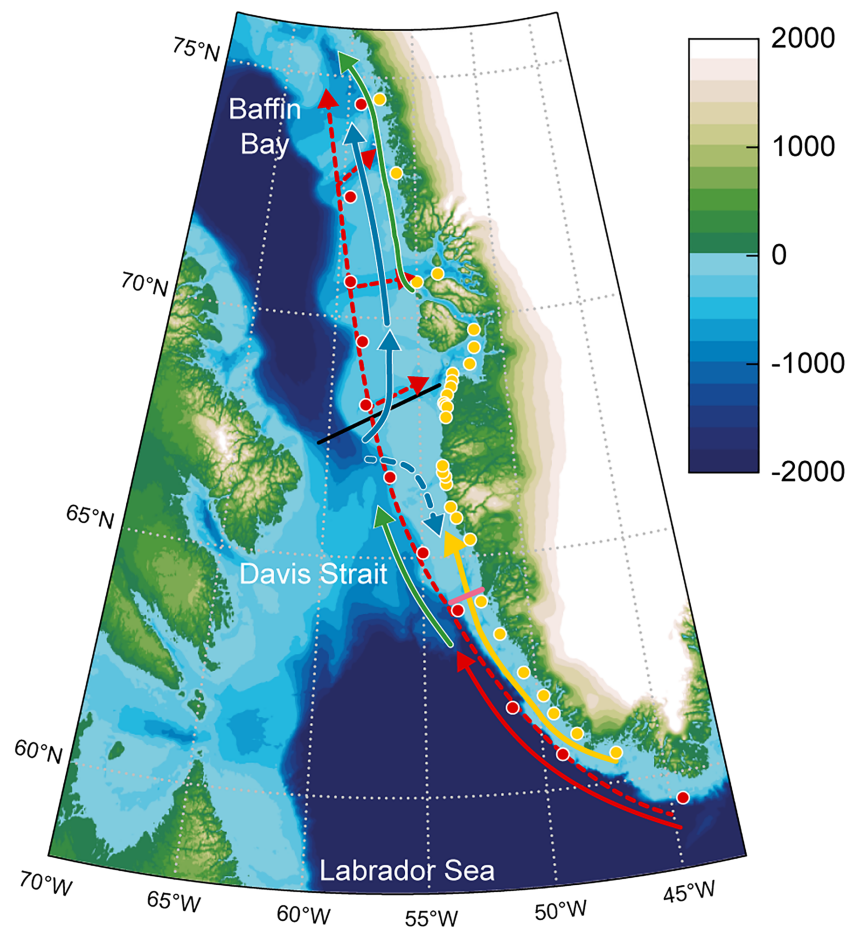
## 2. Study Area and Methodology

The west Greenland coastal system is bordered by the Labrador Sea, Davis Strait, and Baffin Bay (Figure 1). In Davis Strait a 350- to 500-m-deep sill separates deep waters of the Labrador Sea from Baffin Bay. The continental shelf system is ~50 km wide at 64°N but broadens to ~220 km in Baffin Bay north of 75°N. The bathymetry of west Greenland coastal areas is complex with numerous troughs and bank systems (An et al., 2019; Fenty et al., 2016; Morlighem et al., 2017). This complex bathymetry must be considered when investigating exchanges of water masses between the continental slope and fjords with marine-terminating glaciers.

We made hydrographic observations along two sections from Cape Farewell (59°N) to Melville Bay (75°N) in west Greenland (Figure 1): one on the continental slope (red dots) and one on the coast near the entrance of fjords (yellow dots). Between these sections we sampled a number of additional east-west oriented cross-shelf sections.

Temperature and salinity data were derived from vertical CTD profiles collected during 2016 from RV Pâmiut (Aasiaat 68°N to Upernavik 72°N; 10 June to 7 July), HDMS Tulugaq (Ilulisaat 69°N to Cape Farewell 59°N; 13–27 July), and RV Sanna (Ilulisaat 69°N to Kullorsuaq 75°N; 12–30 August). The continental slope and shelf data were obtained by the Greenland Institute of Natural Resource's standard hydrographic coastal monitoring program, whereas data collected near entrance of fjords were collected by a specially designed project executed in connection with the monitoring program. The majority of observations were collected within 1.5 month (10 June to 27 July 2016). By using a near-synoptic data set, we avoid the relatively large seasonal property variations, which have been observed by Curry et al. (2011) and Gladish et al. (2015) at discrete depths at a mooring section across Davis Strait at ~67°N. This makes the interpretation of water masses and their distribution easier. For this reason, we do not make use of the Oceans Melting Greenland program's data set occupied in September 2016. The May 2015 Fyllas Banke section data were obtained by the Greenland Ecosystem Monitoring Programme ([www.g-e-m.dk](http://www.g-e-m.dk)). The CTD profilers (SBE19plus) were calibrated by SeaBird before field-work and data was averaged for 1-m intervals.

We use a water type approach when describing the water masses in the region covered by the data set. This means that a water mass can be described as a single point in a temperature-salinity (*TS*) diagram. Thus, observations can be found in the water type or on the mixing line between neighboring water types, disregarding the surface layer, which is under the influence of the atmosphere. The exact properties of water masses are dynamic and may differ over time. Understanding these temporal changes and the distribution of water masses in the coastal system is important for understanding both the regional circulation system and potential heat sources for melting of the Greenland Ice Sheet. During this study, we make use of a water mass classification based on the generally accepted model by McCartney and Talley (1982) and Mortensen et al. (2011, 2018) which has been previously used in connection with



**Figure 1.** Study area showing Baffin Bay, Davis Strait, and the northern Labrador Sea between Canada and Greenland. Contours are in meters. Red dots show sampling stations on the continental slope, and yellow dots show sampling stations along the coast section during early summer 2016. Red lines show the distribution of warm upper Subpolar Mode Water (uSPMW) associated with the West Greenland Current. Dotted red lines show distribution of deep Subpolar Mode Water (dSPMW). Blue lines show the distribution of cold Baffin Bay Polar Water (BBPW). Broken blue line shows the southward transport of BBPW. Yellow line shows the distribution of Southwest Greenland Coastal Water (CW). Green lines show the distribution of “diluted water” see text for explanation. The black near horizontal line separates the northern and southern parts used in Figures 2 and 3. Pink line shows the location of the Fyllas Banke section at 64°N. The suggested circulation system in 2016 is indicated by arrowheads representative of early summer.

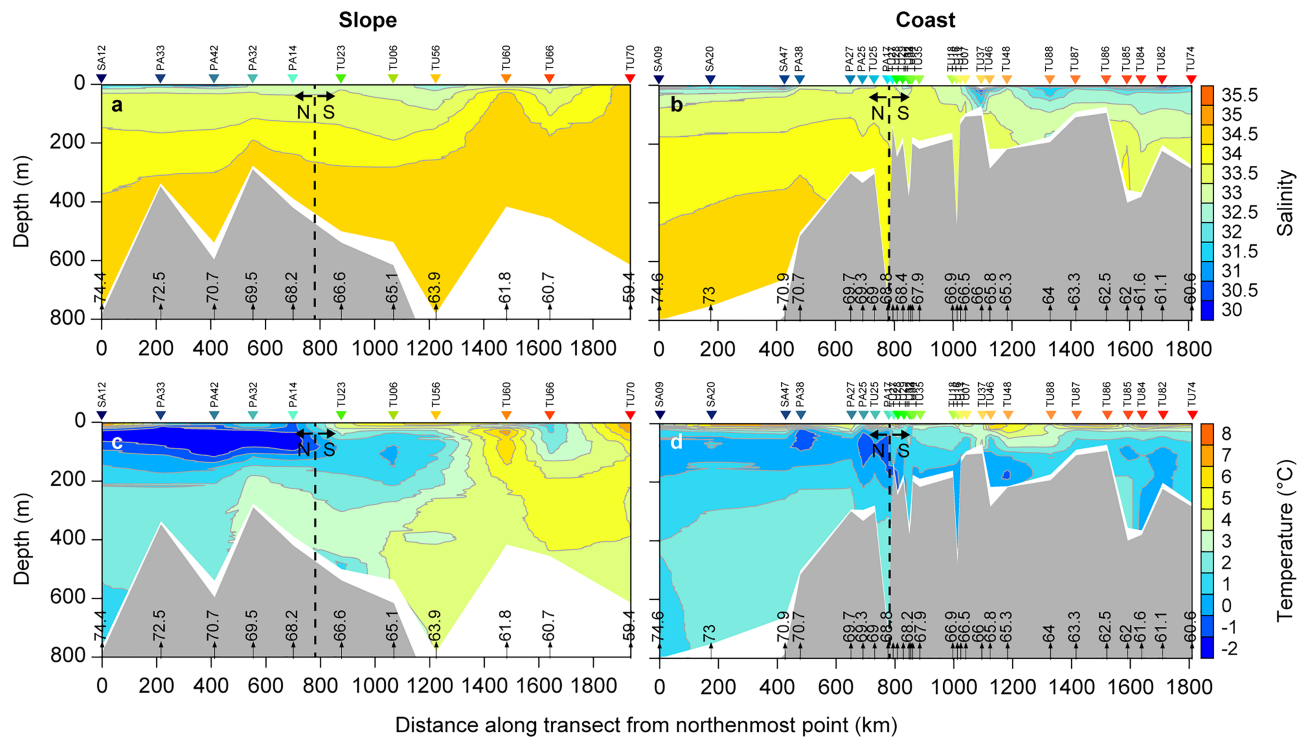
Southwest Greenland fjord studies and the Greenland Institute of Natural Resource's standard hydrographic coastal monitoring program (Mortensen, 2015).

### 3. Results and Discussion

Sectional distribution of temperature ( $T$ ) and salinity ( $S$ , practical salinity scale 1978) shows a marked difference between the hydrographic conditions at the continental slope section (hereafter referred to as slope section) and the section close to entrances of the fjords (hereafter coast section) (Figure 2). For addressing these differences we have performed a  $TS$  analysis (Figure 3), where we have separated the two sections into northern and southern parts. The slope section was divided at  $\sim 68^\circ\text{N}$  and the coast section at  $\sim 68.7^\circ\text{N}$ , a little north of the center of Davis Strait (shown with black line in Figure 1).

#### 3.1. Water Masses on the pan-West Greenland Continental Shelf

Using the above-mentioned water mass classification model, we identify three major water masses in the region: Baffin Bay Polar Water (BBPW), Southwest Greenland Coastal Water, hereafter referred to as Coastal Water (CW), and Subpolar Mode Water (SPMW).



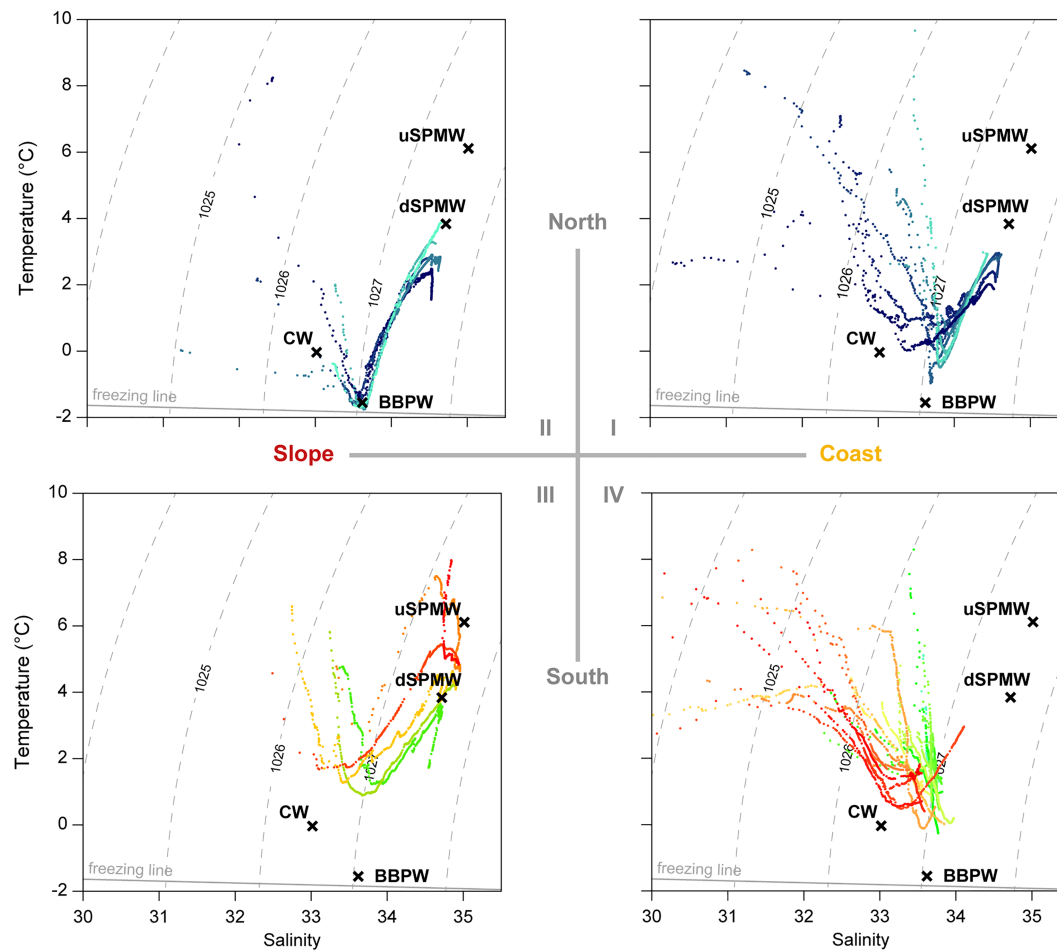
**Figure 2.** Sectional distribution of salinity and temperature along the slope (a, c) and coast (b, d) off west Greenland from Melville Bay (75°N) to Cape Farewell (59°N) from early summer 2016. Latitudes (°N) are provided on the x axis (bottom) and station names in the top of each panel. Colors of station match colors in Figure 3. The black vertical broken line separates the northern part (N) of our section from the southern part (S). Gray color indicates the bottom. White areas indicate data not available.

BBPW is a Baffin Bay winter mode water (i.e., formed by winter convection) found on the northern slope section with a temperature close to freezing point ( $\sim -1.8^{\circ}\text{C}$ ) and salinity close to 33.6. In the *TS* diagram it is observed as a characteristic “knee” (Figure 3, upper left). A diluted version of BBPW was found at the northern coast section and in the northern part of the southern coast section (Figure 3). The formation site of “knee” water (i.e., BBPW) is still unknown, and it may be linked to the BIC. “Knee” water has been observed in the North Water Polynya by both Addison (1987) and Bâcle et al. (2002), but there are presently no observations showing a link between the North Water Polynya and the southeastern part of Baffin Bay as early summer CTD observations from the Canadian side of Baffin Bay-Davis Strait are largely missing due to dense sea ice cover during that season. In the literature BBPW may be classified as or referred to as Polar Water, Polar Surface Water, Arctic Water, Baffin Bay Arctic Water, WGC Polar Water, or Arctic Basin Polar Water (e.g., Addison, 1987; Curry et al., 2011; Myers et al., 2009; Gladish et al., 2014; Lin et al., 2018).

CW enters the southern coast section at Cape Farewell ( $\sim 60^{\circ}\text{N}$ ) as part of the Greenland Coastal Current (Lin et al., 2018). Its *T* and *S* properties are around  $0^{\circ}\text{C}$  and 33, respectively (Figure 3, lower right). CW is the last stage of the transformation of Polar Surface Water, which leaves the Arctic Ocean through Fram Strait with the East Greenland Current. In the literature, CW has been referred to as Polar Water, Polar Surface Water, and deep Arctic-origin water (e.g., Lin et al., 2018; Myers et al., 2009; Ribergaard et al., 2004).

SPMW is a North Atlantic winter mode water that enters the southern slope section at Cape Farewell ( $\sim 59^{\circ}\text{N}$ ; Figure 3, lower left) and becomes an integrated part of the WGC. For the discussion below, we have subdivided SPMW into two classes: upper Subpolar Mode Water (uSPMW) and deep Subpolar Mode Water (dSPMW) (Lin et al., 2018). The warm and saline uSPMW with *T* and *S* properties close to  $6^{\circ}\text{C}$  and 35 is found in the upper part of the water column. dSPMW is colder and less saline than uSPMW and is found below. When dSPMW enters the northern slope section its *T* and *S* properties are close to  $4^{\circ}\text{C}$  and 34.7. In the literature, SPMW has been referred to as Atlantic Water, Atlantic-origin Water, Irminger Water, and West Greenland Irminger Water (e.g., Curry et al., 2011; Myers et al., 2009; Gladish et al., 2014; Lin et al., 2018).





**Figure 3.** Temperature-salinity (*TS*) plots for west Greenland waters during early summer 2016. (I) northern coast section, (II) northern slope section, (III) southern slope section, and (IV) southern coast section. For north-south division see Figure 1. Location of water types are indicated by crosses (x). Upper Subpolar Mode Water (uSPMW), deep Subpolar Mode Water (dSPMW), Baffin Bay Polar Water (BBPW), and Southwest Greenland Coastal Water (CW). Colors of sections match colors of station in Figure 2. Thin gray line indicates the freezing line at the surface (0 m) and thin broken gray lines indicate isopycnals.

The interactions of these three water masses shape the hydrographic conditions on the west Greenland continental shelf of which we focus on in three cases below.

### 3.2. The Regional Southern Freshwater Source

In the southern coast section, a thick layer of cold and fresh water overlain by a warmer seasonally heated surface layer is observed; it is identified as CW (Figures 2b, 2d, and 3). The freshwater carried by the CW has its origin in the East Greenland Current and in runoff from the Greenland Ice Sheet (Lin et al., 2018). In the southern coast section CW can be traced as far north as 65.3°N. Here, its northward progress is blocked by a colder and more saline water mass (Figures 2b and 2d), which we identify as diluted BBPW (Figure 3, lower right). The transition to diluted BBPW is seen as changes in the *TS*-curve shape that becomes more saline and vertical (Figure 3, lower right). The importance of the relatively shallow bathymetry of Davis Strait and especially the bathymetry of the southwest Greenland continental shelf in preventing the northward flow of CW is supported by a model study by Ribergaard et al. (2004) who finds residual anticyclonic eddies around Southwest Greenland shelf banks generated by tides and topography; see discussion below.

In the southern slope section, CW is observed in a diluted form between ~64°N and ~67°N (Figures 2a, 2c, and 3). Similar to the coast section, the northward extension of diluted CW is prevented by BBPW. Consequently, no trace of CW is seen north of Davis Strait (Figure 3). This may lead to an accumulation of CW on the continental shelf and explain the existence of a relatively thick layer of CW observed in the

southern part of the coast section (Figures 2b and 2d). Some of the CW potentially leaves the areas with Irminger rings, that is, warm-core anticyclones shed by the WGC off west Greenland (De Jong et al., 2016). The feature observed on the slope at 60.7°N may be part of one of these rings in the process of leaving the WGC (Figures 2a and 2c). Previously, the area on the slope section around 61–62°N has been identified as a formation site of Irminger rings (de Jong et al., 2016).

We note that previously proposed water mass classification models (e.g., Cuny et al., 2002; Cuny et al., 2005; Curry et al., 2011; Gladish et al., 2015; Myers et al., 2009) cannot distinguish between the regional southern freshwater sources (i.e., CW) and BBPW contributing to the west Greenland coastal system. These classification models are all based on data sets obtained on a local scale and not on a pan-west Greenland coastal scale like the current study. Furthermore, many of the previous models have data boundaries, which coincide with the current study's north-south division line (Figure 1), being the division line between BBPW and CW observed in the current study. For example, the north-south division line coincides with the mooring array used by Cuny et al. (2005), Curry et al. (2011) and Gladish et al. (2015) in their classification models or with the northern data limit in the classification models of Cuny et al. (2002) and Myers et al. (2009).

### 3.3. The Regional Heat Source for Melting Glaciers

Warm subsurface SPMW has been observed as a regional heat source for melting glaciers (Holland et al., 2008). In the southern slope section we observe the presence of a thick layer (0–600 m) of warm and saline water (Figures 2a and 2c), which is identified as uSPMW and dSPMW (Figure 3, lower left). SPMW is transported northward as part of the WGC (Lin et al., 2018). As SPMW reaches 64°N it is joined by CW in the upper 200 m of the water column (Figures 2a and 2c) resulting in a distinct temperature and salinity decrease. The interaction between uSPMW and CW gives rise to strong mixing of both water masses (Figure 3, lower left). As a result, uSPMW is not observed north of Davis Strait (Figures 2 and 3). Only dSPMW continues northward at depth as observed by a tongue of warmer water crossing the Davis Strait and entering the Baffin Bay with a temperature close to 4 °C and salinity of 34.7 (Figure 2c).

A view that claims that warm SPMW subducts the cold CW after rounding Cape Farewell has developed in the WGC literature over the years (e.g., Jakobsen et al., 2003; Myers et al., 2009). This subduction hypothesis has not yet been unambiguously proven. However, our data set, though limited in time, supports a hypothesis of strong mixing of uSPMW and CW instead of subduction (Figures 2a and 2c and Figure 3, lower left), the warm water that continues northward at depth being dSPMW.

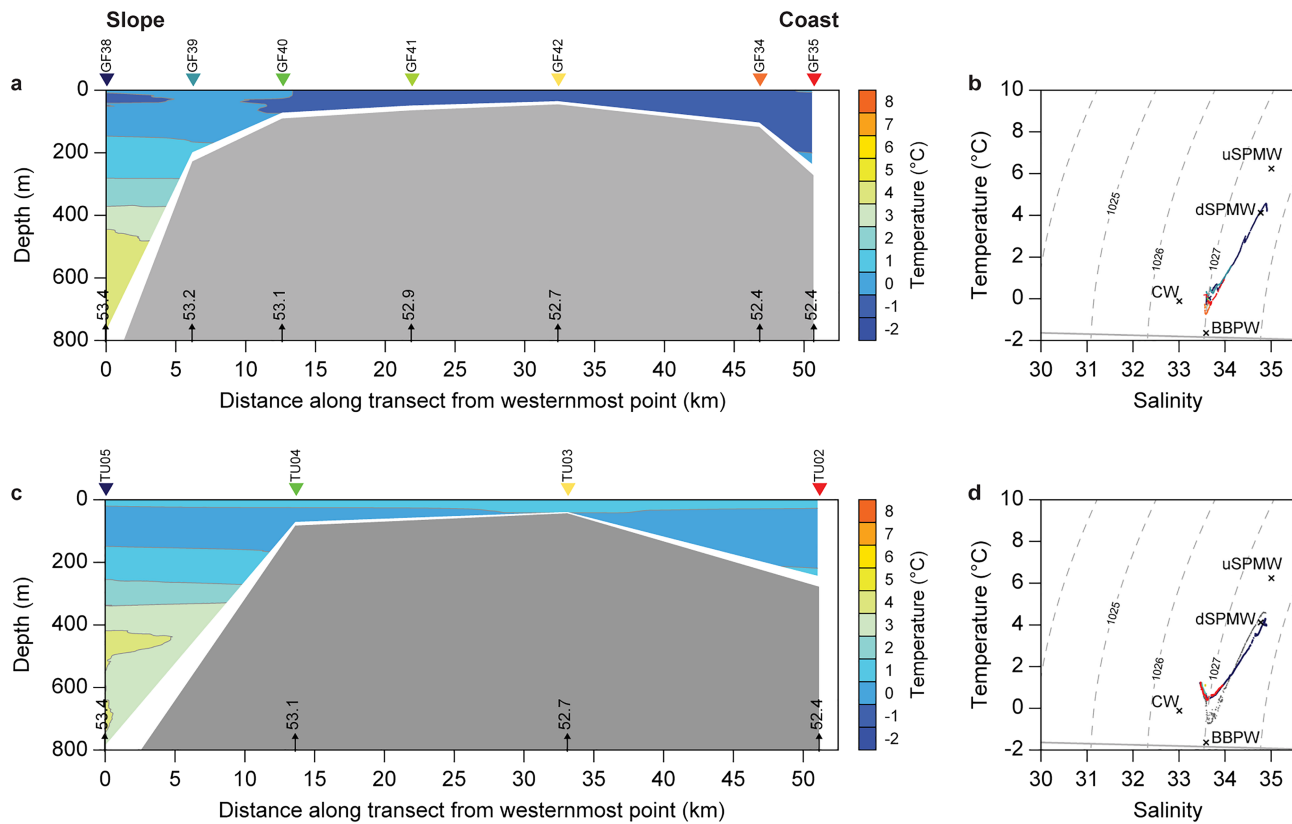
If SPMW is an important regional heat source for glacial melt, the question arises if SPMW is only present on the slope section or if it can also be observed at the coast section. Our data suggest that a distinction should be made between the northern and southern sections (Figures 2 and 3).

SPMW is rarely observed at the coast in the southern section, yet dSPMW is frequently found in the northern coast section (Figure 3, upper right). This suggests that north of Davis Strait (~68°N), dSPMW from the slope can reach entrances of deep silled fjords on the coast almost unobstructed (e.g., Upernavik Icefjord and Uummannaq Fjord). The presence of deeper troughs (>300-m depth) in the northern section allows dSPMW to transit through deep connections across the continental shelf-trough-system (An et al., 2019; Arndt et al., 2015; Morlighem et al., 2017; Walker et al., 2007).

Yet, south of Davis Strait, a thick layer of cold and relatively fresh CW seems to block the free exchange of uSPMW between the slope and coast. Furthermore, troughs in this region are generally shallow (<300-m depth), which makes it difficult for dSPMW to find a pathway through the continental shelf. This observation is confirmed by a recent study from Godthåbsfjord, which highlights that CW seasonally restricts SPMW from entering the fjord (Mortensen et al., 2018). This may be a general feature of the southern Greenland fjords.

### 3.4. A Seasonal Southward Coastal Current?

In the early summer of 2016, pure BBPW was found only at the slope section with the southern limit at around 67.5°N (Figure 2c), whereas diluted BBPW was found along the entire coast section as far south as 65.3°N (Figure 3). This raises the question of whether BBPW could also be transported further southward. The existence of this transport is supported by CTD measurements occupied in 2015 along a shelf cross section (known as the “Fyllas Banke section” at 64°N, Figure 1). Water properties observed in May suggest the

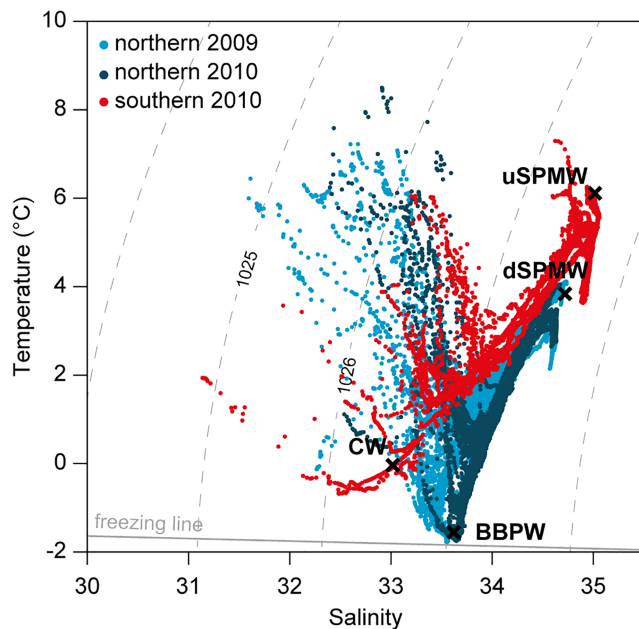


**Figure 4.** Temperature and temperature-salinity (*TS*) plot for the cross-shelf section at  $\sim 64^\circ\text{N}$  (Fyllas Banke section) from May 2015 (a, b) and June 2015 (c, d) with the continental slope to the left and coast to the right in (a, c). Longitudes ( $^\circ\text{W}$ ) are provided on the x axis (bottom) and station names in the top of each panel. Also shown in gray in (d) are two slope station profiles ( $\sim 65^\circ\text{N}$  and  $\sim 66^\circ\text{N}$ ) from June 2015. Location of water types are indicated by crosses (x). Upper Subpolar Mode Water (uSPMW), deep Subpolar Mode Water (dSPMW), Baffin Bay Polar Water (BBPW), and Southwest Greenland Coastal Water (CW). Colors of section stations match colors in *TS* plot. Gray color indicates the bottom and white areas data not available in (a, c). Thin gray line indicates the freezing line at the surface (0 m), and thin broken gray lines indicate isopycnals in (b, d).

presence of diluted BBPW (Figures 4a and 4b), while one month later, in June, no trace of diluted BBPW was found (Figures 4c and 4d). However, diluted BBPW was observed at a slope station further north at  $65^\circ\text{N}$  (Figure 4d). This suggests that diluted BBPW, seasonally at least, is met as far south as  $\sim 65^\circ\text{N}$  close to the coast in June/July and in some years even as far south as  $64^\circ\text{N}$  in May.

The question is now what brings BBPW from Davis Strait up to 500 km southward along the west Greenland continental shelf? We rule out that CW is transformed into BBPW or diluted BBPW during winter by cooling because CW is too fresh and warm. Local winter cooling along Southwest Greenland might create a thin sea ice layer during a limited period, but it will rapidly melt again due to the heat capacity of the water column. This will result in no salinity increase but a temperature decrease. Therefore, we assume that a southward transport of diluted BBPW takes place on the west Greenland continental shelf south of Davis Strait. As the biggest volume of diluted BBPW is observed on the coast side of Fyllas Banke (Figure 4a), the southward transport likely takes place in troughs associated with the inner part of the bank system south of Davis Strait. Our data set shows that the presence of diluted BBPW at  $\sim 65^\circ\text{N}$  may be seasonal, whereas presence of diluted BBPW at Fyllas Banke  $\sim 64^\circ\text{N}$  may be less frequent.

A model study by Ribergaard et al. (2004) supports a southward coastal transport. The authors find that residual anticyclonic eddies are generated around Southwest Greenland shelf banks north of  $64^\circ\text{N}$  and argue that eddies are consistently observed and are the result of interaction between topography and tides. However, the authors do not notice subtle contrasts in water masses indicating the southward spreading of BBPW along the southwest coast off Greenland and do not make the link that the bank systems north of  $64^\circ\text{N}$  act as a conveyor belt bringing BBPW southward along the southwest coast. The presence of the



**Figure 5.** Temperature-salinity (TS) plots for west Greenland waters during early summer 2009 and 2010. The 2010 data have been divided into northern (dark blue points) and southern (red points) parts, whereas only northern (light blue points) data are shown for 2009. For north-south division see Figure 1. Location of water types are indicated by crosses (x). Upper Subpolar Mode Water (uSPMW), deep Subpolar Mode Water (dSPMW), Baffin Bay Polar Water (BBPW), and Southwest Greenland Coastal Water (CW). Thin gray line indicates the freezing line at the surface (0 m), and thin broken gray lines indicate isopycnals.

southward coastal current also potentially facilitates spreading of sea ice during cold winters as far south as 64°N against a current as swift as the WGC. Furthermore, this southward spreading of cold water can have large implication on the west Greenland ecosystems. For example, the southward spreading of BBPW in 2015 may explain the observed change in biomass distribution of the northern shrimp (*Pandalus borealis*) on the Southwest Greenland coast compared to most recent years (Burmeister & Rigét, 2018).

### 3.5. Interannual Variation

Based on data from 2016, three major water masses were identified as dominating the west Greenland shelf area. The spatial extent of the data is large, but its temporal scale is limited, so the question is whether this is a persistent feature on a longer time scale. Figure 5 shows hydrographic data obtained by the Greenland Institute of Natural Resource's standard hydrographic coastal monitoring program cruises at the west Greenland coast in June/July 2009 and 2010. Using the above north-south division and water types as in Figures 1 and 3, it is clear from Figure 5 that the 2009 and 2010 do not differ much from the description given above and that the three water masses used in the present study are persistent in time. The only difference is that BBPW (the “knee” water) was less saline in 2009 compared to 2010 and 2016. We note that diluted BBPW was not observed at the southwest coast in 2010. Instead, the observations in 2009 and 2010 show that BBPW (the “knee” water) is a persistent water mass along the northwest coast off Greenland.

Gladish et al. (2015) have previously proposed a link between the BIC and the west Greenland coast. The spreading of BIC waters (Baffin Bay Arctic water of Gladish et al. (2015) is a water mass significantly fresher than BBPW) in 2010 over the west Greenland shelf likely gave

rise to waters with distinct low temperatures filling Ilulissat Icefjord basin waters in 2010. In Figure 5 we do not observe a flooding of the entire west Greenland shelf by BIC waters in 2010; not even BBPW was observed at the southwest coast in 2010 and strangely BBPW was less saline in 2009 than in 2010. Using our findings above, another explanation might be that the lack of BBPW on the Southwest Greenland coast in 2010 explain an increased accumulation of BBPW on the Northwest Greenland coast and in Disko Bay in the absence of seasonal southward transport of BBPW, giving rise to distinct low temperatures in Ilulissat Icefjord basin waters. Contrary to this, Godthåbsfjord experienced distinct high temperatures in 2010 (Mortensen et al., 2018). Where Khazendar et al. (2019) attribute cooling of the regional heat source (i.e., dSPMW) to a slowdown and thickening of Jakobshavn Isbrae in Disko Bay, our observations suggest that a more voluminous BBPW in Disko Bay may be responsible for the cooling by squeezing dSPMW to a deeper depth range.

The seasonal southward coastal current may help explain how the signal from a Great Salinity Anomaly can pass the Fyllas Banke section at 64°N at an early stage (Belkin et al., 1998; Dickson et al., 1988). During Great Salinity Anomalies minimum salinity (and temperature) in the time series were first observed at the Fyllas Banke section (similar to Figure 4). This event has been linked to advection of a fresh (and cold) anomaly along major ocean currents around the northern North Atlantic. The Great Salinity Anomaly of the 1980s was observed to pass through the Canadian Archipelago. The fact that this feature is first observed at Fyllas Banke could potentially be explained by the above described southward link/current between the Baffin Bay and the Southwest Greenland coast.

It is important to have a more thorough understanding of the seasonal and interannual cycle of this southward coastal current and the distribution of water mass in the entire Baffin Bay and Davis Strait region in order to improve our future knowledge of the dynamics behind a Great Salinity Anomaly (Belkin et al., 1998; Dickson et al., 1988) and melt of the Greenland Ice Sheet.



The importance of understanding the distribution of coastal water types/water masses should be viewed in the light that, in many but not all fjords, the ambient waters close to marine-terminating glaciers to some degree reflect the coastal conditions (Fenty et al., 2016).

## 4. Conclusions

When analyzing data from the first comprehensive near-synoptic hydrographic survey in early summer of 2016 along the west Greenland coastal system, we used a water mass classification model, which can distinguish between the regional southern freshwater source and Arctic waters found in Baffin Bay. We identified three major water masses: SPMW, BBPW, and Southwest Greenland CW. The interplay between these three water masses shapes the dynamics of the west Greenland coastal system. Temperature changes on the shelf can consequently be related to both changes in water mass distribution and advection. Our data show a distinct north-south division but also a division between the slope and coast sections. In Figure 1 we have schematically summarized some of our results.

BBPW is observed to block the northward transport of freshwater associated with the regional southern freshwater source that originates in the East Greenland Current rounding Cape Farewell and runoff from the Southwest Greenland coast (i.e., CW). Consequently, no trace of southern freshwater is observed in Baffin Bay. The regional heat source (SPMW) transported by the WGC and its link to glaciers seem blocked by CW and diluted BBPW in the south but the open deep pathways in the north allow dSPMW to enter fjords.

We find evidence of the existence of an undescribed southward coastal current in connection with the west Greenland coastal system south of Davis Strait. The current causes Arctic waters with origin in the Baffin Bay (i.e., BBPW) to be observed as far south as 64°N on the west Greenland continental shelf. The southward current is likely associated with the inner part of the bank/shelf system south of Davis Strait.

Increased seasonal large-scale and synoptic observational efforts are essential for increasing our knowledge of the seasonal west Greenland coastal system, which has important implications for the ongoing melting of the Greenland Ice Sheet and its impact on the marine ecosystems in the region.

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