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The Atlantification process in Svalbard: a broad view from the SIOS Marine Infrastructure network (ARiS)

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1. Introduction

The Arctic marine systems represent some of the most unique and critical components of the Earth's ecological and climatic framework. The Arctic Ocean and adjacent seas are characterised by extreme seasonal variability and have vast areas of sea ice that significantly influence global weather patterns and ocean currents. The biodiversity in these marine environments is specially adapted to freezing temperatures, limited sunlight in the winter months, and high nutrient abundance during the summer melting period (CAFF 2013). The Arctic marine systems are threatened by climate change to an unprecedented extent. The Arctic, and particularly the Svalbard Archipelago, is affected by the phenomenon known as "Atlantification", a process associated with the increasing influence of Atlantic Water (AW) in the Arctic seas and fjords (Polyakov et al. 2017; Skogseth et al. 2020; Årthun et al. 2021; De Rovere et al. 2022; Vivier et al. 2023). The fjords are highly affected by Atlantification, because of specific atmospheric–oceanic–topographic interaction processes that control the intrusion of AW into the fjords of West Svalbard (Cottier et al. 2007; Nilsen et al. 2016). Together with rising air temperatures, the inflow of warm AW accelerates the loss of sea ice and glaciers (Luckman et al. 2015; Muckenhuber et al. 2016; Holmes et al. 2019). The inflow of AW and declining ice cover not only affects local ecosystems (Payne and Roesler 2019; Hopwood et al. 2020; Jones et al. 2021; Weydmann-Zwolicka et al. 2021), but also has far-reaching consequences for global sea levels and climate (Ingvaldsen et al. 2021; Tsubouchi et al. 2021; Polyakov et al. 2023). A highly valuable way to detect, observe and understand even small changes in the ocean and regional seas is through long-term observatories, i.e., marine infrastructures that ensure the collection of sufficiently long data series with adequate temporal resolution to resolve ocean processes from daily to multi-year scale. Svalbard's unique location, combined with its relatively easily accessible infrastructure, makes it an ideal location for studying the ongoing changes and their impacts on the Arctic environment. The Svalbard SIOS Marine infrastructure is of central importance for monitoring short- and long-term marine processes in the fjords and in the coastal areas around Svalbard. The marine observatories in the Svalbard Archipelago are strategically located (Figure 1) to obtain continuous observations of sea temperature, salinity, current, and biogeochemical properties to understand the complex interactions between the ocean, ice, and atmosphere in this rapidly changing region on seasonal, interannual, and decadal time scales. Research studies conducted through the Svalbard Marine Observatories contribute to global climate modelling, improve the prediction of sea level rise and feedback caused by long-term climatic changes, and provide information for conservation strategies for endangered Arctic species. In addition, the data collected will support international efforts to mitigate the effects of climate change and ensure sustainable management of Arctic resources by providing scientific evidence of environmental change and background information on the need for action by policy makers.

2. Data analysis and overview

This SESS Report chapter focuses on time series obtained from fixed observing systems anchored in fjords, on the shelf and slopes around the Svalbard archipelago. Here, we present a combined spatial and temporal analysis of the long-term oceanographic data series coming from the SIOS Marine Infrastructure network including seasonal, interannual, and decadal variations detected at each observatory. The chapter emphasises signal variability related to the intrusion and northward propagation of AW. Data integration and time series analysis is supported by and is relevant to several national and international projects/initiatives, such as the Arctic PASSION and the A-DBO[1], NorEMSO[2], RAW[3], opKROP[4], and ATTRACTION.

2.1. Methods

Here we present the most comprehensive overview of long-term mooring data from Svalbard waters to date, with standardised analysis on both published and unpublished data. Locations of the moorings are marked as coloured dots in Figure 1 (see also Table 1). We use conservative temperature (T, °C) and absolute salinity (S_A, g/kg). Daily and monthly means were calculated from the original data (e.g., temporal resolution up to 1 h). Multi-year averages (with linear trends) were calculated from monthly mean data. The "climatological" monthly average (for time series longer than 5 years) was also calculated, considering all the data collected within the same months for the entire time series. Note that here we use the term "climatological" even though it does not refer to a period of at least 30 years. For the available datasets, monthly means, monthly "climatological" mean, long-term means, and linear trends were calculated from the T and S_A. The proportions of AW and Transformed Atlantic Water (TAW) were determined in each time series as the days of the year when these water masses were present (reported in Figures 2b, 3b). AW is defined as S_A>35.07 g/kg, T > 3°C for all time series except those recorded in the northernmost part of Svalbard (A-TWAIN and Rijpfjorden), where T > 2°C and potential density (σ_θ) in the range 27.7-27.97 kg/m^3 was used. TAW is defined as S_A > 34.87 g/kg and T > 1°C, according to Sundfjord et al. (2017), Tverberg et al. (2019), Skogseth et al. (2020), De Rovere et al. (2022), and Renner et al. (2023). For time series at S1 (1000 m depth) we defined AW with T ≥ -0.5°C. To avoid seasonal effects of surface warming and freshening in the A-TWAIN, Rjipfjorden, Kongsfjorden Mouth and Mid, and Isfjorden time series, T and S_A were interpolated to discrete depths and then depth-averaged starting from 50 m.

2.1.1. Hornsund fjord (HS)

Year-round T and S_A data are available from shallow (10-25 m) coastal waters in Hornsund fjord. The instruments have been deployed 0.5 m above bottom. T data starts from June 2014 and S_A data from June 2017 onward (excluding part of years 2021-2022). The deployment location has not been fixed and varies somewhat from year to year (approx. location of HS in Figure 1). Most of the measurements are from the northern side of the fjord near the fjord opening, but between January 2021 and July 2022, T is only available from the southern side. For the periods when observations from both sides are available (Jun 2016–May 2017 for T, Jun 2018–Jan 2021 and Sep 2022–May 2023 for both T and S_A), the data show practically no variability between locations, and therefore it was decided to combine all data available from Hornsund into one timeseries.

2.1.2. NorEMSO (The Norwegian node for the European Multidisciplinary Seafloor and water column Observatory) Observatory at South Cape (SC)

An observatory known as the K-Lander (Dølven et al. 2022) has been deployed on the continental shelf southeast Sørkapp, the South Cape of Spitsbergen (76.1070°N,15.9680°E, SC in Figure 1), at around 380 m water depth from 14 April 2022 to 20 April 2023 with the main aim to monitor the release of a major submarine methane eruption (Serov et al. 2017). The K-Lander, a trawl-proof observatory with a diameter of 3.6 m and a height of 1.6 m, measured T, S_A, pH and oxygen at about 1 m above the seafloor. Conductivity–temperature–depth (CTD) casts were conducted immediately before deployment and recovery to ensure quality control.

2.1.3. Deep observatory offshore southwest Svalbard (S1)

The oceanographic mooring S1, located at 76° N and 14° E (S1 in Figure 1), at 1040 m depth on the continental slope west of Svalbard, has

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[1] https://arcticpassion.eu/adbo/
[2] https://www.uib.no/en/noremso
[3] https://raw-grieg.igf.edu.pl/
[4] https://www.mare-incognitum.no/opkrop/

been operating since mid-June 2014. Yearly time series data of T and S_A are obtained after annual maintenance. Data are processed and quality checked by comparing them to calibrated CTD profiles collected before and after each yearly mooring deployment and uploaded to the Italian Arctic Data Centre. The time resolution of the time series is 60 minutes. The data presented here covers the period from 9 June 2014 to 22 June 2023.

2.1.4. Isfjorden moorings

Three different oceanographic moorings were positioned in the mouth and entrance area of Isfjorden over the years to make robust analyses of variability and trends in the AW circulating in the trough and fjord system (Skogseth et al. 2020). The first was placed on the southern slope of the Isfjorden Trough outside the fjord mouth (Isfjorden Mouth in Figure 1). The second was placed inside of the entrance of the fjord also on the southern side (Isfjorden in Figure 1). The third was positioned on the northern slope (Isfjorden North in Figure 1), opposite to the Isfjorden Mouth mooring. Yearly T and S_A from evenly distributed depths have been recorded since September 2005 until present and are still being recorded at the Isfjorden Mouth and Isfjorden moorings, with the Isfjorden Mouth mooring being the longest in operation. The resolution of the time series is 20-60 minutes. Data are published following FAIR principles (Wilkison et al. 2016) at the Norwegian Polar Institute Data Centre (NPDC), available from the SIOS Data Management System.

2.1.5. Prins Karls Forland observatory (PKF)

The K-Lander was deployed around 78.6 °N, 10.14 °E (PK Forland in Figure 1) from June 2015 to May 2016 (Dølven et al. 2022) and from October 2016 to July 2017 to monitor methane release and the influence of oceanic parameters. The instruments were sent for maintenance and calibration between the two deployments. CTD casts were conducted immediately before deployment and recoveries to ensure quality control and to correct any drifts in the time series.

2.1.6. Kongsfjorden moorings

UiT/SAMS observatory at the mouth of Kongsfjorden Svalbard (KF Mouth)

The oceanographic mooring KF Mouth is located at approx. 78.96 °N 11.8 °E in Kongsfjorden, in a water depth of ~225 metres and has been active since September 2002 (Kongsfjorden Mouth in Figure 1). In 2002 and 2003, the mooring was located about 10 km west of its current location at 79.05 °N 11.28 °E. Year-long T and S_A data from evenly distributed depths are obtained after annual maintenance.

IndARC mooring in mid Kongsfjorden (KF Mid)

IndARC (Indian Arctic) mooring was first deployed in the central part of Kongsfjorden at 78.94 °N and 12.01 °E in July 2014 at a bottom depth of ~198 m (Kongsfjorden Mid in Figure 1), with minimal variations in sensor locations/depths and measuring data from ~20 m below the water surface. The mooring has been deployed and recovered annually in the first three deployments. In the last two mooring deployments, it was recovered after two years of data recording. T and S_A have been recorded at five to six evenly distributed depths at an hourly resolution. CTD casts were carried out near the mooring site for quality control.

MDI mooring in inner Kongsfjorden (KF Inner)

MDI (mooring *Dirigibile Italia*) was deployed in September 2010 at 78.914 °N and 12.246 °E (Kongsfjorden, KF Inner in Figure 1) at a depth of 104 m. The mooring is 73 m long, and T and S_A have been recorded almost continuously since 2010 at 85 and 30-35 m (nominal depths). Data is downloaded during periodical maintenance, quality controlled with the spike test and gradient test according to the procedures proposed by SeaDataNet and the Global Ocean Observing System and uploaded to the Italian Arctic Data Centre.

2.1.7. Rijpfjorden mooring (RF)

The Rijpfjorden mooring (Figure 1) was established in summer 2006. The mooring is in the northern part of the fjord at a depth of 230 m, at 80.28 °N, 22.28 °E. The instrumentation used in Rijpfjorden is consistent with that used in Kongsfjorden (KF Mouth). T and S_A data cover the water column for the entire period apart from 2008–2009, when heavy ice conditions made deployment impossible.

2.1.8. Northeast Svalbard moorings: A-TWAIN

A mooring array deployed northeast of Svalbard over the upper part of the continental slope (north of Kvitøya, A-TWAIN in Figure 1) towards the Nansen Basin is part of the project "Long-term variability and trends in the AW inflow region" (A-TWAIN) (Lundesgaard et al. 2021, 2022; Renner et al. 2018, 2023). Measurements started in 2012 at two moorings, positioned over the 200 m isobath (A200) and 800 m isobath (A800). In this chapter we refer to the longest time series, A200, which runs from September 2012 to November 2019 and from November 2021 to October 2022.

2.2. Results: time series from marine observatories

2.2.1. Monthly climatology

The monthly climatological data obtained from the time series at the SIOS Marine Infrastructure (Figure 1) offer a valuable perspective for comparing local thermohaline variability at each location. They also allow valuable insights of the spatial propagation of the warm and salty AW west of Spitsbergen, towards the Arctic Ocean north of Spitsbergen and into individual fjord systems on the way. We acknowledge that the climatology can be highly influenced by the chosen infrastructure location, and that some of the marine infrastructures do not cover the whole water column. However, we have found a set of marine time series that can clearly show the Atlantification of the Svalbard region during the last two decades, and in addition, can provide precious data to investigate the AW propagation and its interaction processes with the continental slope–shelf–fjord system. In summer, the climatological maximum T in Kongsfjorden is found in October (Figure 1) and therefore delayed by one month compared to (depth-average data) Isfjorden, and two months compared to (surface data) Hornsund. Maximum T is found in October/November in Rijpfjorden and at the A-TWAIN mooring northeast of Svalbard and depth-averaged T at A-TWAIN is 1°C lower compared to Isfjorden and Kongsfjorden. The climatological minimum T is found in March/April for all shelf/fjord systems along the West Spitsbergen Shelf (WSS), while the S1 and A-TWAIN moorings have their minimum T in June (Renner et al. 2018; Bensi et al. 2019). At the S1 and A-TWAIN moorings, the seasonal signal in both T and S_A is dominated by the seasonal cycle in advected AW, with maximum influence in October/November when the West Spitsbergen Current (WSC) and Svalbard Branch (SB, Figure 1) are in their strongest phase and T and S_A signals are highest north of Svalbard (Lundesgaard et al. 2022). The seasonal cycle in S_A at the Isfjorden Mouth is more influenced by the fresher Spitsbergen Polar Current (SPC), especially during fall. In winter and spring (January–May) the interplay between the SPC and the Spitsbergen Through Current (STC) determines the interannual S_A variations. However, the maximum S_A at Isfjorden Mouth is found in March due to the strong STC during winter (Skogseth et al. 2020), driven by the strong and frequent winter storms across Svalbard (Cottier et al. 2007; Nilsen et al. 2016). According to Nilsen et al. (2016), the maximum S_A signal is advected northwards by the STC to the Kongsfjorden mouth, passing the PK Forland observatory (Figure 1), with a reduced S_A one month later, in April. The Kongsfjorden Inner seems to be less affected by the SPC since S_A stays close to the same level after the maximum in April but with a local maximum in September due to the increased exchange of AW between the shelf and Kongsfjorden (Cottier et al. 2007; De Rovere et al. 2022). In contrast, at the deep site S1 south of Svalbard, the greatest impact of AW intrusions occurs during the winter season (December–January) as a result of vertical mixing caused by the passage of internal waves along the western margin of Svalbard (Bensi et al. 2019).

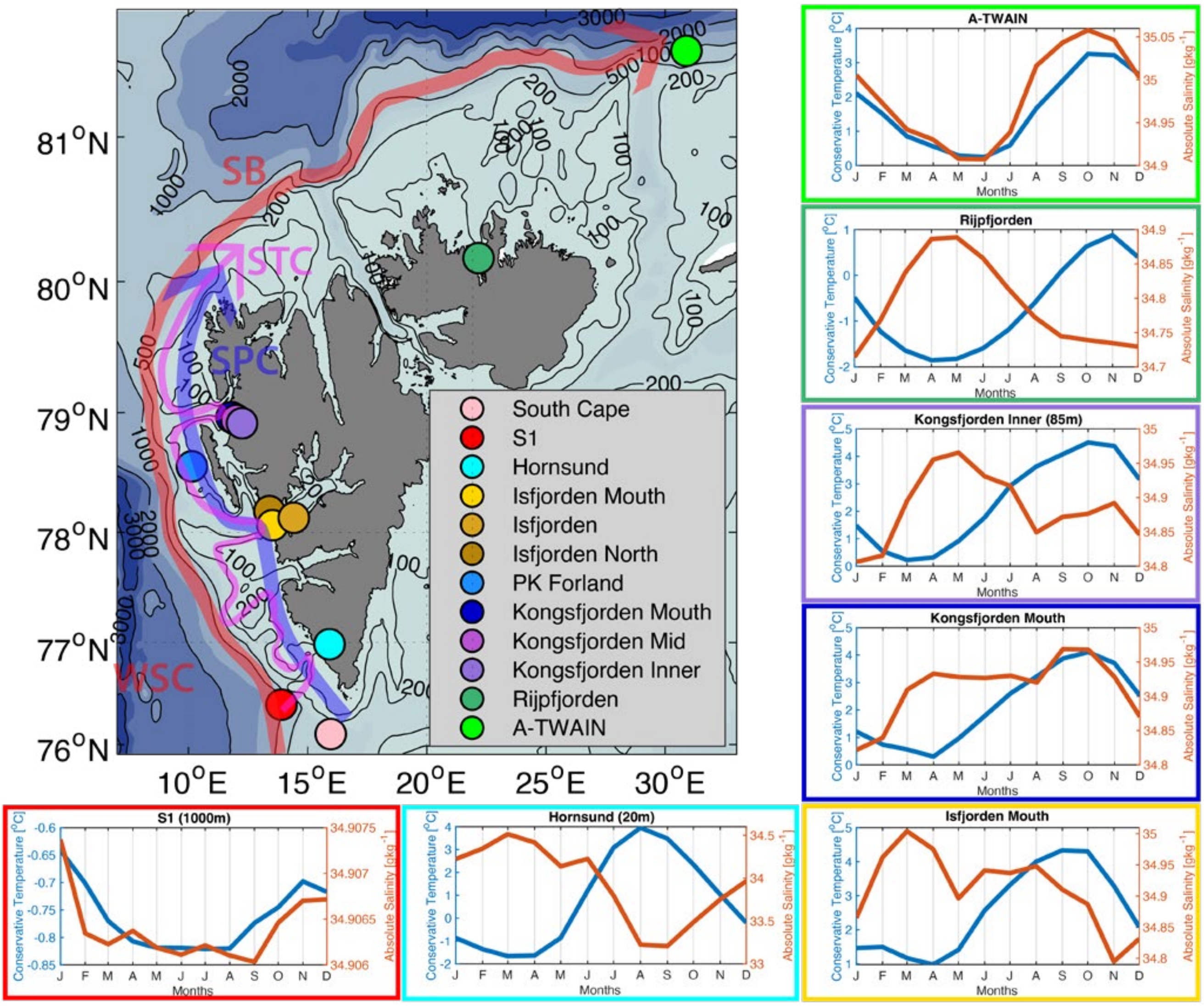

Figure 1: The position of all SIOS Marine Infrastructures described and analysed in this report with illustration of the dominating current systems influencing the West Spitsbergen Shelf, the fjord systems in Svalbard and the shelf north of Svalbard. Monthly climatology of Conservative Temperature and Absolute Salinity are presented for marine infrastructure with a time series longer than five years. Climatology is calculated from depth-averaged time series starting from 50 m and deeper if no specific depth is indicated in the title. Note that the scales differ. WSC: West Spitsbergen Current; STC: Spitsbergen Through Current; SPC: Spitsbergen Polar Current; SB: Svalbard Branch.

2.2.2. Multi-year variability

We analysed the time series of monthly mean data from the offshore marine systems (Figure 2) merged with the model output from Copernicus Arctic Ocean Physics Reanalysis (CMEMS, Arctic Ocean Physics Reanalysis, product ID ARCTIC_MULTIYEAR_PHY_002_003, monthly average[5]) to get an overview of what the fixed observatories are recording with respect to the upstream signals. The long-term thermohaline variability, expressed by the CMEMS time series at 200 m depth, shows both the seasonal signal and the long-term variability. The latter reveals a slight increase (+ 0.8°C) in T from 2002 to 2022, while S_A shows two phases: an increasing phase until around 2012–2013 and a subsequent decrease, more pronounced after 2018. This freshening phase could be related to a delayed effect of the freshwater anomaly of the subpolar regions of the North Atlantic, whose signal is shifted to the high latitudes by the subpolar gyre (Holliday et al. 2020, Figures 2 and 3). The annual and seasonal variations appear to be quite consistent across the four observing systems. The

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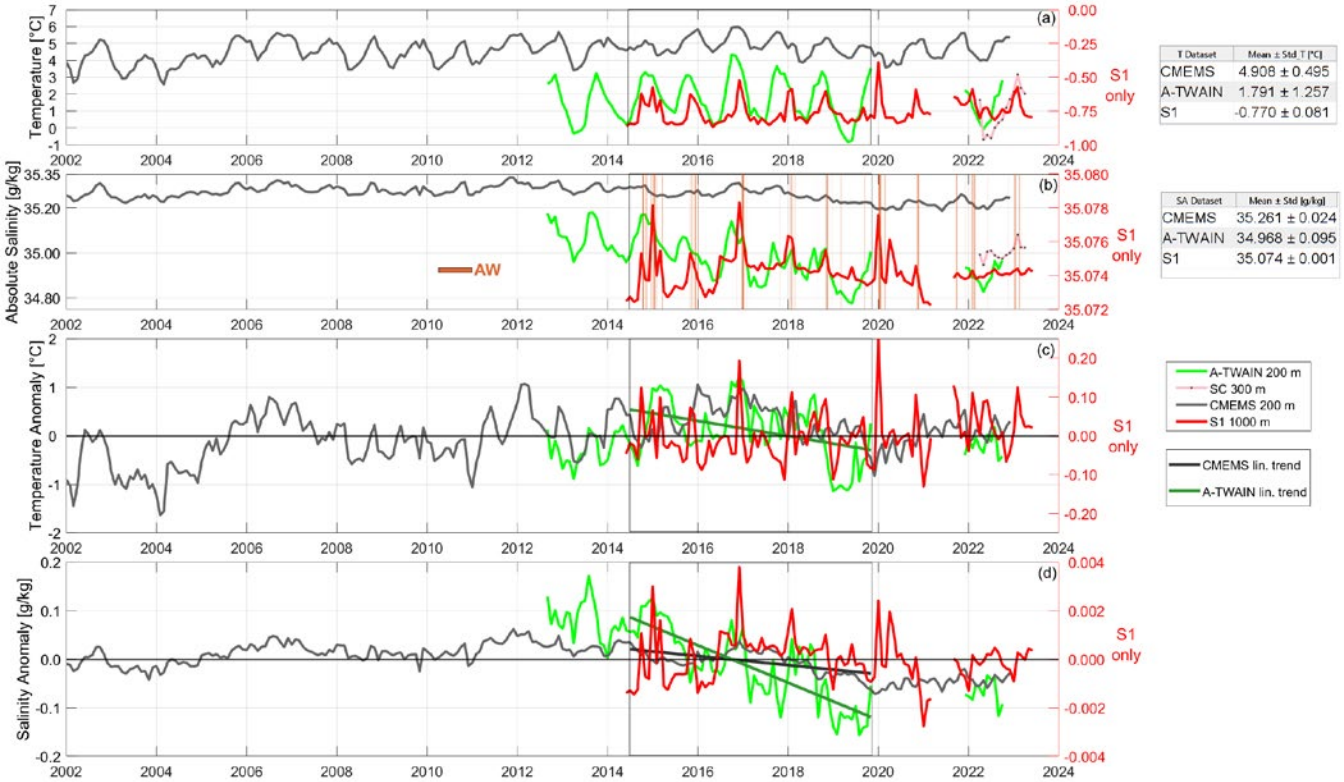
[5] https://doi.org/10.48670/moi-00007

decrease in S_A observed in the CMEMS output is also observed in A-TWAIN and S1, showing that this AW freshening signal propagates both northwards and into the deep ocean. Within the time series in Figures 2a,b, two overlapping periods are considered for which overall means and standard deviations (std) are calculated. During the longer overlapping period, Jul 2014–Nov 2019, mean and std for T (and S_A) are: CMEMS 4.908±0.495 (35.261±0.024), A-TWAIN 1.791±1.257 (34.968±0.095), S1 -0.770±0.081 (35.074±0.001). During the shorter period, Dec 2021–Sept 22, they are: CMEMS 4.573±0.523 (35.218±0.017), A-TWAIN 1.111±0.817 (34.900±0.039), and S1 -0.732±0.065 (35.074±0.000). Larger std values at A-TWAIN reflect a greater thermohaline variability in northernmost Svalbard. The anomalies associated with the monthly climatology (Figure 2c,d) show multi-year cycles of AW inflow in the CMEMS data. The longest persistently positive T anomaly is found between 2015 and 2019. It also appears coherently in the A-TWAIN time series until 2018. A persistently positive T anomaly at S1 is observed after 2020. During the longer overlapping period, Jul 2014–Nov 2019, linear trends for the anomalies are calculated (Figures 2c,d) but only statistically significant trends are reported in T for A-TWAIN (-0.8°C) and S_A for both CMEMS (-0.05 g/kg) and A-TWAIN (-0.2 g/kg).

All hydrographic time series from the continental shelf and inside fjord systems are presented in Figure 3. Figure 3a shows a latitudinal T gradient, with the northernmost fjord, Ripfjorden, being coldest. It also shows the lowest S_A (Figure 3b). However, the southernmost fjord, Hornsund, has a lower maximum T during summer compared to Isfjorden and Kongsfjorden, due to having the closest proximity to the northwestern Barents Sea and Storfjorden, which historically consist of



T Dataset	Mean ± Std T [°C]
CMEMS	4.908 ± 0.495
A-TWAIN	1.791 ± 1.257
S1	-0.770 ± 0.081

SA Dataset	Mean ± Std [g/kg]
CMEMS	35.261 ± 0.024
A-TWAIN	34.968 ± 0.095
S1	35.074 ± 0.001

Figure 2: Conservative Temperature **(a)** and Absolute Salinity **(b)** time series (monthly mean) from the offshore marine observatories (S1, SC, A-TWAIN) at depths indicated in the legend, compared with CMEMS outputs at around 76°N 14°E and 200 m depth (AW core). A-TWAIN data are depth-averaged time series starting from 50 m. The vertical red lines (b) indicates AW intrusions at S1, using the definition described in section 2.1 and based on daily mean time series. Mean values and std for the overlapping period Jul 2014–Nov 2019 are reported in the tables. **(c, d)**: deviation from the climatological mean (anomaly) for the time series longer than five years. Linear trends (statistically significant with $p<0.05$) are shown for the overlapping period Jul 2014–Nov 2019. Note that the y-axis on the right (red) has a different scale to reproduce the variability at S1.

Arctic Water types. There is no apparent trend in T and S_A over the two decades (Figure 3a, b), but the anomalies (Figure 3c, d) reveal cycles of warmer/saltier periods (2006–2008, 2012–2018) and colder/fresher periods (2002–2006, 2008–2012, 2020–present). The flooding of AW on the WSS and into the fjord systems are indicated by the AW and TAW detection in Figure 3b and the period 2012–2018 shows their exceptionally high occurrences. This is what we call Atlantification (i.e., increasing influence of AW in Arctic regions). Cottier et al. (2007) explained the first incident of Atlantification on the WSS during winter 2006 through regional air–ocean interaction mechanisms (i.e., periods of sustained northerly winds along the shelf that generate upwelling, which has the potential to transport AW across the shelf and into the fjords). Moreover, Nilsen et al. (2016) showed

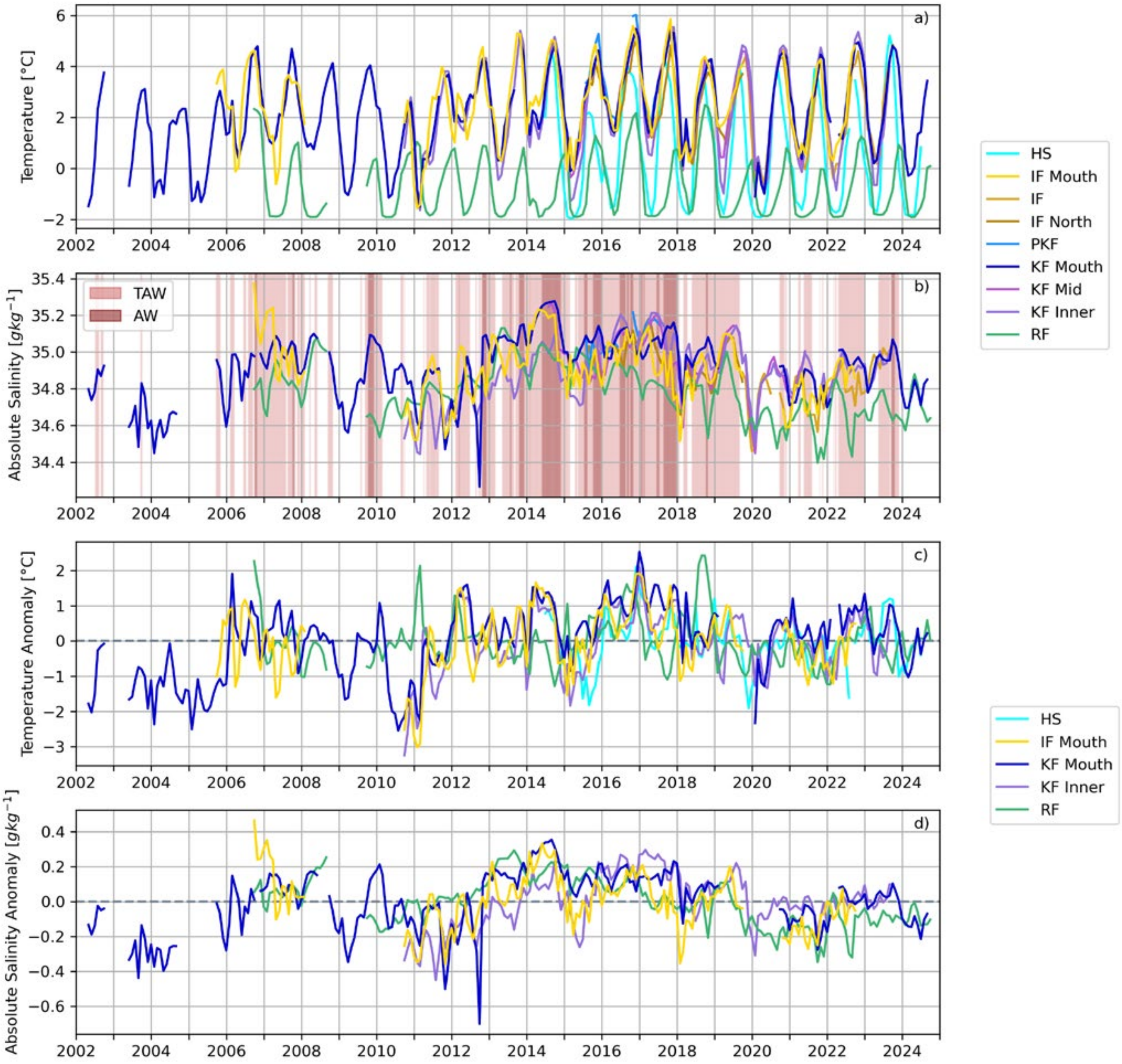


Figure 3: Time series of monthly mean Conservative Temperature **(a)** and Absolute Salinity **(b)** from the marine infrastructures (with similar colour code as in Figure 1) on the continental shelf and fjord systems west and north of Svalbard. These are depth-averaged time series starting from 50 m if no specific depth is indicated in Figure 1. The light red shading **(b)** indicates when AW and TAW are present west of Spitsbergen, using the definition described in section 2.1 and based on daily mean time series. The Isfjorden Mouth time series was used to classify water masses since it has the best coverage of salinity sensors in the water column, and the Kongsfjorden Mouth time series is used whenever the former had a gap. (c, d): deviation from the climatological mean (anomaly) for the time series longer than five years (Figure 1). Abbreviations: HS – Hornsund, IF – Isfjorden, PKF – Prins Karls Forland, KF – Kongsfjorden, RF – Rijpfjorden.

that the Isfjorden system is the Svalbard fjord most exposed to the WSC and hence to the AW source. There, the topography of the Isfjorden Trough favours the entrance of the AW transported by the STC (Figure 1). The T and S_A anomaly time series (Figures 3c, d) show an approximate 6-year cycle of AW and TAW inflow (Figure 3b and Walczowski et al. 2012) in the fjord systems as well as short-term Atlantification pulses occurring during wintertime and reported in literature (Cottier et al. 2007; Nilsen et al. 2016; Skogseth et al. 2020). T and S_A anomalies show a good correspondence between Isfjorden and Kongsfjorden. The freshening phase since 2018 (Figure 3b), as also observed in the offshore marine systems (Figure 2b), and the predominantly negative S_A anomalies in 2020–2021 (Figure 3d), are probably related to the freshening of the north Atlantic and the Nordic Seas that began in 2012 (Mork et al. 2019; Holliday et al. 2020) and transported to high latitudes. This would be consistent with the estimated delay of 4-6 years for the S_A signal to propagate to Svalbard from the north Atlantic (Holliday et al. 2020). The freshening signal after 2018 is also observed in the northwestern Barents Sea (Kolås et al. 2024).

3. Contributions to interdisciplinarity

The Atlantification of Svalbard waters has wide-reaching effects, with implications for multiple disciplines. The large heat content of Atlantic water affects both atmosphere and cryosphere, melting sea ice, tidewater glaciers, and heating the air above. The positive feedback of loss of ice reducing albedo and thus increasing radiative warming (Arctic amplification) is a phenomenon that is particularly evident in western fjords of Svalbard, where air temperatures are rising twice as fast as in other regions. Atlantic water carries nutrients that potentially affect phytoplankton blooms; it also transports marine species from the south, altering the local marine species communities and predator–prey relationships. Increasing interdisciplinary collaboration also has the potential to reveal drivers of Atlantification. Combining the long hydrographic time series with data from local weather stations is useful to clarify the driving mechanisms for the pulses/cycles of AW inflow and predict marine heat waves and the advection of aerosols. While we present purely physical parameters (temperature and salinity) here, mooring infrastructures increasingly carry biological and chemical sensors that contribute to multidisciplinary studies of marine ecosystems over long periods.

4. Unanswered questions

What is the dominant time scale of Atlantification?

The North Atlantic exhibits a pronounced atmosphere and ocean decadal variability (Årthun et al. 2021). Arctic Atlantification is reflected in both long-term and multi-year variability. Recent studies also show that this process appears to have accelerated in the 2000s. The issue is controversial, however, and some palaeoceanographic studies point to signs of Atlantification as early as the beginning of the 20th century (Tesi et al. 2021; Polyakov et al. 2023).

Is the Atlantification permanent and irreversible?

This is not yet completely understood. There is certainly multi-year variability in the system, but the data collected to date show a long-term trend that is linked to the global warming process and cannot be ignored.

5. Recommendations for the future

- MAINTAIN long-term deep-sea observation systems south and north of Spitsbergen to record the variability of the Atlantic Water inflow.
- PLAN AND PROMOTE opportunistic and systematic Conductivity–Temperature–Depth (CTD) measurements in key areas and near marine infrastructure and standard monitoring transects to ensure data quality (comparisons), possibly in collaboration with the Atlantic–Arctic Distributed Biological Observatory (A-DBO) network.
- HARMONIZE marine infrastructures by promoting the installation of oxygen sensors (harmonising marine observatories) to monitor deep-water ventilation or, as an indirect measure, to monitor changes in the ecosystem (e.g., biological carbon pump) linked to the Atlantification.
- EVALUATE the optimisation of marine infrastructures for specific purposes, e.g., monitoring the Atlantification process, and encouraging the international scientific community to opt for common systems, other than standard repeat transects, instead of competing systems near each other.
- INVESTIGATE the sequestration of carbon to ocean depths associated with the seasonal migration of polar zooplankton because of Atlantification.

6. Data availability

Table 1: Data availability and location of metadata from the marine systems used in the ARiS Chapter

Location (lat/lon)	Dataset/Code	Parameter/ depth (m)	Period	Dataset provider	Metadata access (URL)
SouthSvalbard 76°6.42’ N 015°58.02’ E	NorEMSO-South Cape (lander)/SC	T/S@380	2022-23	UiT	https://doi.org/10.18710/XIBMHR
SW Svalbard 76°24.01’ N 013°54.00’ E	S1 mooring/S1	T/S@1040	2014-23 Gap Mar-Sep 2021	OGS, CNR-ISP	https://doi.org/10.71761/2298c267-0e42-4bb8-8196-d2076fdf6d8e
Hornsund fjord 76°59.00’ N 015°55.00’E	LONGHORN mooring/HS	T/S@10-25	2014-24(T) 2017-24(T&S)	IG PAS	https://dataportal.igf.edu.pl/dataset/temp_sal_one_hour_averaged_mooring_data
Western Svalbard 78°33.66’N 010°08.52’E	Prins Karls Forland (lander)/ PKF	T/S@90	2015-17	UiT	https://doi.org/10.18710/IIMSEK
Kongsfjorden 78°54.84’ N 012°14.76’ E	MDI mooring/KF inner	T/S@90	2010-23	CNR-ISP	https://metadata.iadc.cnr.it/geonetwork/srv/eng/catalog.search#/metadata/aa793636-94bb-4c57-8480-1cb0e5af6296
		T@35	2010-23		https://metadata.iadc.cnr.it/geonetwork/srv/eng/catalog.search#/metadata/60ed7e7b-e355-4348-9a22-4888cd088fa1
		T/S@30	2016-23		https://metadata.iadc.cnr.it/geonetwork/srv/eng/catalog.search#/metadata/1044a3a5-6b4f-4834-a718-a47dd2d4e6e5

Location (lat/lon)	Dataset/Code	Parameter/ depth (m)	Period	Dataset provider	Metadata access (URL)
Kongsfjorden 78°58'N 011°48'E (main) 79°03'N 011°18'E (some early years)	KF mooring/ KF Mouth	T/S@3-250	2002-24	UiT, SAMS, UNIS, NPI	https://dx.doi.org/10.5281/zenodo.14016309
Kongsfjorden 78°56.40'N 012°0.60' E	IndARC/KF mid	T/S@17-182	2014-21	National Centre for Polar and Ocean Research, India	https://npdc.ncpor.res.in/npdc/search_mf_data.action?search=location&expedition_type=Arctic&parameter=MF-1131211289&userType=user
Isfjorden 78° 03.64' N 013°31.44' E	Mouth South/IF Mouth	T/S@20-200* *Varies annually	2005-07 2010-19 2020-22	UNIS	https://data.npolar.no/dataset?pageSize=50&q=Isfjorden%20mooring
Isfjorden 78°10.95' N 013°23.63' E	Mouth North/IF North	T/S@20-225* *Varies annually	2015-19		https://data.npolar.no/dataset?pageSize=50&q=Isfjorden%20mooring
Isfjorden 78°07.52' N 014°25.16' E	Entrance South/ IF	T/S@20-160* *Varies annually	2007-08* *Gap Jan-Sep 2008 2019-23* *Gap Jun-Sep 2020	UNIS	https://data.npolar.no/dataset?pageSize=50&q=Isfjorden%20mooring
Shelf break north of Svalbard 81°24.2′N 031°13.2′E	A-TWAIN arrays/ A-TWAIN	T/S@44-137	2012–13	NPI/IOPAN/ IMR/UiT	https://data.npolar.no/dataset/73d0ea3a-fd21-4eab-8eb9-1e033fefcd8e
			2013-15		https://data.npolar.no/dataset/c972dd9c-562b-4c6c-9b4b-44ad0c0f4707
			2015-17		https://data.npolar.no/dataset/ceb74f92-bb58-44f0-b492-c75667ddc86d
			2017-19*		https://data.npolar.no/dataset/e7041026-9d91-4924-a186-48ba2d93b487
			2021*-22*		https://data.npolar.no/dataset/86ec6869-76c2-46f2-a8f2-8dfae84930e5
Rijpfjorden 80° 17.71'N 022° 17.94'E	Rijpfjorden mooring/RF	T@8-230 T/S@20-230	2006-24	UiT/SAMS/ UNIS	https://dx.doi.org/10.5281/zenodo.14018468

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