European Geosciences Union

General Assembly 2017

Vienna, Austria, April 23-28

Report

The **European Geosciences Union General Assembly,** taking place annualy at the Austria Center Vienna (ACV), was held on 23-28 April 2017. The conference was participated by more than 14 000 scientists from 107 countries among which 53 % were students and early carrier scientists. This is the biggest conference in Geosciences in Europe.

During the meeting scientists from around the world had an opportunity to present and disscuss the latest advance in the geosciences at the 649 unique scientific sessions as well as during poster sessions and PICO presentations. The conference also offered wide range of educational sessions for early carrier scientists in a form of short courses and topical meetings, including writing a good grant proposals and how to write and publish your research.

The aim of the co-organized session **CL1.23/BG9.14/CR6.3/OS2.5 Polar continental margins and fjords – climate, oceanography, tectonics and geohazards** was to bring together scientists working on northern and southern high-latitude continental margins and fjords, investigating the dynamics of past ice sheets, climate, tectonics, sedimentary processes, physical oceanography, and palaeo-biology/ecology. During the session I had an opportunity to show results of my study in a form of scientific poster entitled **Hydrographic response of Hornsund Fjord (South Spitsbergen) to climate change**, focusing on changes in water temperature, salinity and thus water masses in the fjord resulted from oceanic, atmospheric and sea ice impact.

My participation in the conference was possible due to funds of the Leading National Research Centre (KNOW) received by the Centre for Polar Studies for the period 2014-2018, which I would like to sincerely thank.

Agnieszka Promińska

European Geosciences Union
General Assembly 2017
Vienna | Austria | 23–28 April 2017

Hydrographic response of Hornsund Fjord (South Spitsbergen) to climate change

A. Promińska[1] (promyk@iopan.gda.pl), E. Falck[2] and W. Walczowski[1]
[1]Institute of Oceanology PAS, Sopot, Poland, [2]University Centre in Svalbard, Longyearbyen, Norway

Centre for Polar Studies

KNOW

1. Introduction

Fjords act like a buffer in which oceanic water mixes, transforms and exchanges with locally formed water, affecting the marine and terrestrial ecosystems. Fjords along the west coast of Spitsbergen are of special interests as they are located on the main pathway of Atlantic Water (AW) to the Arctic Ocean. AW carried by the West Spitsbergen Current (WSC) is a huge source of heat and salt to the Arctic Ocean, but it also plays a significant role in transport of heat and salt to the fjords.

Recent study showed warming in the west Spitsbergen fjords, as a response to changes in a large – scale atmospheric circulation in the Arctic and Fram Strait[1]. Increased occurrence of cyclones travelling through Fram Strait instead of the Barents Sea during winter months, results in a flooding of the West Spitsbergen Shelf (WSS) by the Atlantic Water from WSC[2]. Increased inflow of AW in the fjords may affect sea ice production and this has decreased significantly in Svalbard fjords since 2006[3].

- What is the response of Hornsund on observed changes in the Svalbard region?
- Does the fjord tend to transform towards more Atlantic type?

To address this questions, we use high resolution hydrographical measurements conducted every summer between 2001 – 2016.

2. Methodology

Hornund is a small, southernmost fjord of the west Spitsbergen.
It is influenced by two interacting currents, warm and saline West Spitsbergen Current and cold and fresher Sørkapp Current (Figure 1.)

Measurements of water temperature and salinity were carried out onboard *RV Oceania* every July since 2001. Data were taken along the longitudinal section using towed CTD system. In years 2010 – 2013 two moored systems were deployed recording temperature and salinity at different levels on the shelf, just outside the fjord (black squares in Figure 1).

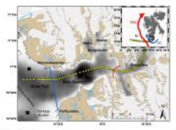

Figure 1. Map of study area, location of CTD measurements (yellow dots) and mooring positions (black squares).

3. Interannual variability

Measurements of water temperature and salinity at moorings located on the shelf shows classical transition from summer (Atlantic) conditions to winter (Arctic) conditions and back in the northern location (dashed line in Figure 2).

Mooring located in the southern location shows inflow of Atlantic Water in winter months (January – March).

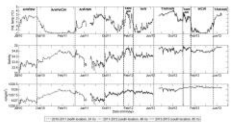

Figure 2. Daily mean water temperature (upper panel), salinity (in the middle) and density (lower panel) from moored Microcat for July 2010-July 2011 at 24 m (dashed line), July 2011 – July 2012 at 46 m (dashed-dotted line), and August 2012 – July 2013 at 85 m (solid line). Vertical dashed lines separate different water masses.

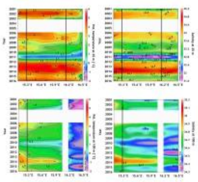

Figure 3. Longitudinal water temperature and salinity distribution at 25 m (upper) and 100 m (lower) in Hornsund in July 2001 - 2016. Black lines indicate boundaries between outer part, main basin and inner part of the fjord defined by the blue and red line in Figure 1.

Distribution of water temperature and salinity at 25 m shows significant warming in the last 4 years with the warmest and the most saline summer 2014. The coldest and freshest summer was in 2011 (Figure 3) due to inflow of highly concentrated pack of sea ice carried by the Sørkapp Current from the Barents Sea, resulting in a thick layer of Arctic origin waters in the fjord (Figure 4a).

Observations at 100 m depth shows a large difference between main part of the fjord and Brepollen (Figure 3). The warmest water was observed in summer 2014, the year when Atlantic Water was observed in the main part of the fjord for the first time during study period and modified AW entered Brepollen (Figure 4b).

Flooding of the fjord by either Atlantic Water from West Spitsbergen Current or Arctic Water from Sørkapp Current resulted in strong temperature (up to 2°C) and salinity anomalies in the most extreme summers 2001 and 2014 (Figure 5).

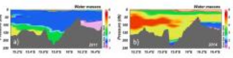

Figure 4. Distribution of water masses along the fjord in two contrasting summers: 2011 (left) and 2014 (right) The following numbers are assigned to particular water masses: 1 – Winter Cooled Water (WCW, pink); 2 – Local Water (LW, blue); 3 – Intermediate Water (IW, green); 4 – Transformed Atlantic Water (TAW, yellow); 5 – Atlantic Water (AW, red); 6 – Surface Water (SW, orange).

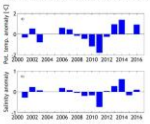

Figure 5. Temperature (a) and salinity (b) anomalies in Hornsund in July 2001 – 2016.

4. How Winter Cooled Water has changed over 15 years?

- Winter Cooled Water (WCW) forms typically due to brine release during ice formation but polynya activity plays a significant role in production of this dense water as well.
- As WCW is observed almost every summer in Brepollen, this water can reflect sea ice conditions in a previous winter.
- Larger area of the along fjord section in July is covered with WCW for lower winter air temperature and higher number of days with the fast ice (Figure 6).
- High positive correlation between WCW area and number of days with the fast ice cover (R = 0.79) and negative correlation with air temperature in winter (R = -0.70) was found.

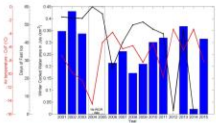

Figure 6. Winter Cooled Water section area in July (blue bars) compared to winter (DJF) air temperature (red) in Hornsund and number of days with the fast ice in the fjord (black) during short season. There were no data of WCW in 2004 and 2005. Days of fast ice are available for the period 2001 – 2014.

5. Interactions at the seaward boundary of the fjord

- Sea ice concentration (SIC) from the area south of Sørkapp Land is taken as a representative for Sørkapp Current
- Temperature of Atlantic water was measured along the section N located south of Hornsund (Figure 1).
- There is a high negative correlation between water temperature in Hornsund and yearly mean SIC (R = -0.69)
- There is a weak and statistically irrelevant or practically no correlation between water temperature and salinity in the main basin in Hornsund with temperature and salinity of AW in the WSC

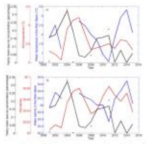

Figure 7. Water temperature (a) and salinity (b) in the Main Basin in Hornsund (blue) compared to temperature (a) and salinity (b) of Atlantic Water (red) and yearly mean sea ice concentration (black) at the fjord foreground between 2001 – 2015. Black dots indicate events with sea ice in July. SIC data obtained from ICDC.

6. Summary

Hydrographic measurements show that Hornsund undergoes significant transformation towards warmer conditions. Increasing warming and salinity of water in the fjord is accompanied by increasing variability in both temperature and salinity[6].

More extreme events may result in more unmodified AW observed in the fjord in the coming years. However, our results show that AW have indirect influence on the fjord hydrography either through the atmosphere[5] or due to extreme weather events that force WSC to flow onto the shelf. There is a strong and direct influence of Sørkapp Current that act as a barier for WSC and strongly modify AW that enters the fjord.

However, Sørkapp Current is still poorly investigated. Thus future work is addressed to study variability and the role of Sørkapp Current for Hornsund as well as interaction between SC and WSC.

Acknowledgements
The main part of this study was supported by the statutory research, subject 4.1, carried out by the Institute of Oceanology Polish Academy of Sciences in Sopot. We thank the crew of *RV Oceania* for assistance during measurements and all scientists, technicians, and students who contributed to the collection of the impressive hydrographic database from Hornsund. Financial support was also received from the Polish-Norwegian project AWAKE-2 (Arctic climate system of ocean, sea ice and glacier interactions in Svalbard; Pol-Nor/198675/17/2013). The largest part of the archival data was processed under the activity of the project GAME (Growing of the Arctic Marine Ecosystems) financed from the National Science Center funds under the no. DEC-2012/04/A/NZ8/00661. This study is a part of the doctoral project that is conducted at the Centre for Polar Studies KNOW (Leading National Science Center). We would like to also thank the Institute of Geophysics, Polish Academy of Science, and especially Tomasz Wawrzyniak, for providing meteorological data from the Polish Station in Hornsund. Many thanks to Joanna Pardus for providing shapefiles for the basemap of Hornsund.

Fot. Anna Maciejewska

References
[1]Pavlov A.K., Tverberg V., Ivanov B.V., Nilsen F., Falk-Petersen S. & Granskog M.A. 2013. Warming of Atlantic Water in two Spitsbergen fjords over the last century (1912-2009). *Polar Research* 32, 11206, http://dx.doi.org/10.3402/polar.v32i0.11206.
[2]Nilsen F., Skogseth R., Vaardal-Lunde J. & Inall M.2016. A simple shelf circulation model – intrusion of Atlantic Water on the West Spitsbergen Shelf. *Journal of Physical Oceanography* doi:10.1175/JPO-D-15-0058.1.
[3]Muckenhuber S., Nilsen F., Korosov A. & Sandven S. 2016. Sea ice cover in Isfjorden and Hornsund, Svalbard (2000-2014) from remote sensing data. *The Cryosphere* 10, 149-158, doi: 10.5194/tc-10-149-2016.
[4]Nilsen F., Cottier F., Skogseth R. & Mattsson S. 2008. Fjord-shelf exchanges controlled by ice and brine production: The interannual variation of Atlantic Water in Isfjorden, Svalbard. *Continental Shelf Research* 28, 1838-1853.
[5]Promińska A., Falck E., Walczowski W., Interannual variability in hydrography and water mass distribution in Hornsund, an Arctic fjord on Svalbard, Polar Research (submitted)
[6]Promińska A., Cisek M., Walczowski W., Kongsfjorden and Hornsund hydrography - a multiyear survey in fjords under different drivers, Oceanologia (submitted)