Atlantic Water in the Nordic Seas - properties and variability

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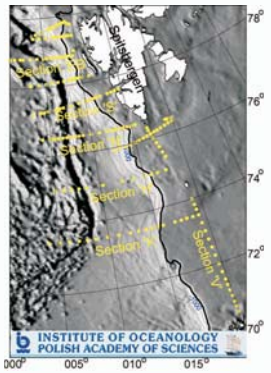
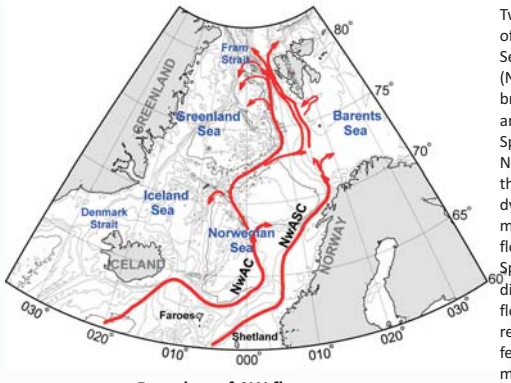
During the last decade meaningful changes of Atlantic Water (AW) properties in the region of western Spitsbergen and Fram Strait has been observed. 13-years time series of summer observations carried by Institute of Oceanology Polish Academy of Sciences reveal the West Spitsbergen Current (WSC) warming trend of 0.06 °C/year. During observations time, two 6 years-long periods of increasing and falling AW temperature and salinity occurred. Horizontal distributions of Atlantic Water properties show, that in summers 2004-2006 isotherm 5°C at 100m depth has moved meridionally 4.5° (500 km) northward. In 2006 temperature of AW core reached record-high values, warm and salty water expanded over the shelves and inflowed into fjords. Changes of AW properties and extension forced changes in fiords hydrology, biology, and even influenced climate: AW temperature is well correlated with yearly mean air temperature in Hornsund.

In 2007 and 2008 rapid decreasing of the Atlantic Water salinity and temperature occurred, but in summer 2009 both values were higher. It suggests beginning of the new warming cycle.



DATA

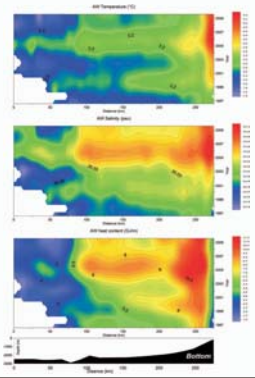
IO PAS has completed time series of summer hydrographic data from the Norwegian and Greenland Seas. The Atlantic Domain was covered by series of sections. Most of sections spread from the submarine ridges (Mohna and Knipowich Ridge) in the west to the Barents Sea or Spitsbergen shelves in the east. It allows observing the main AW flow to the Arctic Ocean: the West Spitsbergen Current. Two meridional sections close the Barents Sea Opening and Storfjorden. To close the investigated region from the south, in 2005-2009 period Norwegian (IMR) CTD data from Gimsoy Section were used.



Branches of AW flow

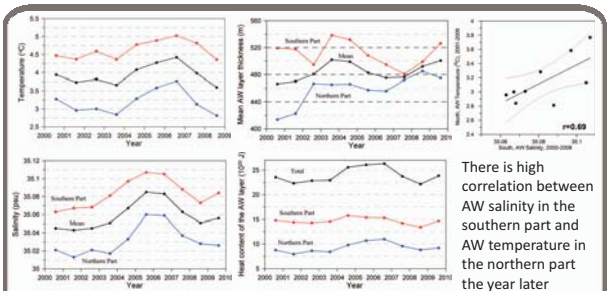
Two branches of the Norwegian-Atlantic Current (NwAC), slope and offshore, carry warm, salty AW northward through the Norwegian Sea. The eastern branch, called the Norwegian Atlantic Slope Current (NwASC), is a nearly barotropic flow related to the Norwegian shelf break. This current continues northward over the Barents Sea slope and along the West Spitsbergen shelf break as the core of the West Spitsbergen Current. The western WSC branch, a continuation of the NwAC offshore stream, is an along-frontal baroclinic jet steered by the bottom topography of the Mohns and Knipovich Ridges. The dynamics of this flow is characterized by high variability and mesoscale activity. The bottom configuration causes the poleward flowing branches of the WSC to converge in the region of western Spitsbergen, at latitude of about 78° N. Continuing north, the current diverges again into three paths. The Svalbard and Yermak branches flow into to the AO through the Fram Strait, while the offshore branch recirculates westward and then southward. The Svalbard Branch is fed by the along-slope core of the WSC, and recirculation is maintained by the western branch of the WSC.

Hovmoeller plot, section N, 76°30'N



Two sources of the warming observed since 2003 has been recognized: core of the WSC flowing along the Barents Sea and Spitsbergen shelf-break the baroclinic western branch. This WSC branch, continuing over the submarine ridges as an extension of the Norwegian Atlantic Current, played important role in the last AW warming.

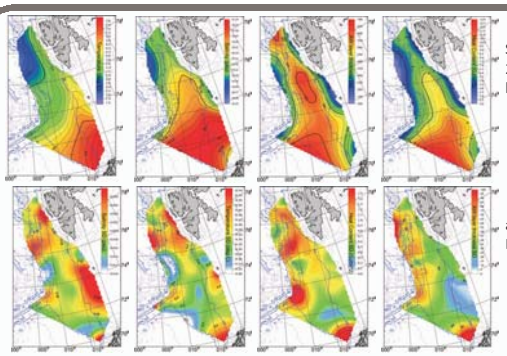
It is well visible at the Hovmoeller plot - much warmer and salty water in the western branch in 2005-2006



There is high correlation between AW salinity in the southern part and AW temperature in the northern part the year later

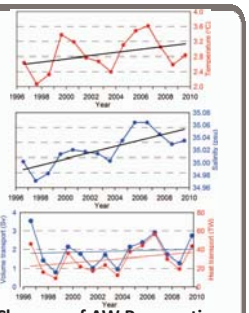
Temporal Changes of Mean AW Preoperties

AW properties were calculated for entire investigates area, its northern (north of 74°N) and southern part.

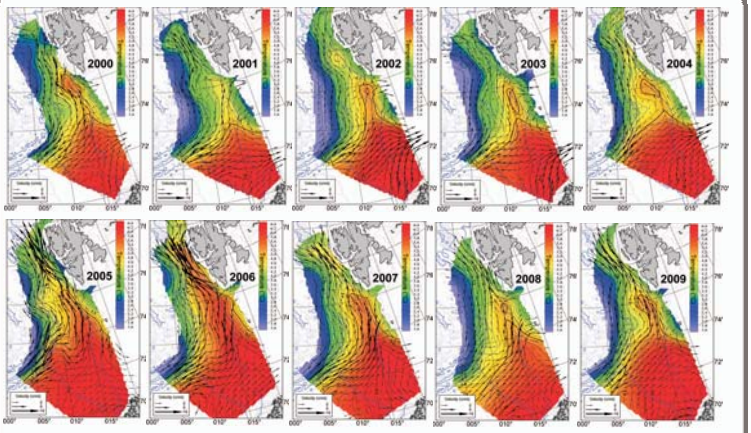


Summers 2000-2009 mean AW layer properties

and Standard Deviations

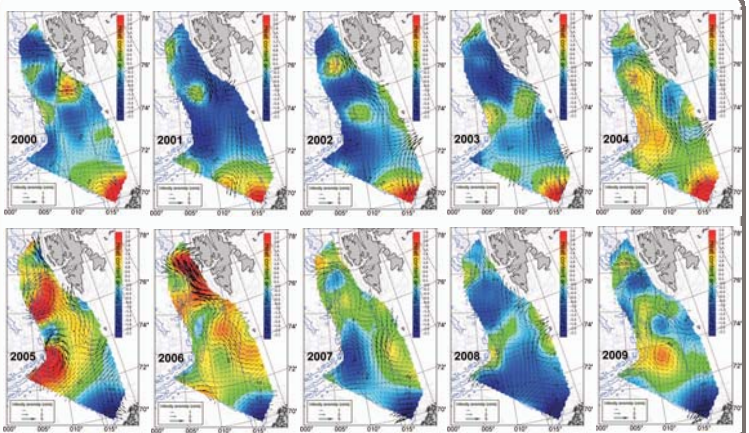


Changes of AW Preoperties at section 'N' along the 76° N



AW temperature an 100 m. and baroclinic currents at 100 dbar. No motion level 1000 dbar

Progressive warming of the West Spitsbergen Current were observed since 2004. During summer 2006 temperature and salinity of the core of AW reached the highest ever observed by the IOPAS values. Also the northward component of the baroclinic currents were the highest.



Anomalies of the AW layer heat content relative to the 2000-2009 mean and anomalies of baroclinic currents at 100 dbar

Positive heat anomalies occur as the mesoscale anticyclonic eddies. The largest anomalies were observed in 2005 and 2006 in the western branch of WSC, over the submarine ridges.