The Atlantic inflow to the Barents Sea

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Background

The inflow of Atlantic Water is of crucial importance for the physical and ecological conditions of the Barents Sea. With the inflowing Atlantic Water, fish larvae and zooplankton are advected into the Barents Sea from the Norwegian Sea (e.g. Skjoldal *et al.*, 1992). The climatic conditions affect the growth rate and distribution of zooplankton and fish larvae, as well as fish population parameters as growth, recruitment, migration and distribution (e.g. Ottersen and Loeng, 2000).

The Barents Sea also influences the Arctic Ocean. Both by providing a pathway for Atlantic Water to the Arctic Ocean, but also as a shallow shelf sea producing dense water through cooling and brine release. When passing through the Barents Sea the Atlantic Water is strongly modified by cooling, mixing and freezing during winter, and all the Atlantic Water entering in the west is modified and leaves the shelf toward the Arctic Ocean mostly with temperatures below 0°C (Schauer *et al.*, 2002). Resent modelling results indicate that the Barents Sea outflow significantly contribute to the boundary flow continuing along the slopes of the Arctic Ocean (Maslowski *et al.*, 2004). According to Maslowski *et al.* (2004) the contribution of the Barents Sea branch of Atlantic Water into the Arctic Ocean is equally, if not more, important than the Fram Strait branch.

To investigate the Atlantic inflow, 4-year long records from an array of moored current meters across the western entrance to the Barents Sea are analysed (Figure 1).

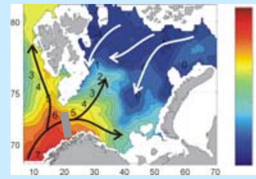

Figure 1. Mean temperatures and main currents in the Barents Sea. The grey line shows the section where the current moorings were deployed

The velocity field

Earlier investigations have shown that the variability in the Atlantic inflow has a strong coupling to the local wind (Ådlandsvik and Loeng, 1991) and that the inflow is mainly barotropic (Blindheim, 1989 and Figure 2).

This poster link the two aspects together by showing that the local wind field gradients, through Ekman transport, change the surface elevation and accelerate the flows due to horizontal pressure gradients (Figure 3). Southwesterly winds in the inflow area will, in general, create broad inflows in the southern part while northeasterly winds will result in broad outflows, mainly in the northern parts. These flow regimes may be persistent for up to a month, and are related to the relative strengths and lateral extensions of the Icelandic low and the Arctic high.

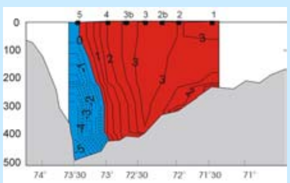

Figure 2. Mean cross-sectional velocity (cms^{-1}). Red areas show eastward flow (i.e. flow into the Barents Sea).

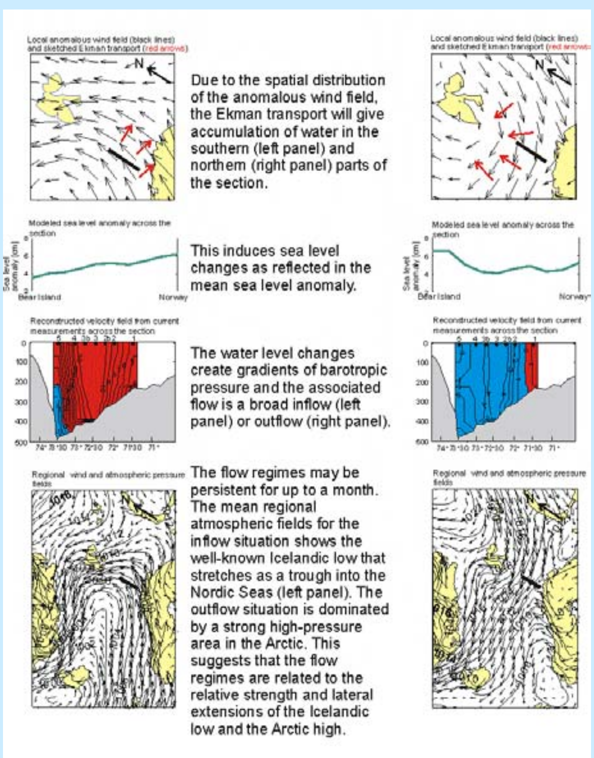

Figure 3. Mean characteristics associated with the broad inflows (left panels) and broad outflows (right panels).

Atlantic Water transports

The monthly mean transport of Atlantic Water entering the Barents Sea show a pronounced transport minimum in spring (Figure 4). This phenomena is caused by a seasonal shift in the meridonal wind field from the dominating southerlies to a spring event of northerlies (Figure 5).

The apparently lack of seasonal signal in the Atlantic Water transports is partly due to a very high inflow during the summer of 1998 (Figure 4). In fact, substantial differences appear if seasonal mean transports are calculated separately for the first and the last 3 years (Table 1). The first year of the measurements was a transition year from a cold to a warm period in the Barents Sea, which indicates strong externally forcing. Note also that if the first year of the measurements is not included, the year-to-year differences in the monthly means of the total transport are reduced (Figure 4). Based on this we propose that the first year of the measurements is not likely to be representative for the stable state (or most usual) seasonal cycle. The mean transport of Atlantic Water (including the areas not covered by the moorings) is estimated to 1.7 Sv (1 Sv=10^{6}m^{3}s^{-1}) during winter and 1.3 Sv during summer. The long-term mean transport for the period August 1997-August 2001 was 1.5 Sv. In years with abnormal transports, the estimate may differ substantially from this.

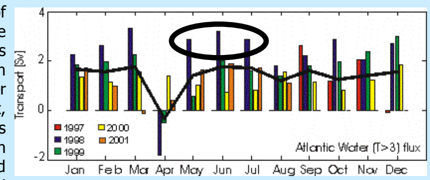

Figure 4. Monthly mean Atlantic Water transport estimated from current meter moorings.

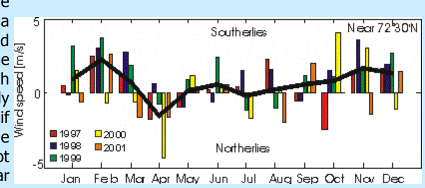

Figure 5. Monthly mean north-south wind speed.

	Atlantic Water	
	Winter	Summer
Sep 97- Aug 98	1.7 $\pm$ 4.1	2.1 $\pm$ 3.0
Sep 98- Aug 01	1.5 $\pm$ 1.9	1.1 $\pm$ 1.8

Table 1. Mean Atlantic Water transports [Sv] and error estimates from current measurements separated in the first and the last 3 years. *Winter* denote the months of December through March, and *summer* June through August.

Conclusions

• The spatial distribution of the velocity field is to a large degree determined by sea level changes caused by Ekman transport

• The spatial distribution of the wind field associated with a strong Icelandic low (southerly winds) will create wide inflows

• The spatial distribution of the wind field associated with a strong Artic high (northerly winds) will create wide outflows

• The mean AW transport to the Barents Sea was calculated to be a net inflow of 1.5 Sv

• Except for the first year of the measurements, there was a higher inflow during winter than in summer

• There is a pronounced minimum in Atlantic inflow during the spring due to the annual occurrence of northerly winds

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