ASOF-N

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REPORT

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Atlantic Water pathways in the Greenland Sea

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WP1 Milestones
2. Annual oversights on WP-progress available, months 26.

4 Annual water mass distributions available months 24.

6 Annual flow pattern available months 24, 36

1. Observations 2004

AREX2004 cruise of Institute of Oceanology Polish Academy of Sciences (IOPAS) vessel R.V Oceania was performed in period of June 08 2004 – July 19 2004. 214 CTD profiles along 12 sections were done (Fig 1, Attachment 1). Sections were situated perpendicular to the supposed direction of the Atlantic Water flow. Some transects were repeated two or even three times (section EB2) to observe the short-term variability of hydrological fields and currents.

For CTD measurements the Seabird SBI9/11plus probe was used. The probe was serviced before the cruise. Temperature and conductivity sensors were calibrated by the Sea-Bird Electronics service. Water samples collected by means of the rosette water sampler SBE32 were analysed at the ship and in IOPAS laboratory with the Guildline Autosal 8400A.

Measurements of currents were performed by means of lowered Acoustic Doppler Current Profiler (LADCP). The self-recording 300 kHz RDI device was used to profile entire water column during the standard CTD casts.

During the whole cruise continuous currents measurements by the ship-mounted ADCP, RDI 150 kHz were conducted.

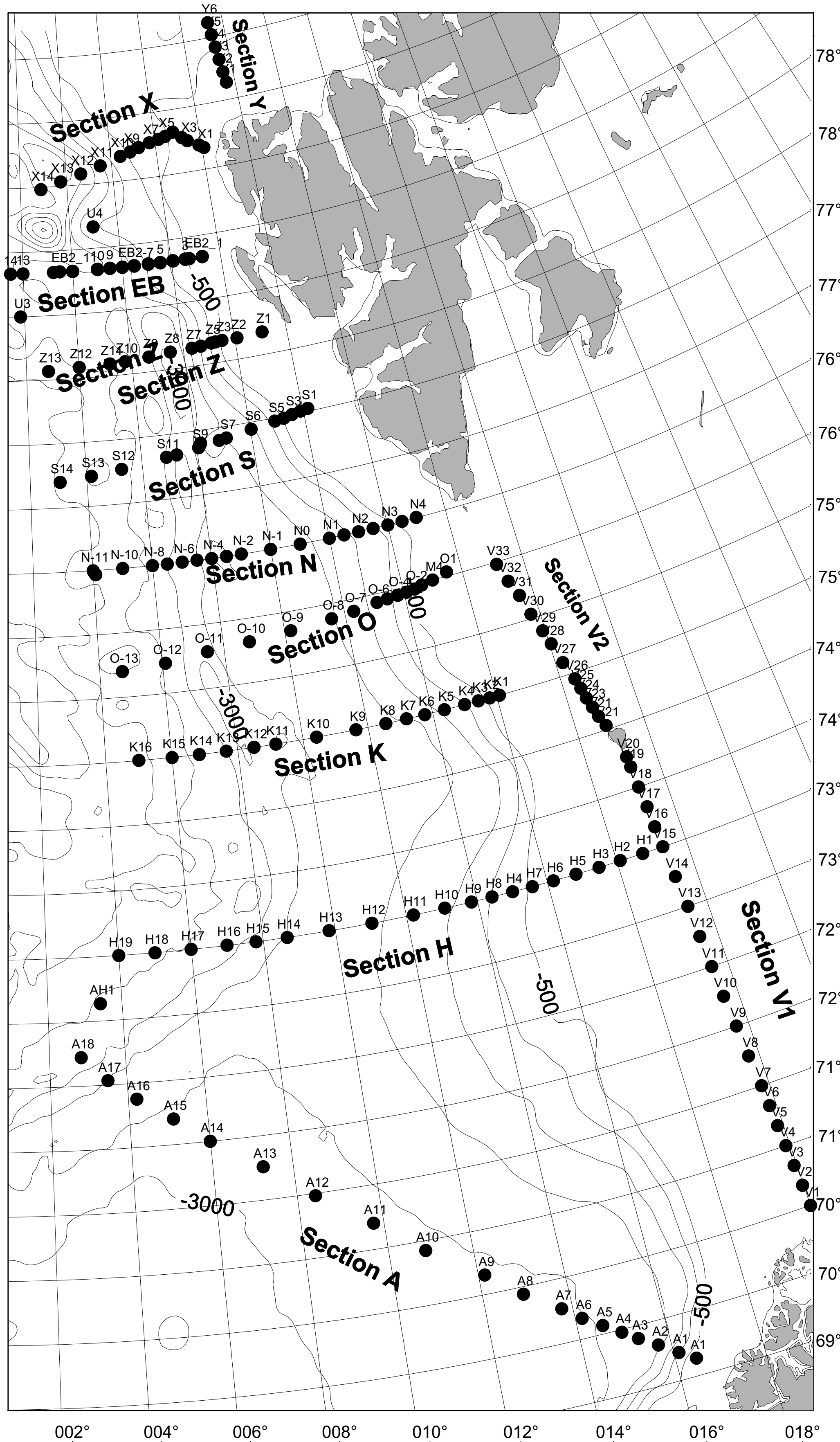

Fig. 1. Stations grid performed during R.V ‘Oceania’ cruise, summer 2004.

2. Some preliminary results

As in earlier cruises, during 2004 cruise two northward flowing branches of Atlantic Water in the Greenland Sea were observed. The main branch of the West Spitsbergen Current flows along the Barents Sea continental slope and western slope of Spitsbergen shelf break. The second, colder and less saline branch continues along the Mohns and Knipovich Ridges as a jet stream of the Arctic Front. Due to the bottom topography, both branches of AW converge west of the southern Spitsbergen coast.

Figure 2 presents the distribution of temperature, σ_Θ and baroclinic currents at 100 m (currents calculated for the reference level of 1000 m.) during summer 2004. Atlantic Water (AW) is defined as water with Θ>2°C and 27.7<σ_Θ < 27.97 (bold lines). Figure 3 presents the same properties at 300 m. Considerable part of AW flowing along the Norwegian coast proceeds eastward into the Barents Sea. Strict description of currents pattern in the southern part of polygon is impossible due to the spare data distribution. The rest of AW inflow continues northward as two separated branches. The branch related to the Barents Sea slope is warmer and more saline. The stream bifurcates at 78° 30' N, AW partly recirculates westward, partly inflows into the Arctic Ocean via Fram Strait as separated warm eddies. The mesoscale activity along the shelf-break, especially along the Spitsbergen's shelf is pronounced. Also jet-streams of Arctic Front, which form the western branch, create mesoscale meanders and eddies. Even separated eddy of Arctic Water inside the Atlantic Domain is visible. The western branch recirculates westward between 78º-79ºN.

The flow structure obtained from LADCP measurements is similar to those from hydrography-based calculations, however velocities of measured currents are much higher (Fig 4). LADCP measurements show even the mesoscale eddy north of recirculation zone, at latitude 78° 50'N (fig 5).

Also the flow structure across the sections obtained from hydrography-based baroclinic calculations, Vessel Mounted ADCP and LADCP measurements are similar (Fig.6), however baroclinic transports calculated from hydrography and total transports from LADCP measurements differ a lot. It confirms the importance of barotropic fraction of the flows. Table 1 presents total transports and AW transports across selected sections, calculated from detided LADCP data.

The high temporal currents variability was observed directly this year. Currents changes seem to be related to wind direction and induced by barotropic flows. The possible mechanism is that winds blowing along the Spitsbergen coast, due to the Ekman flow causes rising or lowering sea level. The sea tilt induces geostrophic barotropic current along the Spitsbergen coast. Measurements at the section EB2 were repeated 3 times. The structure and amount of the transport has changed considerably during 3 days between the first and second pass. During this time the wind direction has changed from the southern to northern one.

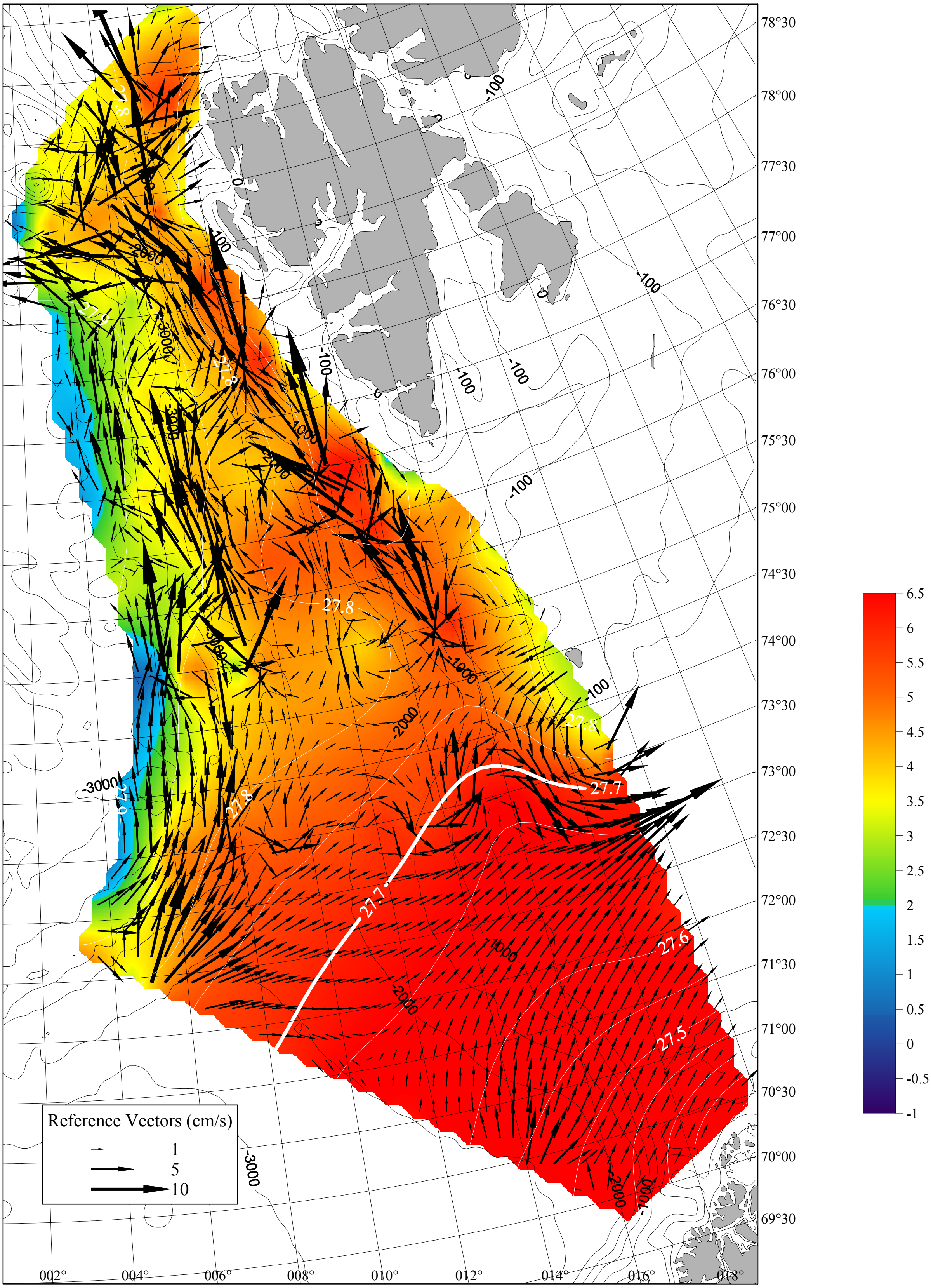

Fig. 2. June-July 2004. Temperature distribution (colour scale), σ_Θ (white lines) and baroclinic currents at 100 m. Reference level 1000 m.

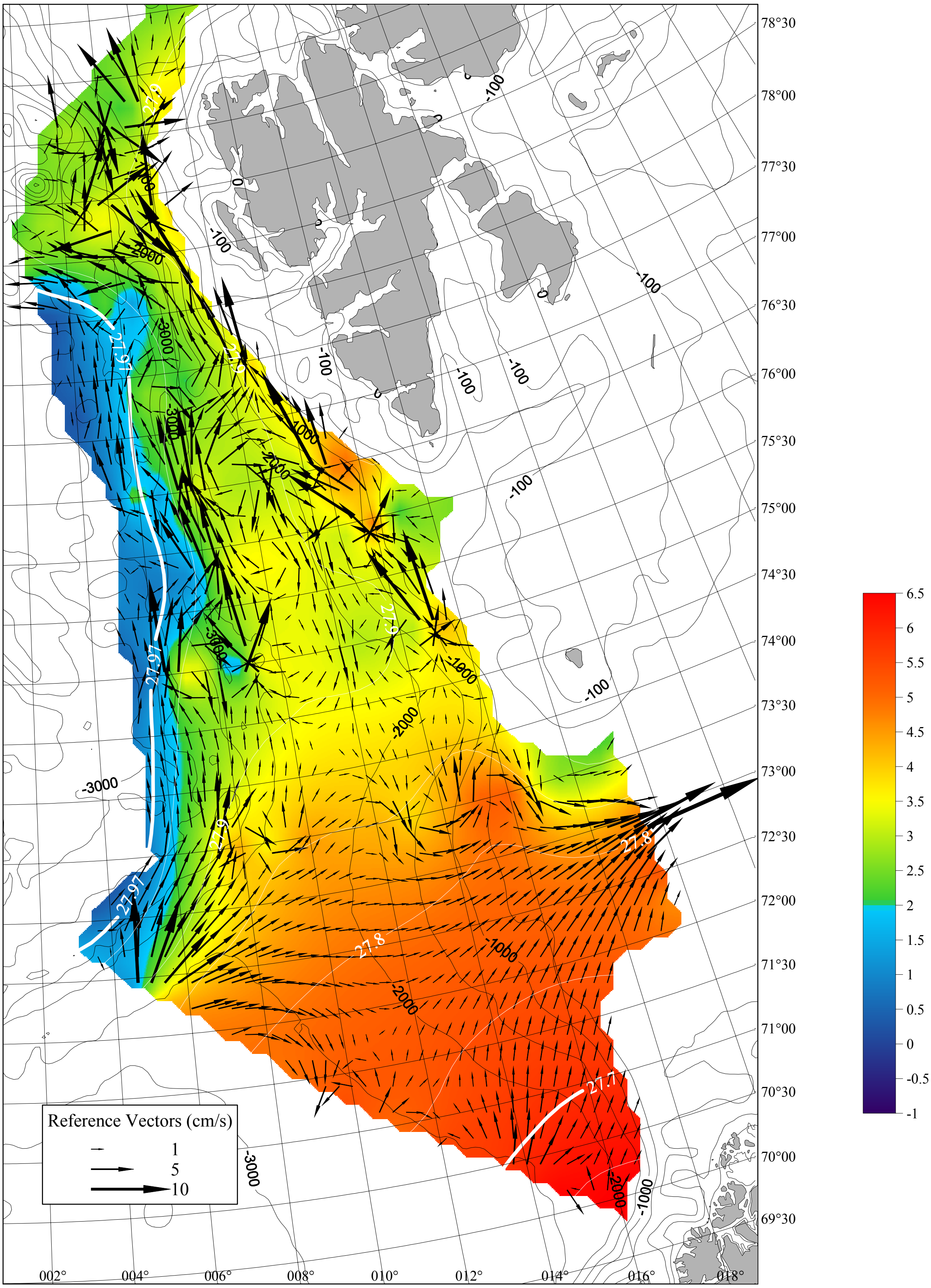

Fig. 3. June-July 2004. Temperature distribution (colour scale), σ_Θ (white lines) and baroclinic currents at 300 m. Reference level 1000 m.

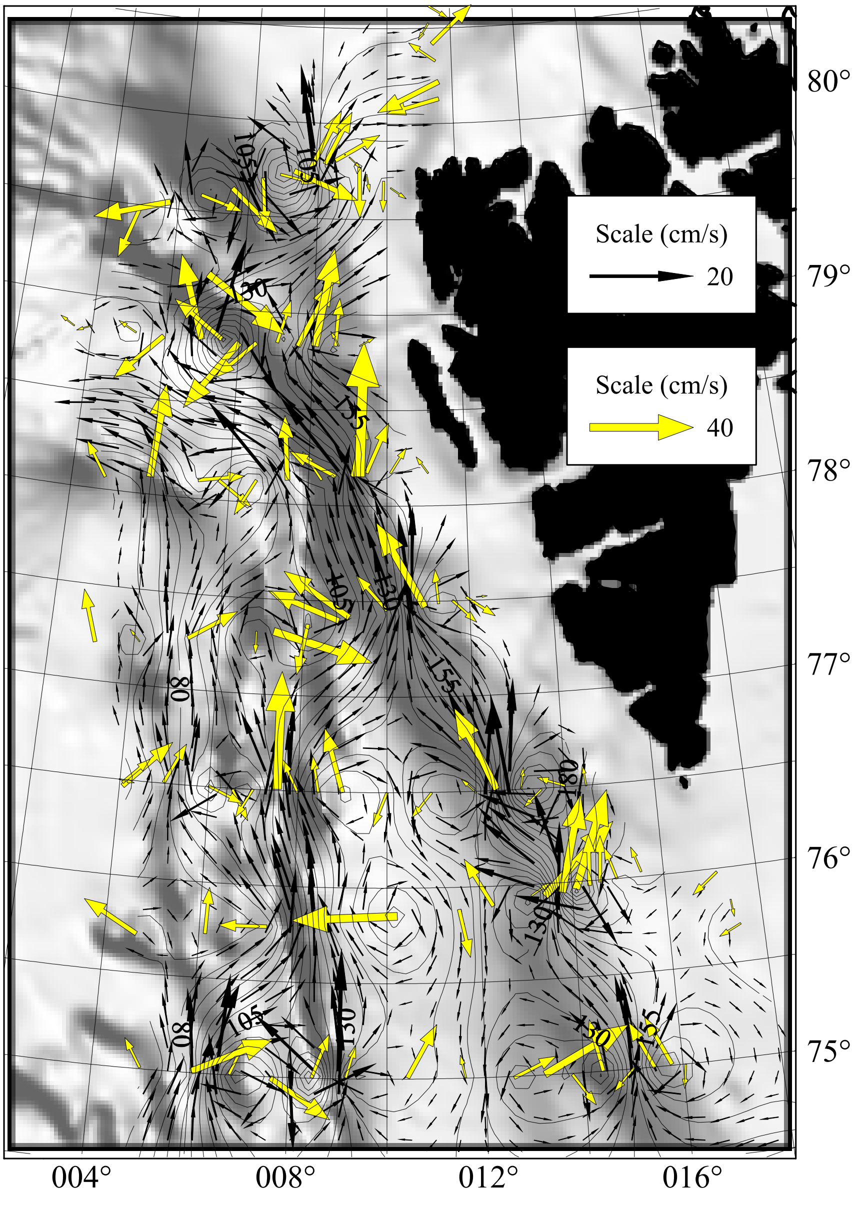

Fig. 4. June-July 2004. Baroclinic flows (black arrows) and LADCP measured currents (yellow arrows) at 100 m. Reference level 1000 m. Isolines of geopotential anomalies are drawn.

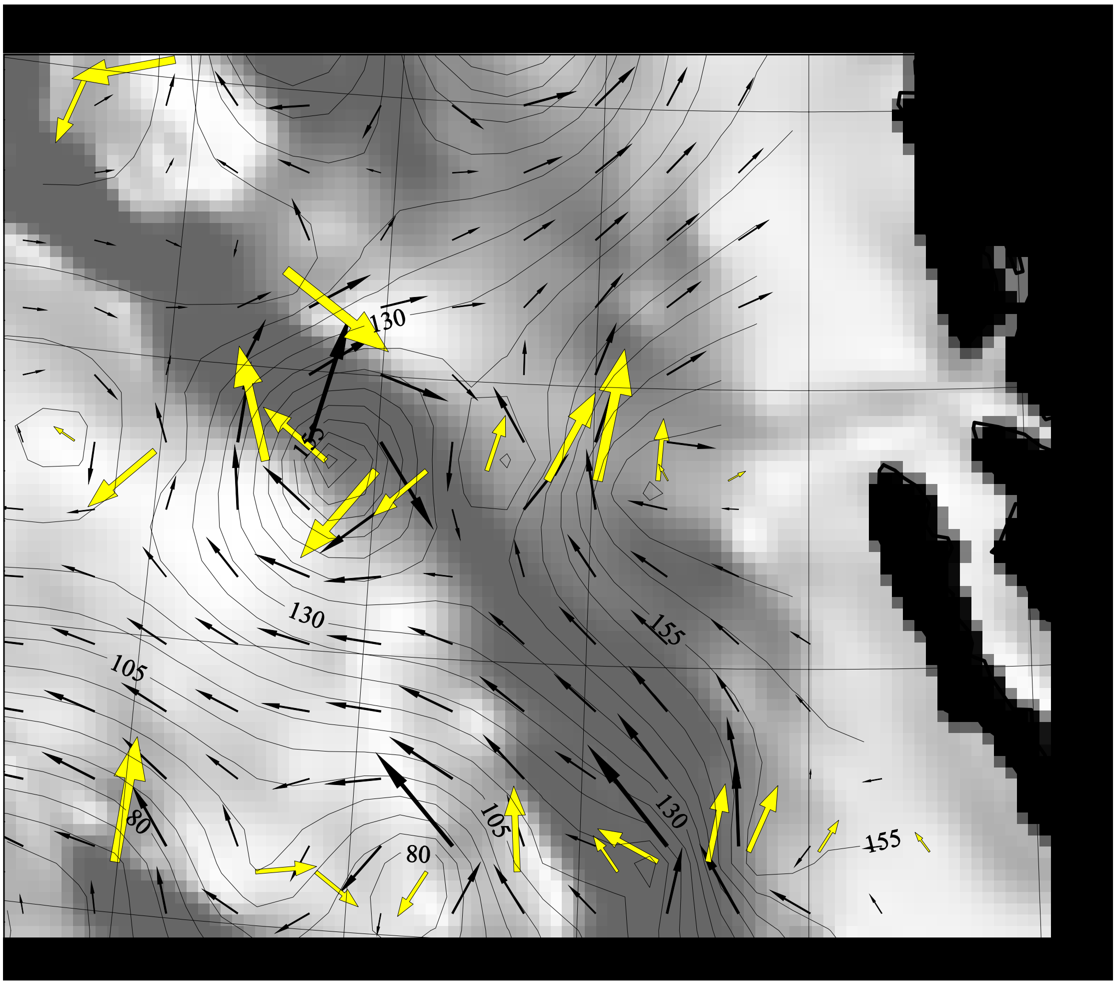

Fig. 5 Anticyclonic eddy of AW at latitude 78° 50'N. Yellow arrows indicate LADCP measured currents at 100 m.

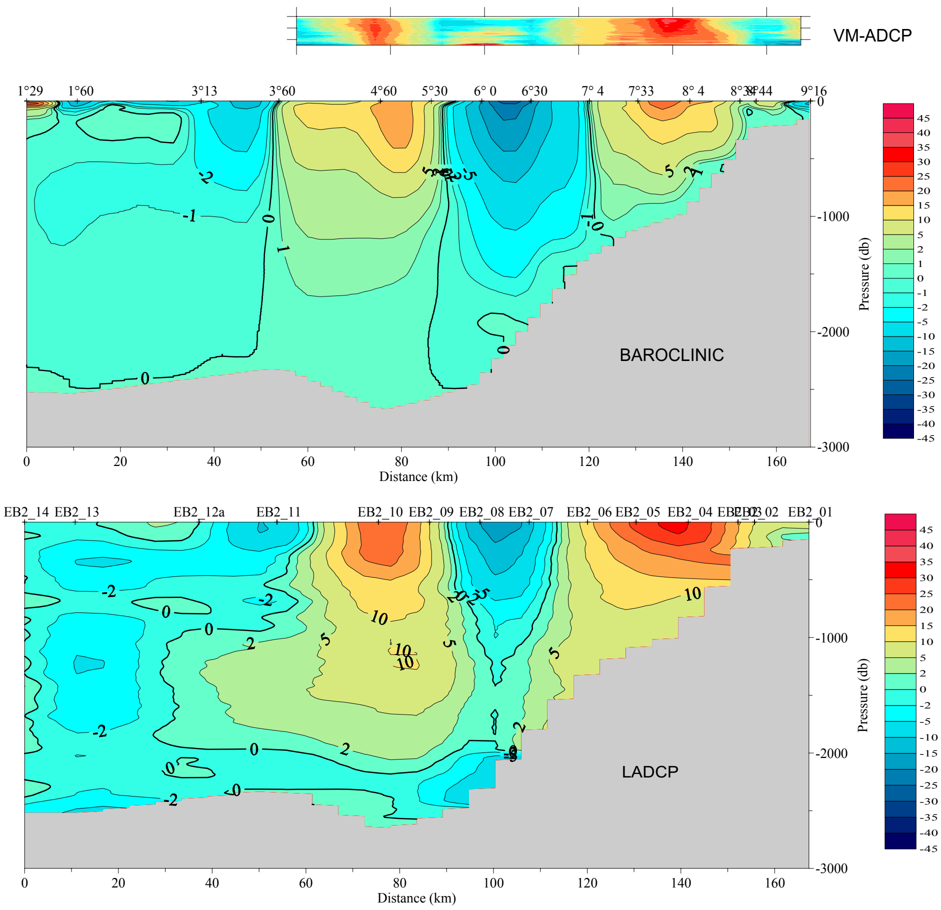

Fig. 6. VM-ADCP currents (upper bar), geostrophic baroclinic currents and LADCP measured flows cross the West Spitsbergen Current. Section EB2 along the 78° 50'N. R.V. 'Oceania', June 2004.

Table 1
Volume transports cross the selected sections.
Positive transport indicates northward flow. Atlantic Water calculated against temperature 2° C. Detaided data from LADCP were used.

Section	Net Vol. transport (Sv)	North-ward Vol (+)	South-ward Vol (-)	**AW Vol.** (Sv)	AW+	AW-	AW Heat (TW)
K (75°00'N)	37.7	41.0	-3.3	**11.2**	8.5	-0.5	43.6
N (76°30'N)	14.0	23.8	-9.8	**7.2**	6.7	-1.2	35.8
S (77- 78°N)	7.7	19.1	-11.4	**4.9**	4.6	-0.9	22.5
Z (78-78°20')	15.5	21.9	-6.4	**4.5**	3.6	-0.3	18.4
EB2 (78°50'N)	6.0	12.2	-6.2	**3.7**	4.0	-0.9	14.0

3. WSC structure in 2003 and 2004

Figure 7 show comparison of some results from 2003 and 2004. Vertically integrated transports of AW calculated from hydrography and LADCP measurements are presented. Multipath structure of WSC at section 'N' and 'S' is presented. North of the zone of recirculation, pronounced stream over the slope is visible. In 2004 at section EB pronounced baroclinic eddy is visible west of the slope-branch.

In general, northward flow of AW over the shelf in 2004 was more intensive. It is also visible comparing horizontal distributions of properties and northern range of IOPAS field measurements in 2003 and 2004 (fig 8). In 2003, probably due to weak AW inflow, the ice extend was shifted southward and R.V "Oceania" did not reach 80º N, in 2004 extend of measurements was much higher. In 2003 recirculation was much more intensive, in summer 2004 meaningful portion of AW continued north-east into the Arctic Ocean.

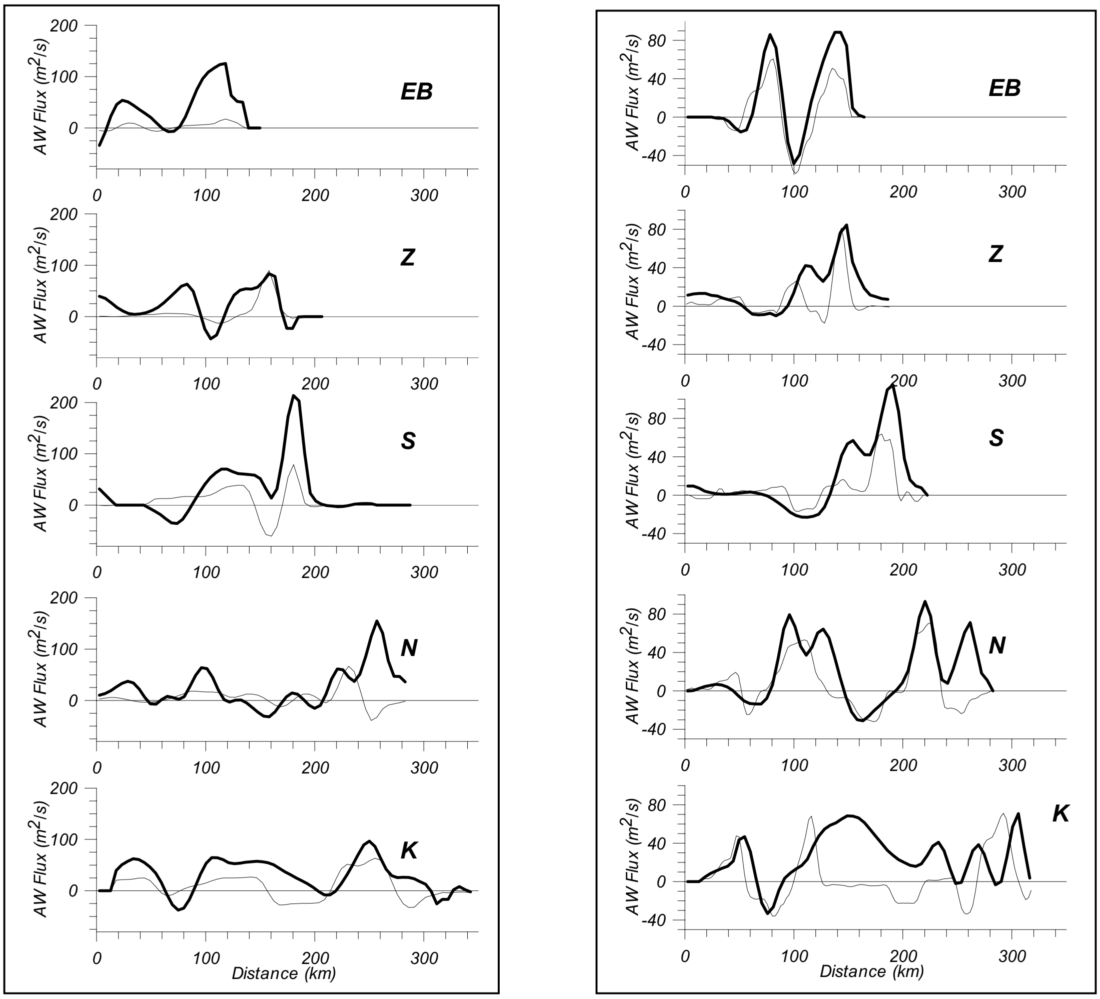

Fig. 7. Vertically integrated AW transport across selected sections in 2003 (left) and 2004. Thick lines indicate results from LADCP measurements, thin lines – baroclinic calculations.

Also temperature and salinity of WSC indicate more intensive inflow of Atlantic Water in 2004. Salinity and temperature of AW across section 'N' along 76º30' N were much higher than during last summers. Also core of AW stream over the slope was much wider (fig. 8).

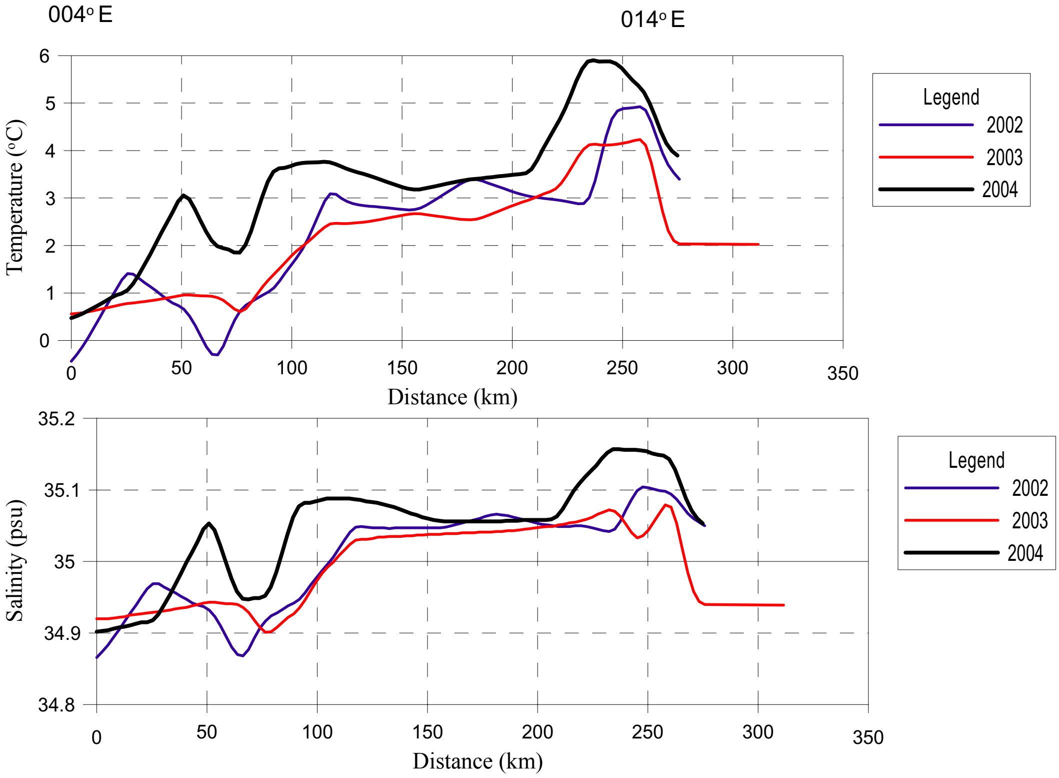

Fig. 8. Salinity and temperature at 200 m. along section 76° 30'N.

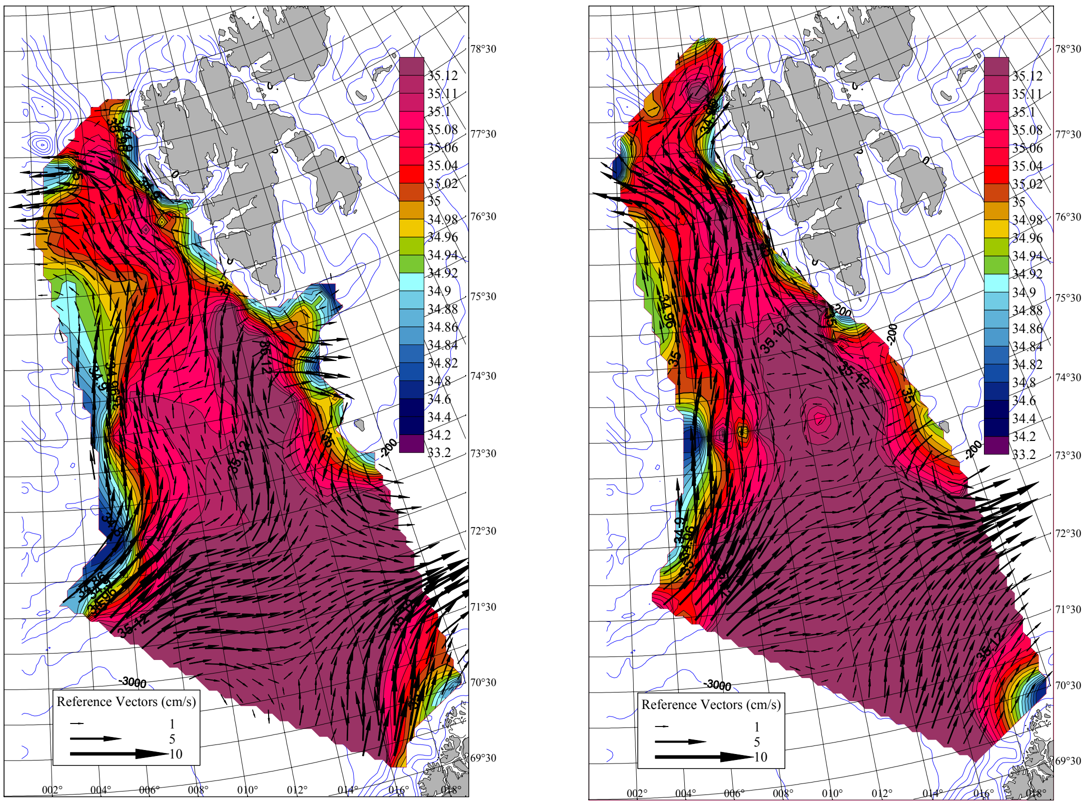

Fig. 9. Salinity distribution and smoothed baroclinic vectors at 100 m. Summer 2003 (left) and 2004.

4. Time Series

During 2004 some data from IOPAS data-base were analysed. Salinity, temperature, AW layer thickness at two sections was correlated with the North Atlantic Oscillation index (fig. 10). Here we present some results for section along the 15ºE meridian (section V1). Mean AW salinity exhibited tendency to lead the winter NAO index, while temperature changes were time lagged. The final conclusion is that the temperature of AW was predicable one year in advance from the AW salinity (fig 10) (Schlichtholz, P., Goszczko, I., Geophysical Research Letters, accepted).

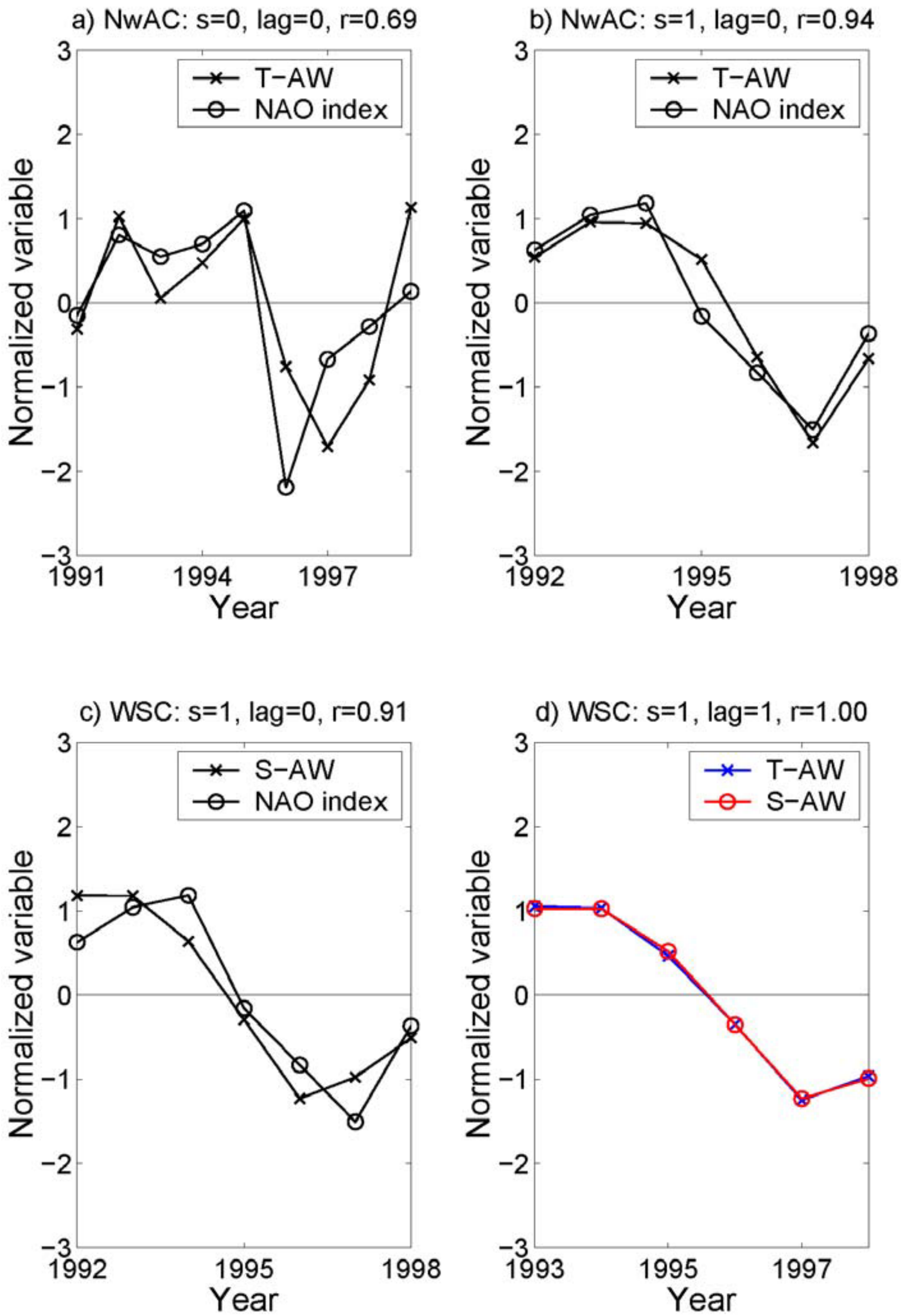

Fig. 10. Temporal development of the AW properties on the 15º E section and the winter NAO index in the 1990s.