



Water exchange in the southern Barents Sea: indirect integral characteristics and impact on the abundance of NEA cod

by

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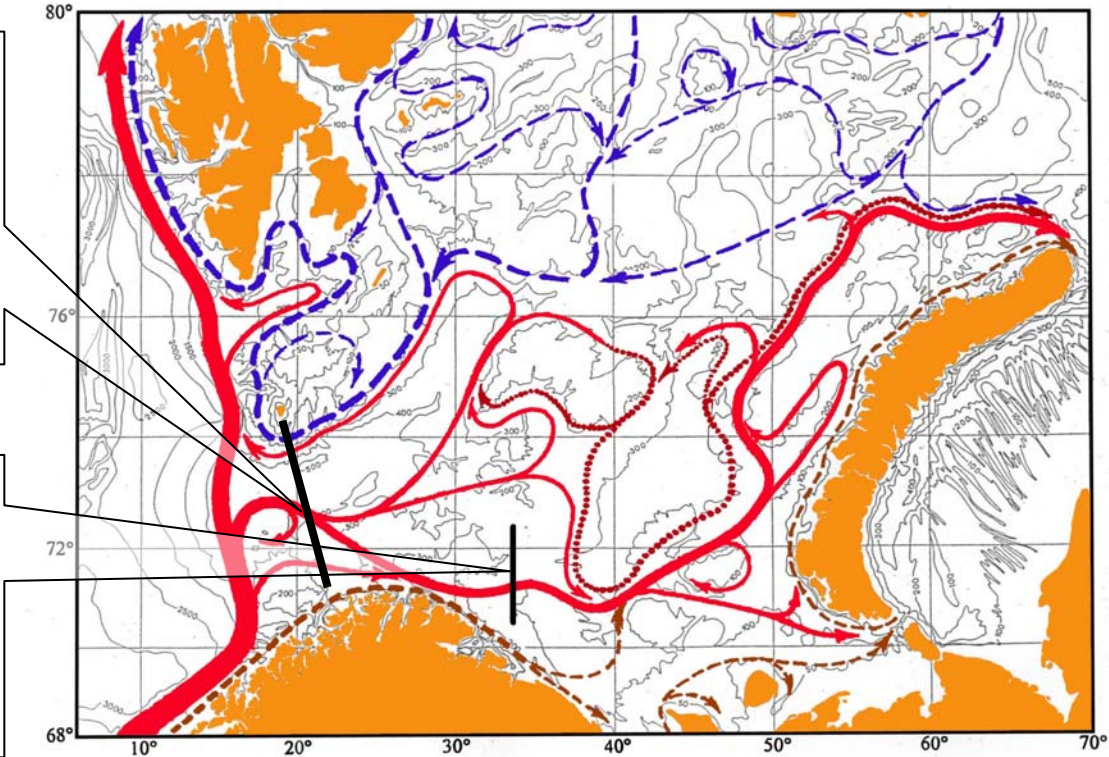
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Introduction

Fugløya-Bear Island section
Lat: 70°30' - 74°15'N;
Lon: 20°00' - 19°10'E

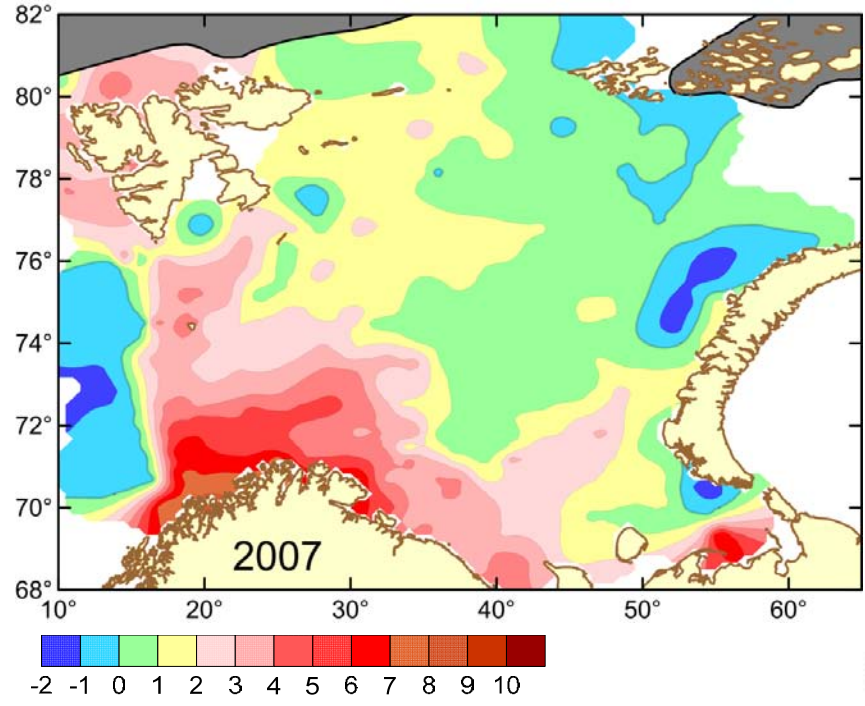
Kola section
Lat: 70°30' - 72°30'N;
Lon: 33°30'E
Depths: 215-280m



Currents in the Barents Sea (after Ozhigin et al., 2000). Red indicates water of North Atlantic origin, blue indicates water of Arctic origin and the black bars indicate the Kola and Fugløya-Bear Island sections



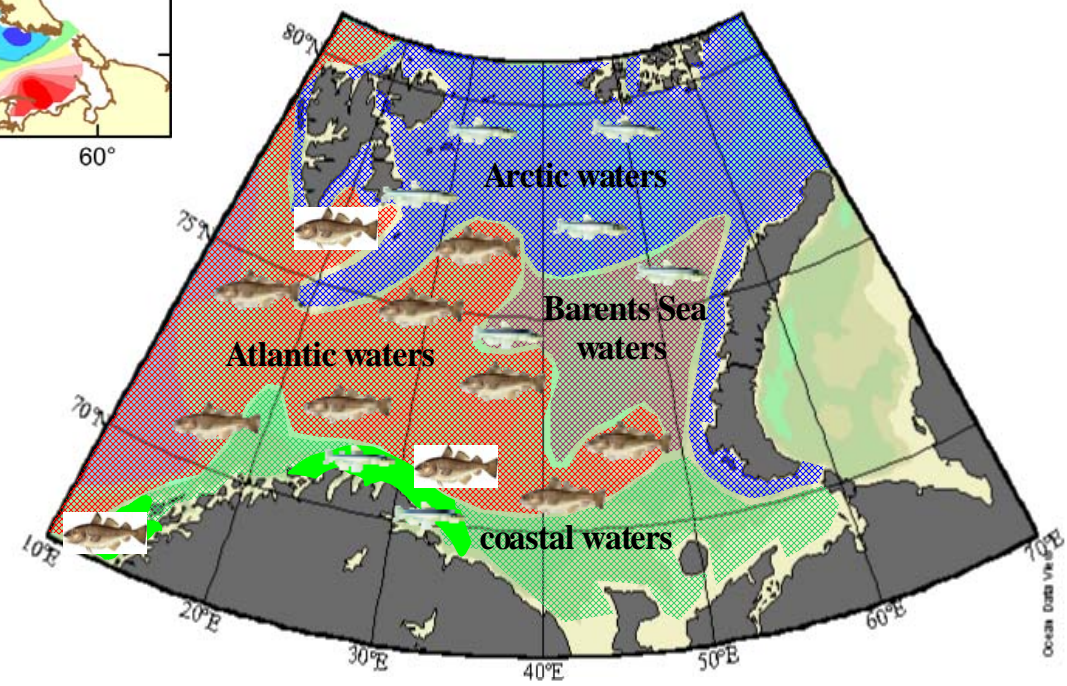
Introduction



Ice cover and bottom temperature in the Barents Sea in August-September 2007

Water masses in the Barents Sea (after Loeng, 1991).

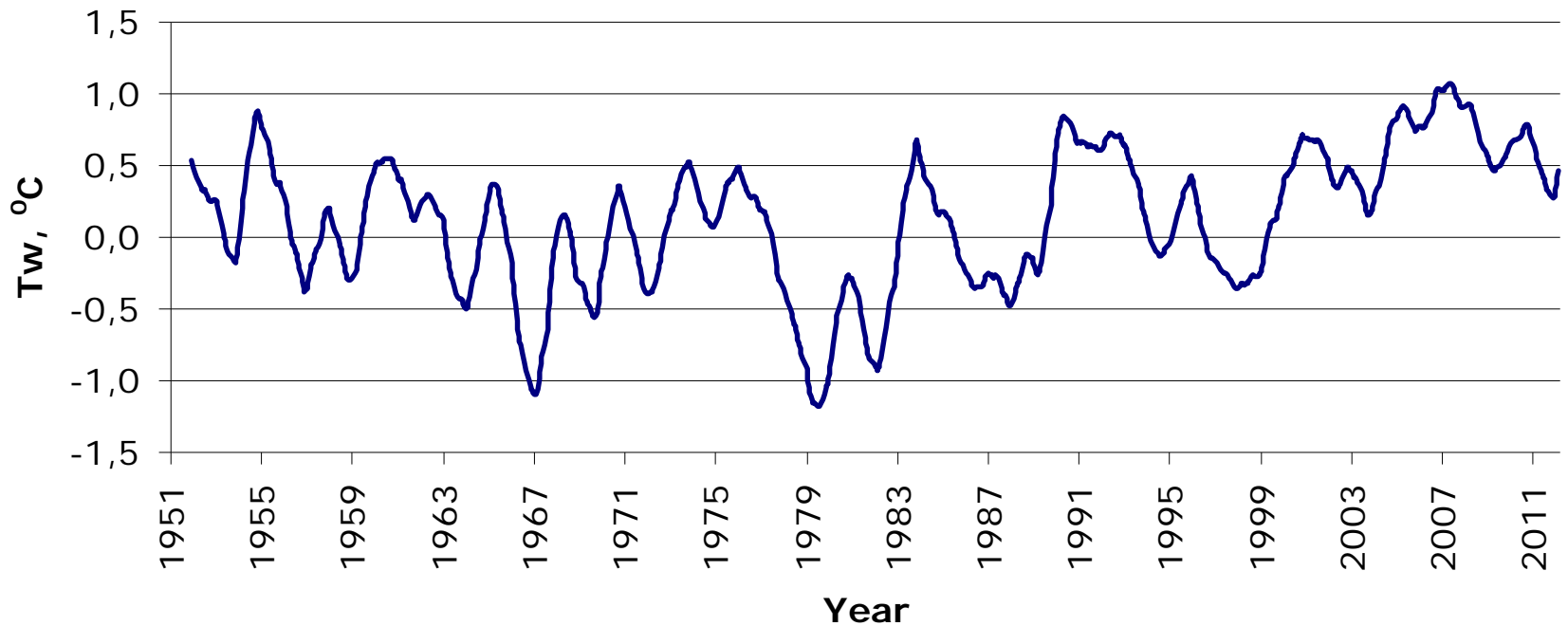
Feeding areas (fishes) and spawning grounds (green) of NEA cod and capelin.





Introduction

■ Throughout the 20th century it was believed that the change in water temperature in the Barents Sea is the main result of changes in the intensity of warm Atlantic waters inflow.

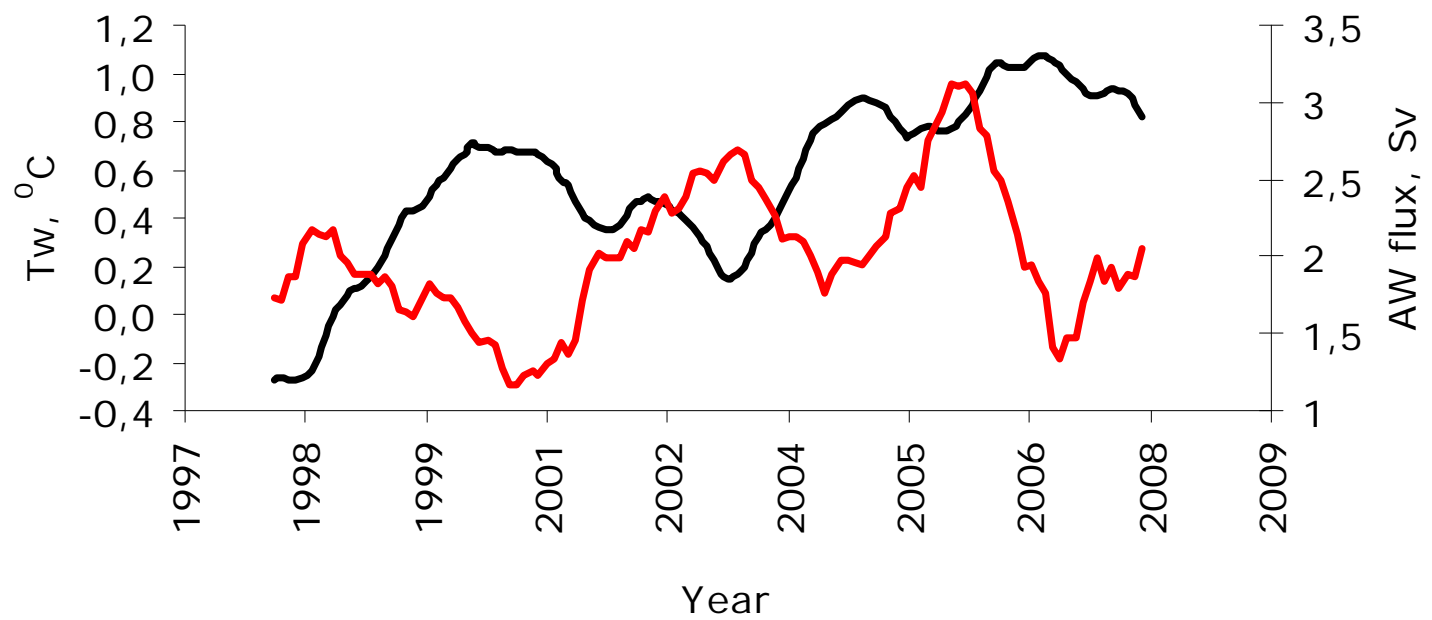


Monthly mean water temperature anomalies in 0-200m layer St.3-7 of the Kola section smoothed by moving-average method for the year (PINRO data)



Introduction

■ Instrumental measurements of currents in the south-western border of the Barents Sea have shown no direct relationship of water temperature in the Barents Sea on Atlantic waters inflow.



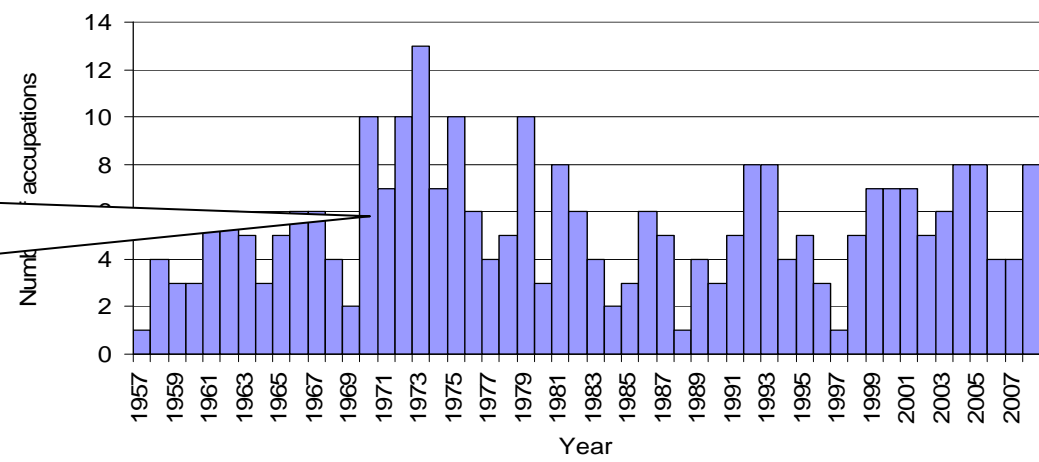
Monthly mean water temperature anomalies in 0-200m layer St.3-7 of the Kola section (PINRO data) and volume flux from current meter moorings Fuløya-Bear Island (IMR data), smoothed by moving-average method for the year



Material and methods

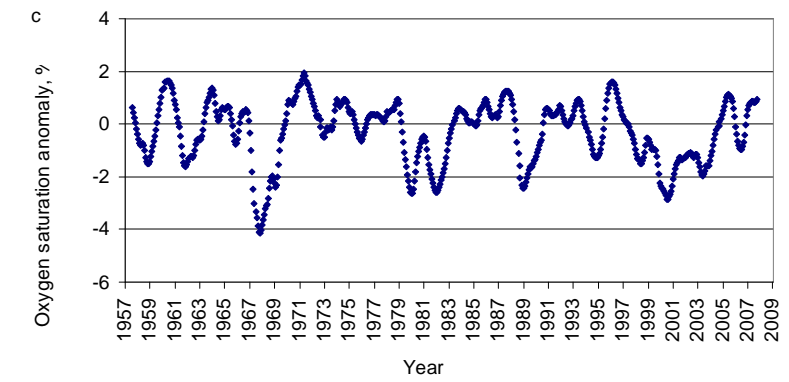
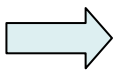
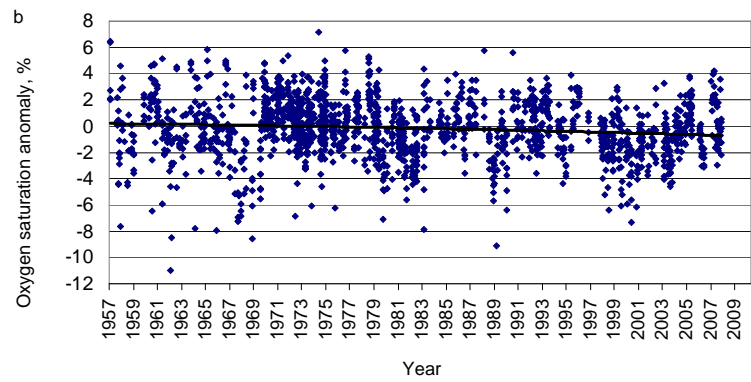
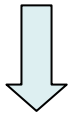
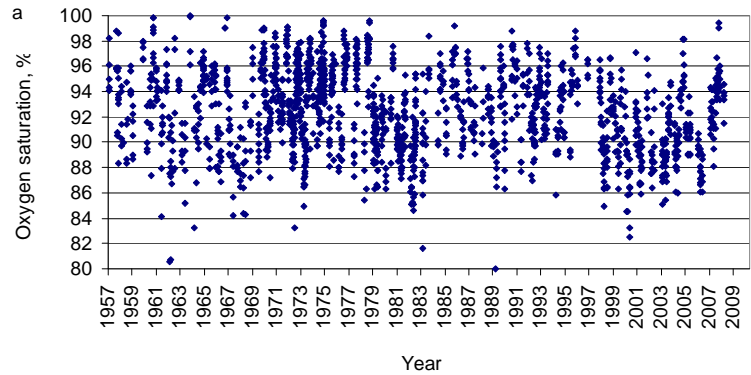
- **Water exchange indicator** – oxygen saturation in bottom layers (% oxygen content in relation to its equilibrium content in water at pressure, salinity and temperature *in situ*)
- Oxygen content, pressure, salinity and temperature were measured concurrently in bottom waters at each station of the Kola section in the southern Barents Sea (NEA cod habitat).
- Oxygen content in seawater was measured applying Winkler's method immediately after sampling in the vessel laboratory.
- The time series of oxygen content in seawater on the Kola section is the most long-term and rich in data as compared to other standard sections in the World Ocean. In 1957-2011, the section was done more than 300 ti

Number of observations over oxygen content in the Kola section in 1957-2008





Material and methods



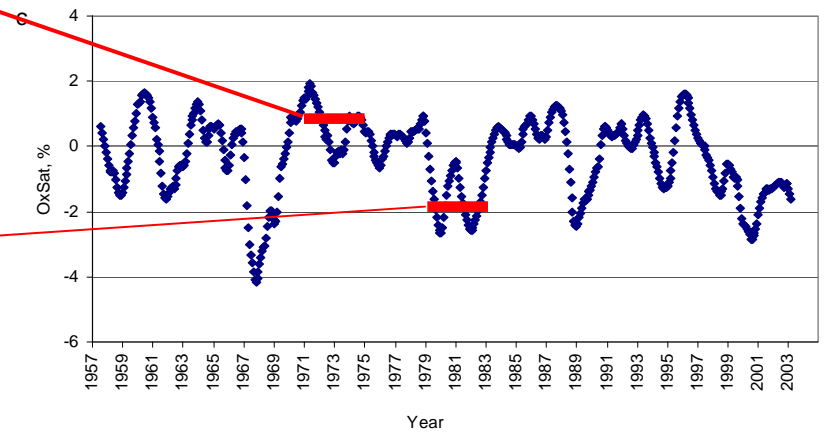
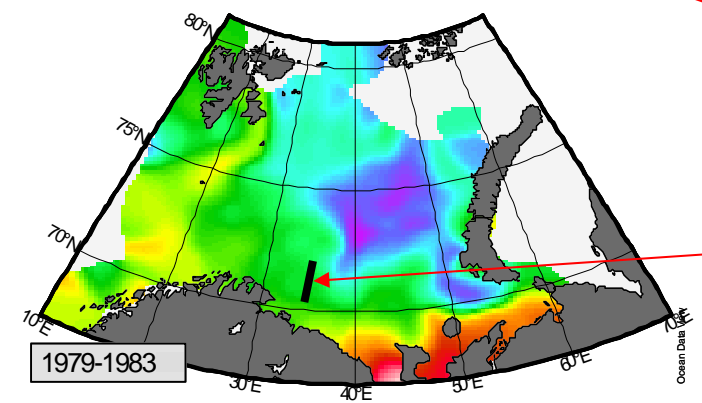
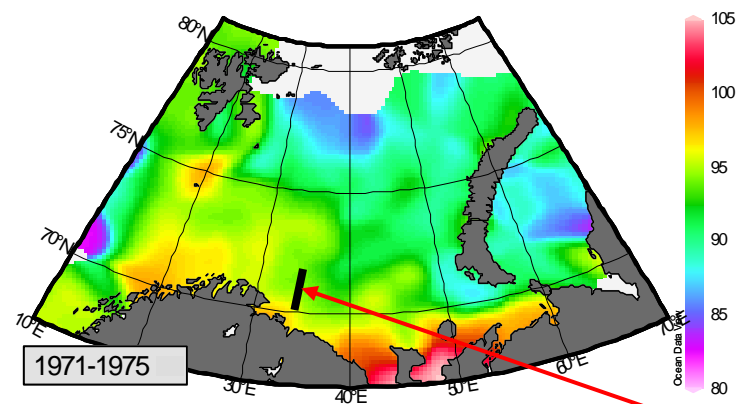
The results of oxygen saturation measurement were filtered to remove seasonal variations. Then the anomalies of oxygen saturation were smoothed.

Oxygen saturation of bottom layers on Stations 3-7 of the Kola Section *in situ* (a), anomalies (b), anomalies smoothed by averaging for Stations 3-7 and by moving-average method for the previous year (OxSat) (c).



Material and methods

■ Oxygen saturation of bottom waters in the southern Barents Sea fluctuates within 80-100% and is characterized by considerable year-to-year variability, and in a good agreement with observations in the Kola section.



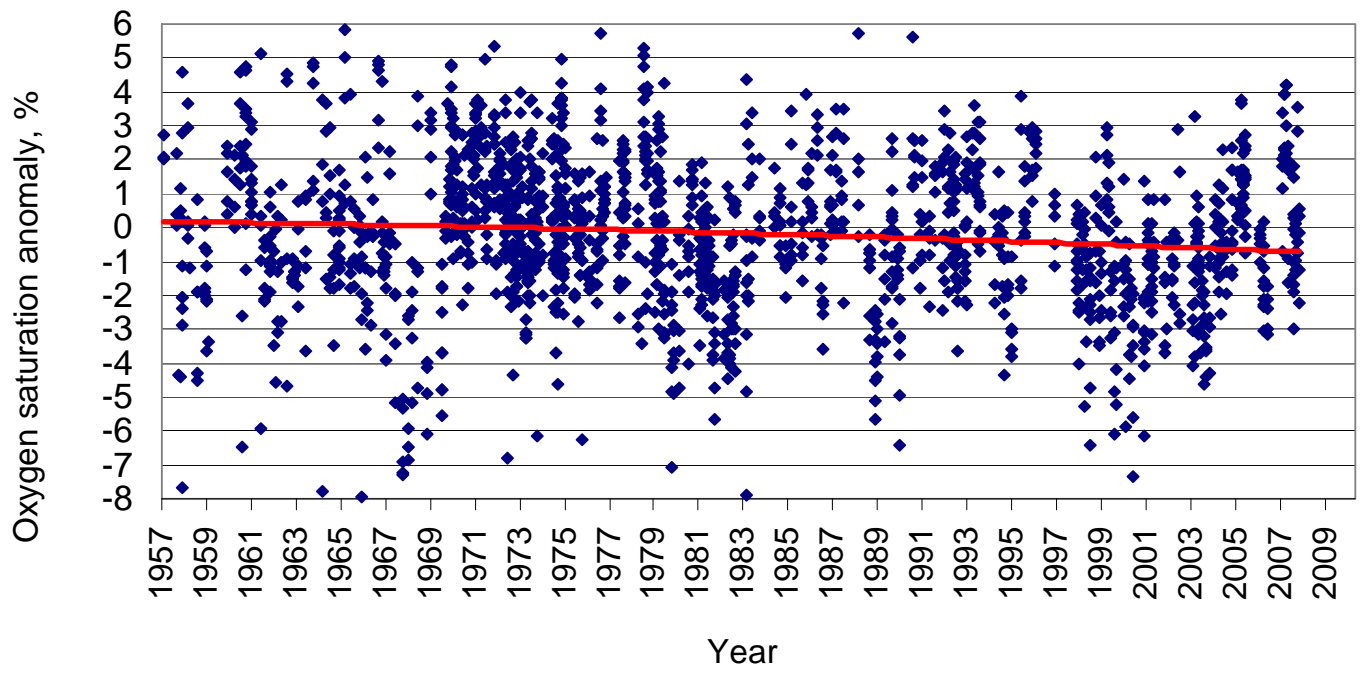
Oxygen saturation of bottom layers averaged for a number of years. The red line shows the position of the Kola section (left)

Oxygen saturation anomalies, smoothed by averaging for Stations 3-7 and by moving-average method for the previous year (OxSat) (right).



Results

■ Long-term changes in oxygen saturation in the Barents Sea bottom layers are characterized by statistically insignificant negative trend, with the largest decrease was observed in recent decades under climate warming.

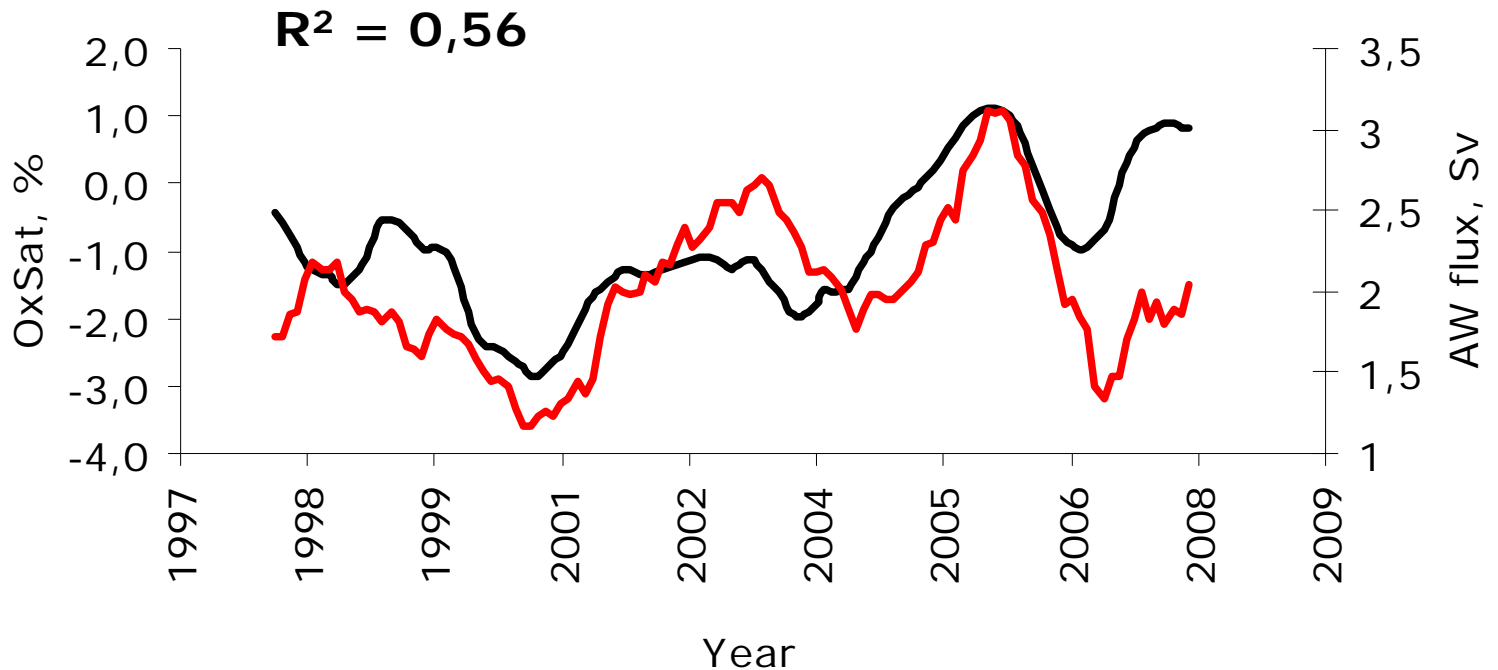


Oxygen saturation anomaly in bottom layers on st. 3-7 of the Kola section and logarithmic trend



Results

■ Aeration of bottom water in the Barents Sea directly depends on well-aerated Atlantic water flow into the Barents Sea

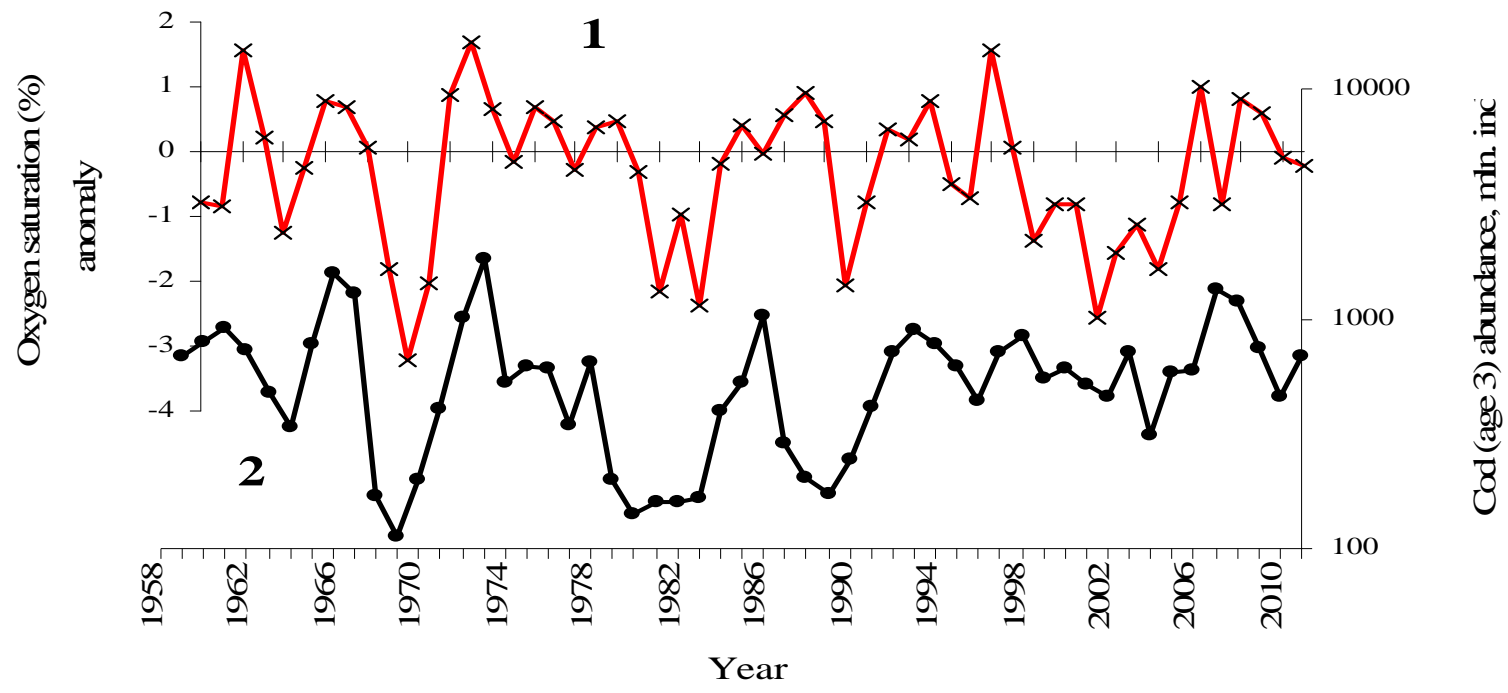


Monthly mean oxygen saturation anomaly in bottom layers of the Kola section (PINRO data) and volume flux from current meter moorings Fuløya-Bear Island (IMR data), smoothed by moving-average method for the year



Results

■ Strong cod recruitment on the whole appears in periods of increasing aeration of bottom layers, however this relationship is of complicated character.

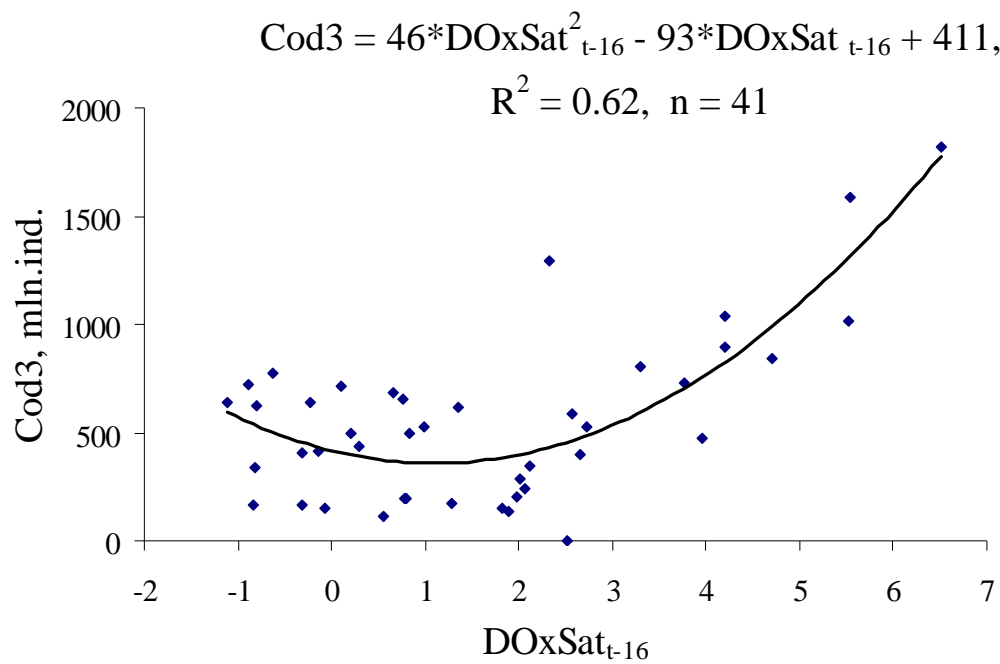


Oxygen saturation anomaly (1) in bottom layers of the Kola section, averaged for the year (April-March) before the recruitment of NEA cod yearclass at age 3 to the cod population and abundance of this yearclass (2) (Titov, 2001)



Results

■ Based on oxygen saturation data, up to 62% of NEA cod recruitment variability may be described.



Relationship of cod abundance recruitment (Anon., 2003) and DOxSat index. The inferior indices show a time lag (month) prior to April of the year when recruitment took place. The trend line and relationship equation are given.

$DOxSat = \exp(OxSat) - OxSat_{t-28},$

In the formula: OxSat – oxygen saturation, inferior indices mean time lags (month).



Conclusions

- The saturation bottom waters by dissolved oxygen is an indirect integral characteristic of water exchange in the southern Barents Sea. This is consistent with current meter moorings observations in the southwestern Barents Sea border and modern literature data (Emerson et al., 2001; Keller et al., 2002; Kim et al., 2000; Watanabe et al., 2001; Ono et al., 2001; Shaffer et al., 2000; Bindoff and Mc Dougall, 2000).
- Based on bottom aeration data for the past 50 years, it may suggest that the intensity of water circulation in the southern Barents Sea has almost unchanged or slightly decreased.
- Based on bottom aeration data, up to 62% of NEA cod recruitment variability may be described. Consequently, strength of cod generations depends on the intensity of water exchange in feeding areas.



**Thank you
for attention!**