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Some Remarks on Time-Series on Annual Intervals

by

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Abstract

The paper tries to enumerate the possible sources of variation which contribute to the measured variablity. Based on a short time series of temperature and salinity profiles at station 4 of the Fylla Bank section the problems of interpretation of the documented changes in the thermohaline fields is discussed. It is the final conclusion of the paper that since there are at present no better means available to sense ocean variability in West Greenland waters, standard station work should be continued. Each scientific research program which has the objective of fishery research, must necessarily cover these requirements in a wider or smaller range, but in a way which enables to work on data sets which are comparable, which are worth to be connected for longer climatic time-series.

Background

The grid of NAFO Standard Oceanographic Sections and Stations is a well accepted means to collect oceanographic data at comparable positions in the NAFO area. Based on this grid some very valuable data sets of temperature and salinity profiles have been accumulated during past decades, some of them covering already 4 decades. In combination with biological surveys these station grids have been sampled more or less completely. Calculations of variability of measured parameters on different time-scales have been performed and presented during past NAFO and ICNAF meetings, most of them are based on time-intervals of a year. All data sets were analysed with the basic **assumption of invariant position.** However, comparison of data sets obtained at the "same position" reveal different depths at same places, sometimes amounting to more than several hundreds of metres.

What is wrong with these standard station measuring philosophy? Is it worth to continue research along these lines of fixed grid measurements?

Sources of Variabilty

What is a standard station? According to NAFO recommendations (**ANON., 1988** and **STEIN, 1988**) the position is the essential criterion for a standard station and not the depth.

Several sources of variation contribute to the observed variability:

a) Position error

If a satellite fix is available, position determination should be good; if not, position determination has to be done by radar or other equipment which can lead to considerable differences in the accuracy of position determination.

b) Strong currents

Strong currents at the station site (e.g. Fylla Bank Station 4) cause ship's drift. This implies that depth varies during measurement. If there is wind, the vessel steams to keep a vertical wire angel during the performance of the profile, if there is no wind, the vessel drifts slowly, the position varies, the depth varies.

c) Problems encountered due to preconditioning factors

Considering we measure in the month of November in West Greenland waters. There is pre-conditioning by atmosphere (**STEIN and BUCH, 1990**) and ocean. Different wind regimes lead to different situations in the Ekman layer (**STEIN and BUCH, 1985**). Ice transport varies on different time- and space-scales (**STEIN, 1989**). During the 1989 autumn season there were anomalous amounts of icebergs in the southwest sector off West Greenland with a distinct cut-off in the distribution of bergs south of Frederikshaab glacier. This glacier is one of the largest iceberg sources for West Greenland waters. The advection of icebergs from East Greenland around Cape Farewell to areas like Julianehaab bight leads to increased **injections of cold and diluted polar water** to the West Greenland Current system. The signal of advected polar water to southwest Greenland waters emerges from anomaly computations as performed for standard stations in this area for the years 1983 to 1989 (**STEIN, 1990**).
Air pressure distribution on the large-scale (e.g. high pressure cell off East Greenland) may lead to a **blocking situation** for cyclones travelling northeastwards from the North American continent. Increased inflow of warm air masses as experienced in November 1989 consequently leads to warming of the surface layers.

d) Variability inferred by depth of considered water layer

Standard deviation is maximal in the upper 30 to 50m of the water column (e.g. turbulent mixing, Ekman drift, seasonal variation), whereas variability in deep water layers, e.g. below 200m metres depth should be low. This affects calculated means, mean profiles etc.

e) Meso-scale fronts and eddies

Another source of changes inferred to the thermohaline fields at a given standard station can emerge from the passing of meso-scale fronts and eddies. Unless synoptic mapping, or observations on a short time-scale are available, this variability is difficult to attribute.

Results

Figures 1 and 2 display a time series of temperature and salinity observations at Fylla Bank Station 4 between November 10 and 17, 1989, Table 1 gives position, depth, wind, air temperature and air pressure information.

As indicated in table 1, positions vary by about 300m to about 1000m from the given standard position which is 63°53.00'N, 053°22.00'W. Although the profile obtained on November 17, 1989 was performed on the standard position, the depth value is about 300m larger than the value as given in the above mentioned papers(**ANON., 1988** and **STEIN, 1988**).

Wind ranged from 3 Bft to 7 Bft, blowing mostly from the northeast. Air temperatures were mostly below 0°C.

Sea surface temperatures varied from -0.65°C in the upper 30m (891110), to -0.15°C (891113), 0.04°C (891114), 0.8°C (891116), and 1.2°C (891117). The thermal profiles indicate surface layer heating from below, which emerges clearly from the data on November 16, 1989 (c.f. fig. 1 right half).

Salinity indicated a similar development from low values during the beginning to more saline conditions versus the end of the observation period.

At depth, the thermohaline fields reveal tremendous changes, especially in the temperature distribution below 200m depth. On November 17, 1989 the entire water column below 400m depth was inhabited by water of more than 5°C. Salinity is above 34.8 PSU at these depths, with vertical displacements of the 34.8 PSU isohaline of about 100m.

Conclusions

It would appear that the changes in the thermohaline fields as observed at depth on November 13, 1989 and November 14, 1989 refer to the large distance of the profile position by about one kilometre from the standard station (979m and 1049m, respectively). Due to the filar structure of the West Greenland Current system, with the polar and Irminger current component governing the hydrographic scenario, position inaccuracies of about one kilometre can easily lead to measuring in different bands of the Irminger component at station 4 of Fylla Bank section. If one considers meandering of these bands, the first measurements could easily have hit a cooler portion of the current bands than the observations on November 13, 1989 and November 14, 1989. Temperature anomaly computation for the upper 200m, as performed since 1963 for this standard station, is based on annually sampled profiles, obtained during the autumn season. The derived 1989 mean profile incorporates largest variability in the upper 50m of the surface layer, amounting to as much as ±0.9°K for the 30m standard depth value. Taking one individual profile for anomaly computation, implies either a cold surface layer due to preconditioning (891110), or a warmed surface layer (891117). In the deep layers thermal variability amounts to a maximum of ±0.2°K.

Oceanographic features like internal waves may also contribute to the picture in the deeper layers as depicted by the salinity field (fig. 2).

Very little can really be said about the oceanographic mechanisms which form the mid November picture as given in figs. 1 and 2. What we can do is just try to explain some of the features. However, the intial question, whether it is worth to continue measuring on an annual basis along the lines of standard sections, has yet to be answered.

The best approach to measure variabilty in West Greenland waters would be a measuring grid of moored, towed, and remote sensed data sets. This is not available and not feasible. Chains of moored devices may be seriously damaged or even lost due to the wild ocean scenario on the West Greenland banks. Remote sensed data are very scarce due to the cloud cover, and they just pic up information from a fraction of the upper millimeter of the surface layer.

Since our interest is dedicated to obtain the variability in the water column, we have to rely on profiling techniques, or towed device techniques. We have to continue along the station orientated measuring programmes, i.e. along standard positions. We should try to repeat measurements as often as possible on these standard stations on different time scales, to gain insight into the complex web of ocean climate variability. This requires ship time and modern profiling techniques, since it is **not worth to scratch** just the **upper 100m of the water column.** It is the **entire water column** which has to be sampled regularly since the exchange of salt and heat, to enumerate the most measured parameters, is essential both on the horizontal and on the vertical through advection and turbulent mixing.

Each scientific research program which has the objective of fishery research, must necessarily cover these measurements in a wider or smaller range, but in a way which enables to work on data sets which are comparable, which are worth to be connected for longer climatic time-series.

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Table 1: Station data of Fylla Bank Station 4 observations

Latitude	Longitude	Date	Depth [m]	Wind [°]	[kn]	Air T.	Press.
63°53.01'N	053°22.57'W	891110	939	341	30.0	-3.2	1017.7
63°52.91'N	053°21.62'W	891113	1002	046	17.5	-1.6	992.0
63°52.80'N	053°21.81'W	891114	877	048	19.9	0.5	979.5
63°53.32'N	053°22.14'W	891116	795	002	10.2	-3.8	1004.3
63°53.00'N	053°22.00'W	891117	902	053	12.2	-5.3	1015.7

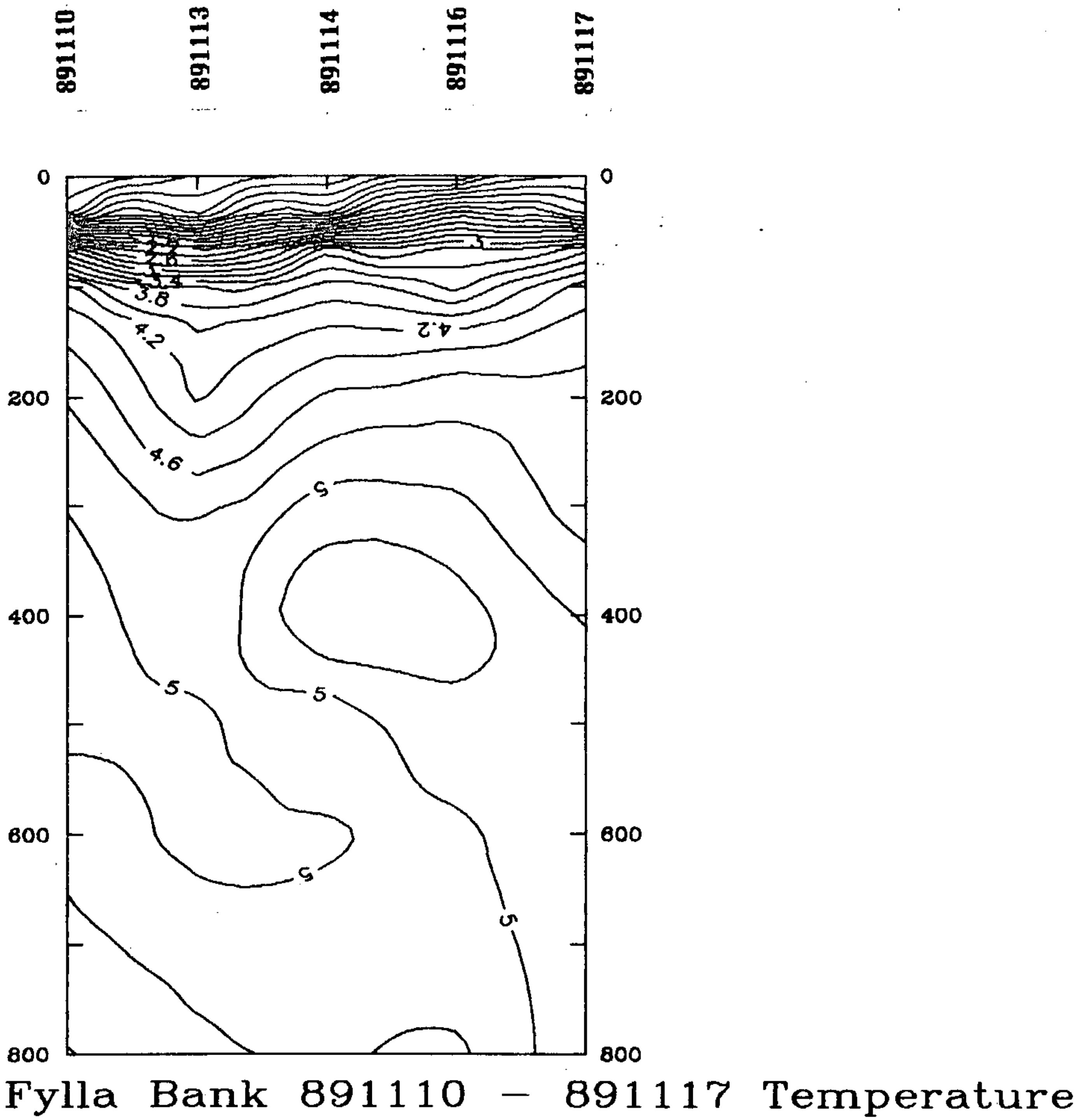

Figure 1 Time-series of temperature at Fylla Bank Station 4/West Greenland

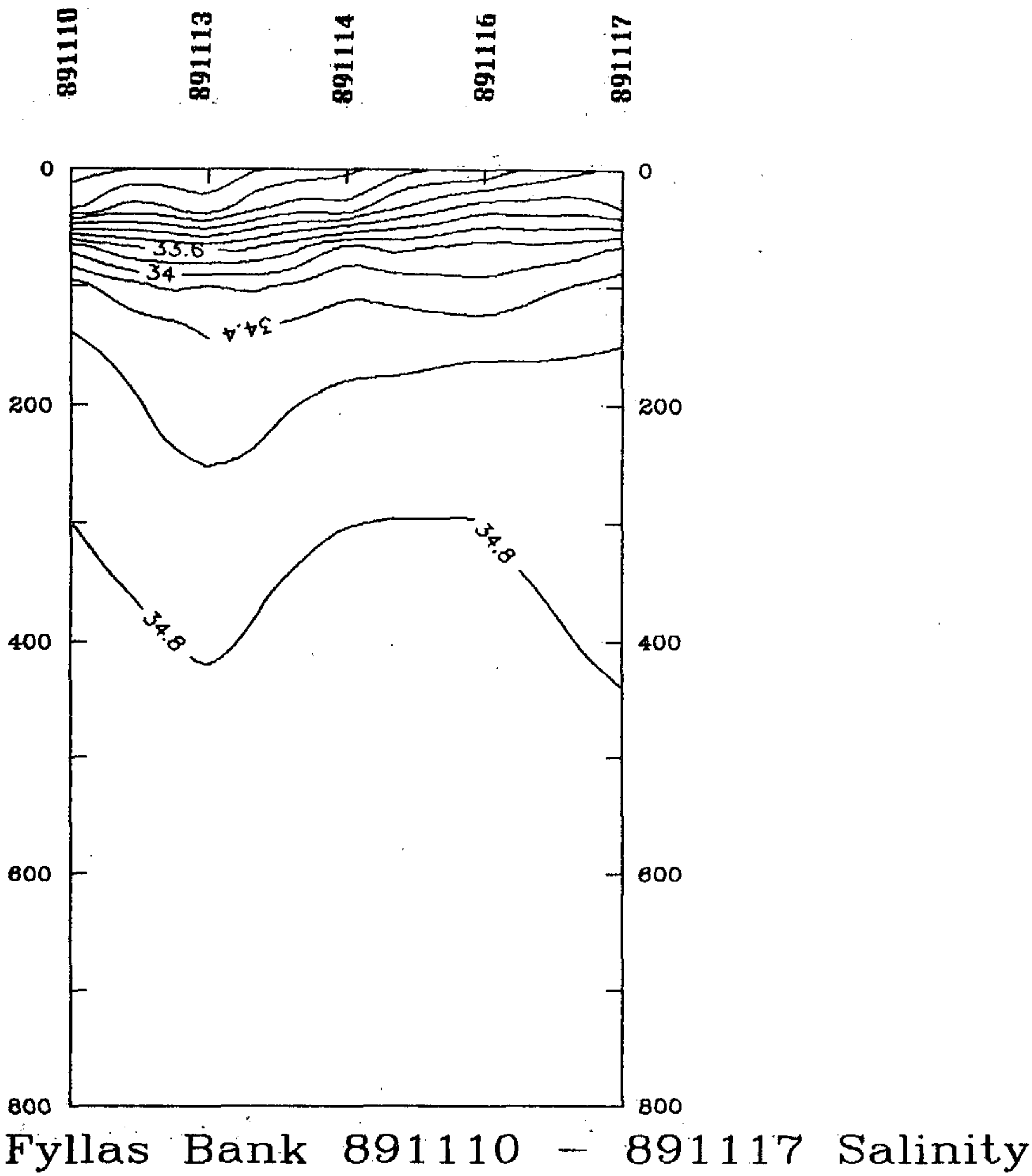

Figure 2 Time-series of salinity at Fylla Bank Station 4/West Greenland