The retroflection of the Faroe Current into the Faroe-Shetland Channel

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Summary

The Faroe Current (FC) flows eastward north of the Faroes, but when it reaches the northeastern corner of the Faroe Plateau a part of it is retroflected back into the Faroe Shetland Channel (FSC). Here Mean Sea Level Anomaly (MSLA) data and current mooring data are used to explore the variability of the retroflected FC. An EOF analysis of the MSLA indicates that there is a link between the MSLA over the central Nordic Seas and the strength of the FC and its retroflection. The first PC is compared to velocity data in the FC and the FSC. The comparison indicates that the variability of the MSLA is reflected in the velocities in the FC and along the slope on the Faroese side of the FSC, but not in the central part of the channel. The first PC has a strong seasonal signal resulting in the strongest velocities in January. Additionally, the first PC has an inter-annual variability that can be interpreted to cause the apparent variable strength of the reflected FC and how far it progresses into the FSC.

Introduction

The flow of warm and saline water from the Atlantic Ocean, across the Greenland-Scotland Ridge into the Nordic Seas is an important source of heat and salt to the Arctic region. Nearly half of the inflow flows through the Iceland-Faroe gap and converges in the FC to the north of the Faroe Islands. At the northeastern corner of the Faroe Plateau a part of the FC is retroflected back into the FSC where it re-circulates and joins the inflow of Atlantic Water from the Slope Current.

The volume transport in the FC has been monitored since 1997 and shows both short-term and long-term variability, but no significant seasonal variation (Hansen *et al.*, 2010). On the other hand, the retroflected branch of the FC shows a seasonal variability as does the net inflow of warm water through the FSC (Berx *et al.*, 2013). Additionally, the along channel location of the recirculation in the FSC seems to have inter-annual variability and can apparently take place far south in the channel.

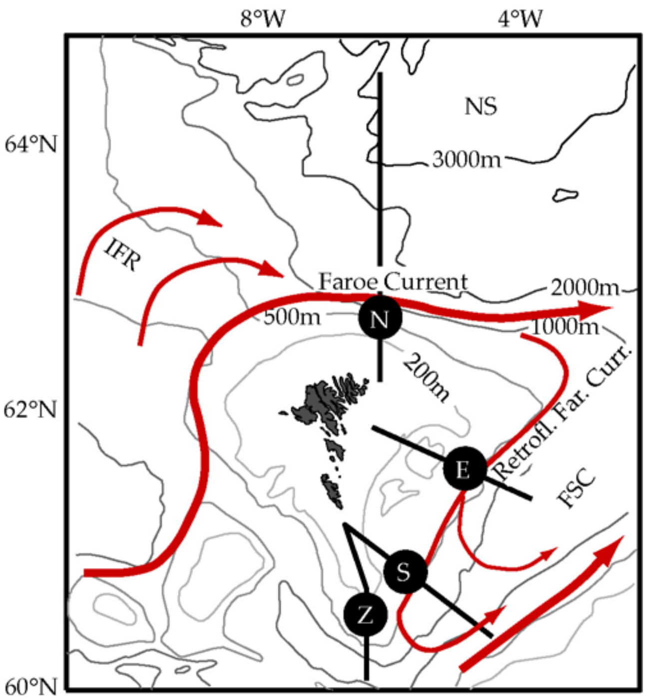

Figure 1. Topography of the Fareo Plateau and surroundings showing the Iceland-Faroe Ridge (IFR), the Nordic Seas (NS) and the Faroe Shetland Channel (FSC). Red arrows indicate inflow of Atlantic Water. Black lines indicate standard sections, were each is labelled with a letter. ADCP mooring sites are along these sections.

Materials and Methods

Current velocity data are obtained from Acoustic Doppler Current Profiler (ADCP) mooring sites on section N (Figure 1) crossing the FC north of the Faroe Islands and along the Faroese side of the FSC. In the channel ADCP data are available from three sections – from north to south these sections are termed E, S and Z (Figure 1). Some of the mooring sites have been monitored since the mid 1990ies while other sites have been monitored in shorter periods only. The current velocity data are de-tided and daily average velocities are calculated. From these, monthly average timeseries are produced for each mooring site.

The current velocity data are compared to sea level height from satellite altimetry. These are MSLA obtained from AVISO. The data are on a rectangular grid with approximately 18 km resolution and are sampled once a week. For this purpose a rectangle covering the area (60°N – 65°N; 12°W – 0°W) has been selected and used in the analysis. Samples from each month are averaged to a monthly timeserie for the period October 1992 – December 2012. Additionally, an EOF analysis is performed on the weekly data producing patterns of mode 1 and mode 2 and their respective PCs.

Results and Discussion

Mode 1 from the MSLA EOF analysis represents the variability of the sea level height over the central Nordic Seas with a clear extension into the FSC. North of the Faroes the FC has its path along the border of this mode. Dynamically, we can expect a relation between the lowering of the sea level height over the Nordic Seas and the flow in the FC. Thus, current velocities at approximately 200m depth from all ADCP sites have been compared with both the first and second PC from the MSLA EOF analysis. As expected, large correlations were found between the first PC and a long term site in the FC both for along topography and cross topography velocities. Additionally, velocities from two short term mooring sites on the sloping topography in the FSC correlated well with the first PC. The correlations were found for along channel velocities and these two sites were located at section E and S, but there is no temporal overlap between the sites. A similar short term site at section Z did not correlate with the first PC. Velocities in the central part of the channel mainly had none or weak correlation with the first PC, but at a site on section S situated higher up on the plateau cross channel velocities correlated (at better than 5% level of sign.) with the first PC. The second PC (for mode 2) was also correlated with the site in the FC and with along channel velocities at the two shallowest sites at section S, but these correlations were weaker than for the first PC.

These results indicate that when the first PC is strongly negative (i.e. the sea level height over the Nordic Seas is low) this strengthens the currents along the rim of the Nordic Seas and even deep into the FSC. The circulation in the FSC is known to be complex and highly variable (Berx *et al.*, 2013), and generally the retroflected FC is considered to reach only half way into the FSC before it is re-circulated. Here we find that it at least periodically can reach section S more than half way through the channel. One of the long term sites at section S located at the foot of the shelf break has a weak correlation with the first PC, but analysis of individual years indicate that the retroflected current has inter-annual variability and does not always reach this far into the channel. This is in agreement with Chafik (2012), which finds a relation between the extent of the retroflected FC and the NAO index.

Thus apparently, the variability of the retroflected FC is linked to the variability of the first PC. A power spectrum analysis of the first PC shows a clear annual variability and some longer term variability. A seasonal analysis showed that the first PC is strongest in January which is consistent with other findings (Berx *et al.*, 2013). Some inter annual variability can be seen in the first PC and it might be suggested that the strongest years are able to create a strong retroflection of the FC. Unfortunately, the strongest winters are before the ADCP measurements were initiated.

References

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