Surface current patterns in the Ibiza Channel with the use of High Frequecy Radar system

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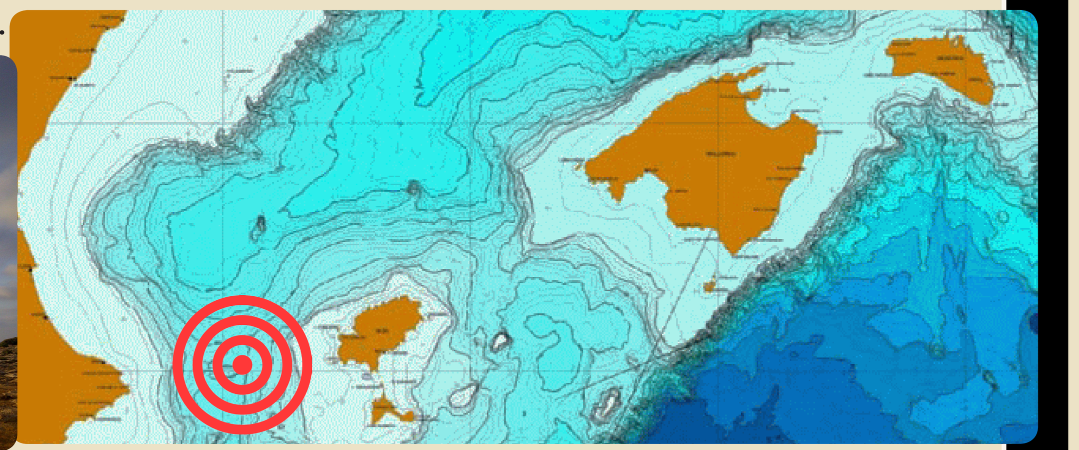
Abstract

The Ibiza Channel is a well-known biodiversity hot spot. This area is relevant due to the interaction of water masses coming from the Atlantic Ocean - ascending through the Iberian Peninsula coast - with the older Atlantic waters descending from the Gulf of Lion. The deployement of a **High Frequency Radar**, part of the SOCIB monitoring multi-plataform system (www.socib.es), provides hourly surface current maps.



The HF Radar consists of two CODAR SeaSonde antennas located in Ibiza and Formentera islands (GALF and FORM stations). The system operates operationally since June 2012 up to now. Radial data are processed from each antenna, and combined in order to produce total surface data. Radial and total data are Quality-Controlled in order to ensure that the data being produced are of the highest quality. The automated **Quality Control** procedures implemented at the **SOCIB HF Radar Facility** are reviewed.

System description

HF Radar system:

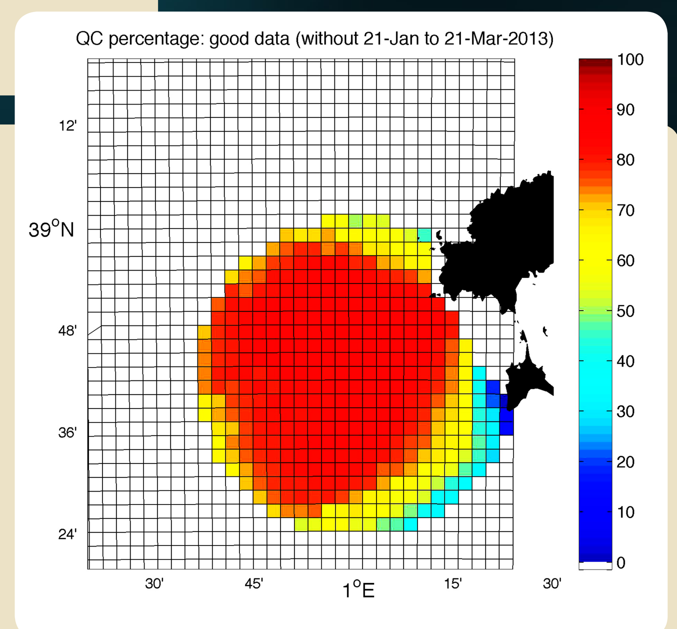
Two Tx-Rx antennas situated in two islands (Ibiza and Formentera)
Tx Central Frequency: 13.5 MHz, Bandwidth: 90 kHz
Radial Resolution: 3 km, angular resolution: 5 deg
Radial Range ~ 80 Km
Temporal Coverage: 75 min, moving average, hourly data
Grid resolution: 3 km

QA/QC

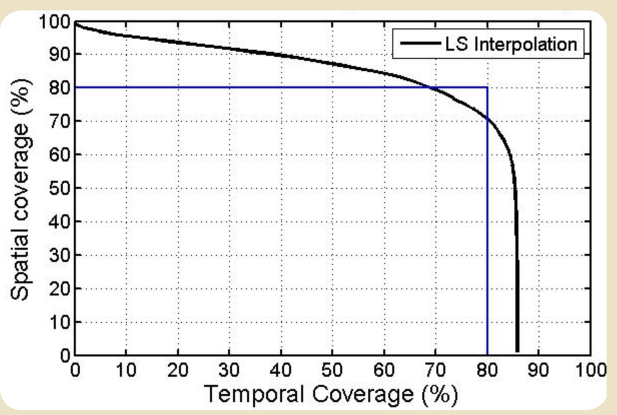
QA/QC procedures - additionally to CODAR QC, based on international references, MARACOOS (Roarty et al., 2012) and UCSB (Emery and Washburn)

Radial parameters selected as system performance quality:

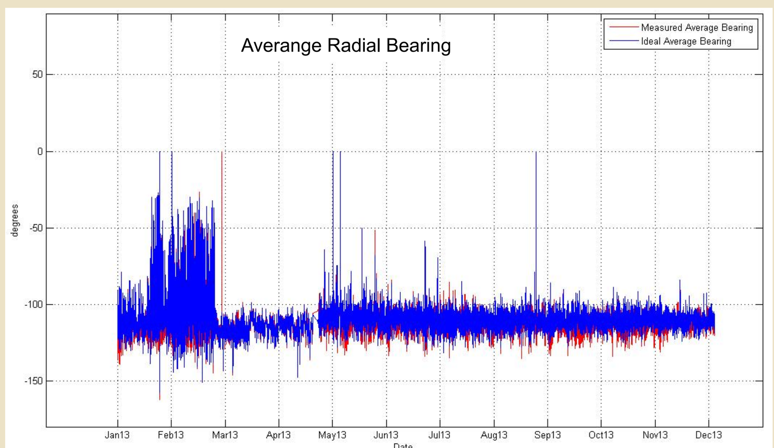
- **Signal to Noise Ratio**: it gives an indication of the signal strength from which the radials are computed. If they are too low, radial quality is not reliable.
- **Total number of Radial Vector solutions**: Radial vectors found at different bearings and ranges. It is a clear indication of system health.
- **Averaged Bearing of all radial vectors**: A sharp change in this values may indicate an antenna problem.
- **Comparison between radial ideal and measured Bearing**: if the distortion of the environment is low or the antenna is in good conditions, these two measurements should be close to each other.



Percentage of good data in the SOCIB HF Radar coverage for the period: June 2012 - April 2014



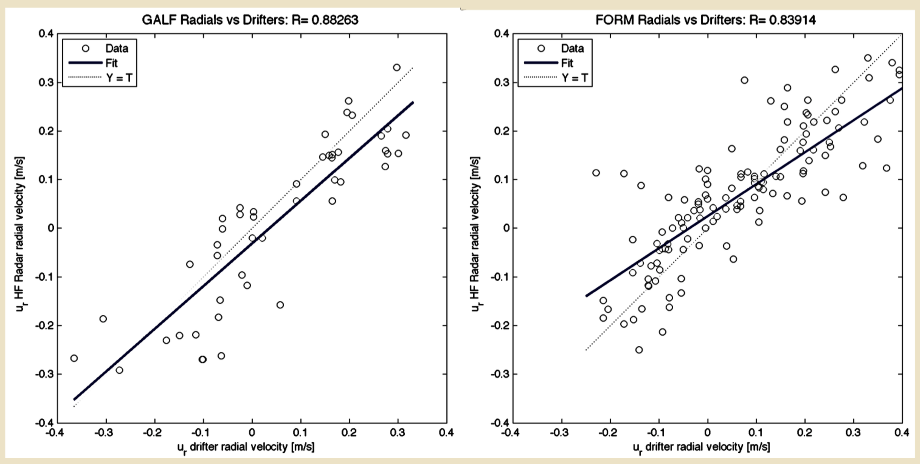
Temporal and Spatial coverage of SOCIB HF Radar for the period of functioning taking into account the QC flags applied to the SOCIB HF Radar facility. For the period between June 2012 - April 2014.



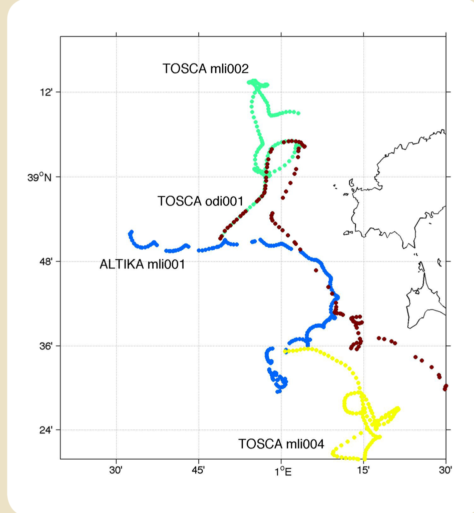
Example of the differences between the Average Radial Ideal and Measured Bearing for a period of no-functioning system

System validation

The validation and assessment of HF radar currents is performed by comparing them to currents derived from surface drifters. **Surface drifter velocity** is descomposed in **radial components** and compared against the radial vectors from each of the individual antennas, obtained from two different oceanographic campaigns: TOSCA (in the frame of the Med TOSCA project) and G-ALTIKA (as part fo the MyOcean2 project).
The correlation values are in agreement with similar studies (eg. Cosoli et al. 2013, Rubio et al, 2014, Ohlmann et al 2007, Rypina et al. 2013).



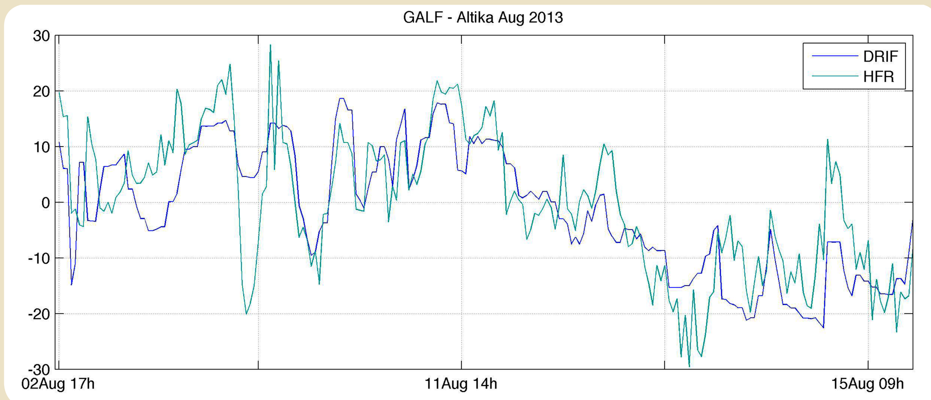
Scatterplots of TOSCA drifter odi001 (as example) for GALF and FORM

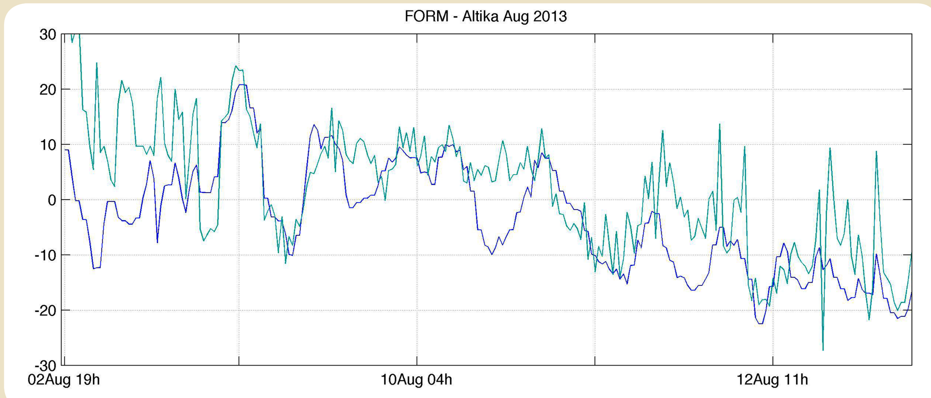


Trajectories of the drifters released in the area of the HF Radar that are compared against radial and total Radar-derived velocities.

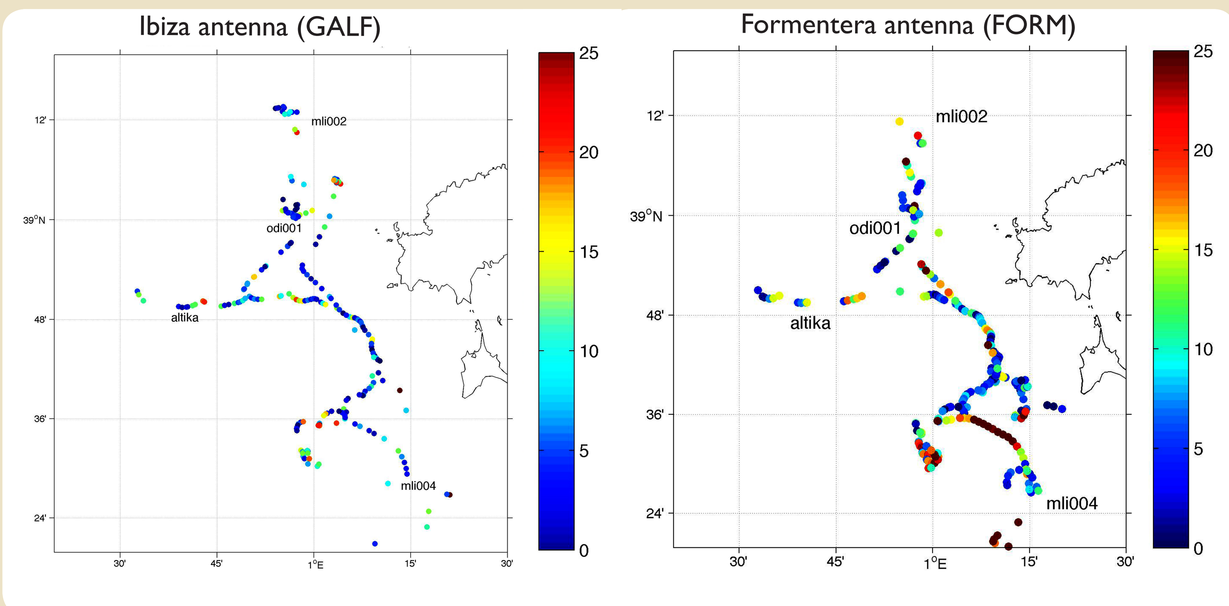
HF Radar derived hourly velocities are 75 min running mean average centered each hour, therefore, in order to be consistent with the processing of Radar data for the sake of comparisons, drifter derived velocities have been averaged over 75 min periods centered at each integer hour.

In order to have a more visual representation of the drifter-radar derived velocities comparison, the temporal evolution and the spatial differences were computed to indentify the moments and areas where there is a higher or lower agreement between HF Radar radial data and drifter velocities.





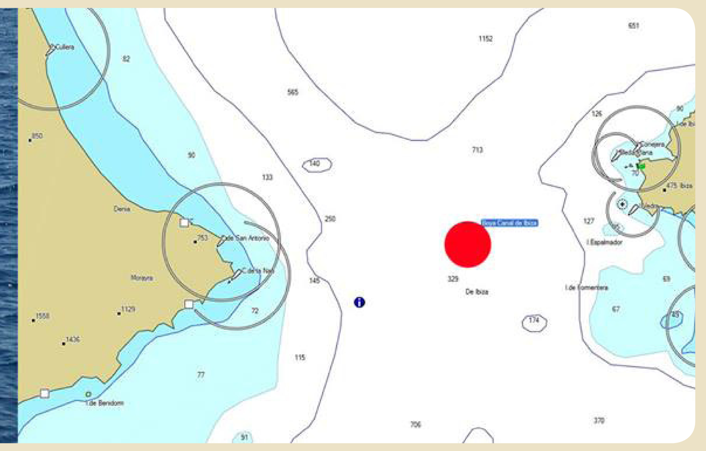
Temporal evolution of the hourly HF Radar radial velocity against MLI001 drifter derived velocity. For GALF and FORM radial velocities



Difference between HF radial velocity and surface radial current data at each drifter position for GALF (left) and FORM (right) stations.

IBIZA Channel MOORING

A surface (1 m depth) current meter (SCB-FSI002) was deployed in the Ibiza Channel in 24th September 2013, located 40 kms from GALF station and 55 kms from FORM station. The data will be a useful tool to validate the HF Radar data.

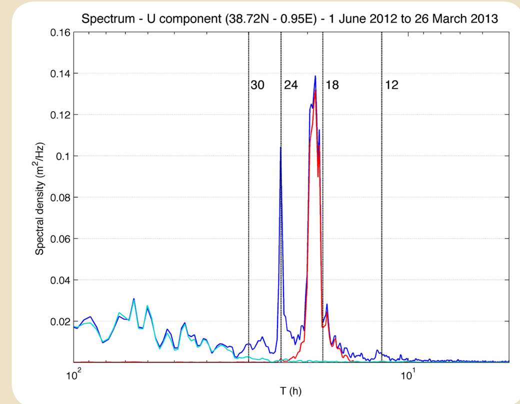


References:

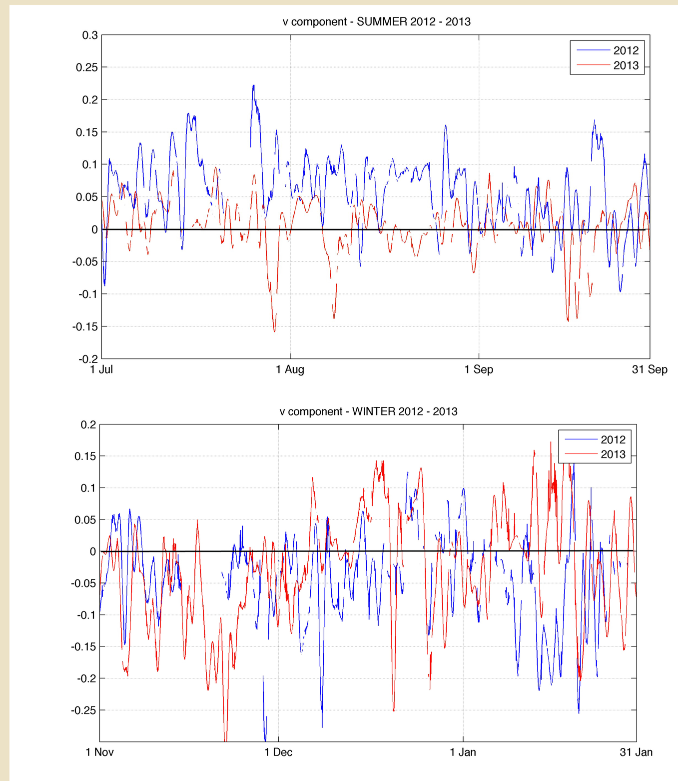
Cosoli et al. 2013, Surface circulation in the Gulf of Trieste (northern Adriatic Sea) from radar, model and ADCP comparsons. *Journal of Geophysical Research - Oceans, Vol 118, Issue 11, pages 6183-6200*
Lohitzune et al. 2014, Surface water circulation patterns in the southeastern Bay of Biscay: New evidences from HF radar data. *Continental Shelf Research 2014-02, vol 74, p. 60-76*
Ohlmann et al. 2007, Interpretation of Coastal HF Radar-Derived Surface Currents with High-Resolution Drifter Data. *Journal of Atmospheric and Oceanic Technology vol 24, p. 666*
Rypina et al. 2013, Results from a mass drifter deployment in the coastal ocean near Martha's Vineyard, MA: testing the correspondence to high-frequency radar surface currents. *Submitted*
QC reports:
Emery and Washburn, "Evaluation of SeaSonde Hardware Diagnostic Parameters as Performance Metrics", *UCSB, technical Report.*
Roarty et al 2012 "Automated Quality Control of High Frequency Radar Data", *OCEANS*

Surface circulation patterns and variability: spectrum analysis

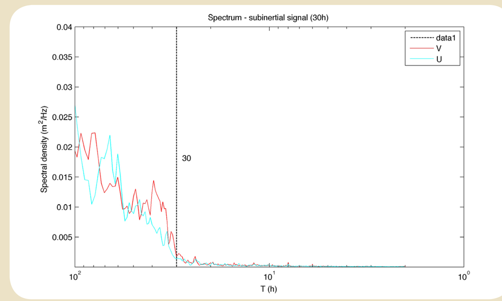
Power spectra are used to indentify inertial, subinertial and tidal (diurnal and semidiurnal) signals in the surface ocean currents from HF Radar. Dominant peaks are observed in the spectral energies. A Lanczos filter was applied to the time series at each node in order to analyse the surface current patterns at different time scales of variability. A low-pass filter (filtered out T<30h signal) is applied to isolate sub-inertial, and a band-pass to isolate the tidal oscillations.



Power spectra inferred form HF Radar surface velocities for a central gridpoint.



SUB-INERTIAL component:

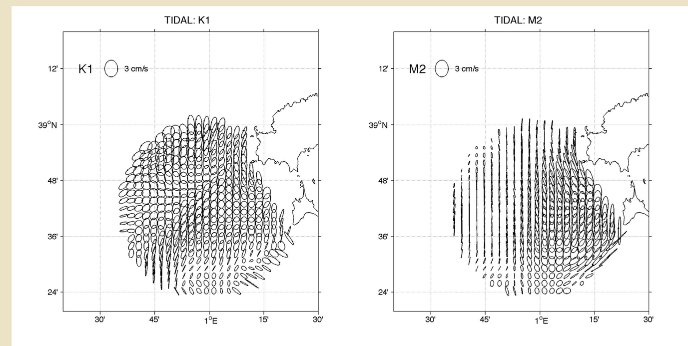


The resulting low-frequency surface velocity fields were averaged for summer and winter periods to study the seasonal variability of the observed fields.

Summer: Temporal evolution of the meridional transport (north-south component) through an horizontal section shows a Northern current tendency.
Winter: Temporal evolution through an horizontal section shows a mean Southern surface current.

TIDAL component:

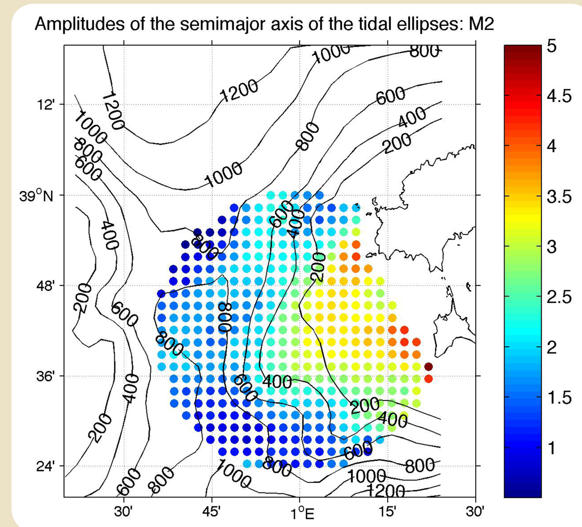
The diurnal current component (K1) dominates according to the spectral and harmonic analysis. The principal lunar semi-diurnal tidal (M2) shows an energetic signal in the spectral analysis of the HF surface currents, much lower than the diurnal signal. The geography and bathymetry of the Ibiza Channel area have an important influence on the distribution of the tidal filtered surface currents.



Tidal ellipses for the K1 and M2 tidal signals. The diurnal K1 signal shows a northeaster orientation, and higher amplitudes

Symbol	Name	Period	Amplitude of major axis (mean cm/s)	Phase (mean degrees from Greenwich)
K1	Linusolar diurnal	24h	2.26	85.10
M2	Principal lunar semidiurnal	12.42	2.1	142.09

Amplitude of semimajor axis of the tidal M2 component



Conclusions

HF Radar is a valuable tool to identify the surface current variability, seasonal patterns and mesoscale structures at the ocean surface.

An automated **QC procedure** in accordance with international standards has been implemented in SOCIB HF Radar facility.

Dominant energy peaks in the spectrum are located at diurnal, semidiurnal and local inertia for both U and V components. Low-pass filtered sub-intertial currents show a seasonal variability: southward in winter period and northward in summer.

Velocity ranges, seasonal and spatial distributions are measured for the first time with the use of the HF Radar surface measurements. The magnitude of the main tidal currents (2.3 cm/s for the K1 constituent) has been measured and related with the bottom topography (larger amplitude in the shelf area).

More **validation experiments** against *in-situ* instruments and comparation with **ocean models** are needed.

The relevant north-south surface water transport exchange variability will be further studied.