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# BEAWARE II : Data Provision Report

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Project BE-AWARE II
Reference A036390 (COWI reference)
Document version: 0.4
Date: 2014/11/07

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# 1. Introduction

The BE-WARE I and II projects are projects coordinated by the Bonn Agreement secretariat in order to further develop and coordinate the response capacities to face oil pollution in the greater North Sea. These developments should also be based on risk assessments, gap analysis and regional and sub-regional approaches. Therefore it is essential to assess the alternatives to ensure that investments in future response and risk reducing technologies deliver the optimal effect at the regional and sub-regional scale.

The BE-AWARE I project, which ran from 2012-2014, laid the ground for this analysis by assessing the risk of oil pollution both now (2011) and in the future (2020) was well as the likely size of any spills. However in order to assess which methods and technologies will be most effective in reducing and responding to oil pollution further analysis is required.

BE-AWARE II will therefore model the outflow of oil from the spills predicted in BE-AWARE I for ten different response or risk reducing scenarios, taking into consideration the hydrodynamics of the North Sea Region. This will be combined with and analysis of the environmental and socioeconomic sensitivity of the region to assess the impact of the different scenarios. Based upon these and the cost of implementing the measures risk management conclusions will be develop for each of the 5 project sub-regions.

The project is a two year initiative (2013-2015), co-financed by the European Union (DG ECHO), with participation from the Bonn Agreement Secretariat, Belgium, Denmark, France, the Netherlands, Norway, Sweden and the United Kingdom, and co-financing from Ireland and Germany. COWI has been mandated as main consultant to carry out most of the technical work. RBINS-MUMM is acting as sub-consultant, providing its expertise in the North Sea hydrodynamics.

This Data Provision Report collates and presents wind, tidal currents and residual currents information that will further be used by COWI in its oil spill drift modelling work.

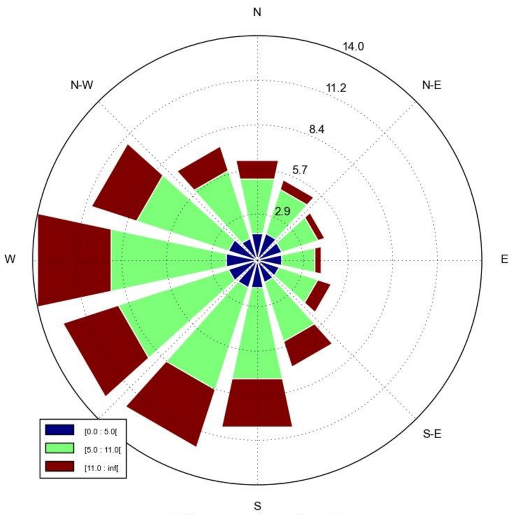
# 2. Wind data

The statistical distributions of wind speed and wind direction vary throughout the project area. In order to include the variance in the subsequent analysis, the project area is subdivided into meteorological sub-regions. Each meteorological sub-region is selected so the wind data approximately are homogeneous and that are significantly different from the neighbouring area. The statistical wind description is given as monthly wind-roses at numerous locations in the project region, provided in (Admiralty, 2011). Seven meteorological sub-areas have been identified by COWI.

Figure 1 present the wind rose for the 7 locations marked as A to G, each location being representative of a meteorological sub-region. The data are derived and interpolated from the UK met office global meteorological forecast RBINS-MUMM uses to force its marine forecast models. The actual data are provided in annexes spreadsheets.


Figure 1: Location of the 8 wind stations at which wind roses are computed

## Station A (52.642771°N; 11.331501°W)

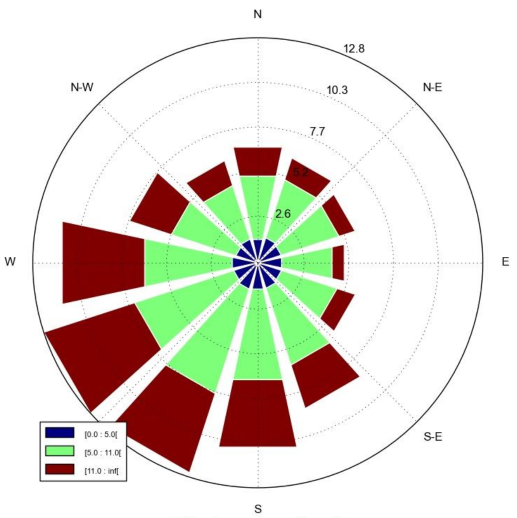



Windrose location A

| Station A | | | Wind speed interval | | |
|---|---|---|---|---|---|
| | | | W < 5 m/s | 5m/s < W & W < 11 m/s | 11m/s < W |
| wind sector | 345°-15° | North | 1.69 | 3.48 | 1.19 |
| | 15°-45° | | 1.75 | 2.89 | 0.63 |
| | 45°-75° | | 1.61 | 2.38 | 0.44 |
| | 75°-105° | East | 1.55 | 2.11 | 0.42 |
| | 105°-135° | | 1.43 | 2.53 | 0.89 |
| | 135°-165° | | 1.45 | 3.88 | 1.67 |
| | 165°-195° | South | 1.75 | 5.80 | 3.09 |
| | 195°-225° | | 1.79 | 6.70 | 3.80 |
| | 225°-255° | | 1.88 | 7.23 | 3.63 |
| | 255°-285° | West | 1.97 | 7.36 | 4.69 |
| | 285°-315° | | 1.89 | 6.02 | 2.97 |
| | 315°-345° | | 1.43 | 4.45 | 1.60 |

**Table 1: Percentage of the 36 different wind classes at station A**

## Station B (57.999236°N; 8.821067°W)

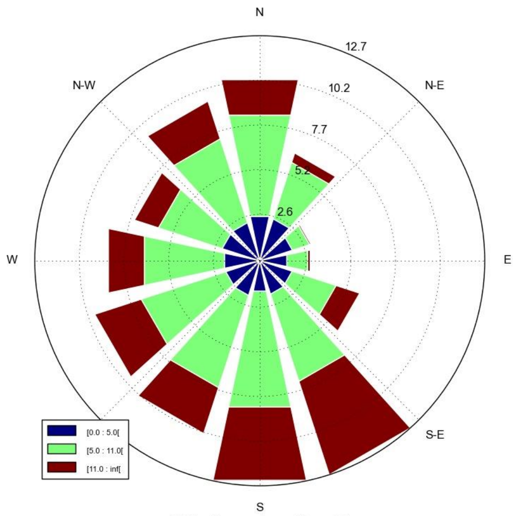



Windrose location B

| Station B | | | Wind speed interval | | |
|---|---|---|---|---|---|
| | | | W < 5 m/s | 5m/s < W & W < 11 m/s | 11m/s < W |
| wind sector | 345°-15° | North | 1.36 | 3.70 | 1.70 |
| | 15°-45° | | 1.50 | 3.48 | 1.31 |
| | 45°-75° | | 1.40 | 3.47 | 0.97 |
| | 75°-105° | East | 1.39 | 2.94 | 0.72 |
| | 105°-135° | | 1.43 | 3.33 | 1.10 |
| | 135°-165° | | 1.53 | 4.60 | 2.62 |
| | 165°-195° | South | 1.53 | 5.29 | 3.94 |
| | 195°-225° | | 1.58 | 6.26 | 4.76 |
| | 225°-255° | | 1.44 | 5.94 | 5.46 |
| | 255°-285° | West | 1.48 | 5.11 | 4.82 |
| | 285°-315° | | 1.31 | 3.87 | 2.52 |
| | 315°-345° | | 1.42 | 3.21 | 1.50 |

**Table 2 Percentage of the 36 different wind classes at station B**

## Station C (60.162441°N; 1.862944°E)

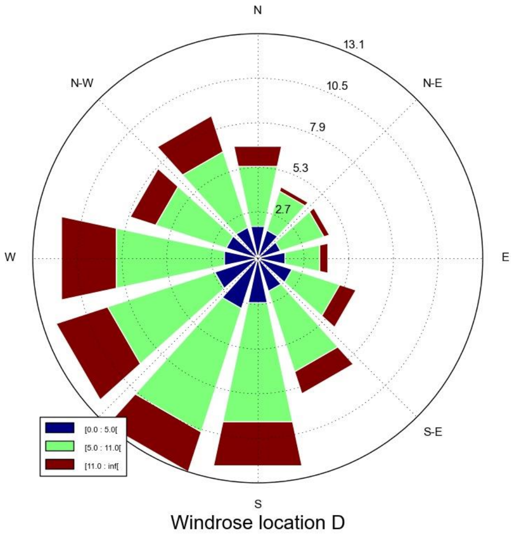



Windrose location C

| Station C | | | Wind speed interval | | |
|---|---|---|---|---|---|
| | | | W < 5 m/s | 5m/s < W & W < 11 m/s | 11m/s < W |
| wind sector | 345°-15° | North | 2.55 | 5.86 | 2.06 |
| | 15°-45° | | 2.48 | 3.36 | 0.56 |
| | 45°-75° | | 1.94 | 1.02 | 0.09 |
| | 75°-105° | East | 1.56 | 1.21 | 0.14 |
| | 105°-135° | | 1.92 | 2.62 | 1.40 |
| | 135°-165° | | 1.98 | 5.19 | 5.56 |
| | 165°-195° | South | 1.75 | 6.70 | 4.24 |
| | 195°-225° | | 2.06 | 5.49 | 2.73 |
| | 225°-255° | | 2.01 | 5.04 | 2.77 |
| | 255°-285° | West | 2.03 | 4.64 | 2.09 |
| | 285°-315° | | 2.23 | 3.80 | 1.43 |
| | 315°-345° | | 2.26 | 4.99 | 2.24 |

Table 3 Percentage of the 36 different wind classes at station C

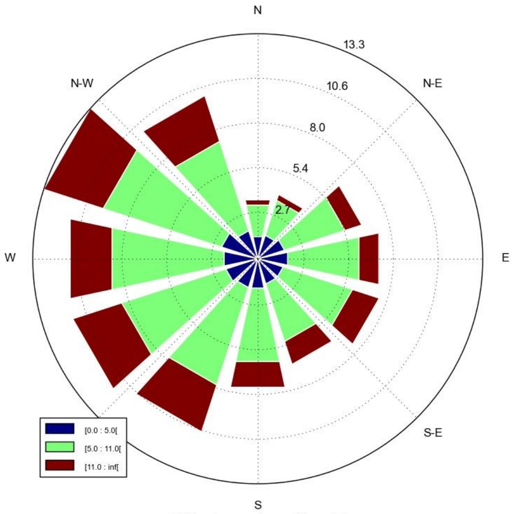
### Station D (55.755592°N; 0.347137°W)




| Station D | | | Wind speed interval | | |
|---|---|---|---|---|---|
| | | | W < 5 m/s | 5m/s < W & W < 11 m/s | 11m/s < W |
| wind sector | 345°-15° | North | 1.89 | 3.58 | 1.21 |
| | 15°-45° | | 1.72 | 2.40 | 0.26 |
| | 45°-75° | | 1.39 | 2.66 | 0.34 |
| | 75°-105° | East | 1.62 | 2.06 | 0.50 |
| | 105°-135° | | 2.09 | 2.92 | 1.00 |
| | 135°-165° | | 2.02 | 4.94 | 1.36 |
| | 165°-195° | South | 2.65 | 7.10 | 2.63 |
| | 195°-225° | | 3.08 | 7.58 | 2.45 |
| | 225°-255° | | 2.62 | 6.57 | 3.15 |
| | 255°-285° | West | 1.98 | 6.43 | 3.27 |
| | 285°-315° | | 1.92 | 4.32 | 1.57 |
| | 315°-345° | | 1.89 | 4.65 | 2.21 |

Table 4 Percentage of the 36 different wind classes at station D

## Station E (56.429988°N; 7.116150°E)

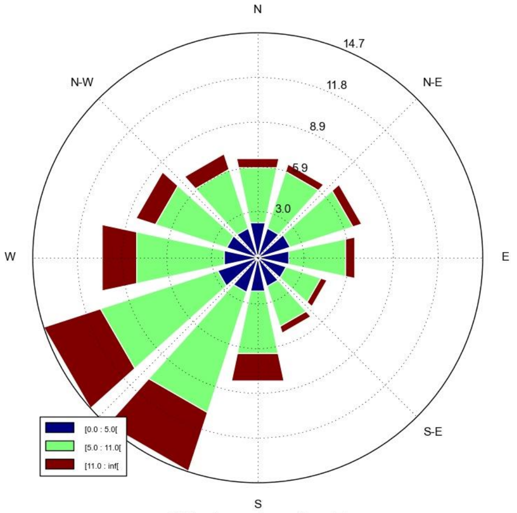


Windrose location E

| Station E | | | Wind speed interval | | |
|---|---|---|---|---|---|
| | | | W < 5 m/s | 5m/s < W & W < 11 m/s | 11m/s < W |
| wind sector | 345°-15° | North | 1.33 | 1.91 | 0.31 |
| | 15°-45° | | 1.45 | 2.17 | 0.37 |
| | 45°-75° | | 1.65 | 3.75 | 1.05 |
| | 75°-105° | East | 1.80 | 4.30 | 1.21 |
| | 105°-135° | | 1.57 | 4.31 | 1.66 |
| | 135°-165° | | 1.56 | 3.57 | 1.42 |
| | 165°-195° | South | 1.76 | 4.43 | 1.55 |
| | 195°-225° | | 1.78 | 6.04 | 2.90 |
| | 225°-255° | | 1.97 | 6.46 | 3.04 |
| | 255°-285° | West | 2.02 | 6.77 | 2.52 |
| | 285°-315° | | 2.24 | 7.34 | 3.69 |
| | 315°-345° | | 1.73 | 5.55 | 2.84 |

Table 5 Percentage of the 36 different wind classes at station E

## Station F (52.713918°N; 3.466096°E)

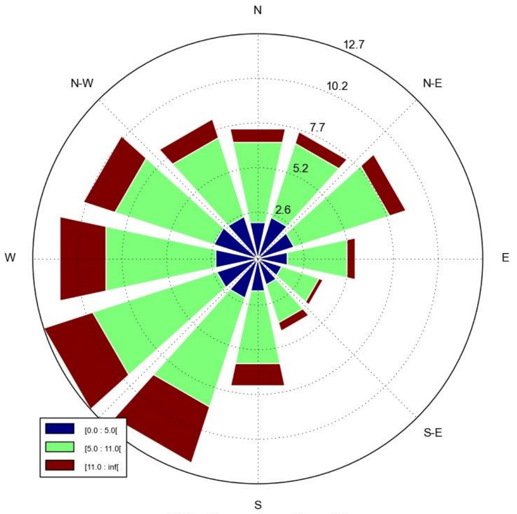


Windrose location F

| Station F | | | Wind speed interval | | |
|---|---|---|---|---|---|
| | | | W < 5 m/s | 5m/s < W & W < 11 m/s | 11m/s < W |
| wind sector | 345°-15° | North | 2.33 | 3.67 | 0.62 |
| | 15°-45° | | 2.03 | 3.89 | 0.50 |
| | 45°-75° | | 2.22 | 4.31 | 0.60 |
| | 75°-105° | East | 2.07 | 3.78 | 0.62 |
| | 105°-135° | | 1.94 | 2.39 | 0.42 |
| | 135°-165° | | 1.97 | 2.75 | 0.46 |
| | 165°-195° | South | 2.22 | 4.16 | 1.84 |
| | 195°-225° | | 2.36 | 8.26 | 4.02 |
| | 225°-255° | | 2.75 | 8.05 | 3.89 |
| | 255°-285° | West | 2.23 | 5.86 | 2.30 |
| | 285°-315° | | 2.12 | 4.89 | 1.34 |
| | 315°-345° | | 2.02 | 4.04 | 1.06 |

Table 6 Percentage of the 36 different wind classes at station F

## Station G (48.615983°N; 5.677813°W)




Windrose location G

| Station G | | | Wind speed interval | | |
|---|---|---|---|---|---|
| | | | W < 5 m/s | 5m/s < W & W < 11 m/s | 11m/s < W |
| wind sector | 345°-15° | North | 2.09 | 4.64 | 0.78 |
| | 15°-45° | | 2.45 | 4.40 | 0.70 |
| | 45°-75° | | 2.15 | 5.70 | 0.97 |
| | 75°-105° | East | 1.70 | 3.45 | 0.48 |
| | 105°-135° | | 1.42 | 2.22 | 0.24 |
| | 135°-165° | | 1.55 | 2.26 | 0.50 |
| | 165°-195° | South | 1.85 | 4.21 | 1.28 |
| | 195°-225° | | 2.33 | 6.48 | 3.33 |
| | 225°-255° | | 2.43 | 7.38 | 2.92 |
| | 255°-285° | West | 2.42 | 6.35 | 2.67 |
| | 285°-315° | | 2.60 | 5.89 | 1.88 |
| | 315°-345° | | 2.50 | 4.69 | 1.11 |

Table 7 Percentage of the 36 different wind classes at station G

# 3. Tidal data

COWI has divided the project area into 11 tidal sub-regions. The sub-regions are selected in such a way that the tidal conditions can be assumed to be relatively uniform within the sub-region and that the conditions are significantly different from neighboring sub-regions.

In this section, tidal current information is provided for the 11 off-shore locations marked as I to XI in Figure 2 (left). However, tidal information given at VIII, IX and X do not characterize the tide currents between the Wadden Sea's islands and tidal flats (Figure 2 (right)). Indeed, in this area, tidal currents are constrained by local straits and channels that are often orthogonal to the coastlines.

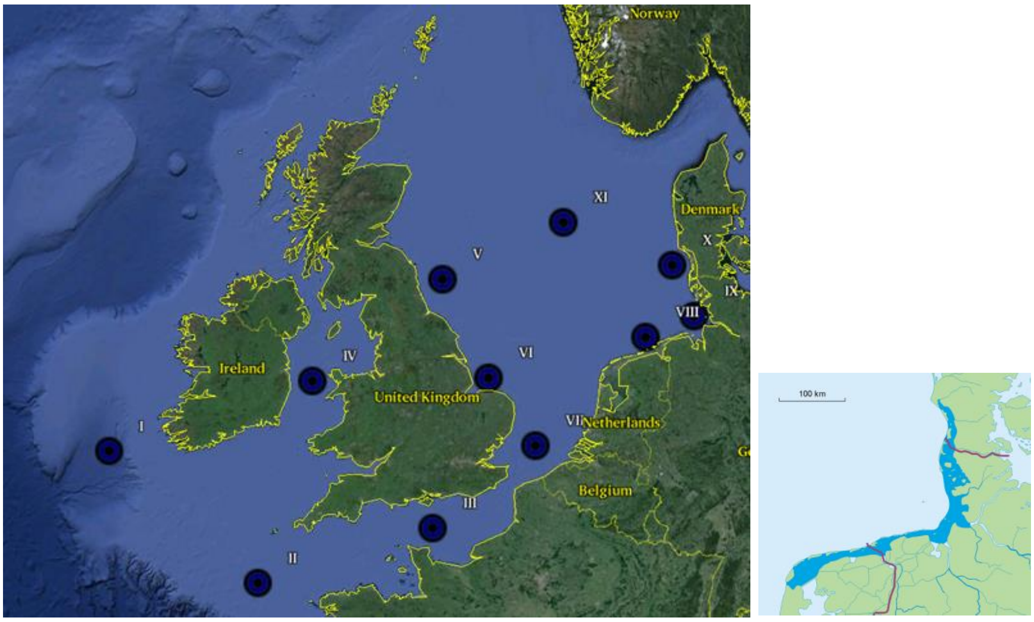



**Figure 2 - The tidal data are provided at 11 locations marked as I to XI, representative for the XI tidal subregions defined by COWI at which tidal data are provided (left). Please note that the provided data are not representative for the tides at the Wadden Sea (right).**

## Tidal properties of the M2 constituent

| Station | Lat | Lon | tidal range (m) | tidal current | | |
|---|---|---|---|---|---|---|
| | | | | amplitude (m/s) along major axis | amplitude (m/s) along minor axis | orientation of the major axis |
| I | 51243°N | 12.179°W | 2.12 | 0.0526 | 0.0075 | 18°-198° |
| II | 48.815°N | 6.766°W | 3.22 | 0.4787 | 0.2427 | 41°-221° |
| III | 50.147°N | 1.077°W | 2.76 | 1.301 | 0.1056 | 80°-264° |
| IV | 53.191°N | 5.189°W | 2.48 | 0.98 | 0.0963 | 2°-182° |
| V | 55.344°N | 0.57°W | 2.6 | 0.3668 | 0.084 | 157°-337° |
| VI | 53.217°N | 0.955°E | 3.38 | 0.7507 | 0.1876 | 139°-319° |
| VII | 51.808°N | 2.436°E | 2.1 | 0.7267 | 0.0964 | 28°-208° |
| VIII | 53.844°N | 6.556°E | 1.76 | 0.5549 | 0.0549 | 80°-260° |
| IX | 54.142°N | 8.373°E | 2.8 | 0.6908 | 0.0095 | 102°-282° |
| X | 55.257°N | 7.351°E | 0.8 | 0.25 | 0.07 | 138°-318° |
| XI | 56.394°N | 4.0004°E | 0.41 | 0.132 | 0.0365 | 59°-239° |

NB : degree given according meteorological convention : 0° -> current coming from North (heading southward), 90° current coming from East (heading westward), 180° -> current coming from South (heading northward); 270° -> current coming from West (heading eastward)

## Tidal properties, with all constituents during a spring tide condition (values for the 2014/09/26)

| Station | Lat | Lon | tidal range (m) | tidal current | | |
|---|---|---|---|---|---|---|
| | | | | amplitude (m/s) along major axis | amplitude (m/s) along minor axis | orientation of the major axis |
| I | 51243°N | 12.179°W | 2.66 | 0.07027 | 0.00216 | 19°-203° |
| II | 48.815°N | 6.766°W | 4.1 | 0.6581 | 0.30958 | 44°-219° |
| III | 50.147°N | 1.077°W | 3.73 | 1.568 | 0.1281 | 82°-262° |
| IV | 53.191°N | 5.189°W | 3.17 | 1.364 | 0.1056 | 8°-182° |
| V | 55.344°N | 0.57°W | 3.26 | 0.4886 | 0.1065 | 155°-337° |
| VI | 53.217°N | 0.955°E | 3.96 | 0.9721 | 0.2332 | 145°-329° |
| VII | 51.808°N | 2.436°E | 2.81 | 0.9282 | 0.07881 | 24°-210° |
| VIII | 53.844°N | 6.556°E | 2.29 | 0.5844 | 0.0448 | 76°-256° |
| IX | 54.142°N | 8.373°E | 3.37 | 0.76 | 0.03261 | 105°-278° |
| X | 55.257°N | 7.351°E | 0.95 | 0.27 | 0.06 | 136°-306° |
| XI | 56.394°N | 4.0004°E | 0.57 | 0.1925 | 0.03269 | 50°-230° |

NB : degree given according meteorological convention : 0° -> current coming from North (heading southward), 90° current coming from East (heading westward), 180° -> current coming from South (heading northward); 270° -> current coming from West (heading eastward)

# 4. Time averaged currents

Figure 3 represents the yearly residual currents at 30 meter, computed as the averaged currents on 696 (12*58) M2 tidal cycles as computed by the AMM7 North West Shelf model between May 2013 and May 2014 (MyOcean). The colors represent the norm of the residual current, ranging between 0 m/s (dark blue) and 0.5 m/s (red) and the arrows represents the residual current direction. Areas in deep red are shallower than 30 meter.

The main features are:

- As a branch of the Gulf Stream, the slope current along the shelf break between Scotland and Norway is a dominant and permanent feature, with residual currents greater than 0.3 m/s. This slope current further branched and make a loop in the Norwegian trench.
- The slope current at the shelf break along Bay of Biscay, Celtic Seas and Ireland is much weaker and versatile. However, on a yearly average, its direction is mainly heading northward.
- In the northern North Sea, the dominant feature is the presence of an anti-clockwise gyre at about 200 km east of Scotland.
- In central North Sea, the dominant feature is the residual circulation around the Dogger Bank. This circulation is usually anti-clockwise but can reverse depending on wind and tides. This explains the reason why in average this circulation is so weak.
- The residual current shows its largest variability in southern North Sea and English Channel, with residual currents ranging between 0 and 0.5 m/s sometimes heading northward, sometimes heading southward, as a function of the wind. In 2013-2014, the residual circulation in the southern North Sea was mainly northward oriented. No specific pattern can be deduced for the English Channel.
- Finally, the residual circulation in the Irish Sea is oriented northward.

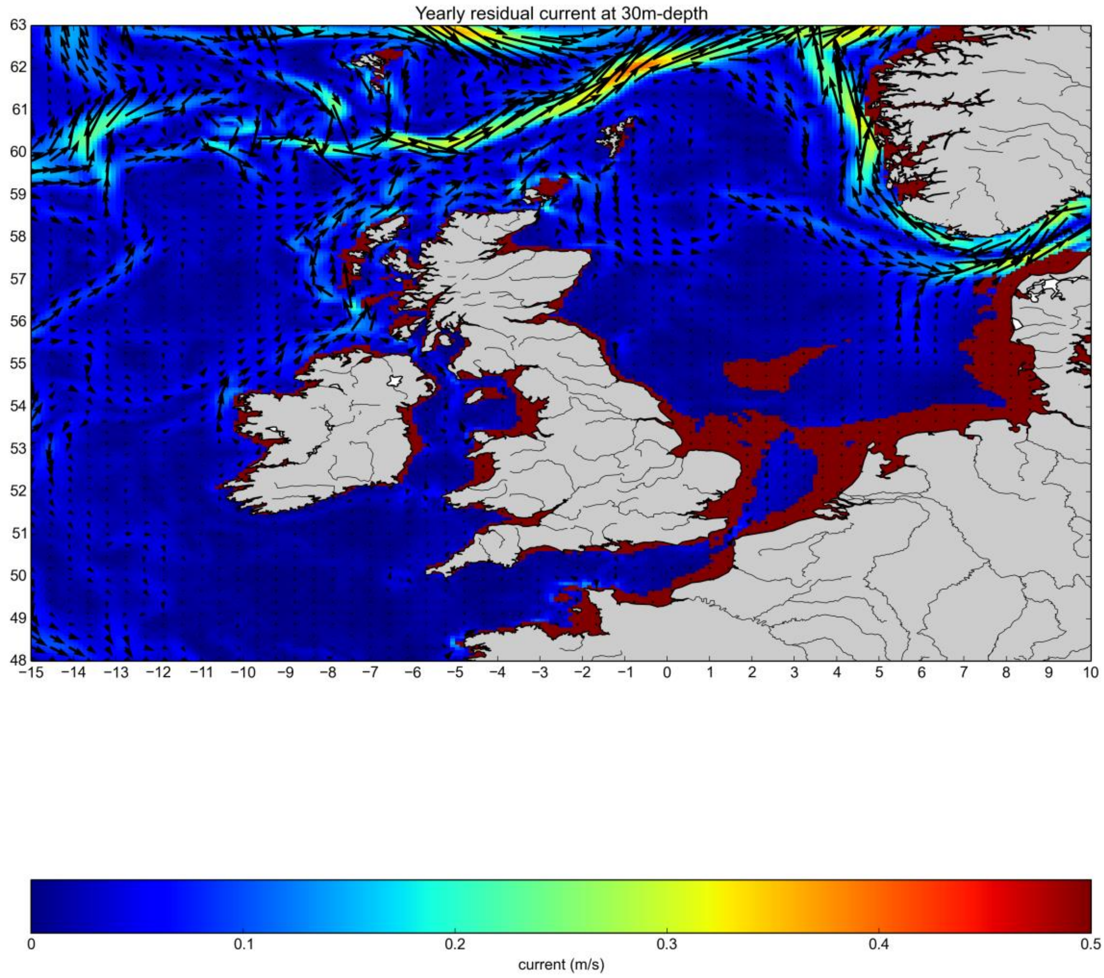



**Figure 3 : Yearly-averaged residual currents at 30 meter depth.**

The actual values of the yearly averaged residual currents are provided in the netcdf file “”. Table 1 presents the yearly averaged residual currents at locations A to E shown in Figure 1.

| Station | sub-surface current speed (m/s) | sub-surface current direction (deg N) |
|---|---|---|
| A | 0.0385 | 278 |
| B | 0.1308 | 223 |
| C | 0.0252 | 253 |
| D | 0.0284 | 305 |
| E | 0.0655 | 228 |

**Tableau 1 - Residual currents at location A to E**

NB : degree given according meteorological convention : 0° -> current coming from North (heading southward), 90° current coming from East (heading westward), 180° -> current coming from South (heading northward); 270° -> current coming from West (heading eastward)

## Data sources

- Wind data have been extracted and interpolated from UK met office global numerical weather prediction.
- Tidal currents have been extracted from the AVISO FES2012 product.
- Residual currents have been extracted and averaged from the North West European shelf seas forecast, available from the MyOcean service (www.myocean.eu)

# Appendix 1 – Monthly residual currents at 30 m.

This series of plots illustrates the variability of the monthly residual currents at 30 meter, computed as the averaged currents on 58 M2 tidal cycles. The colors represent the norm of the residual current, ranging between 0 m/s (dark blue) and 0.5 m/s (red) and the arrows represents the residual current direction. Areas in deep red are shallower than 30 meter.

The main features are:

- As a branch of the Gulf Stream, the slope current along the shelf break between Scotland and Norway is a dominant and permanent feature, with residual currents greater than 0.3 m/s. Part of this slope current enters in the Norwegian trench.
- The slope current at the shelf break along Bay of Biscay, Celtic Seas and and Ireland is weaker and more versatile. Actually, its direction and intensity depends on the Gulf Stream location as well as on the presence of other mesoscale eddies in the neighboring margin Atlantic Ocean.
- In the northern North Sea, the dominant feature is the presence of an anti-clockwise gyre at about 200 km east of Scotland.
- In central North Sea, the dominant feature is the residual circulation around the Dogger Bank. This circulation is usually anti-clockwise but can reverse depending on the wind and tides.
- The residual current shows its largest variability in southern North Sea and English Channel, with residual currents ranging between 0 and 0.5 m/s sometimes heading northward, sometimes heading southward, as a function of the wind.
- Finally, the residual circulation in the Irish sea is usually oriented northward. Its intensity is also related with the wind.

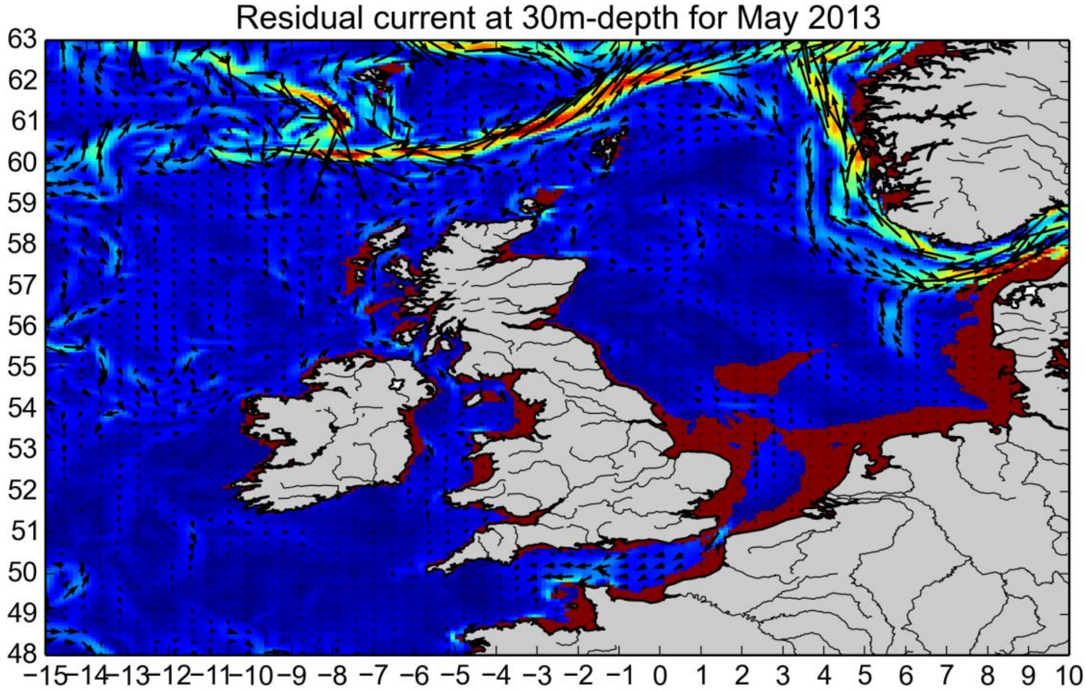



**Figure 4: Monthly averaged residual current for May 2013 (Same color bar as for Figure 3).**

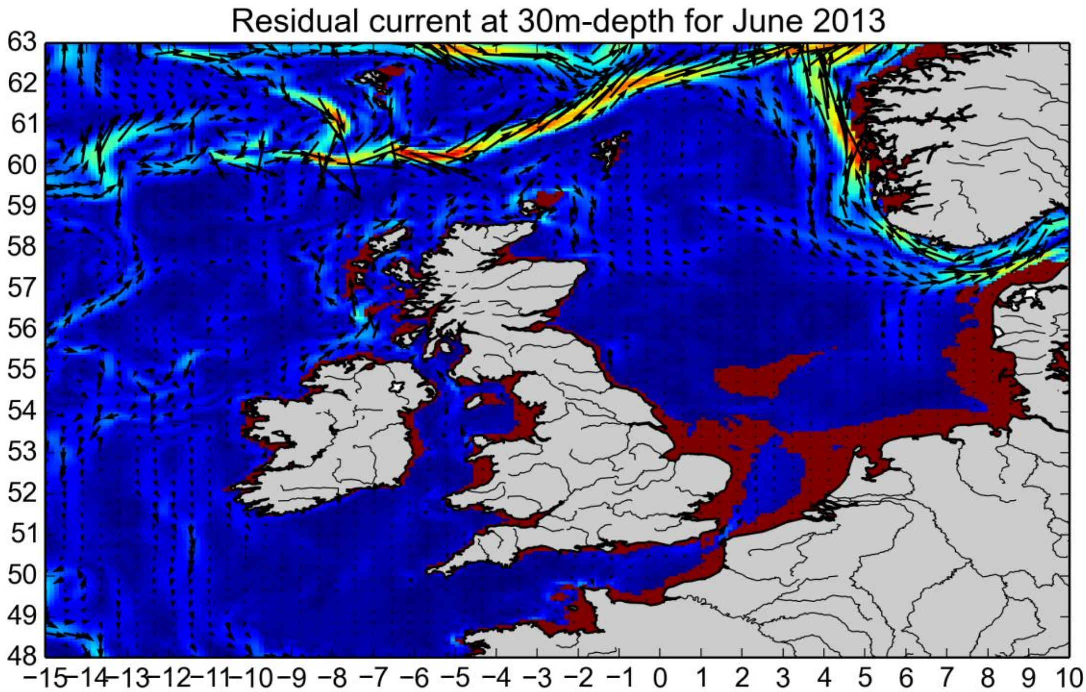



**Figure 5: Monthly averaged residual current for June 2013 (Same color bar as for Figure 3).**

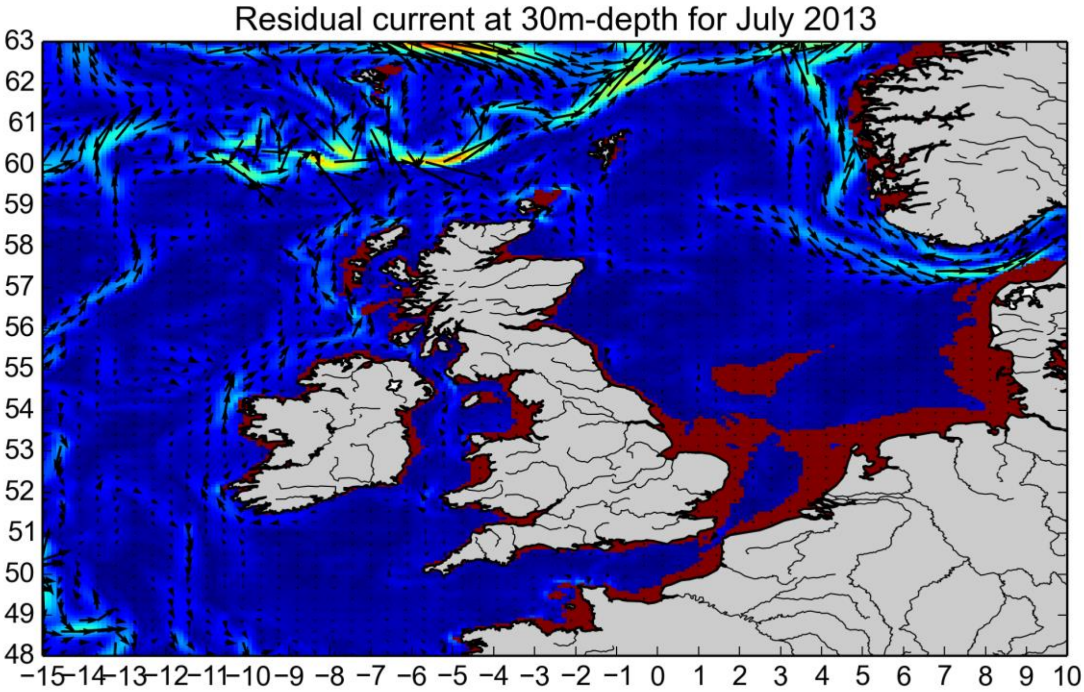



**Figure 6 Monthly averaged residual current for July 2013 (Same color bar as for Figure 3).**

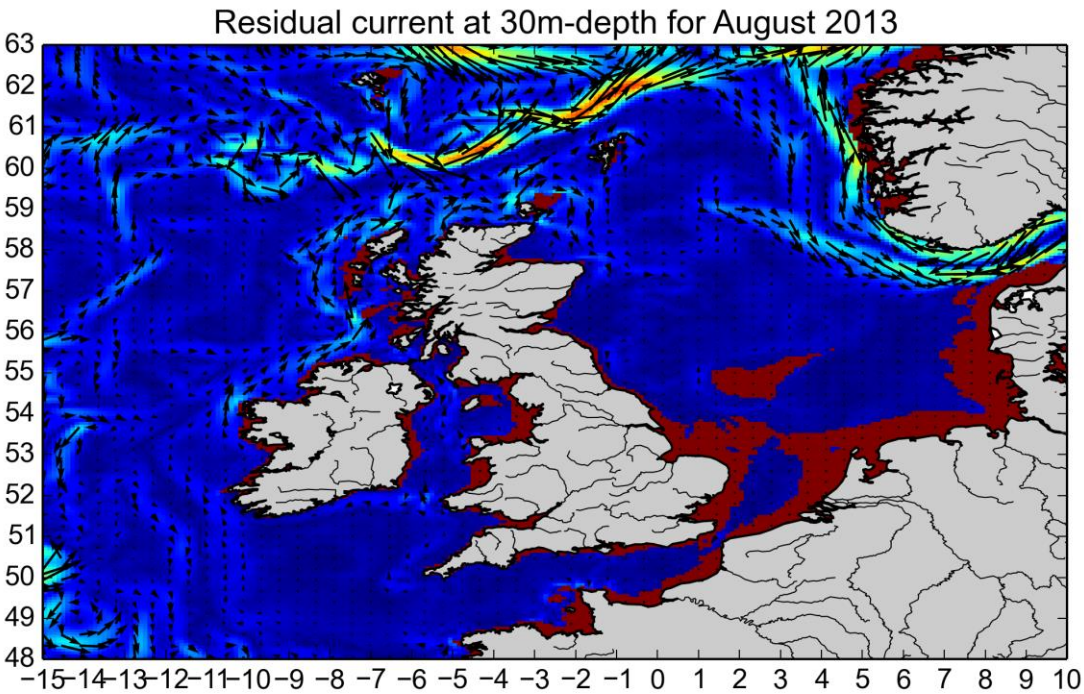



**Figure 7 Monthly averaged residual current for August 2013 (Same color bar as for Figure 3).**

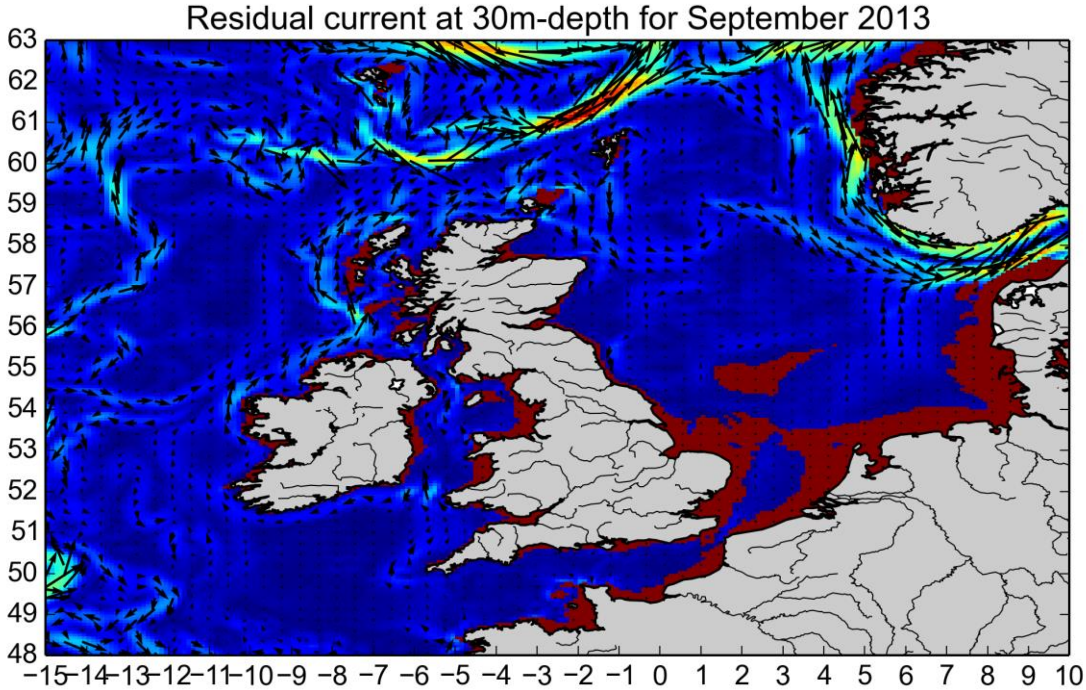



**Figure 8 Monthly averaged residual current for September 2013 (Same color bar as for Figure 3).**

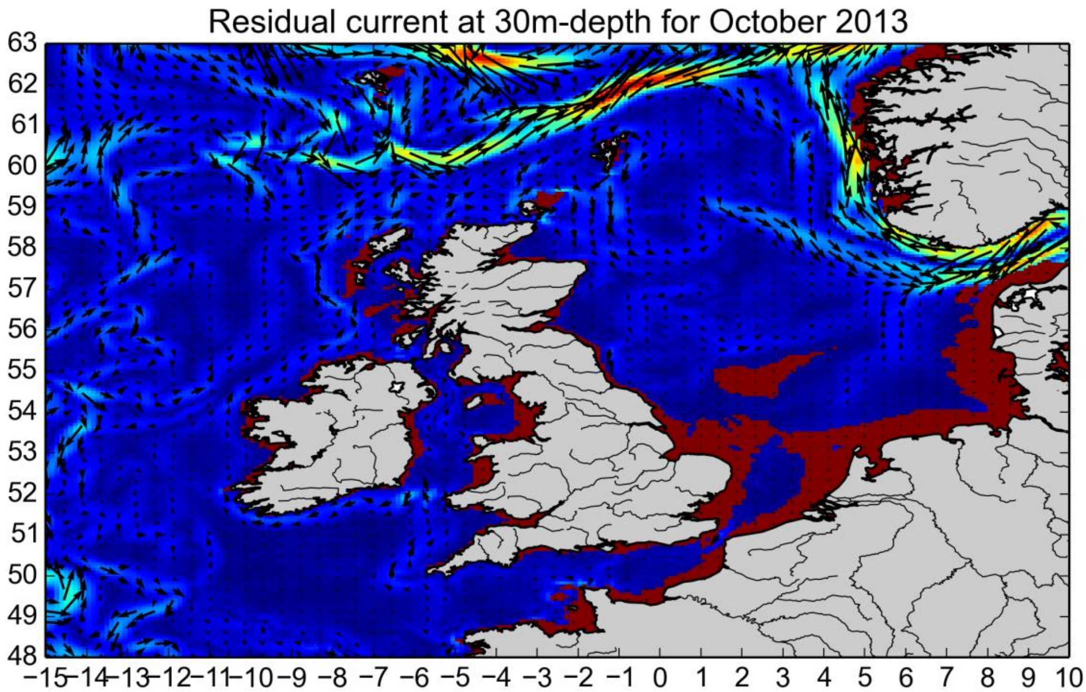



**Figure 9 Monthly averaged residual current for October 2013 (Same color bar as for Figure 3).**

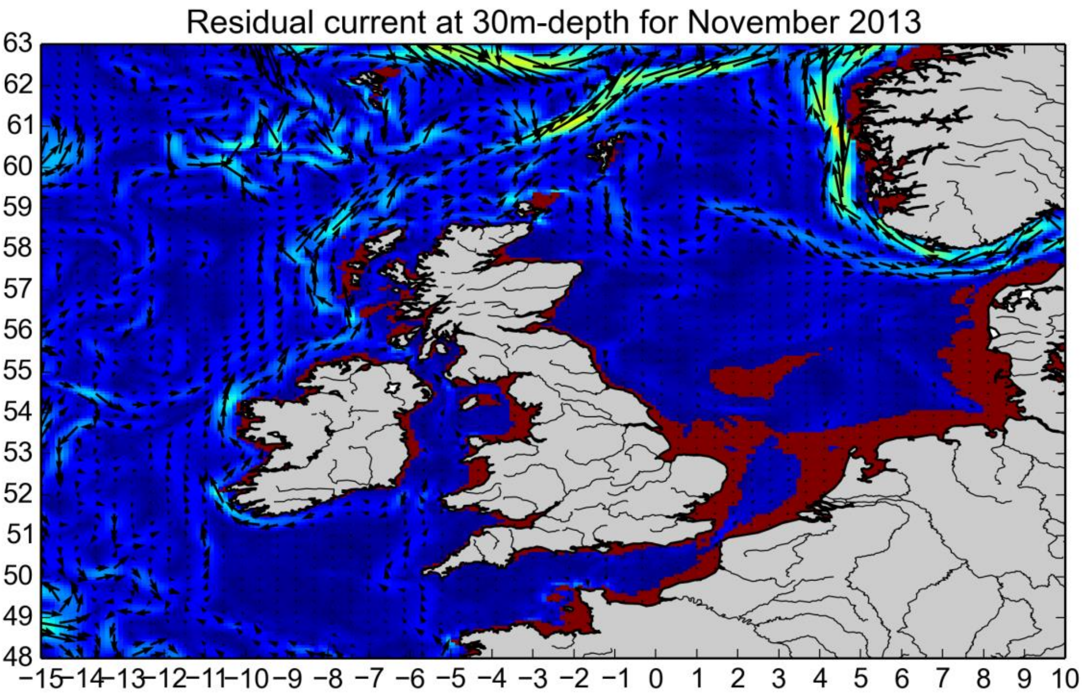



**Figure 10 Monthly averaged residual current for November 2013 (Same color bar as for Figure 3).**

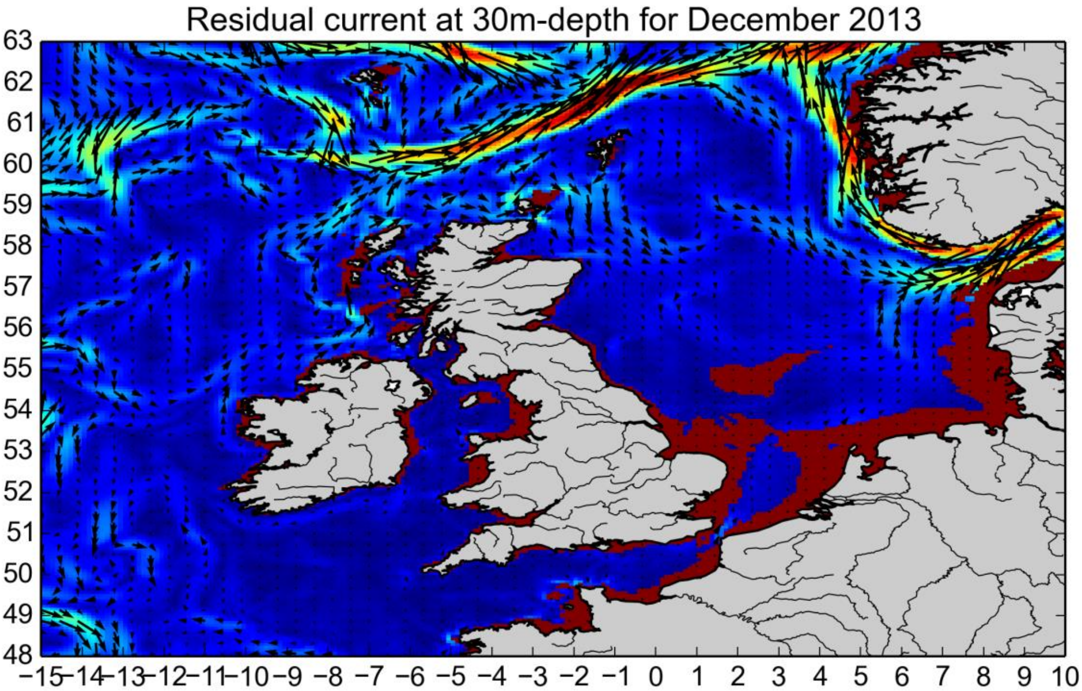



**Figure 11 Monthly averaged residual current for December 2013 (Same color bar as for Figure 3).**

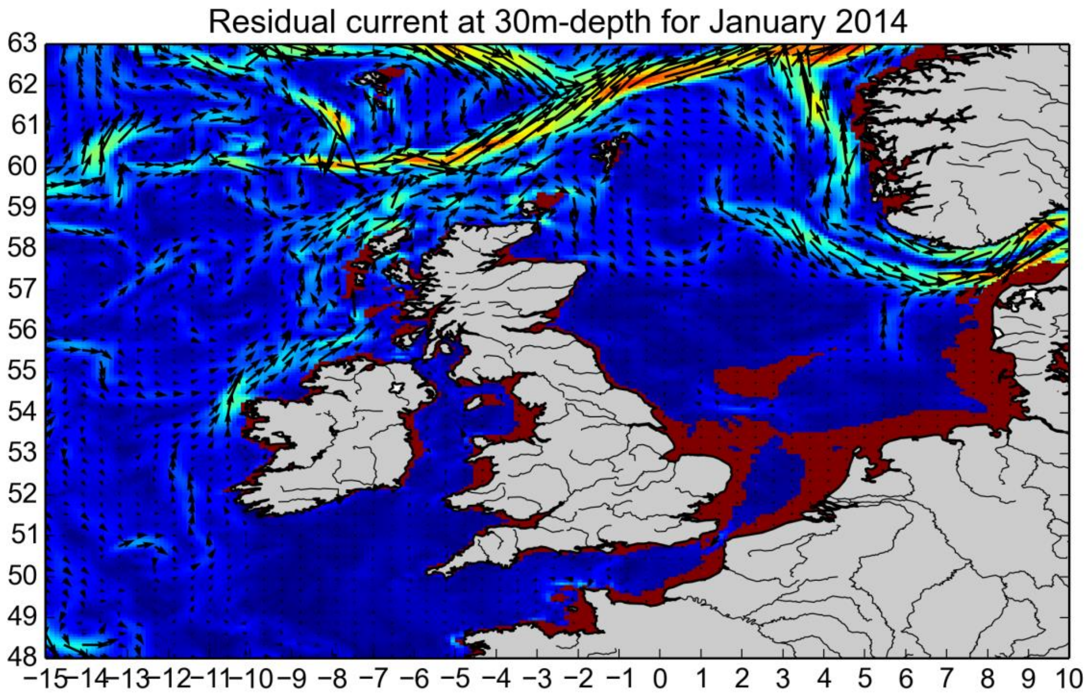



**Figure 12 Monthly averaged residual current January 2014 (Same color bar as for Figure 3).**

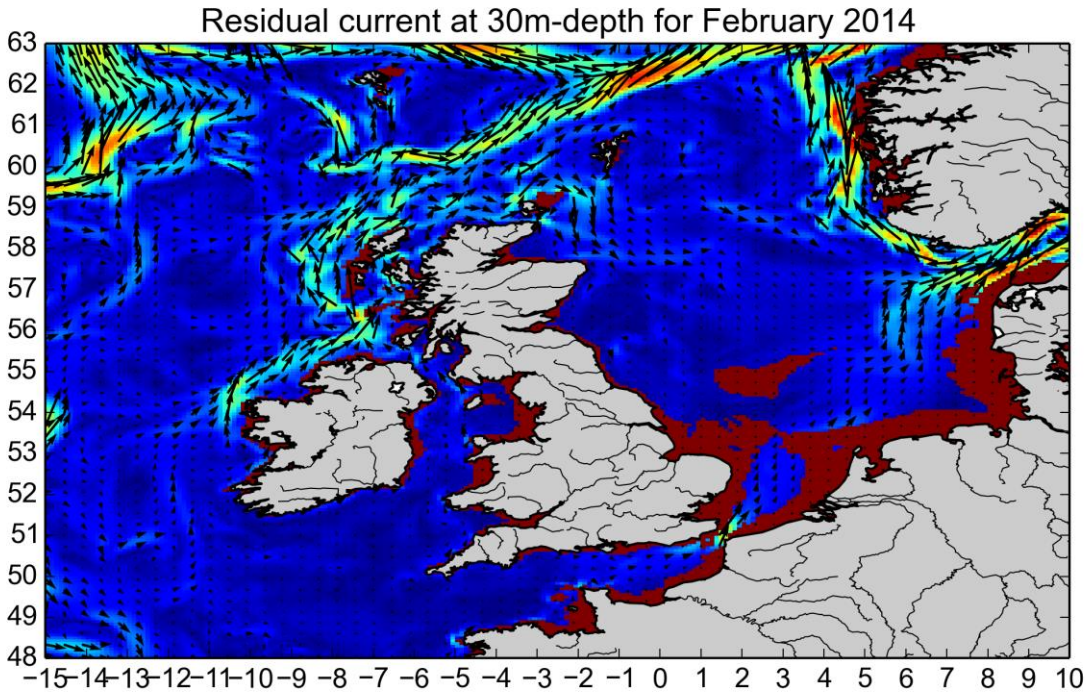



**Figure 13 Monthly averaged residual current for February 2014 (Same color bar as for Figure 3).**

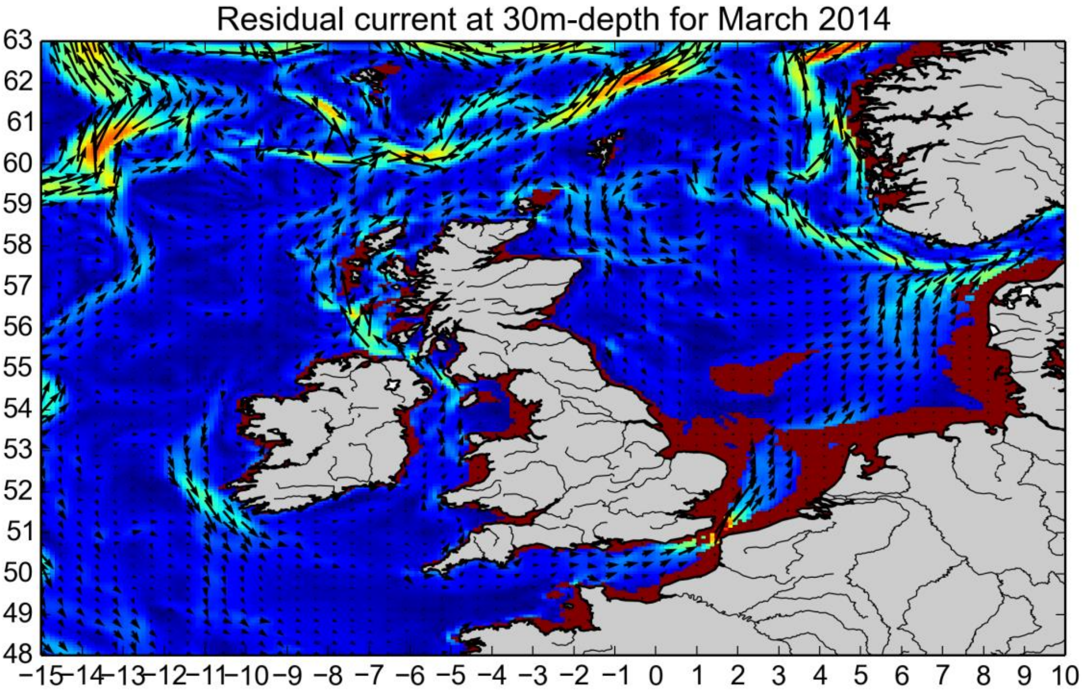



**Figure 14 Monthly averaged residual current for March 2014 (Same color bar as for Figure 3).**

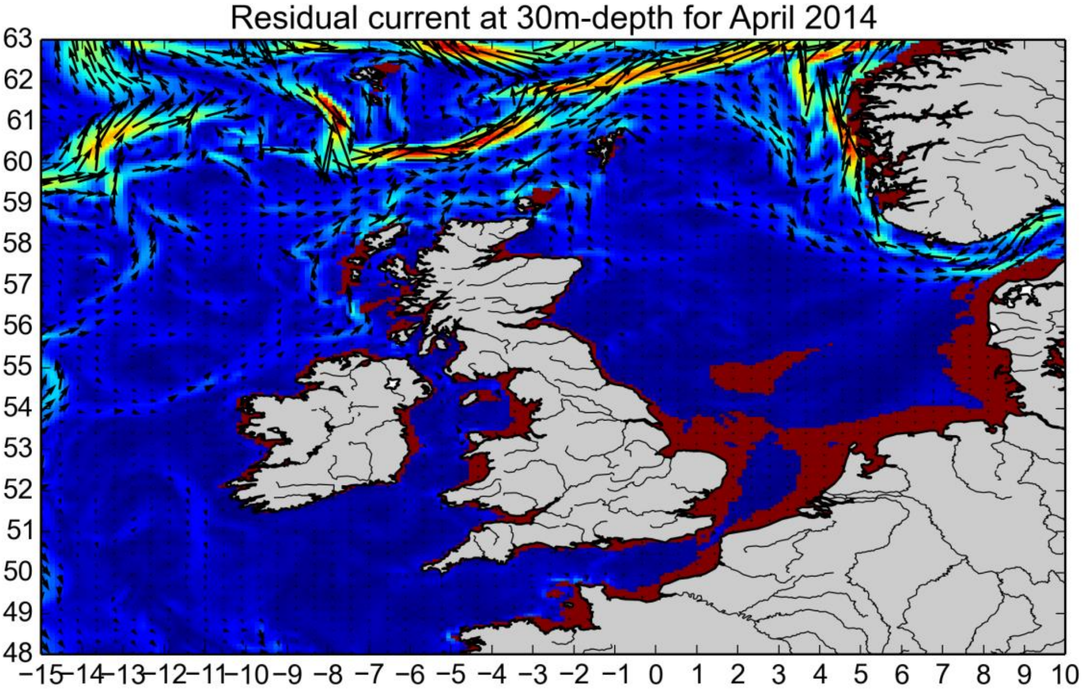



**Figure 15 Monthly averaged residual current for April 2014 (Same color bar as for Figure 3).**

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## Colophon

This report was issued by RBINS/OD Nature in October 2014, as a deliverable prepared for COWI in the framework of the project BE-AWARE II.

Status: ☒ Draft

☐ Final version

☐ Revised version of document

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