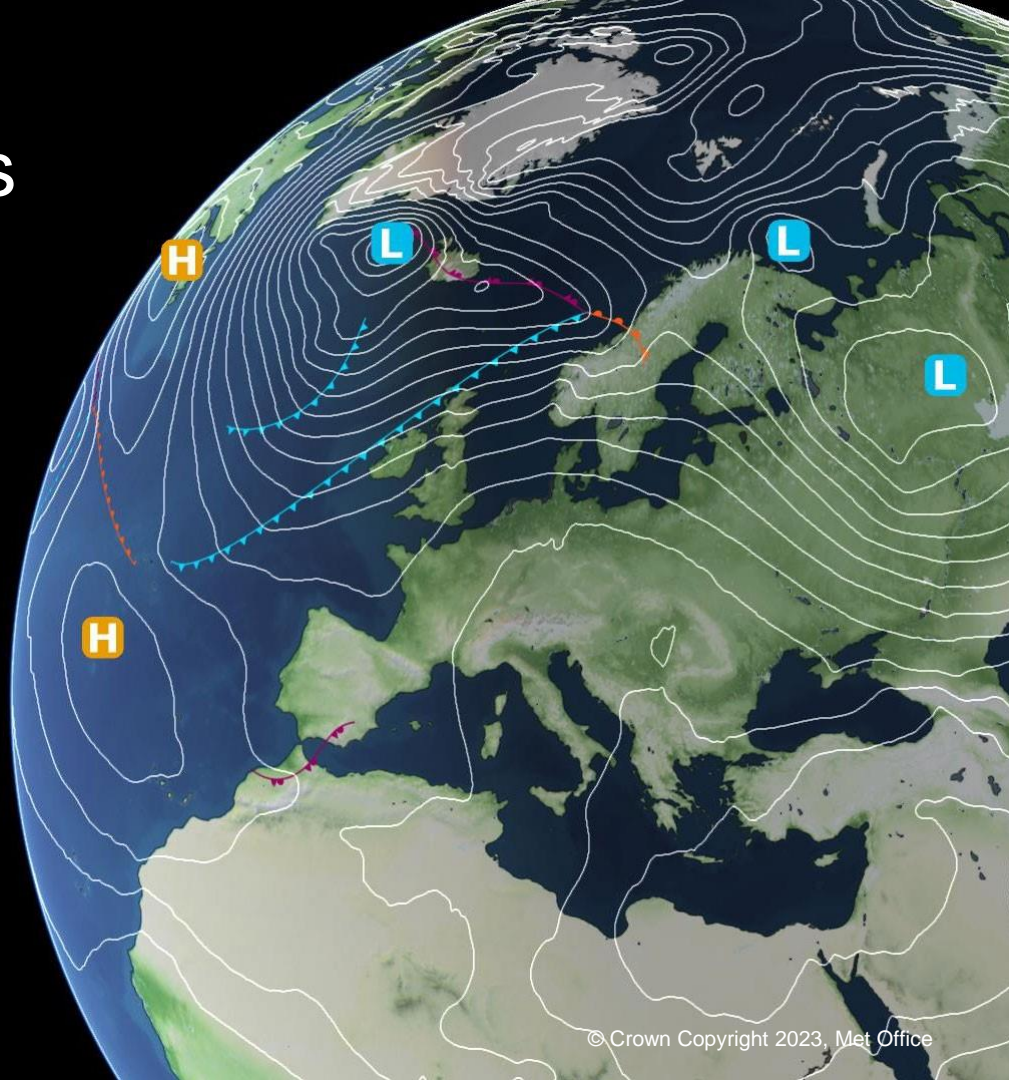


North Sea marine gliders - towards a 24/7/365 operational service

A collaboration between the
Met Office and the National Oceanography
Centre

Jon Turton

GOOS OCG-14, June 2023



Background



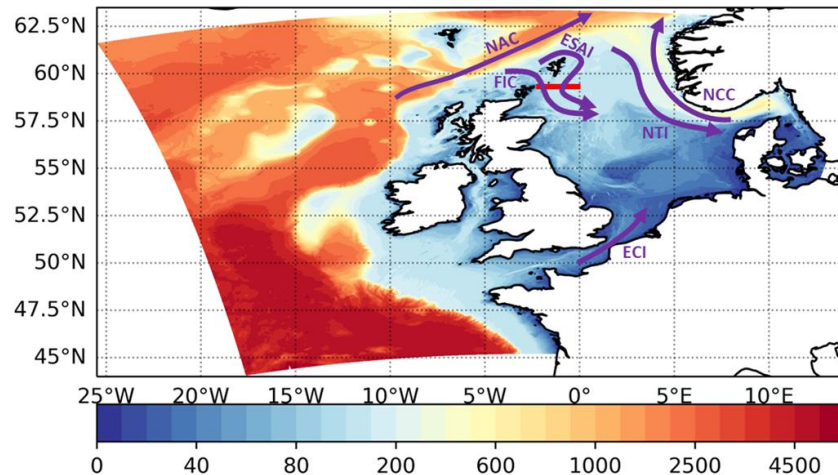
- Funding agreed in 2021 for our next-generation supercomputing service through to 2032 (10-year contract with Microsoft)
 - initially 6x current capability, ~18x by 2027/28
- Includes a portfolio of observations projects to deliver data to support the supercomputing investment
 - improved observation of boundary layer humidity in the UKV Model area
 - increased atmospheric wind observations to underpin improvement of Global Model forecasts
 - enhanced ocean observations to improve North Sea modelling and resolve regional climate biases => North Sea glider project with the National Oceanography Centre (NOC)

Role of the gliders

- Can provide reliable sub-surface temperature & salinity information across key area for exchange of waters between the North Sea and North Atlantic
- Few, if any, profiles in our shelf seas – Argo is designed for deeper waters and need ‘steerable’ observations to avoid infrastructure in the North Sea
- Proof of concept of the potential operational use of gliders
- Builds on our long-standing partnership relationship with NOC, who operate the largest fleet of autonomous equipment in Europe

Requirements

- 24/7 service to provide profiles of temperature & salinity in the northern section of the North Sea
- Data assimilated in the Met Office's 1.5 km resolution Atlantic Margin ocean model (AMM15)
- Data targeted in an area where waters of the Atlantic mix with the waters of the North Sea
- The AMM15 model now provides time-varying sea surface temperatures (SST) to the Met Office's regional atmospheric model so improved performance of the ocean model should feed through to better weather forecasts

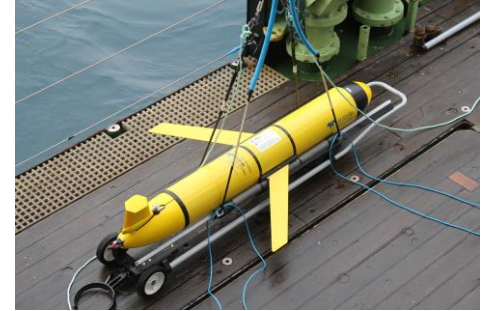


Requirements

- Data available in near-real-time with transmissions timed to coincide with the AMM15 model ingestion cycles (4 times a day)
- Additionally, the gliders arrive at the surface at 23:40 UTC to provide data one last time, just before the close of the model data processing window.
- At least one profile of temperature & salinity (or part of a profile) for each model grid box (for a model grid size of 1.5 km), water depth ~100m
- To maximise the available data within the constraints of the project budget, this allows to run 2 gliders in the spring and autumn and a single glider during the winter and summer

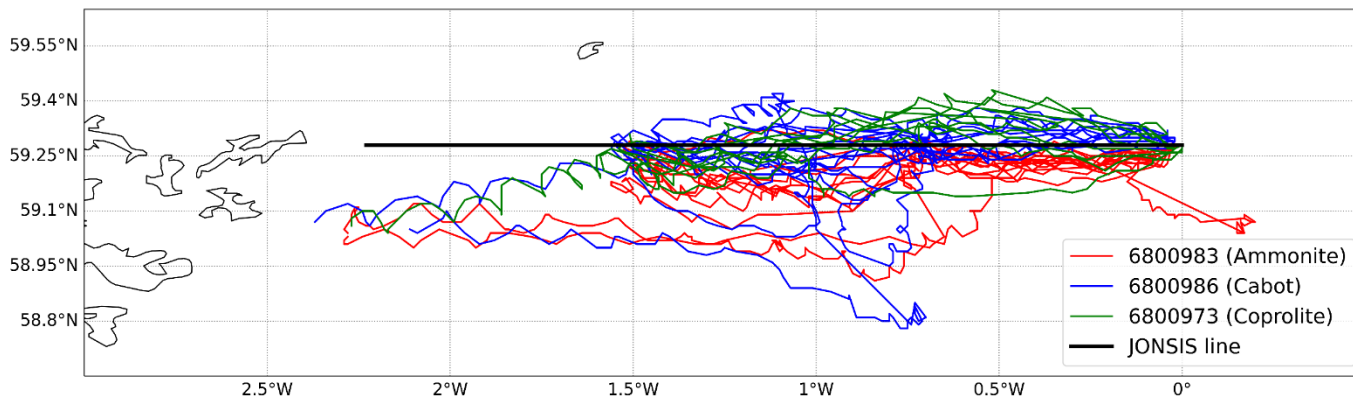
Operational glider service

- The gliders are deployed and operated (piloted) by NOC, who deliver the data to the Met Office as a service
- Swap-outs of the gliders made by using a small craft operating out of Kirkwall
- Typically, each glider is in the water for ~3 months and during that time can cover over 2,000 km and provide over 600 profiles of temperature and salinity



Glider operations

- First two gliders (Cabot & Ammonite) launched 1st and 2nd September 2022, and were recovered on 5th December
- Glider Coprolite launched 5th December and swapped out with Raleigh on 19th March 2023
- Raleigh is an extended bay glider and will continue its deployment until August
- Ammonite deployed 9th May but has a leak so is being kept at the surface, will be recovered and replaced by Cabot
- Both Raleigh and Cabot will be recovered in August and replaced



Location of
gliders between
01/09/2022 to
25/01/2023

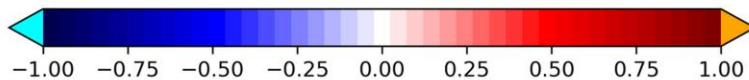
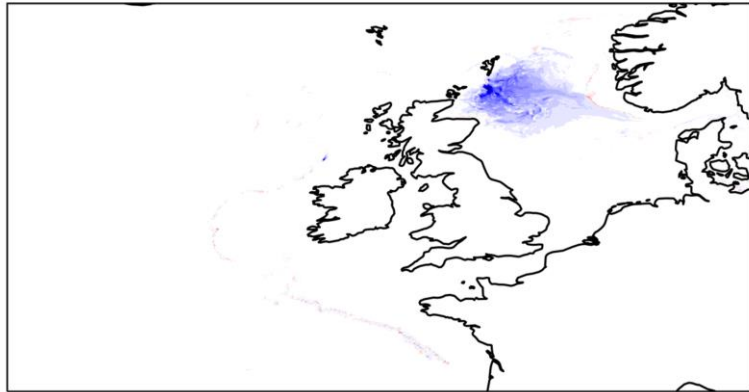
Model data assimilation experiments

- Aim to evaluate the impact of the North Sea glider data in AMM15
- By running two AMM15 suites in parallel - one assimilating the North Sea glider data (experiment), the other without assimilating the data (control)
- Both model suites run from 1st Sept 2022 to 25th January 2023
- All other available data were assimilated into both suites, so any differences between the results are down to the impact of the North Sea glider data

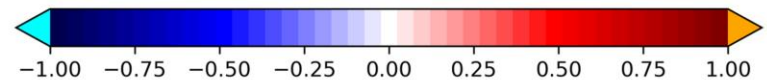
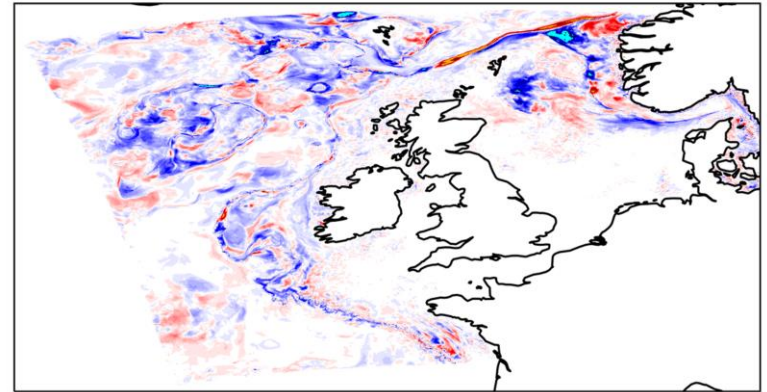
Impact of glider data assimilation

Bottom temperature monthly averages for September (month 1) and December (month 4)

Bottom Temperature experiment-control difference.
Model run: -36, Date: 202209



Bottom Temperature experiment-control difference.
Model run: -36, Date: 202212

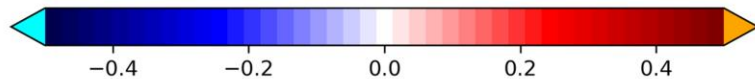
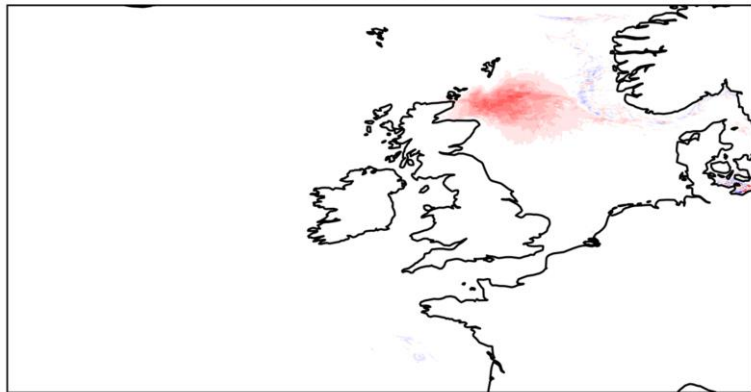


Bottom temperature initially cools before converging towards the control run. Locations where the Atlantic Ocean floor meets shallower waters (such as at the shelf sea boundary) show increased variability but no clear preference for warmer or colder values

Impact of glider data assimilation

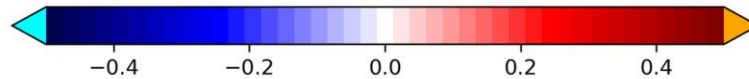
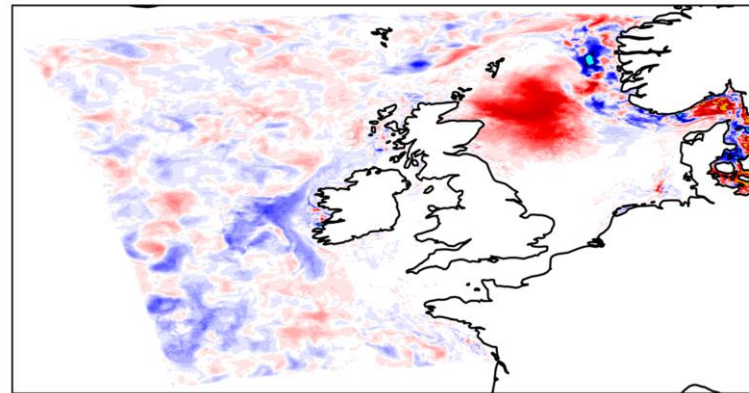
Surface salinity monthly averages for September (month 1) and December (month 4)

Surface Salinity experiment-control difference.
Model run: -36, Date: 202209



Model becomes saltier in the region of the gliders

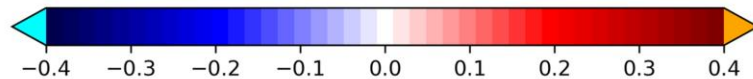
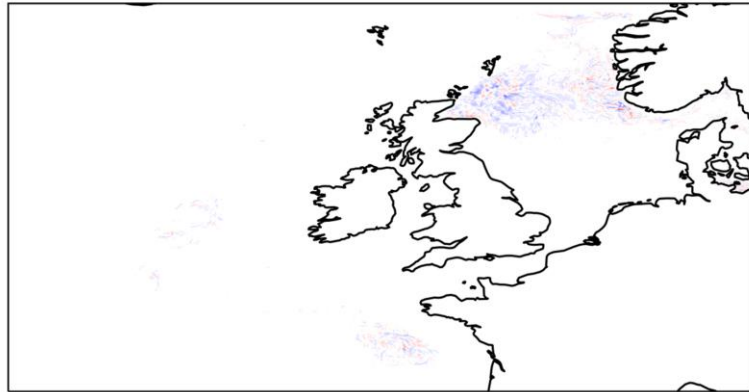
Surface Salinity experiment-control difference.
Model run: -36, Date: 202212



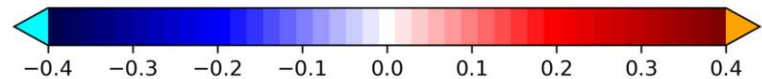
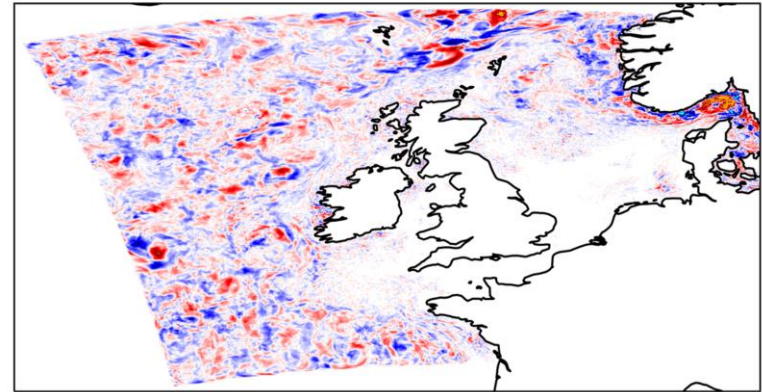
Impact of glider data assimilation

Surface temperature monthly averages for September (month 1) and December (month 4)

Surface Temperature experiment-control difference.
Model run: -36, Date: 202209



Surface Temperature experiment-control difference.
Model run: -36, Date: 202212



Less impact seen in surface temperature because satellite surface temperature data are plentiful and already constrain the temperatures at the model surface

Conclusions

- Although we have been assimilating glider data from NOC for many years, this was the first time we have carried out an impact assessment
- In time the impacts of the glider data spread away from the region where the gliders were operating, where it is thought that the changes away from the glider region are caused by differences in the positions of ocean features that develop over time from small perturbations because their positions are not being constrained by the assimilation
- One common feature in all the variables examined, is that there are very few changes in the Southern North Sea basin - one proposed theory is that the Dooley Current is limiting the penetration of the impact into the central and southern parts of the North Sea basin
- North Sea glider data have been routinely assimilated into the operational version of AMM15 since 9th February 2023
- Excellent and responsive partnership service provided by NOC