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MOCCA

D4.4.11 Improving availability of Southern Ocean specific DMQC resources

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[1] As indicated in the "Technical and Scientific description of the Euro-Argo ERIC" July 2013 attached to the Euro-Argo Statutes.

[2] Integers correspond to submitted versions.

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1. INTRODUCTION

This document describes the development of a new data product to support the Delayed-Mode Quality Control (DMQC) of Argo floats in the Southern Ocean as part of a wider effort to improve the resources available to DMQC operators. This work was instigated under the MOCCA project by Dr. Matt Donnelly from the British Oceanographic Data Centre (BODC), which is part of the National Oceanography Centre (NOC), and has progressed in partnership with the University of Bristol. The involvement of the University of Bristol has been funded by the ERC Starting Grant 678371 (ICY-LAB). ICY-LAB is led by Dr. Kate Hendry, Reader in Geochemistry, and this work involved Rhiannon Jones (research assistant) and Luke Roberts (Masters student).

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As a result of engagement with the international Argo community, including through the 1st European Delayed-mode QC workshop in 2018, it became apparent during the MOCCA project that the Southern Ocean posed a particular challenge to DMQC operators in making quality control decisions. This is because the Southern Ocean is a complex regime, characterized by strong circumpolar oceanic fronts, the position of which vary in both space and time, and either side of which the oceanic properties are significantly different. As floats are carried by the oceans currents, they can cross these fronts, or even sit within a front, posing a challenge in interpreting the behaviour of the sensors against a complex oceanic regime. It was identified that an additional tool would be beneficial to assist DMQC operators in interpreting the oceanic regime of the floats.

The focus of the work has been to characterize all Argo profiles in the Southern Ocean according to the oceanic regime in which they were sampled. This povides a DMQC operator with an instant initial assessment of the life of an Argo float, but also has the benefit of providing insights into the spatio-temporal variability of the Southern Ocean regimes.

This work was undertaken as part of BODC's role as the coordinating partner of the Southern Ocean Argo Regional Centre (SOARC). SOARC is responsible for ensuring the sustainability of the Argo array in the Southern Ocean and the reliability of the data available in this dynamic, complicated and under-sampled region of the global ocean. In doing so, BODC has enhanced European leadership in the region, and has improved the sustainability of the array in the Southern Ocean beyond the life of the MOCCA project. In addition, this work has laid the foundations for further development of SOARC capabilities during the EU H2020 project EuroArgo RISE project WP5, T5.3 on establishing Southern Ocean regional data quality assessments.

2. SOUTHERN OCEAN PROFILE CHARACTERISATION PROJECT

2.1. Background

In the Southern Ocean, the series of oceanic fronts associated with the Antarctic Circumpolar Current (ACC) vary in location by as much as five degrees of latitude over the course of a year. These fronts are strong gradients in hydrographic properties which separate different zonal bands that extend around the Southern Ocean. The ACC travels eastwards around Antarctica, transporting water masses at all depths and facilitating exchange between the Atlantic, Indian and Pacific Oceans. Characterising the location of individual Argo float profiles will provide context regarding the environment in which the float has been operating and greatly assist both quality control operators at Argo Data Assembly Centres and Delayed-Mode QC groups, as well as operational and delayed-mode data users. When combined, the characterisation of every Argo float profile will in turn allow the tracking of the positions of oceanic fronts and zones in time and space.

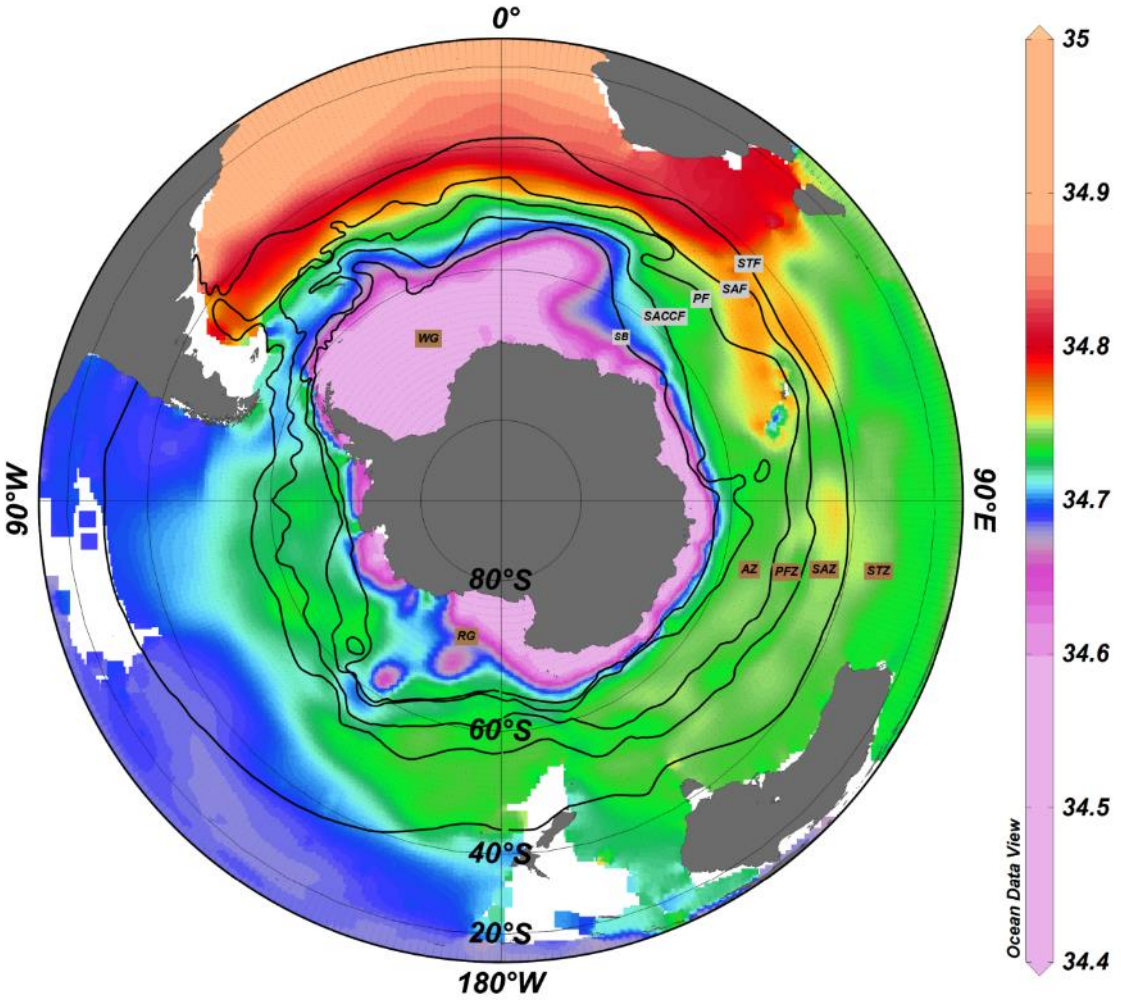


Figure 1- Salinity on the 28.05 kg m-3 Neutral Density surface from the World Ocean Atlas 2009 with the major fronts (black lines and grey highlighted labels) and zones (brown highlighted labels) as follows: Sub-Tropical Front (STF), Sub-Antarctic Front (SAF), Polar Front (PF), Southern ACC Front (SACCF), Southern Boundary (SB), Sub-Tropical Zone (STZ), Sub-Antarctic Zone (SAZ), Polar Front Zone (PFZ), Antarctic Zone (AZ), Weddell Gyre (WG) and Ross Gyre (RG).

2.2. Approach

2.2.1. New collaboration

The project to implement the characterization of Argo profiles in the Southern has been pursued through a new collaboration between BODC and the University of Bristol (UoB). This collaboration was formed as a result of efforts by the Southern Ocean Observing System (SOOS – www.soos.aq) to develop connections between institutions, in this instance the result of a particular focus on student projects. Initially, work began to develop a functional set of code undertaken by Rhiannon Jones, a research assistant at the UoB, and this was followed by a Masters thesis research project by Luke Roberts which investigated what insights the characterization could provide as to the seasonal and interannual variability of the ACC fronts.

2.2.2. Code capabilities

The code allows the user to create an index file and associated surface plots of the spatial distribution of these zones from a user-specified driver file defining time range, spatial range and allows for the selection of an individual float. From this, evaluation of frontal movement over the desired temporal and spatial resolution is possible. Float profiles are characterised by a true/false system for temperature and salinity values. For example, float profiles that have a temperature value greater than 6.85 at 400 decibar pressure and a salinity of less than 34.6 psu at 100 decibar are categorised as sampling the Sub-Antarctic Zone (SAZ). Altering the front/zone categorisation within the code is flexible, allowing for adjustment based on peer-reviewed studies of the region. If a float profile fits more than one criterion, the float profile is characterised as unclassified, and is annotated as such on the images. Those profiles that fit none of the criteria are defined as non-classified, and either represent profiles taken equator- or poleward of the defined fronts and zones, such as in the Weddell Gyre, or highlight a region in which further research is warranted.

2.2.3. Research use

was the first to undertake analysis on the performance and future use of the code. He found that the code has the ability to capture both seasonal and interannual trends that show fair alignment with results from high-powered models. However there were issues with under-representation of profiles in the Southern Zone and over-representation of unclassified floats, which warrants further investigation on the sensitivities of the classification system used within the code.

2.2.4. BODC's role

BODC provided the initial brief and requirements for the project, and provided remote assistance during the development of the code. This included both technical and oceanographic advice, and a code review at the end of the initial period of development. The code base was then deployed at BODC for initial user acceptance testing and this was successfully completed. BODC then worked to support the develop of the Masters project concept, and during the work provided further support, particularly addressing a software bug that had not previously been identified.

Following the conclusion of the Masters project, BODC has established a mirror of the Argo Global Data Assembly Centres to enable routine running of the code against the most recent data and has implemented a number of upgrades to the code. This has included:

- Adjustment to the limits for the upper boundary of the Polar Front Zone to adopt the Orsi et al. (1995) definition, rather than the more recent Sokolov and Rintoul (2009) definition;
- Addition of the capability to define a single Argo float to focus on, in addition to the spatio-temporal parameters;
- Code refactoring to improve maintainability, performance and minor revisions to output plots.

2.3. Examples of float characterisation

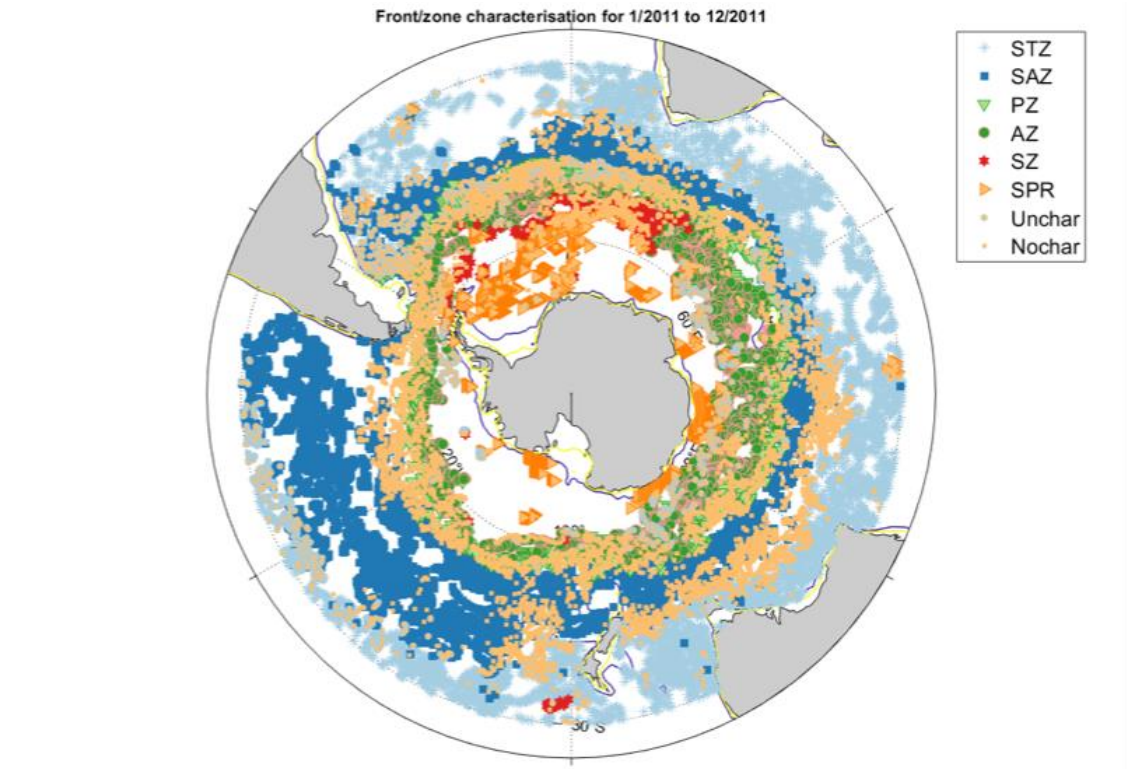


Figure 2 - Southern polar stereographic projection showing the characterisation of all profiles from 2011.

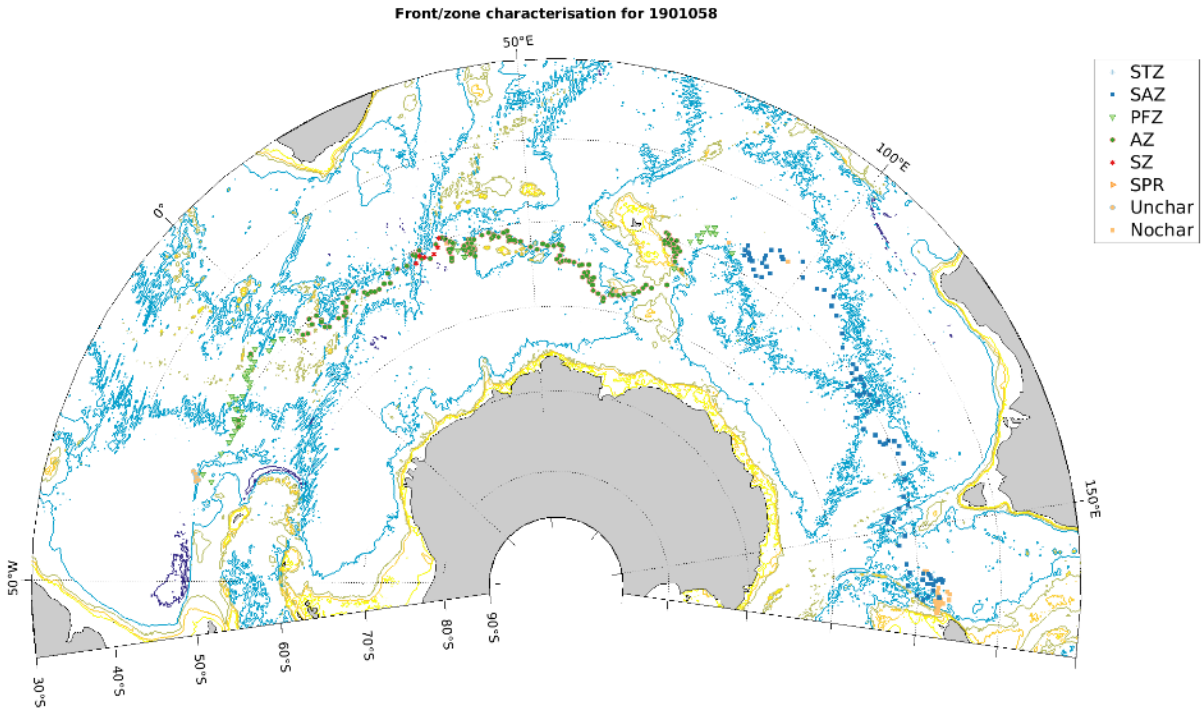


Figure 3 – Lamber conformal conic projection showing the characterisation of all profiles for Argo float 1901058

2.4. Communications

2.4.1. Open source code

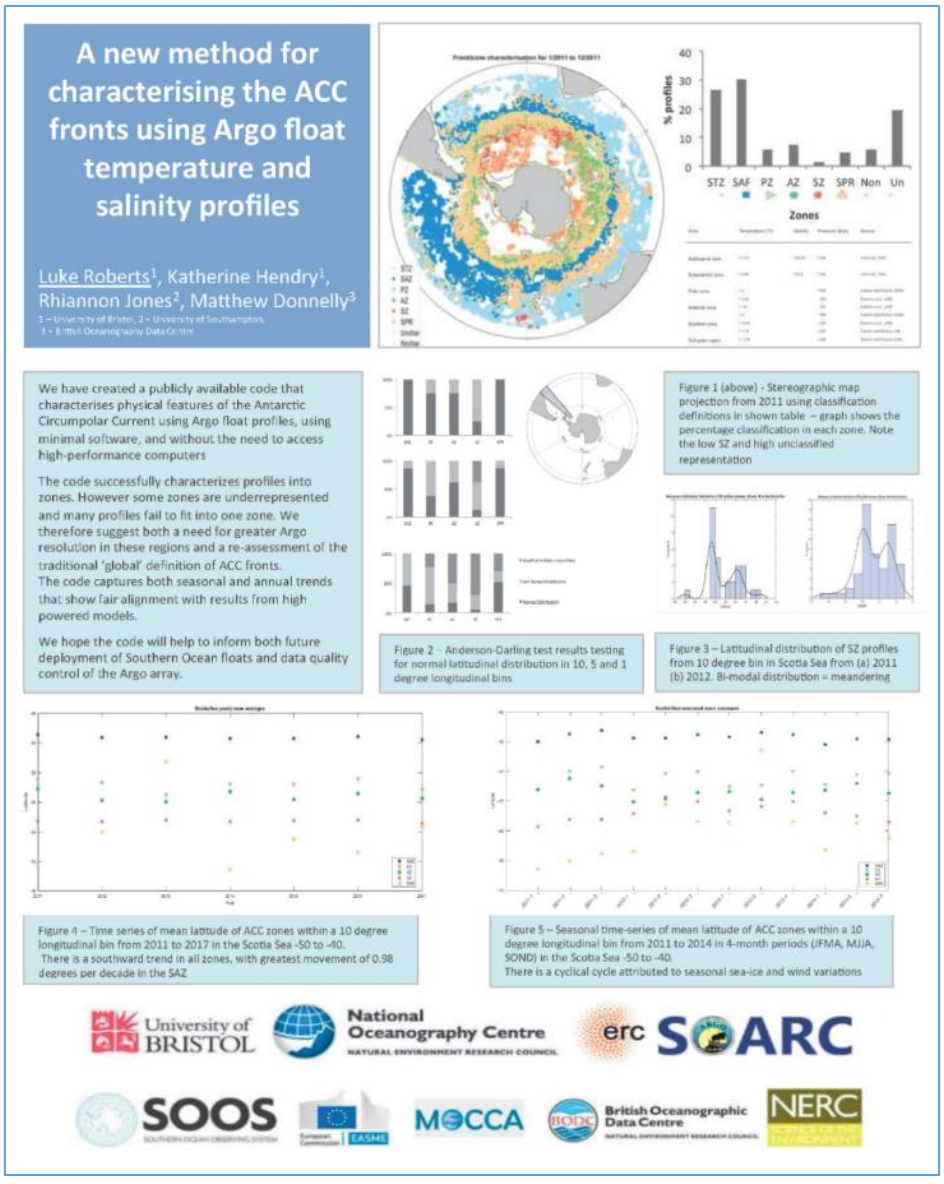
The code for the float characterization has been published on the *SOARC GitHub repository*, the first time SOARC has published code.

2.4.2. Challenger Society blog

Rhiannon Jones wrote a blog on her experience of developing the initial float characterization code and plots. This was published on the UK's Challenger Society for Marine Sciences 'Captain's Blog' website in December 2019 entitled: "*The Antarctic Circumpolar Current – what can Argo floats tell us?*"

2.4.3. Presentation at EGU General Assembly 2020

Luke Roberts remotely presented the analysis he undertook as part of his Masters Thesis using the float characterization work at the EGU General Assembly 2020 during the COVID-19 pandemic. The abstract is available on the *EGU GA website* and the poster presented is shown below:



3. FUTURE

This work has provided the foundations for a number of avenues of future development. Firstly, the establishment of a routinely updated mirror of the Argo GDACs at BODC will underpin a range of SOARC activities related to the quality control of data and metadata. Secondly, it has demonstrated a basis for future collaboration with universities by leveraging the data management and Southern Ocean expertise of BODC, and the environmental research orientated focus of students to implement well-defined functionality and then explore the results. Thirdly, the float characterization project has provided a basis for future work to establish regional data quality analyses of the Southern Ocean as part of the EU H2020 project EuroArgo RISE WP5 (extensions in high latitudes).

4. REFERENCES

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Sokolov, S., and Rintoul, S. R. (2009), Circumpolar structure and distribution of the Antarctic Circumpolar Current fronts: 1. Mean circumpolar paths, J. Geophys. Res., 114, C11018, *doi:10.1029/2008JC005108*