March 2022

International Nutrient Inter-Comparison 2023: Newsletter #8

Keep up to date on the facts, plans and people involved with the International Nutrient Inter-Comparison voyage (INIV2023) scheduled for May 2023

Photo Credit: CTD underwater - MNF

INIV is an opportunity for global nutrient chemists to come together to gain first-hand knowledge and experience of measuring nutrients in the ocean.

The goal of this voyage is to enhance peer to peer communication while tackling a broader understanding of time-scale nutrient changes for the oceanographic community.

Across the voyage our focus will be on better understanding method variabilities that cannot be achieved with a standard proficiency study. We hope to answer questions and improve techniques that will be shared with the global community

Welcome

Welcome to the 8th INIV newsletter. This newsletter aims to provide monthly updates around the current and future activities for INIV 2023. In this newsletter, Gabrielle and Elliot, our two summer students, take over to tell you about what they worked on for the INIV voyage during their time at CSIRO. Read on to know about their exciting findings and know a bit more about them!

Voyage Update

While we anticipated announcing the rescheduled 2023 dates for the voyage, we cannot confirm them at this time. 2023 dates will be communicated to the participants by email once the schedule is released.

Summer Student Project

In November 2021, Elliot and I joined the CSIRO Hydrochemistry team to complete a vacation studentship. Our project focused on collating and processing historical nutrient data on the SR03 GO-SHIP line, as well as developing a workflow for comparing nutrient data sets that could be used during the upcoming INIV voyage. We aimed to address the following questions:

1. Where in the water column should samples be taken from based on the need for a high nutrient concentration and high temporal and spatial stability?
2. What is the best way to compare and visualise nutrient data sets?

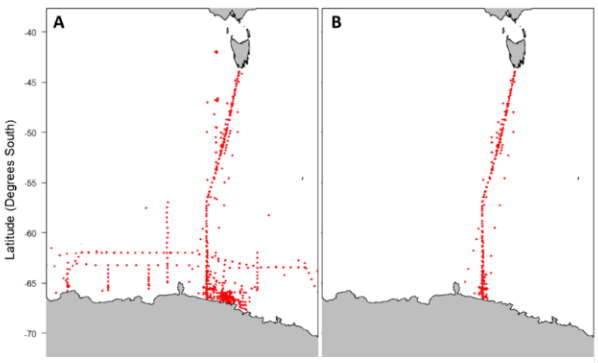

Figure 1. Spatial map of the Southern Ocean showing the extent of data points before (A) and after (B) geographically filtering for SR03.

We collected historical SR03 CTD and hydrology data from 23 voyages over 28 years from 3 countries. Data came from a variety of sources and included voyages that targeted SR03 specifically, as well as those that

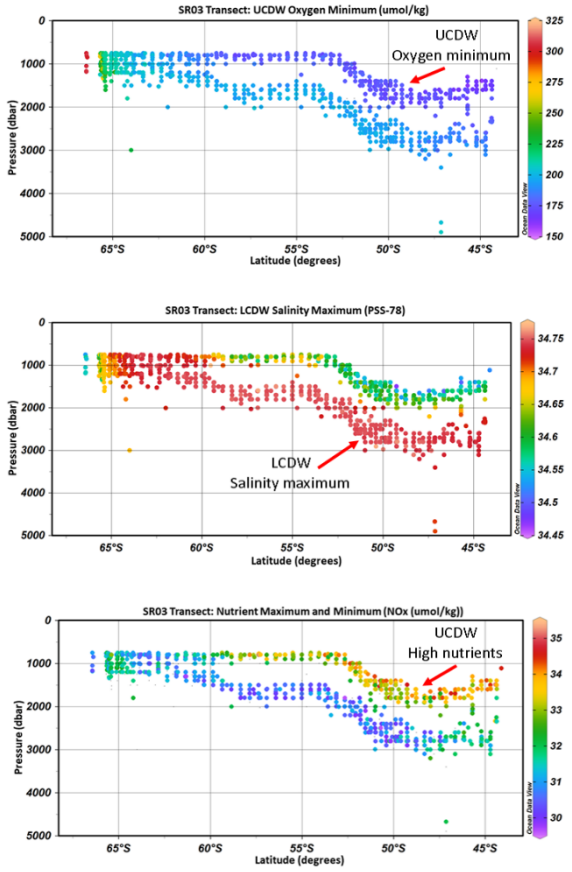

Figure 2. TS plot coloured by NOx. Each point represents an SR03 station at a certain depth at a certain time. The potential density contours are calculated with the TEOS-10 method incorporated into ODV.

visited a few stations on the way to the voyage study site or resupply Antarctic stations. After collecting the available data, we geographically filtered it using a polygon we created in RStudio. Only data within the polygon (i.e., part of the SR03 transect line) was retained (figure 1). We conducted quality control checks which included checking column header consistency, standardising date, time, and quality flags, calculating missing nutrient concentrations (e.g., $NO_x = NO_{2-} + NO_{3-}$), and creating new variables with badly flagged values omitted. We collected metadata information on the country, vessel, and dates (i.e., season) of a voyage as well as the CTD, instrumentation, and analytical technique used for data collection. We found that there was a diverse range of instruments and techniques used for data collection with approximately 6 different analysis methods used per nutrient over time.

We met with CSIRO oceanographers Chris Chapman and Benoit Legresy to gain insight into the stability of water masses in the Southern Ocean. From our discussion we determined that the Circumpolar Deep Water (CDW) was an ideal candidate for sampling nutrients on INIV and the results of our summer project reinforce this idea. The CDW is a very old, thick, and stable water mass that has a relatively high concentration of nutrients (Talley et al. 2011). It is formed by the intermixing of deep waters that originate in the Atlantic, Pacific and Indian Oceans. Temperature-salinity (TS) plots are routinely used by oceanographers to identify Southern Ocean water masses because they each correspond to different features on the plot. The CDW is identified by a distinct elbow (figure 2). The CDW is typically divided into an upper (UCDW) and lower (LCDW) layer which each have their own distinct characteristics (figure 3). The UCDW is shallower and is defined by an oxygen minimum (Talley et al. 2011). It also has a high concentration of nutrients. The LCDW is deeper and is defined by a salinity maximum.

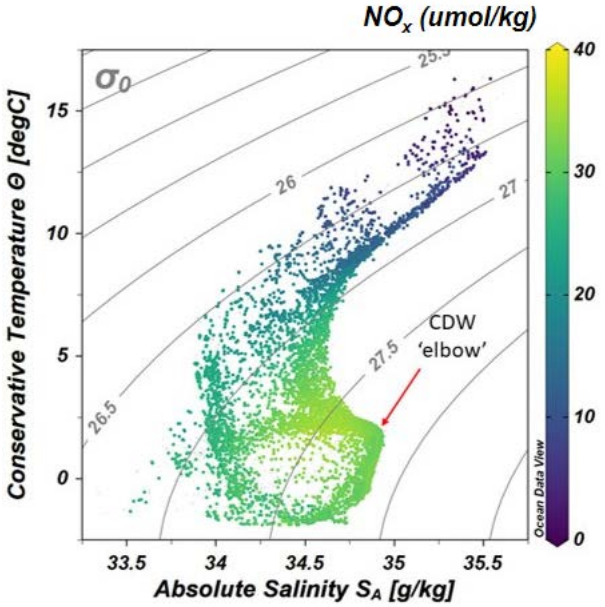

Figure 4. ODV section plots highlighting the distinct features of the UCDW and LCDW.

After identifying a suitable stable water mass to sample on INIV, our next step was to develop a method for extracting data within the UCDW and LCDW from our giant file containing all the data from each historical voyage. To do this we wrote a code using RStudio. We developed and trialled several

different methods for identifying and extracting the UCDW and LCDW. Incorporating depth, temperature, salinity, and oxygen data. Our final code iterated through each CTD drop performed on each individual voyage and filtered the data for the minimum oxygen value (UCDW) and maximum salinity value (LCDW) below a specified depth threshold. If the filter criteria were satisfied, the code extracted all measurements in that row and labelled it as either the UCDW or LCDW. This data was exported as a new data set that only contained data at the oxygen minimum (UCDW) or salinity maximum (LCDW) layers.

After extracting the CDW, we then needed to find the historical data that corresponded with the proposed INIV stations (figure 4). First, we filtered the CDW data set so that only points above -57 degrees latitude were included. Then we developed a code in RStudio that iterated through each proposed INIV station and found the closest historical station from each voyage. We set a cut off at 0.1 degrees latitude and longitude around each proposed INIV station so that we could ensure that all the historical data associated with a proposed station was close enough to be considered as the same station.

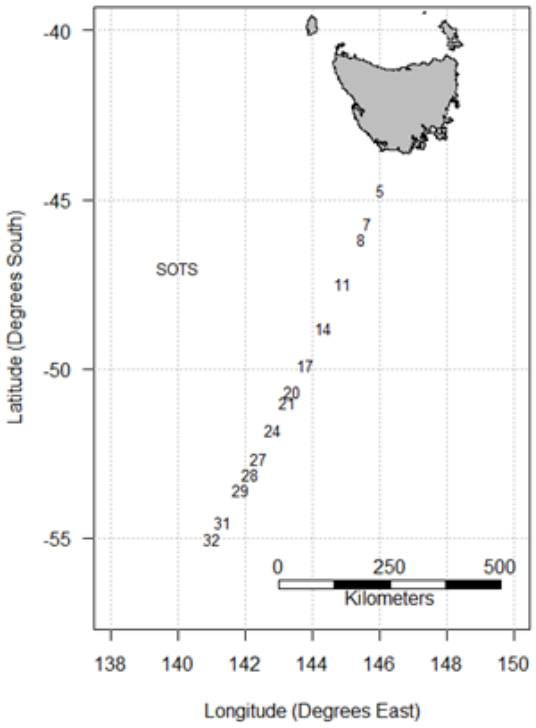

Figure 5. Map of proposed INIV stations and SOTS.

We found that nutrients in the oxygen minimum layer (UCDW) is very stable, with most historical data at each of the proposed INIV stations fitting within 1-3% variation from the median (as recommended by the GO-SHIP guidelines for accuracy in nutrient measurements). The most stable stations overall were station 14, 27 and 31. As part of our project we also investigated the value of adding SOTS (Southern Ocean Time Series) to the proposed list of stations for INIV. We found that the oxygen minimum layer at SOTS has a stable nutrient concentration, with 94% of historical data for NO_x fitting with 1-3% variation from the median. There are several other reasons why we think sampling SOTS would be valuable but most importantly it has a high availability of historical data in the CDW with 26 useable data points in the UCDW compared to a maximum of 9 data points for the most frequently occupied SR03 station. It has also been sampled consistently by the same country, using the same analytical methods, which would provide a good point of comparison for the work conducted during INIV.

Overall, we really enjoyed working on this project. It was an amazing learning opportunity that really helped us to quickly develop our R coding skills and gave us a much deeper understanding of how different factors in the ocean interact with each other. It was great to contribute to a scientific voyage and know that our findings have had a positive impact on voyage preparations. We look forward to seeing all the great science that will happen during INIV in 2023!

– Gabrielle

Participant Bios

Name: Gabrielle Henderson

University: University of Tasmania (UTAS)

Major/Degree: Bachelor of Marine and Antarctic Science. I majored in (1) marine biology and (2) marine and Antarctic ecology. I minored in GIS and remote sensing.

Favourite part of the project: My favourite part of the student project was gaining deeper insight into the collection and analysis methods of Southern Ocean nutrient data as well as its uses across a wide variety of scientific fields. I also enjoyed gaining experience working with complex, real-world data sets which helped me to improve my problem solving and R coding skills and of course the tour of the RV Investigator! That was so cool!

Career aspirations: I'd like to complete a PHD and get a job working in marine conservation. I'd love to come back and work for the CSIRO one day! Or work overseas! I'd also like to contribute to and/or make a documentary, visit Antarctica on a research voyage (at least once), give a talk at a scientific conference and travel around talking to school children about all things marine science and inspire the world's future scientists!

Name: Elliot Styles

University: University of Tasmania

Major/Degree: Bachelor of Marine and Antarctic Science, majoring in marine biology.

Favourite part of the project: Learning all about hydrochemistry, hydrographic techniques and the oceanographic aspects that really helped direct the project. It's been a huge learning experience for me and I'm super grateful to have completed the project with Gabbi as my teammate, she helped me out of more than a few rabbit holes. I'm very proud of what we have achieved!

Career aspirations: My career aspiration is to become a research scientist doubling as a university lecturer, focusing on biogeochemical oceanography out in the field (hopefully voyages!).

Hobbies outside of work: Anything that keeps me outside and exploring; mountain biking, hiking, snorkelling, boating and general adventure! If it requires sunscreen, you know I'll be there.

Voyage Website

We have a website! Check it out for additional information about our voyage including voyage location, planning, getting involved, FAQ and more: **https://wp.csiro.au/iniv/**

Contact Us

Please feel free to reach out to the CSIRO Hydrochemistry team at any time during the planning process – iniv2022@csiro.au

RV Investigator in Fremantle, Australia. Photo credit: Deanna Shanahan

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For further information

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