RV *Investigator* Scientific Highlights

Voyage #:	IN2017_V02		
Voyage title:	SOTS: Southern Ocean Time Series automated moorings for climate and carbon cycle studies southwest of Tasmania		
Mobilisation:	Hobart, Wednesday, 15 March 2017		
Depart:	Hobart, 0800, Friday, 17 March 2017		
Return:	Hobart, 0800 Tuesday, 28 March 2017		
Demobilisation:	Hobart, Tuesday, 28 March 2017		
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Principal Investigators:	Mark Rayner		
Project name:	International Nutrient Intercalibration Exercise		
Affiliation:	CSIRO	Contact details:	Mark.Rayner@csiro.au
Principal Investigators:	Eric Woehler		
Project name:	Spatial and Temporal Variability in the Distribution and Abundance of Seabirds		
Affiliation:	Birdlife Australia UTAS	Contact details:	Eric.Woehler@utas.edu.au
Principal Investigators:	Philip Boyd		
Project name:	Trace Element Cycling		
Affiliation:	UTAS	Contact details:	Philip.Boyd@utas.edu.au
Principal Investigators:	Rudy Kloser		
Project name:	Acoustic estimates of zooplankton and fish distributions		
Affiliation:	CSIRO	Contact details:	Rudy.Kloser@csiro.au

Scientific Highlights

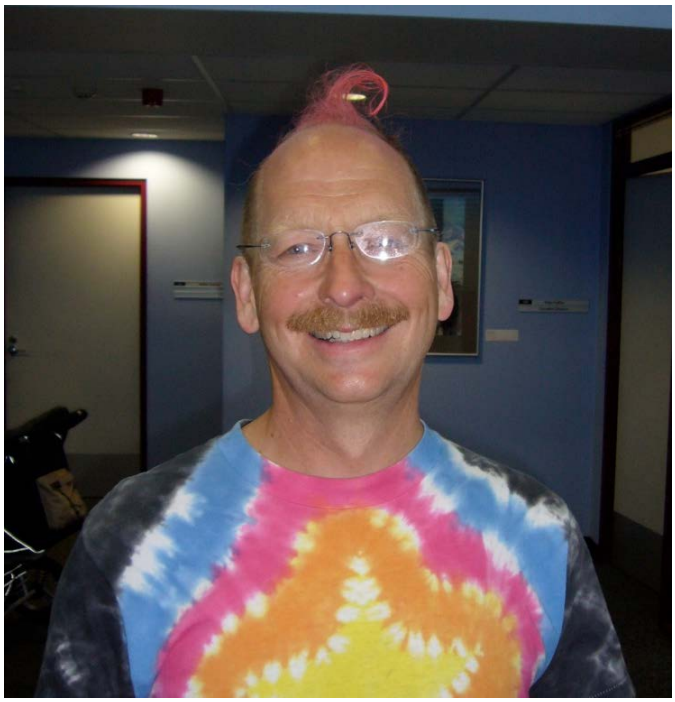
The Chief Scientist

Professor Trull's expertise is in chemical oceanography and marine biogeochemistry, in particular the use of chemical, isotopic, and sensor measurements to trace material flows through microbial foodwebs.

He obtained a PhD from the Massachussetts Institute of Technology – Woods Hole Oceanographic Institution Joint Program in Oceanography in 1989, and after postdoctoral work at the University of Paris joined the Antarctic CRC in 1993, and CSIRO in 2013.

Key achievements include:

1. demonstration that artificial and natural iron fertilization can enhance particulate carbon flux to the ocean interior, but that this capacity is limited and the risks insufficiently understood to merit largescale fertilization. This work contributed to the establishment of the International Maritime Organization moratorium on marine geo-engineering, for activities other than research.
2. contributions to understanding the status and progress of ocean acidification in Antarctic shelf waters.
3. establishment of the Southern Ocean Time Series examining air-sea exchanges of heat and carbon dioxide.



Title

SOTS: Southern Ocean Time Series automated moorings for climate and carbon cycle studies southwest of Tasmania

Purpose

The voyage consisted of five projects with the following objectives:

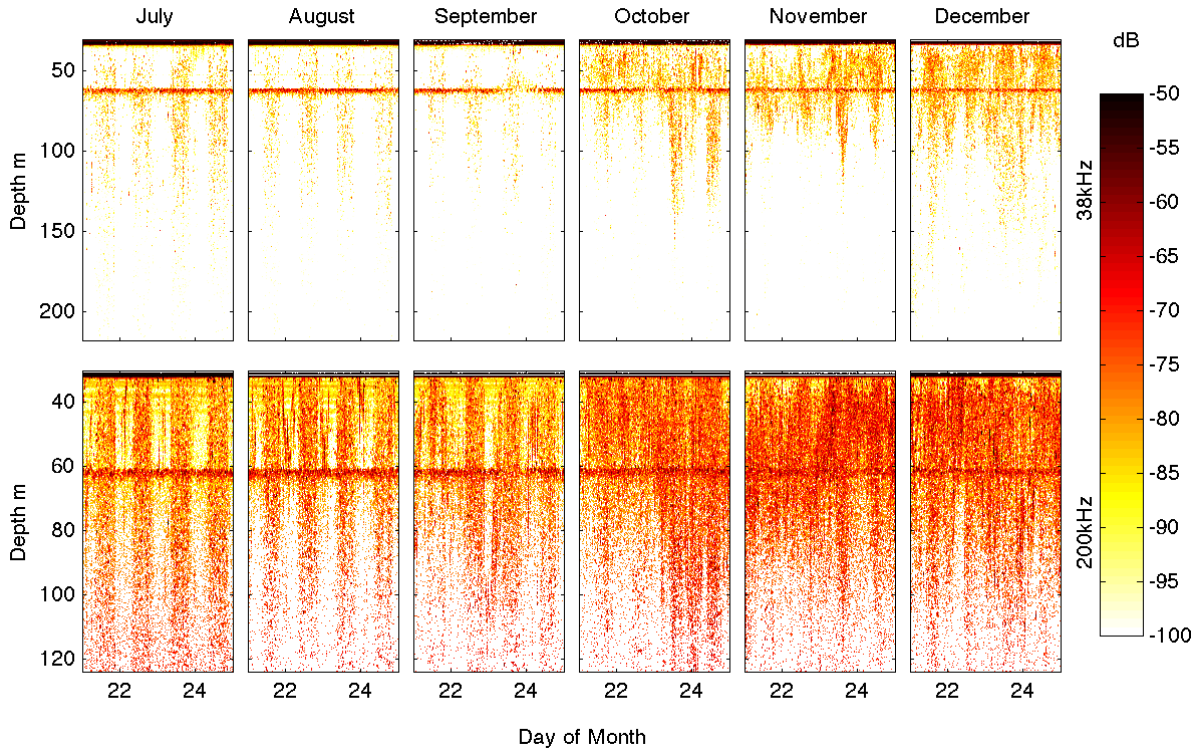
1. SOTS: The Southern Ocean is an important part of the global climate system, soaking up carbon dioxide and heat to moderate the earth's atmosphere. The Southern Ocean Time Series observatory uses a set of automated moorings to measure these processes under extreme conditions, where they are most intense and least studied. The processes occur on many timescales, from the day-night cycle up to ocean basin decadal oscillations and thus high frequency observations sustained over many years are required.
2. Nutrients: Investigation of seawater nutrient analysis, specifically looking at the differences in results obtained by a series of international groups. The analysis of seawater nutrients is completed all over the world, conducted with many different instruments and methodologies. This voyage will assist in the furthering of knowledge on the analysis as well as allowing different groups to highlight differences between attained results. With close collaboration between potentially 5 scientific parties, the science of seawater nutrient analysis can be improved or refined upon.
3. Seabirds: Quantify the distribution and abundance of seabirds at sea around Australia using standardised seabird survey protocols. The data collected will be compatible with previous seabird at sea surveys conducted around Australia and farther south, allowing for analyses and assessments to be extended by the current surveys. The distribution of seabirds at sea is strongly linked with oceanographic features such as convergences that concentrate prey at densities that allow for efficient foraging by seabirds. Our surveys on the voyage will link with oceanographic investigations to identify the types and strengths of oceanographic features at which we observe different species of seabirds that utilise different methods of feeding.
4. Trace elements: Measure profiles of trace element dissolved and particulate concentrations, and to examine the processes that produce and recycle them. The work during IN2017_v02 will in combination with those efforts deliver observations from 3 successive years and thus contribute to defining the stability versus interannual variability in trace element levels.
5. Acoustics Zooplankton and Fish Distributions: Map the top 1000m of the water column for zooplankton and fish at the SOTS site using the PLAOS acoustic optical system. Commonly nets, optic and acoustic samplers are used to determine the taxonomy, size, biomass, trophic linkage and energetics of zooplankton and micronekton. Each of these sampling methods have bias and uncertainty that need to be quantified prior to attributing changes within and between regions. To improve vessel mounted acoustic and net sampling methods of macro-zooplankton and micronekton a new profiling multi-frequency acoustic optical system (PLAOS) has been developed with the ultimate aim of it being used as a remote sampling tool. Development of this methodology and technology will significantly advance our knowledge of micronekton biomass and distribution and provide the necessary structure and function understanding for the development of carbon and ecosystem models of the open ocean.

Contribution to the nation

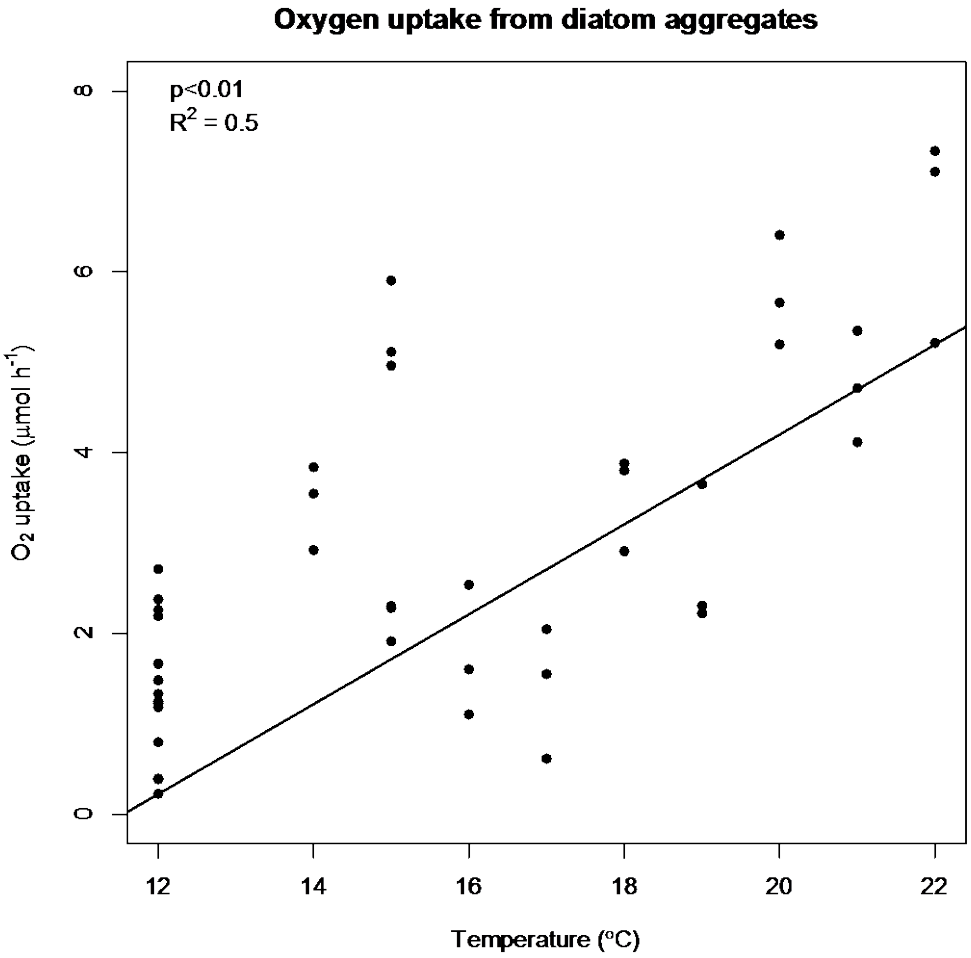
The SOTS research improves understanding of the global climate system by focussing on a key region –the Southern Ocean. Careful sustained observations over the last decade and into the next increases our knowledge of how the ocean interacts with the atmosphere. Improved understanding is essential to enhance advice to the nation on climate variability affecting us now, develop future scenarios and impact assessments, and to make optimal decisions that will affect the nation's future. The work also directly addresses the issue of how ocean biogeochemistry and productivity respond to ocean dynamics, which is an important input to projecting future biogeochemical and ecosystem states. In addition, enhanced understanding of process occurring in the region related to clouds, ocean mixing, waves and rain will also lead to improved forecasts and warnings issued to the public.

As a result of this voyage

As a result of this voyage, we have deployed moored platforms that assemble an integrated view of the seasonality of the processes that control the productivity of the Subantarctic microbial foodweb. This analysis extends from the physics of ocean mixing and insolation, to the chemistry of ocean nutrients and the biological responses of phytoplankton and zooplankton.



Volume scattering at the SOTS site from AWCP at 30m depth on the 2012 Pulse deployment showing the daily and monthly changes in zooplankton distribution (preliminary result)



Oxygen uptake rates experiment results showing the relationship between temperature and the physiology of particle-attached microbes as suggested by the metabolic theory of ecology

Image of a) two squids that were attracted to the PLAOS calibration line and b) a siphonophore

The scientific highlight of the seabird program was the observation of a Gibson's Albatross (a subspecies of the Wandering Albatross) originally banded in 1991 as a breeding adult (10 years or older), so the bird is at least 36 years of age, and likely closer to 50 years old. The bird was observed sitting on the surface close to the vessel on several occasions and was photographed when it was observed to be banded. The colour band allowed for the bird to be uniquely identified.

The banded Gibson's Albatross showing the red band 43G. ©Eric J Woehler