CLIVAR/CliC/SCAR Southern Ocean Region Panel SORP-12: 29-30 June 2017

National activities report

Country: New Zealand
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Receipt of material prior to 15 June 2017 will ensure inclusion in meeting discussion. Receipt of material prior to 15 July 2017 will ensure inclusion in meeting report and contribute to future SORP discussions, as well as input to the SOOS and other CLIVAR/CliC/SCAR activities. All reports will be posted on the SORP website.

Purpose of material gathered for the SORP: To build an overview of
- observational, modeling, ocean reanalysis and state estimation initiatives relevant to the SORP

(This can include a list of activities, maps showing where work has been done, major international project involvement, etc.)

Please refer to SORP's terms of reference (also given at the end of this template) for guidance on scope: http://www.clivar.org/clivar-panels/southern

Note: Biological topics such as marine ecology and marine ecology research, for example, are not within the scope of SORP's terms of reference and are therefore not required in these reports. However, SOOS has an interest in such research, so National Representatives are welcome to include summaries of such research as separate sections.

Note: The Southern Ocean is not explicitly defined in SORP's terms of reference, so please note what the limit used for your national report is (e.g., research on regions only beyond an oceanographic boundary like "south of the Polar Front", or research contained within latitudinal limits like "south of 50°S").

A. Recent and ongoing activities

Does your country have a national committee tasked with oversight of Southern Ocean climate science (e.g., like US CLIVAR)? If yes, please give the name of the committee.
No.

What major activities have been carried out in the last several years or are in progress now? Contact information for the projects would be useful (e.g., Principal Investigators and Associate Investigators).

1. OBSERVATIONS

Electromagnetic Sounding of sea ice

Pat Langhorne (University of Otago)

Wolfgang Rack (Canterbury University)
Christian Haas (York University, Canada)
Greg Leonard (University of Otago)
Mike Williams (NIWA)
Gemma Brett (Canterbury University)
Madelaine Rosevear (University of Tasmania)

Continent-wide satellite estimates of Antarctic sea ice thickness are now becoming available but need to be validated by sea ice transects and ice-ocean and oceanographic observations relating to heat transfer in ice shelf-affected waters. EM induction techniques are the only reliable method of determining sea ice thickness from the air. The technique also shows promise for detecting the sub-ice platelet layer. In 2016, EM induction flights were flown over McMurdo Sound, these were validated by ground measurement using EM techniques and direct methods. The ground observations were further complemented by ocean measurements under the sea ice, and snow measurement on the sea ice. Together these surveys were used to map the geographic extent of the influence of ice shelf meltwater on sea ice. The survey will be extended in 2017 and linked to the broader US-PIPERS experiment, which focuses on early season sea ice growth in the Ross Sea.

Contact pat.langhorne@otago.ac.nz or wolfgang.rack@canterbury.ac.nz

Influence of glacial melt input on sea ice processes

Pat Langhorne (University of Otago)
Wolfgang Rack (Canterbury University)
Craig Stevens (NIWA)
Inga Smith (University of Otago)
Cecilia Bitz (UW, USA)
Andrew Pauling (University of Otago)

The geographic extent of the sea ice response to changing freshwater fluxes (such as from ice shelf meltwater) introduced artificially to the Southern Ocean is being mapped using a global ESM (CESM1 - CAM5) with an existing sea ice module (the Community Ice CodE, CICE). The outcome of this study will be an improved understanding of the pathways of heat exchange between the ocean and sea ice. This insight will be useful with regard to the influence of ocean stability and heat transfer on the large-scale sea ice thickness distribution. Modelling will be supplemented by new generation satellite altimeter measurements (CryoSat-2, Sentinel-3 and ICESat-2). These data will reveal basin-wide spatial sea ice characteristics and their temporal variability, while snow on sea ice will be studied using radar imagery.

The instrumented moorings currently deployed near the Drygalski Ice Tongue will be retrieved and re-deployed in order to continue long-term monitoring of the ice shelfderived plume at the point where it enters the Terra Nova Bay Polynya system. The ice tongue can be considered a proxy for an ice shelf, at a scale that allows for substantial influence on water properties and behaviour while remaining quantifiable. In addition, direct measurements of ice-ocean interactions along the flow path of ice-affected melt water will be conducted from the fast ice of western McMurdo Sound.

Contact pat.langhorne@otago.ac.nz; wolfgang.rack@canterbury.ac.nz or Craig.Stevens@niwa.co.nz

Wave-Ice Interaction

Alison Kahout (NIWA)
Mike Williams (NIWA)

Ocean waves break up sea ice with trends in the retreat and expansion of the sea-ice edge correlated with trends in mean significant wave height. The key to interpreting this correlation lies in understanding wave attenuation in the Marginal Ice Zone, an area of broken ice floes, which is potentially hundreds of kilometres wide, near the sea ice edge. Approximately 12 NIWA-funded waves-in-ice buoys were deployed across the marginal ice zone from the Nathaniel B. Palmer PIPERS cruise in May and June 2017 in the Ross Sea, 2017. Several instruments were deployed well into the pack ice to ensure we fully capture the propagation of large wave events. The focus of the experiment is the energy decay associated with wave propagation through the sea ice pack. We will also run an experiment to capture wave-induced ice floe breakup, an area where there is a critical knowledge gap. Subsequent experiments are planned for the Marginal Ice Zone, with a collaboration with Australia likely in late 2018.
Contact Alison.Kohout@niwa.co.nz or Mike.Williams@niwa.co.nz

Platelet ice influence on ocean boundary layer

Natalie Robinson (NIWA)
Craig Stevens (NIWA)

Ice shelf basal melting can drive seawater temperatures below the surface freezing point. Ice crystals persist in this water and are buoyantly deposited beneath coastal sea ice. There, the crystals may form a porous and friable 'sub-ice platelet layer' which may be several metres thick. Therefore it not only causes sea ice to be thicker than it would otherwise be, but it also alters the hydrostatic relationship between sea ice elevation and thickness, and the hydrodynamic operation of the ocean boundary layer. The same mechanism results in the accretion of marine ice beneath ice shelves, with potential implications for the long-term stability of cold-cavity ice shelves. Five fast-ice sites in Southern McMurdo Sound were visited in October and November 2016 to link observations of boundary layer interactions along a gradient in properties of both ocean water and sub-ice platelet layer with a consistent observational approach.

Contact Natalie.Robinson@niwa.co.nz or Craig.Stevens@niwa.co.nz

Vulnerability of the Ross Ice Shelf in a warming world

Christina Hulbe (University of Otago)
Craig Stevens (NIWA)

The rate at which West Antarctic ice responds to climate forcing depends on a set of processes involving ice, ocean, atmosphere, and the terrestrial subglacial environment. Previous work has led to the understanding that rapid change is most likely to be driven from the sea and focused at the ice shelf grounding line. We seek here to identify the key process interactions and to reduce uncertainty in future change projections via a coordinated set of investigations centred around two hot water drilling field hubs on the Ross Ice Shelf (RIS). Field camps at each site will support interdisciplinary studies of both modern processes and ice and geological records of past states. The hubs will be connected regionally via satellite remote sensing, airborne geophysics, and numerical modelling. Our programme embraces the surface interface with the atmosphere, and the calving front, but emphasizes the grounding line and sub-ice shelf cavity. We will retrieve sea floor sediments for paleoclimate and ice sheet history studies, measure ocean properties, and conduct novel glaciological research at both sites. A mooring will be left in the ocean cavity nearly 200 km upstream of the ice shelf front. Single-season oceanographic observations will be made near the grounding line. When connected with existing observations on the RIS, the new sites yield an effective transect that allows us to consider the coupled system from grounded ice sheet to open ocean.

Contact christina.hulbe@otago.ac.nz or craig.stevens@niwa.co.nz

Interannual variability in the Ross Sea

Alena Malyarenko (NIWA)
Mike Williams (NIWA)

Multiple drivers contribute to the thermohaline and momentum-driven circulation in the Ross Sea. In recent years massive icebergs, variable polynya activity, changing fast ice conditions and a long-term trend towards lower salinity deep water have all contributed to high interannual variability in oceanic properties on the Ross Sea continental shelf – including within the Ross Ice Shelf cavity. This project will combine moored and profiled data from a variety of sources with seal-tag temperature/salinity data to improve understanding of the year-to-year variability in ocean properties.

Contact Mike.Williams@niwa.co.nz

2. MODELLING

Open Ocean convection in the Southern

Erik Behrens (NIWA)
Graham Rickard (NIWA)

A large set of sensitivity model simulations (NEMO-CICE) is under way to investigate the reasons for open ocean convection in the Southern Ocean in forced and coupled simulations. Sensitivities studies involve changes in the surface freshwater forcing and restoring of temperature and salinity throughout the water column. Most simulations being performed with eORCA1, the base model for NZESM, but also higher resolution configurations such as eORCA025 will be used. With this project we try understand the processes which lead to deep convection better to be able to reduce this process in present simulation. We also have an eye on the consequences of open ocean convection and the absence of it. This project is part of the Deep South National Science Challenge (http://www.deepsouthchallenge.co.nz/).
Contact: Erik.Behrens@niwa.co.nz

High resolution Ross Sea modelling: implications of an improved AABW production

Erik Behrens (NIWA)
Graham Rickard (NIWA)

A NEMO-LIM2-based high resolution ocean model using two-way nesting techniques for the Ross Sea region is under development. This model configuration uses a global eORCA1 configuration, with a view to future climate modelling applications. The aim is to improve the representation of mesoscale features and the downslope flow of Antarctic Bottom Water in this region, and to investigate implications for the large scale Southern Ocean circulation. This project is part of the Deep South National Science Challenge (http://www.deepsouthchallenge.co.nz/). It is planned to couple this model configuration to an active atmosphere at a later stage of this project. Related global hind cast simulations with lower horizontal resolution configurations (eORCA1, eORCA025) have been completed and serve as reference simulations.
Contact: Erik.Behrens@niwa.co.nz

Control of Ross Sea dynamics by competing seasonal processes

Stefan Jendersie (NIWA)
Pat Langhorne (Univerity of Otago)
Mike Williams (NIWA)

An application of the Regional Ocean Modeling System (ROMS) to the shallow Ross Sea continental shelf, including the ice shelf cavity, has identified a system of three anti-cyclonic and one cyclonic circulation cells that facilitate the water mass transports in the region. Constrained by the banks and depressions, the cells are spatially persistent but experience different individual temporal changes. The main control of their dynamics are the horizontal differences in density that drive three mechanisms: baroclinic pressure gradients, gravity driven bottom flows and barotropic pressure gradients through sea surface height gradients. i) Circumpolar Deep Water resupply events seem triggered by a zonal shift of the Antarctic Slope Current (ASC) on the order of ~10 km that occurs at different times along the shelf break; ii) density gradients are strengthened via High Salinity Shelf Water production during intense winter sea ice formation the south-western Ross Sea; iii) Local horizontal differences in density are enhanced by Ice Shelf Water (ISW) supplied by ice shelf basal melt. The model predicts phase lags of up to 1.5 years between heat import events to the cavity and the subsequent ISW pulse leaving the cavity. Thus the seasonality of flow dynamics in the Ross Sea is a superposition of the ASC variability, the atmospheric cycle, and the heat import signal to the cavity. Contact Mike.Williams@niwa.co.nz

3. Ocean reanalysis and state estimation

No State Estimation Work is being done or planned

Please give a full list of references at the end of section A.

B. Planned activities

What major activities are planned or likely to occur during the next several years? Contact information for the projects would be useful (e.g., Principal Investigators and Associate Investigators).

1. Observational?
2. Modeling?
3. Ocean reanalysis and state estimation?

New Zealand Southern Ocean research funding is currently being restructured, and more clarity about activities will be able to be given in next year's report.

SORP terms of reference http://www.clivar.org/clivar-panels/southern

"To serve as a forum for the discussion and communication of scientific advances in the understanding of climate variability and change in the Southern Ocean. To advise CLIVAR, CliC, and SCAR on progress, achievements, new opportunities and impediments in internationally-coordinated Southern Ocean research."

Specific Activities:

1. Facilitate progress in the development of tools and methods required to assess climate variability, climate change and climate predictability of the ocean-atmosphere-ice system in the Southern Ocean.
2. Identify opportunities and coordinated strategies to implement these methods, spanning observations, models, experiments, and process studies.
3. Provide scientific and technical input into international research coordination, collaborating as required with other relevant programs, including the Southern Ocean Observing System (SOOS).
4. Monitor and evaluate progress in Southern Ocean research, and identify gaps.

5. Enhance interaction between the meteorology, oceanography, cryosphere, geology, biogeochemistry and paleoclimate communities with an interest in the climate of the Southern Ocean.
6. Work with relevant agencies on the standardization, distribution and archiving of Southern Ocean observations.