Weddell Sea Moorings

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1. Project Summary

The world's deep oceans are filled with water masses formed at the continental margins of Antarctica. The Weddell Sea is a major source of these so-called Antarctic Deep and Bottom Waters. Relatively warm, saline Circumpolar Deep Water (CDW) enters the Weddell Gyre to the east of the Greenwich Meridian. As it traverses the gyre, it feeds bottom water forming processes on the continental shelves, and interacts with floating ice shelves to produce Weddell Deep and Bottom water types. Because these formation processes include heat exchange with the atmosphere and ice shelves, the properties of the water masses formed carry an imprint of any recent changes in atmospheric and shelf ice characteristics, including temperature, distribution of shelf and sea ice, and shifts in large scale wind stress patterns such as those associated with the Southern Annular Mode (SAM) and ENSO.

This project maintains deep and bottom water focused oceanographic moorings south of the South Orkney Islands in the Northwest Weddell Sea to provide a time series of the combined outflow (currents and temperature/salinity) of Antarctic Deep and Bottom Water drawn from various sites within the Weddell Sea. The observation sites were selected to monitor the integrated properties of the outflowing deep and bottom waters after they have traversed the key formation sites in the western Weddell Sea.

The moorings were initially installed and maintained as part of the NOAA-funded Consortium on Oceans Role in Climate: AbRupt climate CHangE Studies (CORC-ARCHES) Southern Ocean Modern Observations program. First installed in April 1999, the moorings have been serviced using ship time made available by other polar programs, primarily through the National Science Foundation Office of Polar Programs (OPP), and principal investigators funded by OPP who graciously allow our team to sail on their cruises. As time and resources allow during the mooring maintenance cruises, oceanographic stations to collect profiles of conductivity, temperature and tracers (CTD/tracer) are occupied at the mooring sites and at stations distributed along a line between the mooring locations (Figure 1). The cost of ship time devoted to the mooring work and associated CTD/tracer stations, typically 3 to 5 days, has been supported by funding from NOAA.

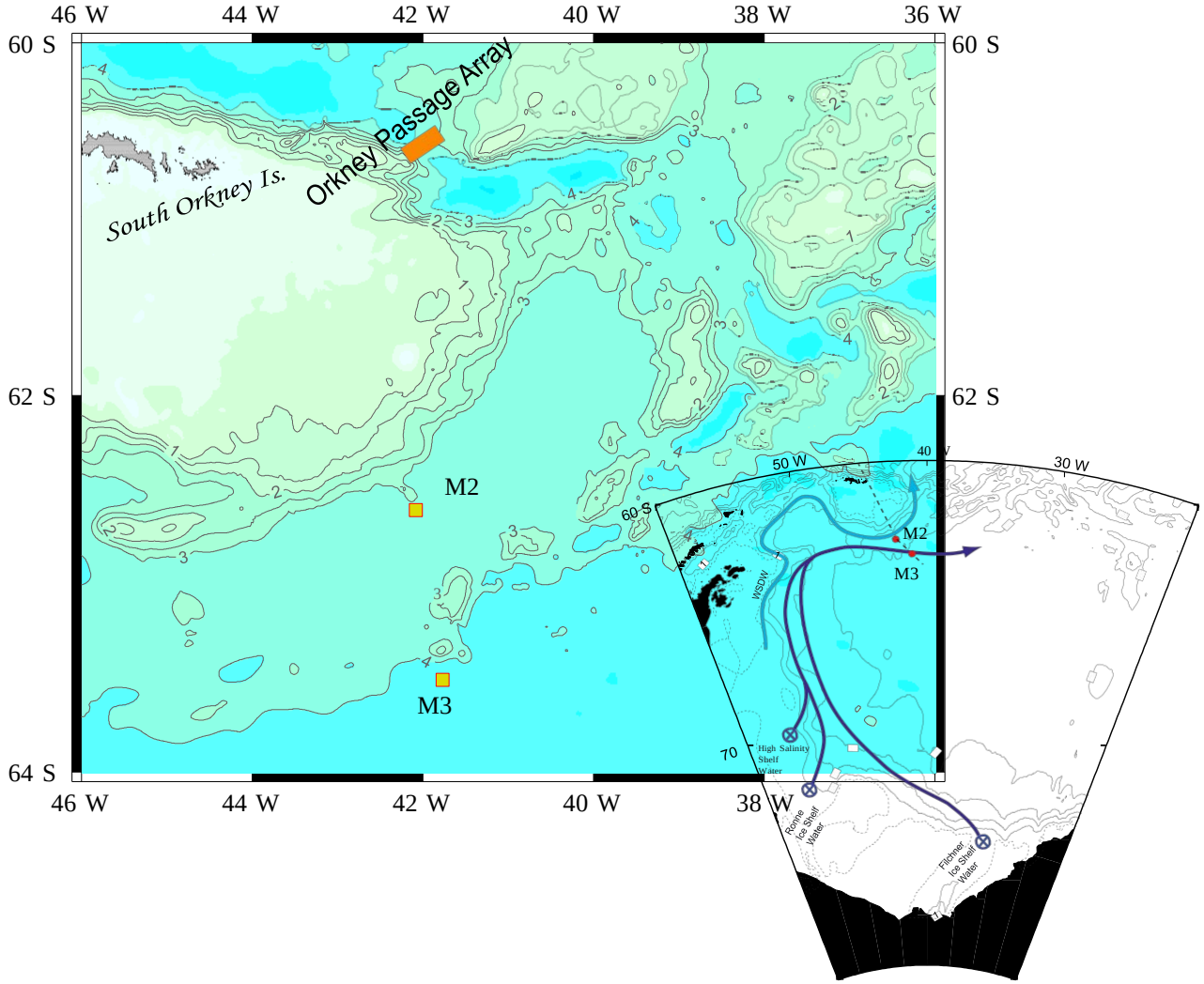

Figure 1. Weddell mooring locations, and schematic of deep and bottom water flow from source regions to the mooring array.

More recently, ship time arrangements have been made with colleagues at the British Antarctic Survey (BAS), under the auspices of an Agreement of Cooperation between Lamont-Doherty Earth Observatory of Columbia University (LDEO) and BAS. The agreement with BAS provides for sharing of equipment, personnel and data between LDEO and BAS to allow the mooring sites to be serviced at nominally two-year intervals, with BAS providing the ship time to do so. Under this agreement, by sharing material resources with BAS, we have been able to expand the mooring array to encompass the Orkney Passage to the east of the Orkney Plateau, a site of potential escape of Weddell Deep Water into the Southern Ocean. Our collaboration with BAS will continue, so this work remains part of an international effort.

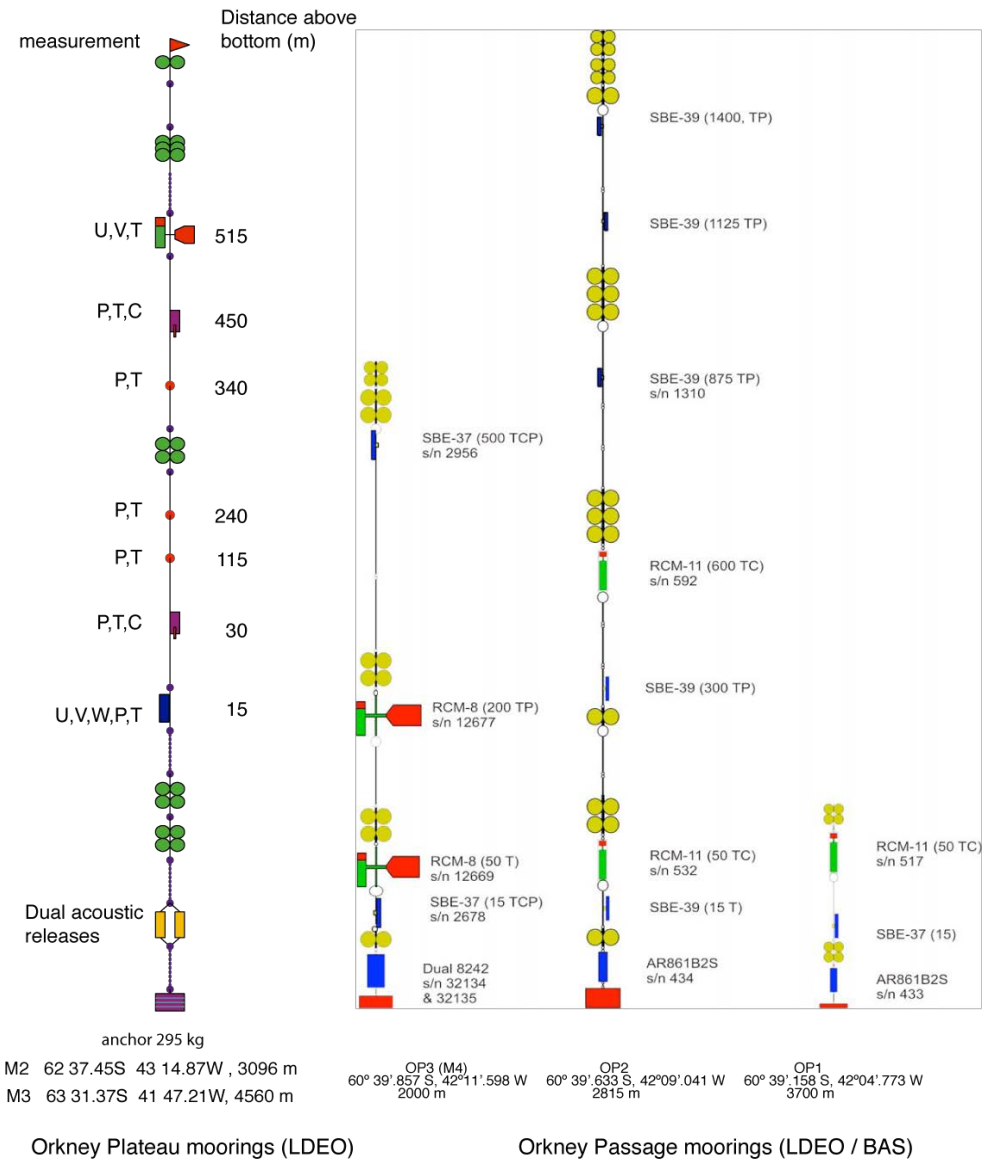

Figure 2. Weddell mooring configurations and positions. RCM current meters are being replaced with acoustic current meters as budget allows. New temperature and temperature/salinity recorders are purchased in off-field years and phased into the mooring array to allow for return and recalibration of older units.

<u>Data Collection: Frequency and Availability</u>

Because the ship time required for servicing the moorings is made available on an opportunity basis, the moorings are not serviced at regularly scheduled intervals. We plan for a nominal two-year cycle, but the moorings are designed with a lifetime in excess of three years in the event that

ship time is unavailable on the 2-year cycle. Moored instrument data and whatever oceanographic profile data we are able to collect are therefore available on a nominal two-year cycle. The moorings are located in regions that are seasonally covered by sea ice, so all data are recorded internally and must be recovered during the service calls. The recovered data are quality controlled, and made available via the web (http://www.ldeo.columbia.edu/res/div/ocp/corc-arches/data.shtml) generally within 12 months of their recovery from the moorings. Descriptions of the moorings and metadata are catalogued at OceanSITES (http://www.oceansites.org/). We are currently awaiting assignment of OceanSITES platform IDs for the moorings.

We have provided the data to many investigators and groups, summarized in Table 1. With the placement of moorings on the continental shelf and slope adjacent to the Larsen B embayment planned for early 2012 (as part of the LARISSA project funded by the US National Science Foundation), the Climate Observation Division Weddell mooring data will soon contribute a down-stream reference point for deep and bottom water formation processes observed in the climatically-sensitive Larsen B and C ice shelf regimes.

Table 1. Weddell Sea Moorings data

Investigator	Affiliation	Data Application
K. Heywood	U. East Anglia	S. Ocean Meridional Overturning Circulation (SOMOC)
M. Meredith K. Nicholls	British Antarctic Survey British Antarctic Survey	Outflow of Weddell Deep and Bottom Waters to the Scotia Sea; SOMOC
S. Kern	CMAS/IOC/Inst. of Oceanography Hamburg	Impact of variations in the Ronne-Filchner polynya on bottom water characteristics
R. Kerr (student)	Laboratório de Estudos dos Oceanos e Clima Instituto de Oceanografia – FURG Brazil	Modeling the transport of Weddell Deep and Bottom waters
R. Robertson	School of Physical, Environmental, and Mathematical Sciences, Australian Defense Force Academy	Teaching; research on mixing and tides on continental shelves and slopes of Antarctica
B. Sloyan	CSIRO Marine and Atmospheric Research, Hobart, Tasmania	Assessment of CCSM4 climate model AABW formation

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