SOOS: Brief introduction, current status

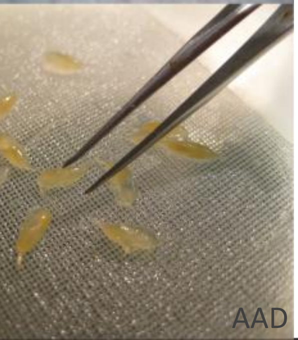
Anna Wåhlin, University of Gothenburg, Sweden

with input from SOOS community, discussions during the FRISP 2012 meeting, the SOOS Under Ice Workshop, and the KOPRI Amundsen workshop .

SOUTHERN OCEAN OBSERVING SYSTEM

IMAS INSTITUTE FOR MARINE AND ANTARCTIC STUDIES

UTAS



The Southern Ocean is changing…

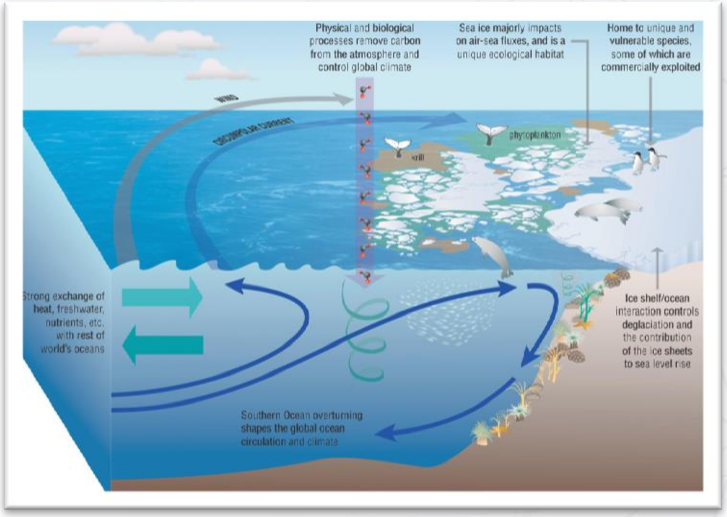
- Regional warming
- Decreased salinity in upper and abyssal ocean
- Basin-wide acidification
- Regional decreases in sea ice
- Shifts in ecosystems

Need to monitor and understand the changes in order to predict future changes, and mitigate impacts.

Support the need for sustained, and internationally coordinated observations of the Southern Ocean

The Southern Ocean Observing System – SOOS

- Many (mono-disciplinary) programmes in Southern Ocean research
- All have individual infrastructure, data routes, etc.
- There is a need for a *single programme* to *connect* across disciplines and programmes to ensure a *coordinated* approach to observing the Southern Ocean



SOOS aims to meet this need

The SOOS Initiative

SOOS
SOUTHERN OCEAN OBSERVING SYSTEM

- An integrated Southern Ocean observing system had been advocated for at least 10 years
- SOOS **launched** in August 2011
- SOOS initiated and **sponsored** by:
- SOOS International Project Office (Hobart, Australia) **sponsored** by:
- SOOS **endorsed** by:

Science Themes

Key science challenges identified as the most pressing issues - both scientifically and societally - to be addressed by the SOOS:

1. **Role of Southern Ocean in global freshwater and heat balance**
2. **Stability of Southern Ocean overturning circulation**
3. **Stability of Antarctic ice sheet and future contribution to sea-level rise**
4. Future of Southern Ocean carbon uptake
5. **Future of Antarctic sea ice**
6. Impacts of global change on Antarctic ecosystems

Ongoing activities and gaps

SOOS

How does SOOS work?

Meetings & Workshops

- 1st SSC Meeting (Salt Lake City, Feb 2012)
- Data Mngt Sub-Committee Meeting (Portland, July 2012)
- SOOS 'Seeing Beneath the Ice' Workshop (Hobart, Oct 2012)
- SOOS 'Town Hall' AGU Fall Meeting (San Francisco, Nov 2012)
- 2nd SSC Meeting (Shanghai, May 2013)
- SOOS Asian Workshop (Shanghai, May 2013
- COMNAP-SOOS Workshop (Seoul, July 2013)

Scientific Proposals

- International Council for Science (ICSU) (pending)
- Census of Marine Life International Cosmos Prize Fund (unsuccessful)
- SCOR Working Group to identify eEOVs (unsuccessful)
- EU 7th Framework Programme for Research (FP7) (unsuccessful)

Currently working with making goals more specific. Needed in order to interact with national Antarctic programs, research funding agencies, international organizations etc

Example: COMNAP collaboration:

An improved database of current and planned future routes and schedules for Antarctic shipping;

A comprehensive list of measurements currently taken regularly from Antarctic bases and vessels;

Recognition and acceptance of standardised methodologies and protocols for collecting marine science data for uptake by NAPs;

Dissemination through COMNAP of information about standardised, high quality measuring equipment that can be easily and cheaply installed on Antarctic vessels; and

Development of a set of priority basic measurement that could be taken regularly from all Antarctic bases and vessels using the abovementioned standardised methodologies and protocols.

CSIRO

Organiser: Esmee van Wijk, Fiona Taylor, Anna Wahlin, Steve Rintoul

Antarctica New Zealand

CliC

pogo

In order to answer key scientific questions we need to measure

* Flow and characteristics of WDW and glacier melt water
    - Onto and off the shelf
    - into and out of the ice shelf cavity

T, S, O2, velocity, (+stable isotopes and noble gases) in good spots

* Water mass modification in the ice shelf cavity

T, S, O2, velocity, mixing in good spots

* Water mass modification on the continental shelf (ice freezing/melting, atmospheric cooling)

T, S, O2, mixing, sea ice, SST, SSS

* Changes to ice shelves (thickness, speed, basal melt)

Ice shelf bathymetry and velocity (satellites, radar), basal melting (altimeter)

* Grounding line position ???

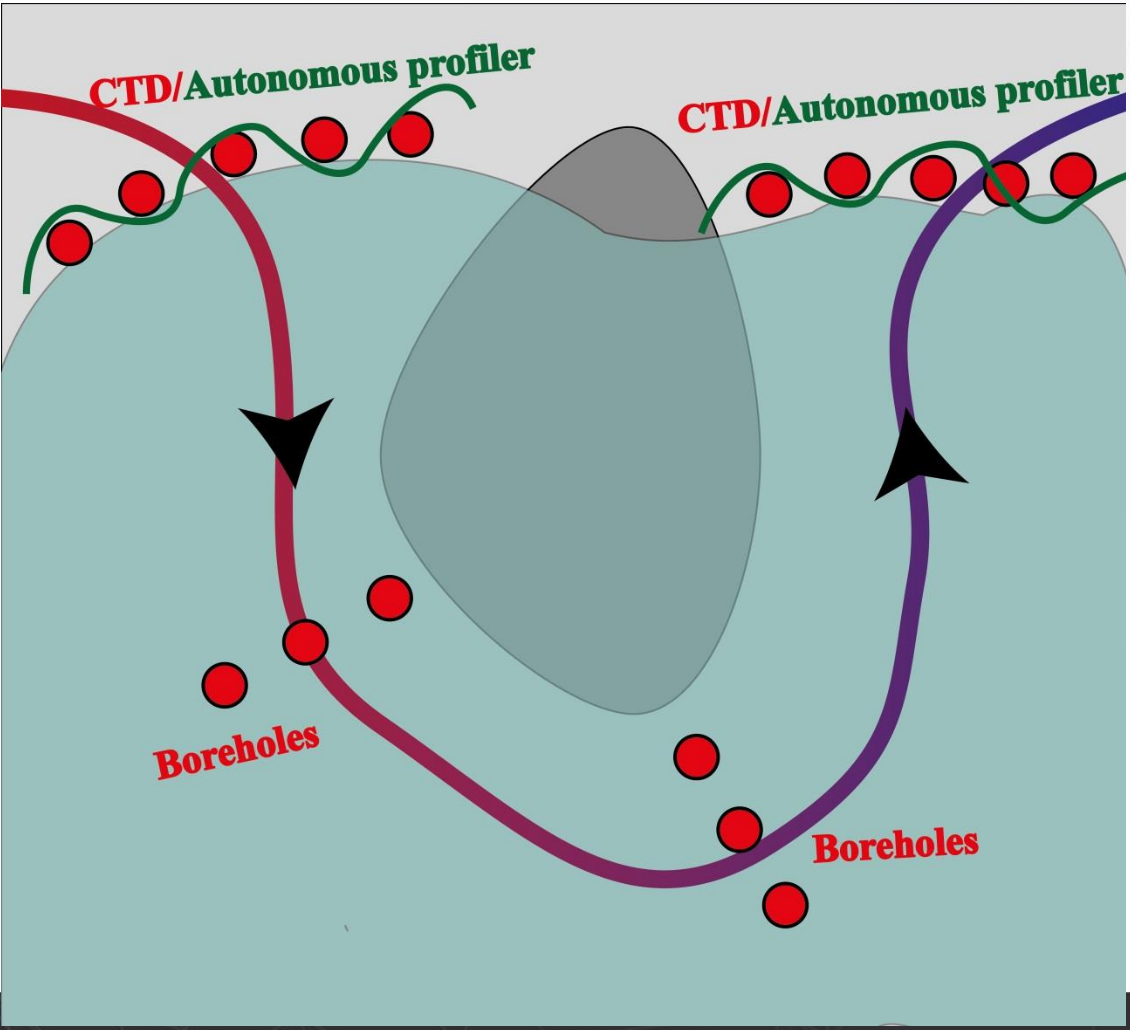
This must be done on timescales up to decadal

Table of key parameters and platforms, colors = state of readiness

	Repeat Hydrography	Argo / drifters	Underway sampling	Moorings	Tide gauges	Animal sensors	Glider /AUV	Satellite	Airborne	Ice stations	IS stations (surface)
Temperature			XBT/XCTD	Yes							Suspended moorings CTDs and distributed temp sensing (DTS)
Salinity			XBT/XCTD	Yes							Suspended moorings CTDs
Velocity			Surface layer	Yes				Surface (if ice free)			Moorings (ADCPs)
Tracers											
Noble gases	Yes		Developing (CHINARE)	Developing (CHINARE)							
Nutrients				Developing (CHINARE)							
Oxygen				Yes							
Microstructure											
Sea Ice											
Wind, accumulation								If ice free		Automatic weather stations on IS and fast ice	Automatic weather stations on IS and fast ice
Sea level rise								If ice free			
Seabed pressure											
IS Topography								InSAR, Radar and Laser alt.	Radar (RES) and Laser altimetry		GPS (Spot values or traverse)
IS thickness								Buoyancy estimates from surface topography	RES, buoyancy estimates from surface topograph		Seismic, RES
IS flow speed								InSAR, feature tracking	Radar (RES) and Laser altimetry		GPS
Glacier topography								InSAR, Radar and Laser altimetry			GPS
Glacier flow speed								InSAR, feature tracking			GPS, boreholes for velocity depth profiles
SST								If ice free			
SSS								If ice free			
Bathymetry below IS									Gravimetry		Seismic
seafloor bathymetry									Gravimetry		Seismic
Bedrock under grounded ice									RES, Gravimetry		RES, Seismic
IS basal melt				Upward-looking altimeter							Phase Coherent RES (at surface)
IS temperatures (=> heat transfer)				Embedded T-sensors (boreholes)							Embedded temp sensors: (boreholes)
Grounding line											

Light Green = Mature, available technology; Yellow = developmental stage;

Strawman observation system



Inflow/outflow into ice shelf cavity:

Sections along ice shelf front

Combination of repeat CTD transects, moorings and autonomous profilers (AUV/glider)

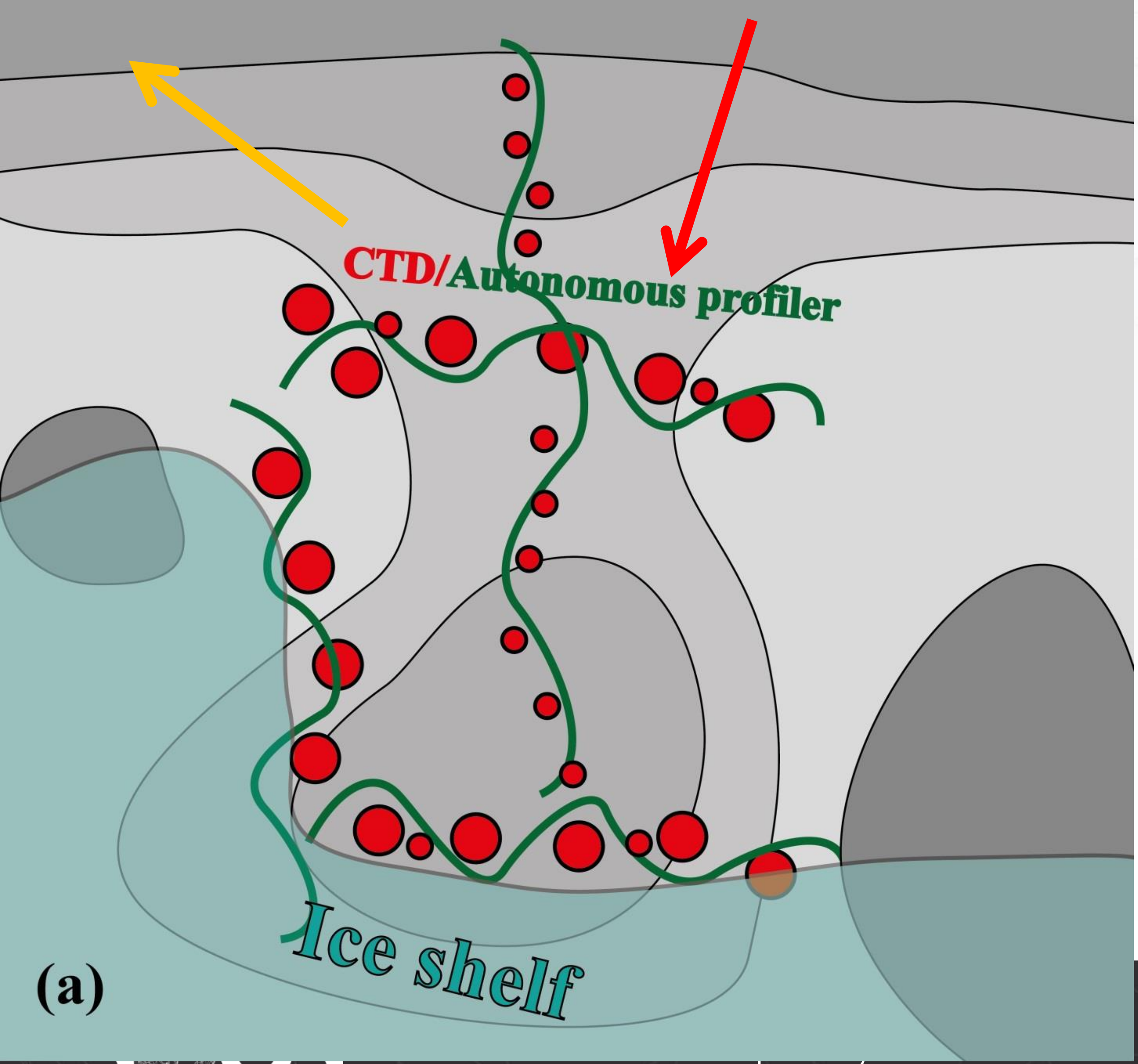
Water mass modification underneath ice shelf:

Sections across flow path (from bathymetry)

Boreholes, moorings

Missions with AUV

Strawman observation system

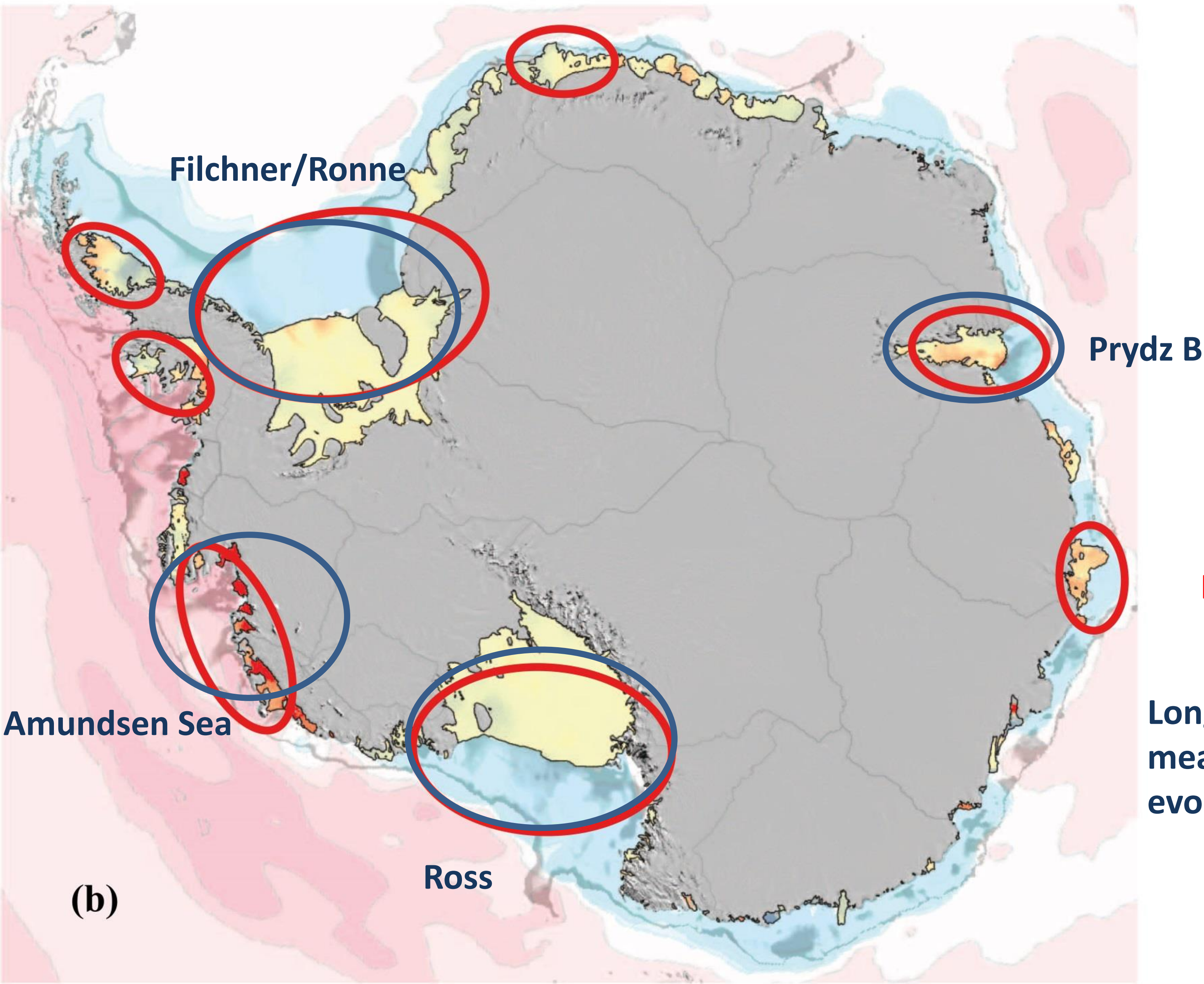


Inflow/outflow onto continental shelf:
Sections along and across deep troughs
Combination of repeat CTD transects, moorings and autonomous profilers (AUV/glider)

Water mass modification on shelf:

Sections + drifters/seals

Present status:



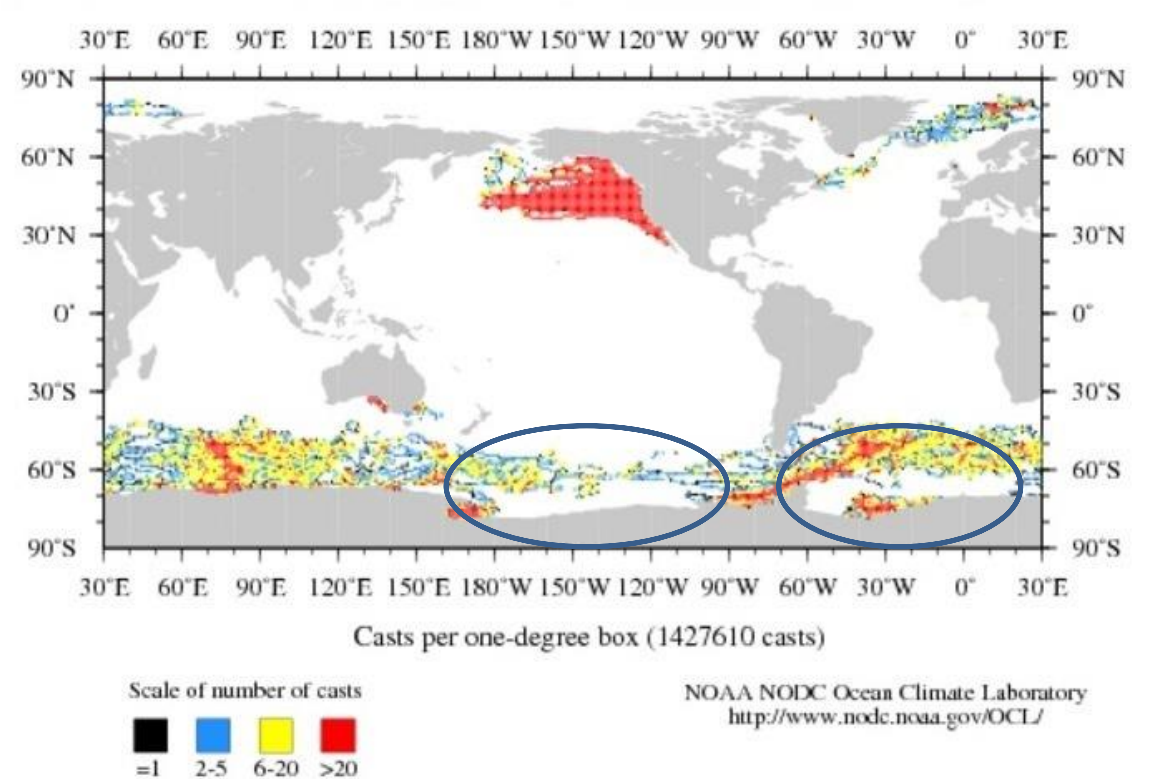
Gaps in knowledge:

1) Strong summertime bias

2) Lack of long time series

3) Some areas very poorly known (bathymetry, CTD, etc)

4) We can not measure the grounding line



Animal sensors (NODC)
Where gaps => very strong summertime bias

Presently (due this week): Develop timeline, strip down long-term goals (gaps) to small portions.

This plan assumes that SOOS will seek to at least maintain the current level of observational activities (repeat hydrographic sections, Argo floats, instrumented sea mammals, satellite measurements, etc.), unless otherwise stated. The activities mentioned represent an evolution or improvement on current activities.

2014:

- Publication of work plan, with map summary of current and planned activities and major gaps identified
- Engagement of air-sea flux community into SOOS via workshop on Southern Ocean air-sea fluxes

2015 - 2016:

- Publications on quantitative identification of T-S-tracer footprints of changes in Southern Ocean overturning
- Publications on causes of climatic changes in AABW
- Engagement of data assimilation community into SOOS design and exploitation activities (via panel membership and / or workshop)

- Implementation of observational plan:
- Commence addressing 'deep ocean' (below 2000 m) and 'ventilation' blind spots by deployment of deep Argo floats and Argo floats with biogeochemical sensors
- Development of technologies to observe the Southern Ocean under ice

2017 - 2018:

- Double the pre-2015 annual number of deep ocean (below 2000 m) hydrographic observations and water column biogeochemical measurements by continuing to deploy increasing numbers of deep Argo floats and Argo floats with biogeochemical sensors
- New sustained observations of the Antarctic margins (e.g. station-based

For long-term time series:

- Identification of a number of standard transects

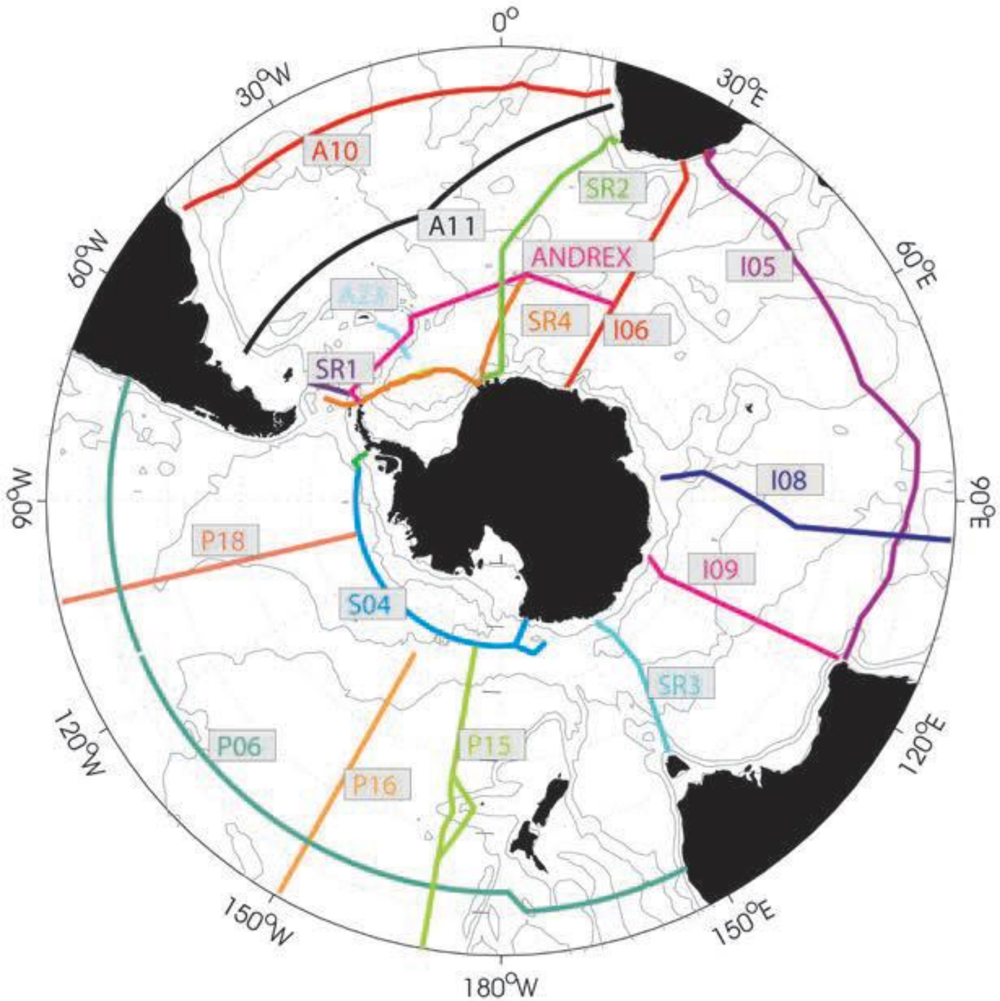
- Join efforts with mooring turnover

- Develop techniques for more autonomous moorings: Data capsules, acoustic transmission of data (acoustic modem, AUV, other solutions). (Problem: Moorings below sea ice or glacier ice)

- Under ice navigation of AUV, glider, floats (under ice workshop report). Sound navigation, sound sources?

Current state of observations and coordination

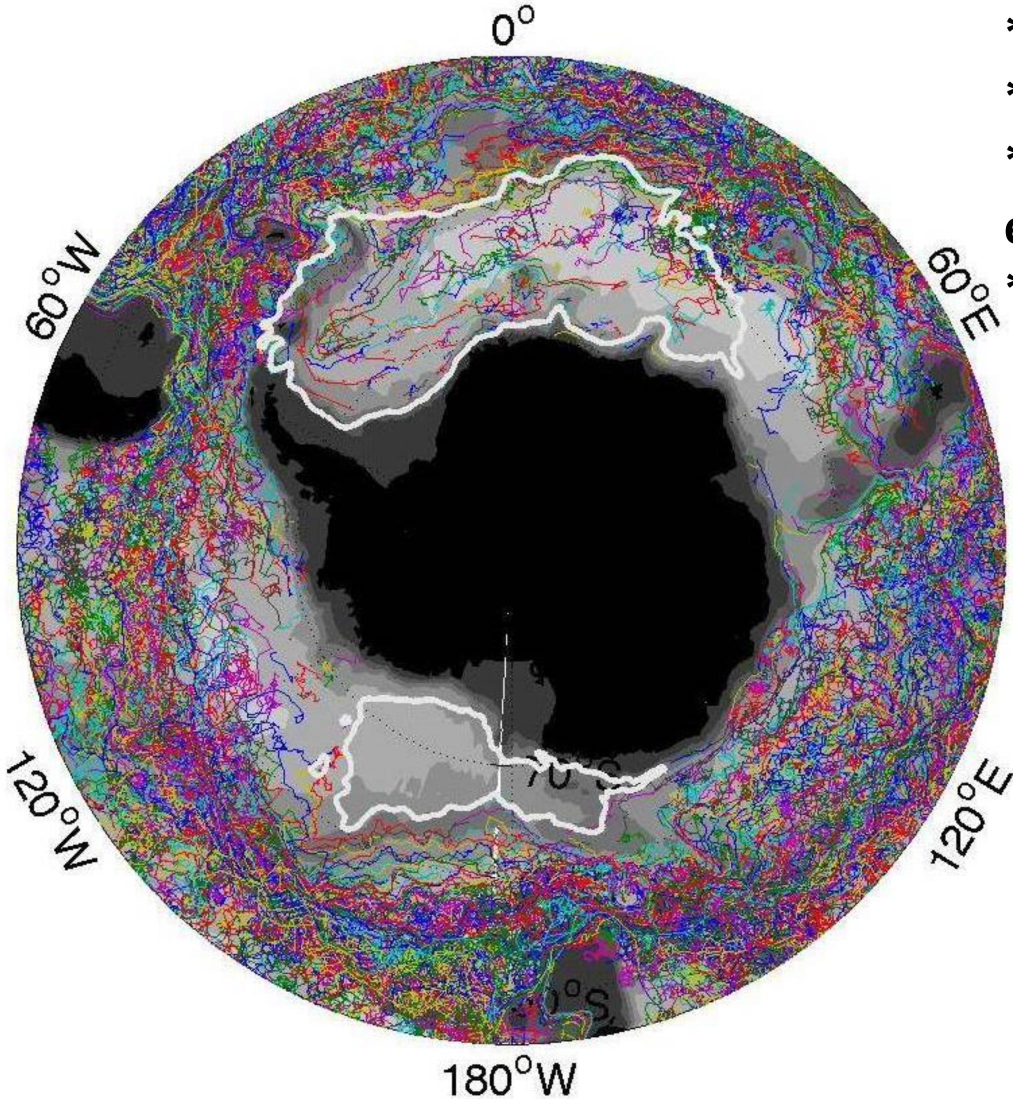
WOCE sections: Coordinated by GO-SHIPS



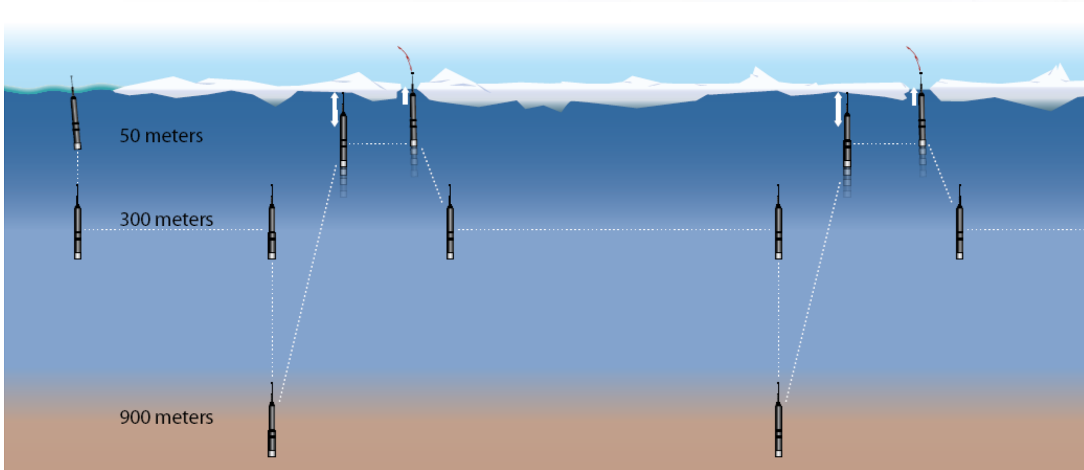
WOCE and CLIVAR sections

- Do not extend onto shelf
- Significant gaps in important areas
- Needs to be complemented by additional sections undertaken by national Antarctic programs
- an important SOOS task is to coordinate and provide help prioritizing: Where, what and how often additional sections are needed in order to address the science questions

* Floats are filling a lot of the gaps
* Coordinated by ARGO
* The ice covered regions are essentially blank
* Under-ice ARGOs being developed

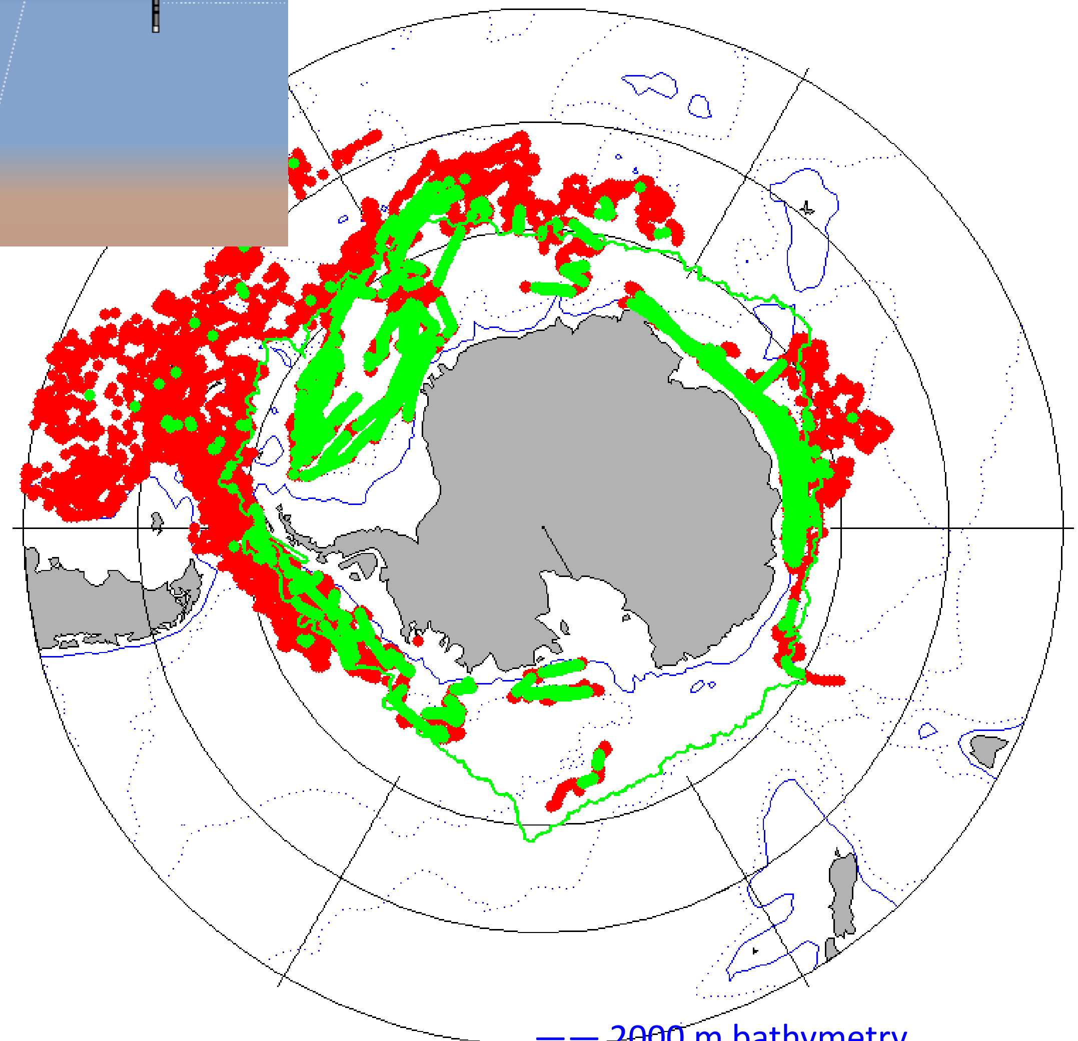


Argo float trajectories as of 2012

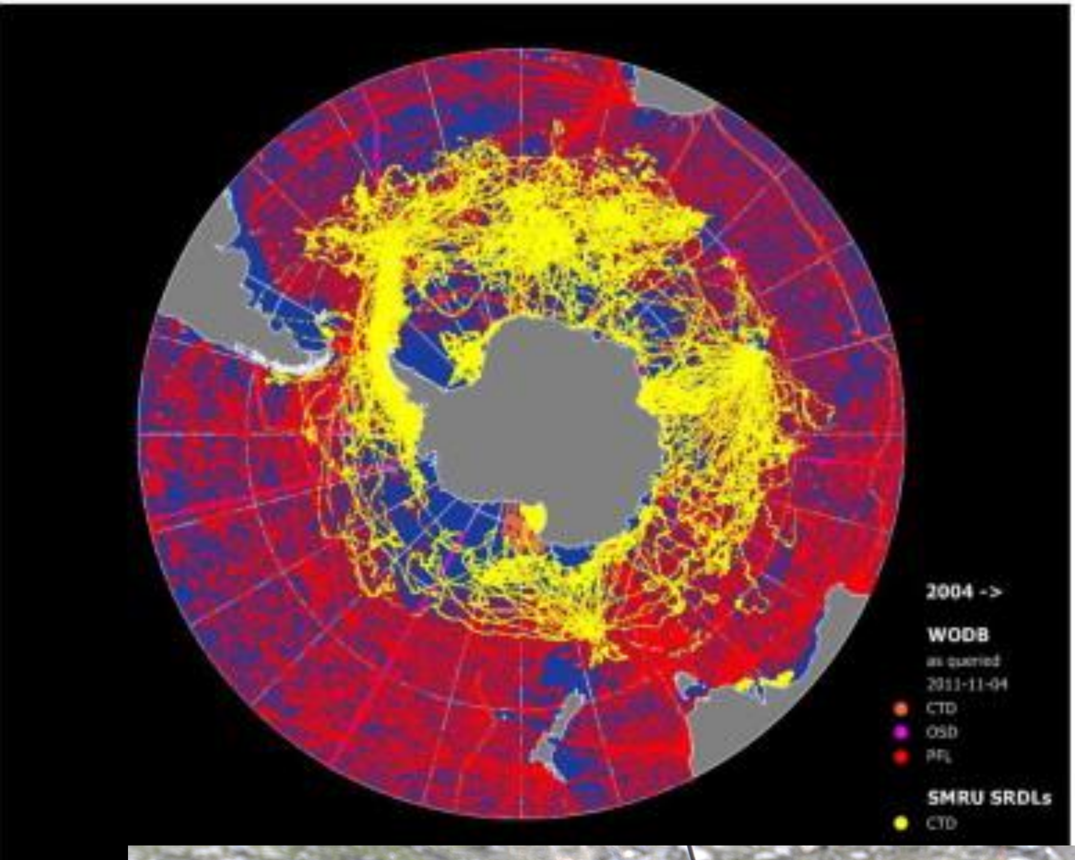


Under ice floats being developed and tried out

Problem: Navigation and position
Sound navigation (need sound sources)?



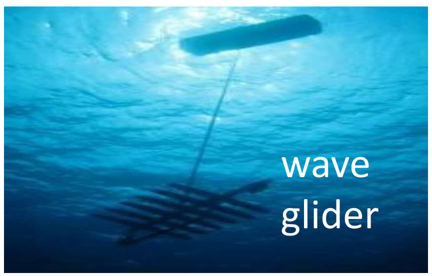
Marine mammal tagging are excellent complement to floats - cover the winter, measures under sea ice. Information about the mammals as well as physical oceanography

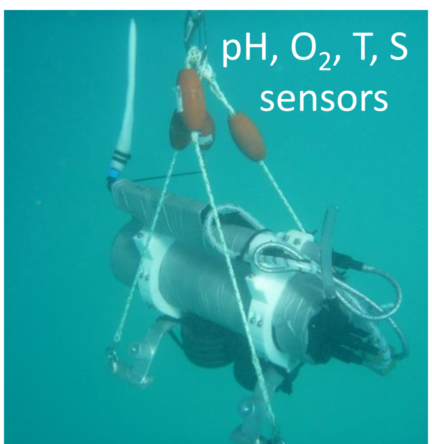


Yellow: Seal tags
Other colors: CTD, floats, moorings

Marine mammal tagging:
* Not presently coordinated internationally
* Still depends on individual projects
* Problems getting funding since it is not recognized as part of an ongoing international program, have to be motivated in every application

Application of new sensor technology using moored sensors (surface and subsurface), gliders and profiling





Southern Ocean Time Series (SOTS, 47S 142E): high frequency measurements including telemetered meteorological air-sea flux data, T,S,PAR, fluorescence, backscatter, pCO_2, O_2, nutrients and MRU wave spectra.

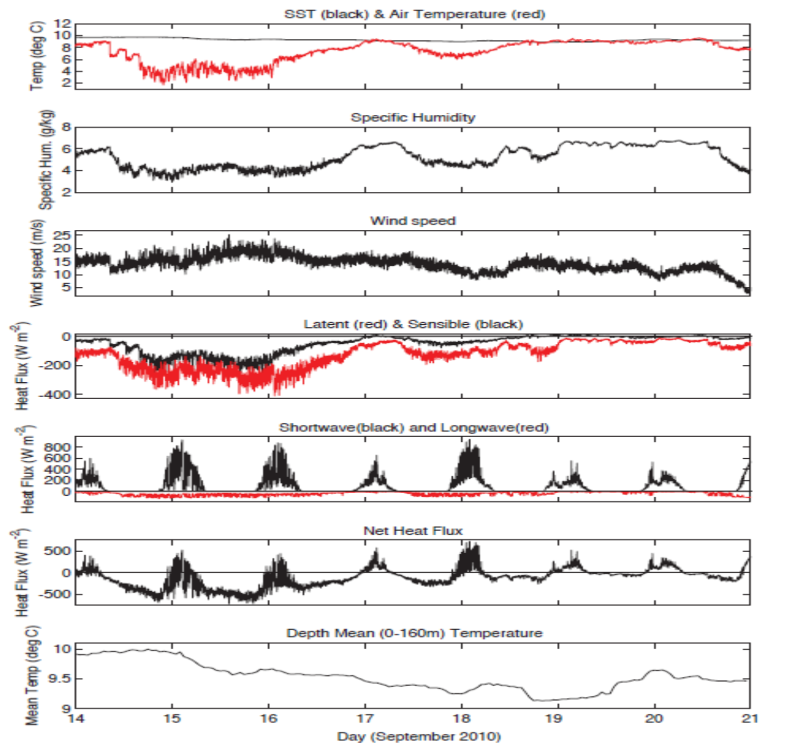
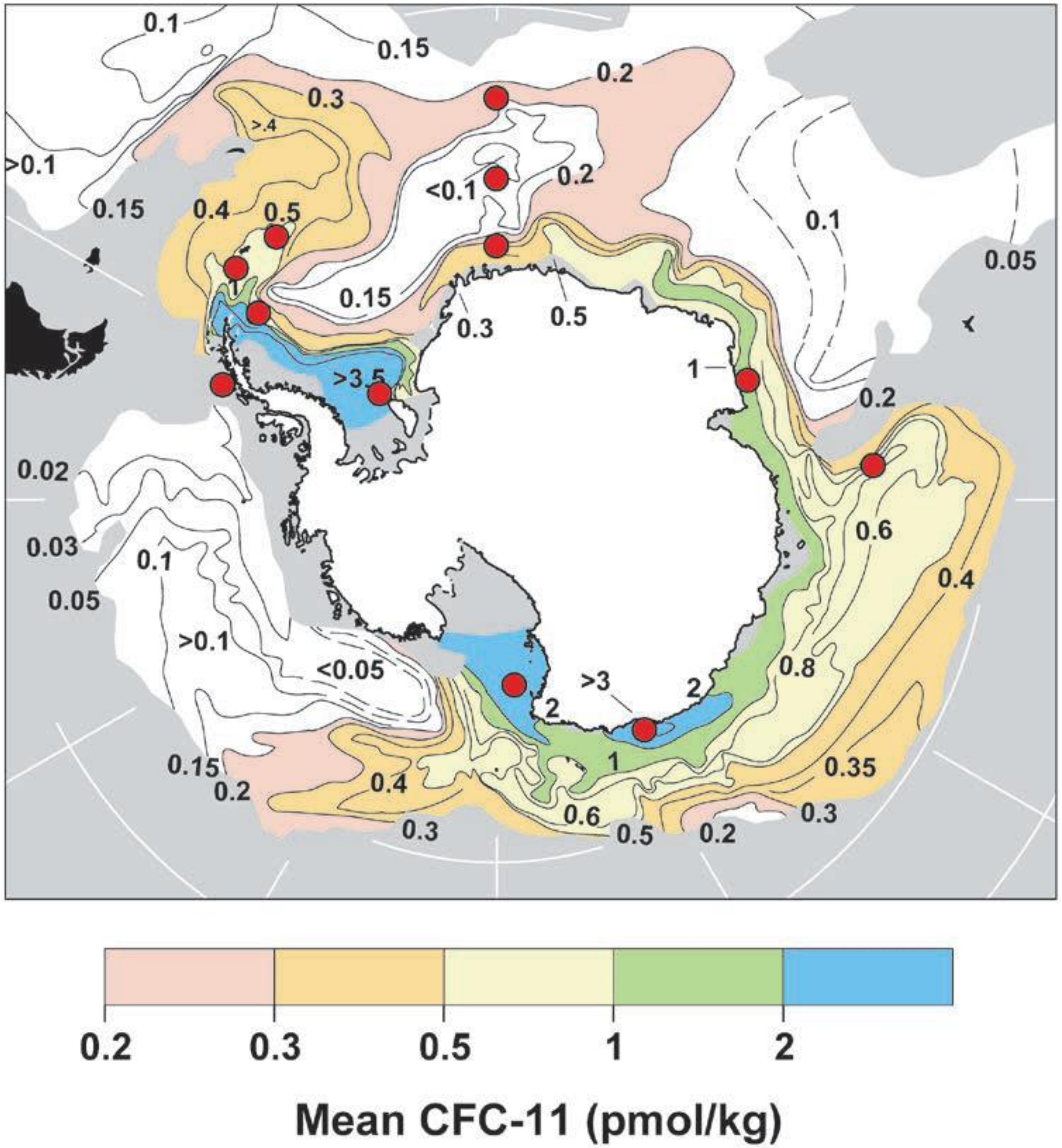


Figure 3 SOFS 1 minute mean surface meteorological variables, air-sea heat fluxes and average ocean temperature in the upper 150 m for the 7-day period Sep14-21 2010 spanning the most extreme heat loss event during the deployment.

Source: Shultz and Trull

Moorings: Year-round, high temporal coverage. Needs to be complemented with sections (only point measurements)



Map showing some sites recently occupied by moorings.
Not up to date, not complete.

*** Moorings are not coordinated internationally**
*** Important task for SOOS: provide information and coordination of mooring sites and instrumentation**

Gliders and AUV:s

* Gliders and AUV platform, can be equipped with multi-disciplinary sensors
* Frees up ship time
* Not internationally coordinated
* Shortage of under-ice capable AUVs (man-power and hardware)
* Under-ice going gliders being developed

More information?

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