Southern Ocean Observing System (SOOS) and the global data collecting system

December 2014

http://www.soos.aq/

Lynne Talley (SIO), CLIVAR/CliC/SCAR Southern Ocean Panel co-chair

Based largely on

- July 2014 presentation from Alberto Naveira Garabato (NOCS, UK), on behalf of the SOOS SSC
- SOOS under-ice workshop presentation from Steve Rintoul (CSIRO)
- CLIVAR SOP presentation on challenges in Southern Ocean

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SOOS
SOUTHERN OCEAN OBSERVING SYSTEM

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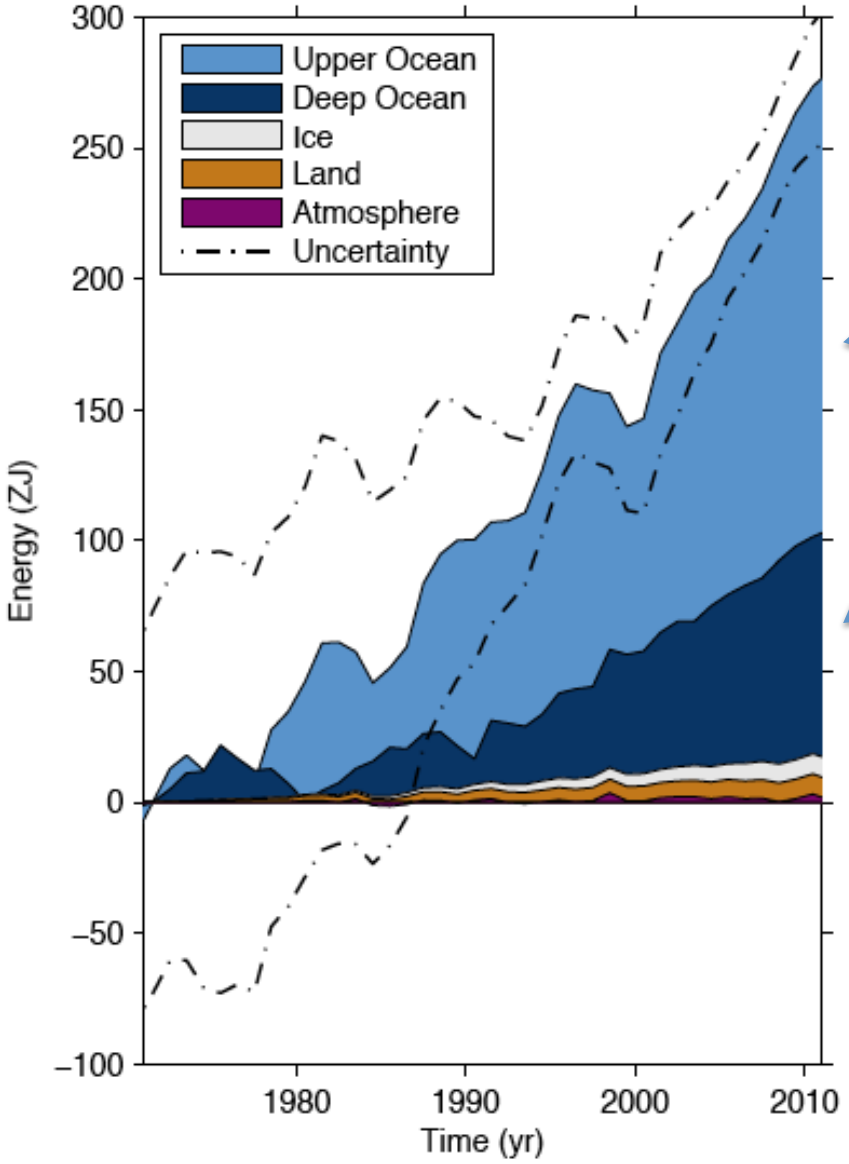
CLIVAR Southern Ocean Panel: General Southern Ocean comments

- Climate science requires observations
- Southern Ocean observing systems are developing and are as yet INADEQUATE. (remote region, bad weather/seas, sea ice, subice cavities)
- Boundaries between science organizations (CLIVAR/CliC) and observing organizations (GOOS) to be surmounted; we should work out ways to work together. OOPC (GOOS)/CLIVAR regional panel chair meeting is excellent opportunity.
- Build structures to obtain resources that best combine ongoing/new observations and the science that comes from them

1. Need for long-term observations: global heat balance

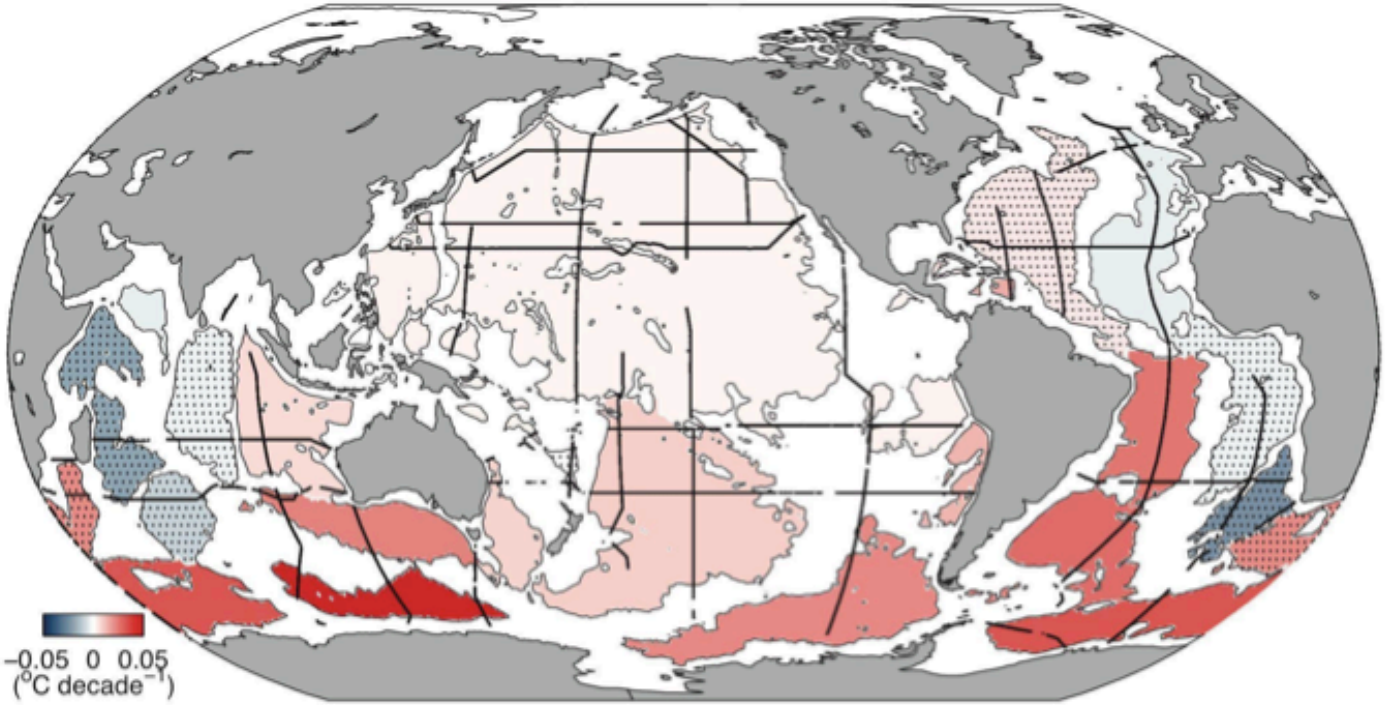


The global energy imbalance goes into the ocean

Box 3.1, Figure 1: Plot of energy accumulation within distinct components of Earth's climate system relative to 1971.

IPCC AR5

1. Need for long-term observations: global heat balance



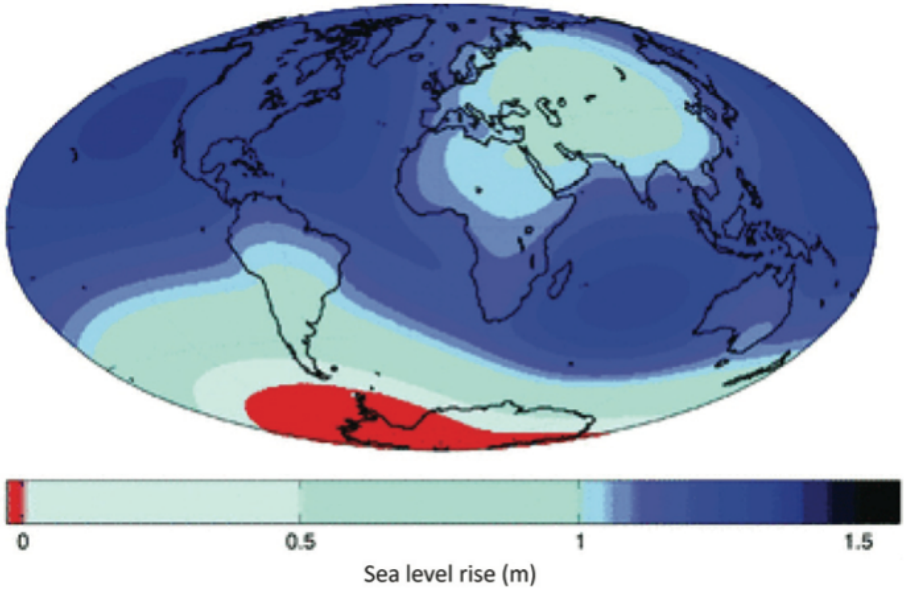
(IPCC, 2013 based on Purkey and Johnson, 2010)

IPCC AR5

- This map was made using repeat hydrography (GO-SHIP), which is part of the sustained observing systems (GOOS).
- It should be possible to do this with more observations and temporal resolution (deep Argo, under ice Argo). Need improved air-sea fluxes, sea ice fluxes for understanding changes.

1. Need for long-term observations: sea level and ice sheets

Ice sheet mass balances
→ sea level



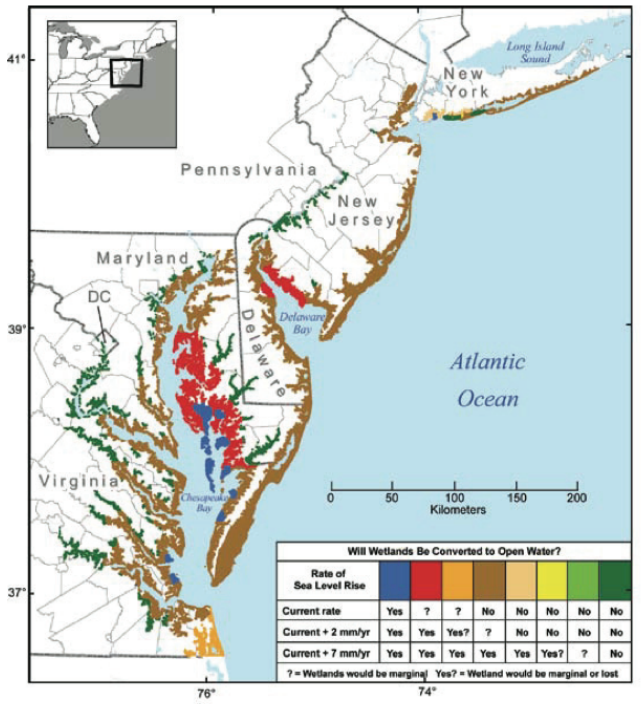


FIGURE 2.2 Sea level changes in response to a collapse of the West Antarctic Ice Sheet represented as an additional change relative to the global average of 5 meters; this highlights the significant local deviations. Sea level rise is 15 percent higher than the global average along the U.S. coast line. Changes over land can be ignored. SOURCE: Mitrovica et al., 2009, reprinted with permission from AAAS.

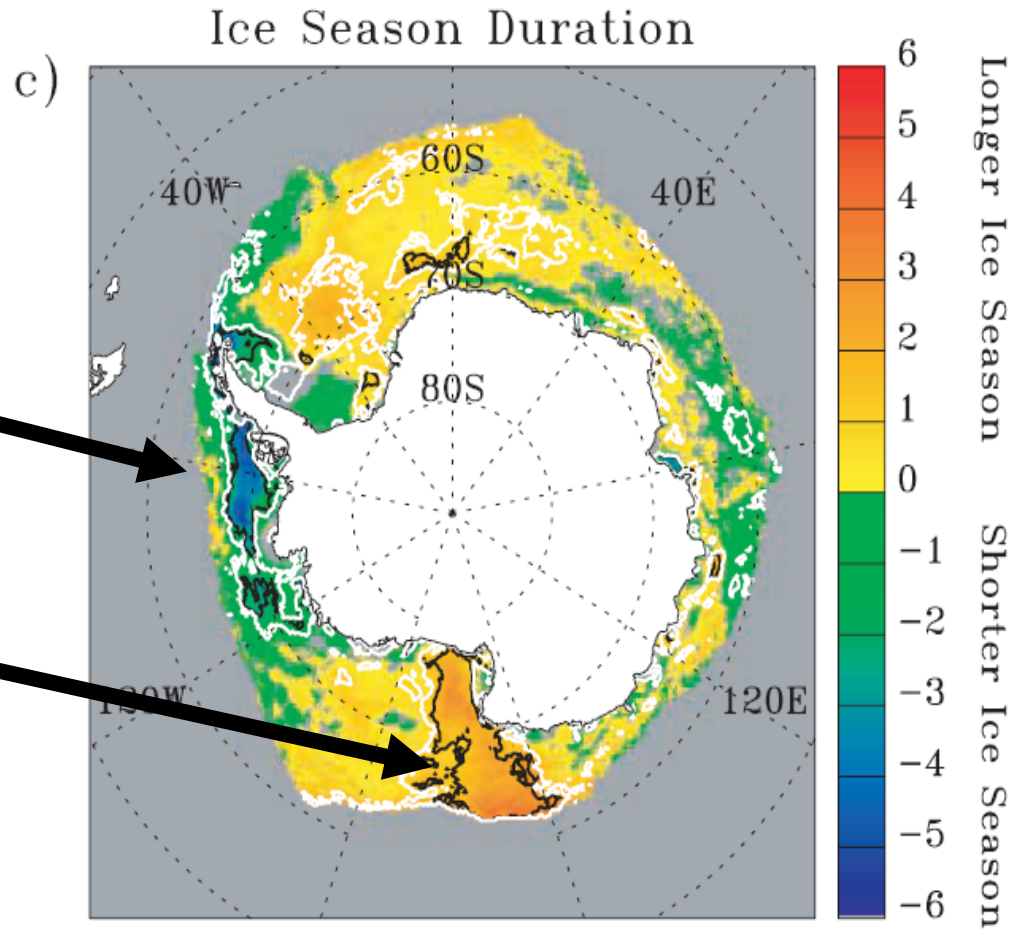
National Academy of Sciences (2011)

1. Need for long-term observations: sea ice cover

Changes in sea ice duration: 1979 – 2006

-83 ± 23 days

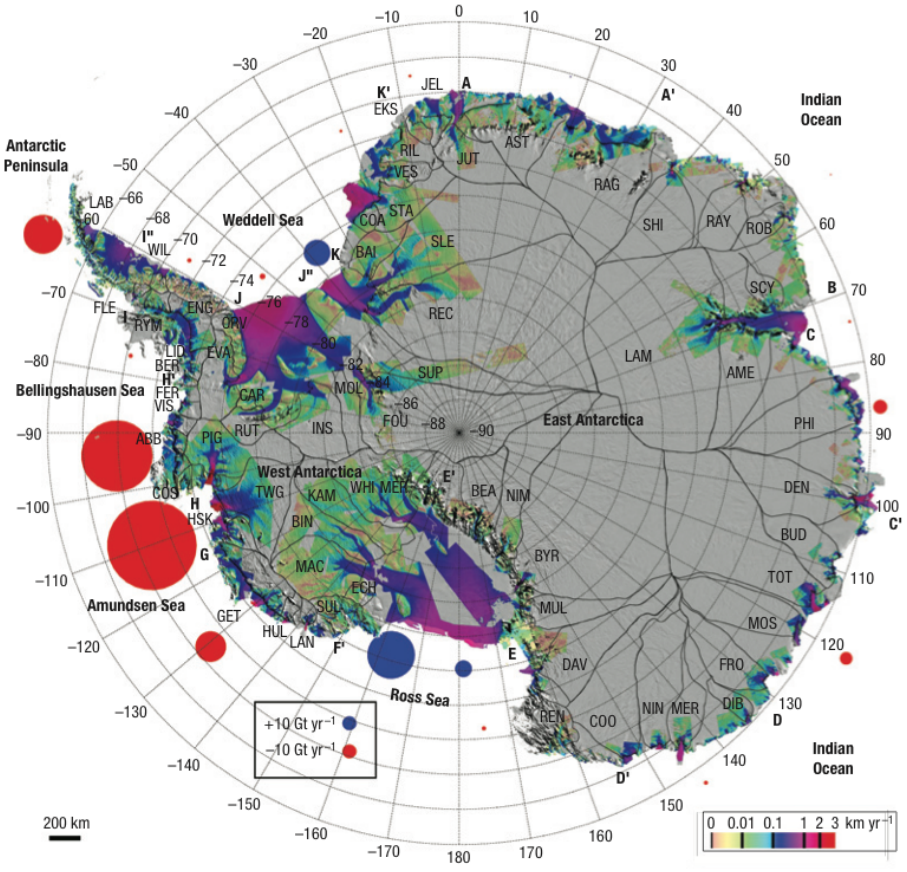
57 ± 13 days



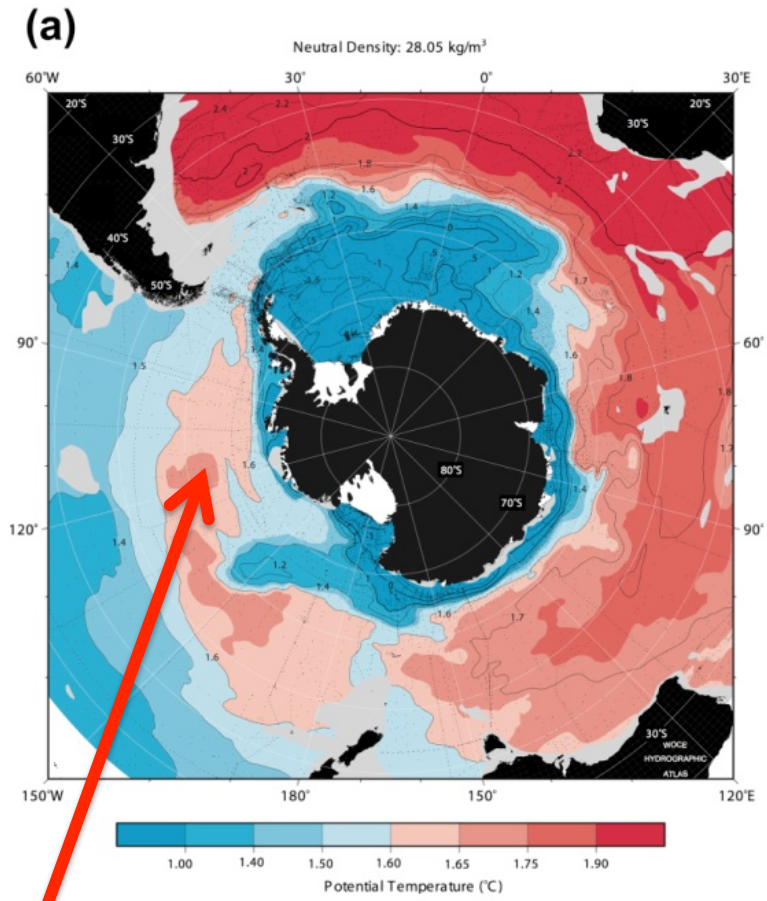
Stammerjohn et al. (2008)

1. Need for long-term observations: sea level and ice sheets

Ice sheet mass balances
→ sea level



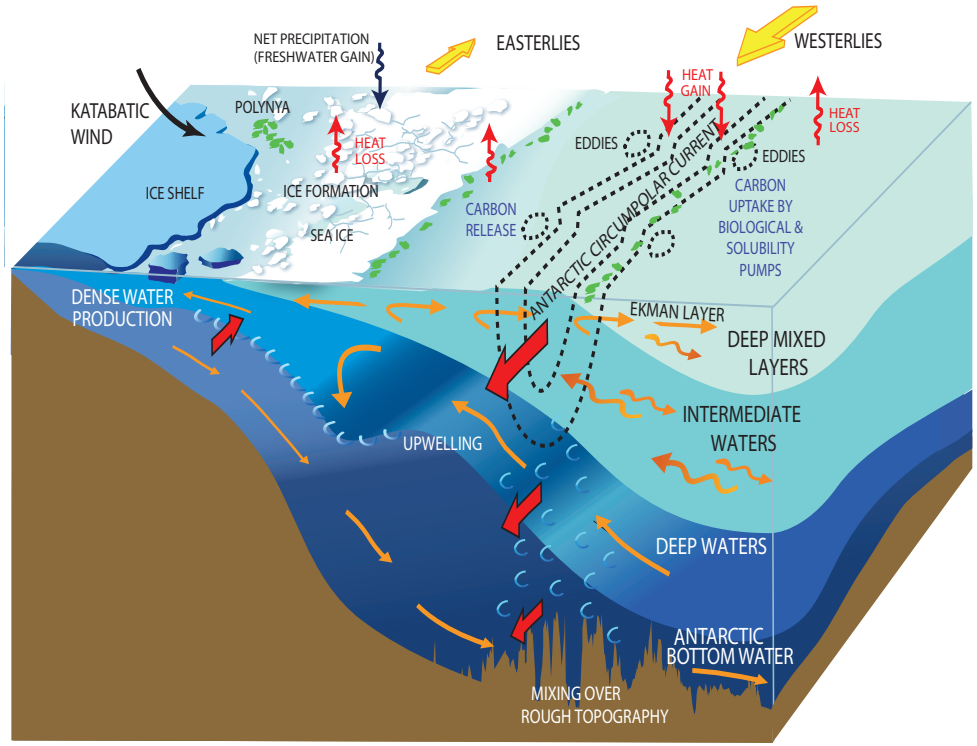
Rignot et al. (2008)



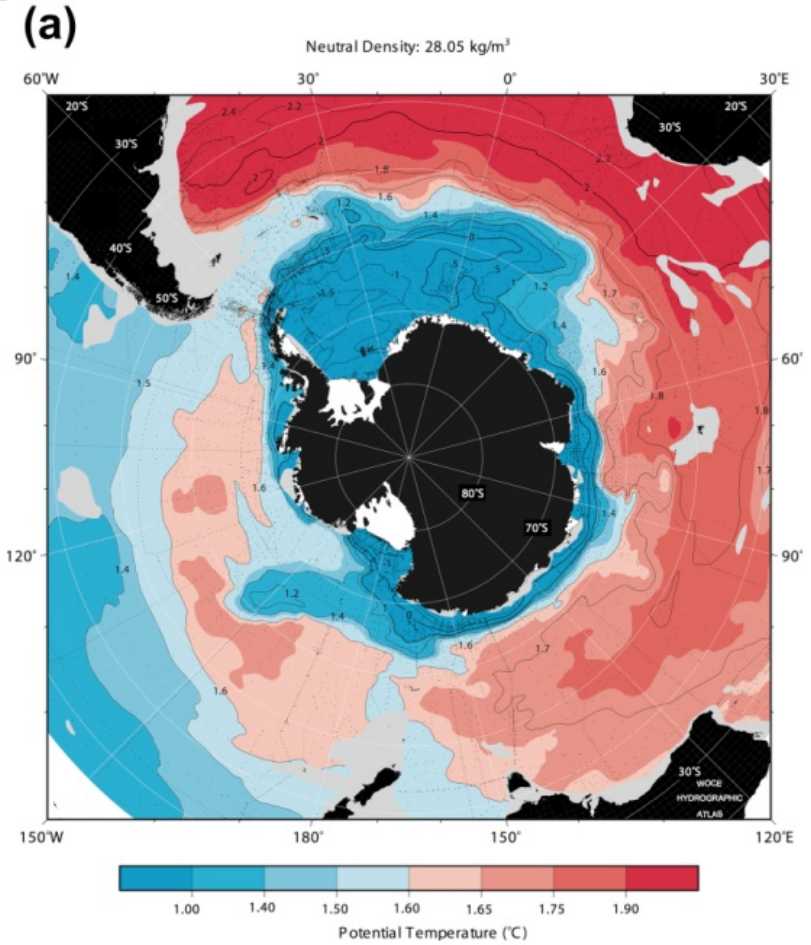
Orsi and Whitworth (2005)

It should be possible to track this heat input on a routine basis, using under-ice Argo profiling, and importantly, shelf under-ice Argo

1. Need for long-term observations: global overturning, biogeochemical processes, etc.



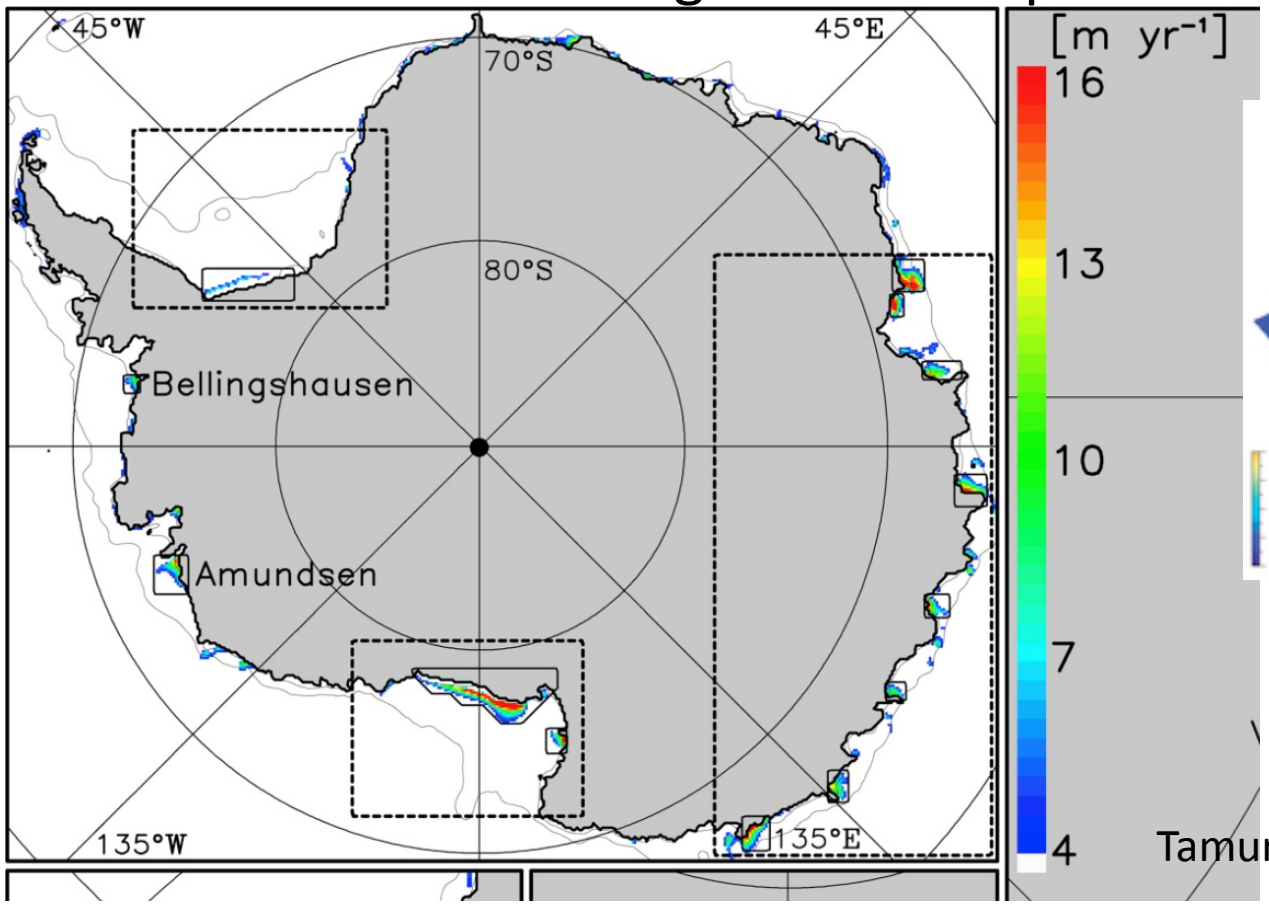
Talley, after NRC (2011)

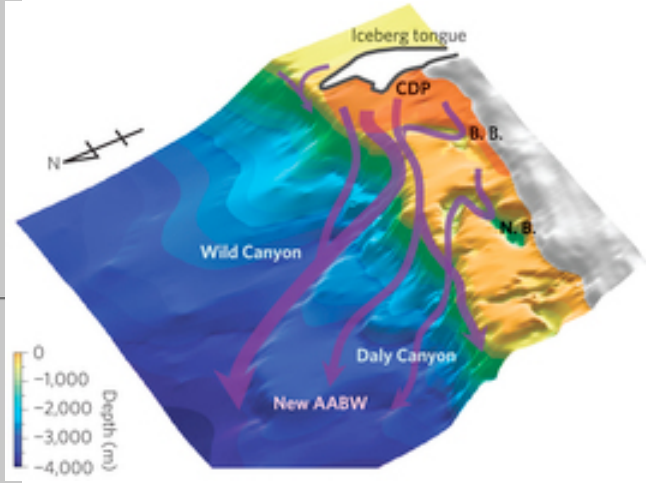


Orsi and Whitworth (2005)

Three-dimensional circulation: not just overturning, but significant horizontal structure, much of it under sea ice in winter

1. Need for long-term observations: global overturning, biogeochemical processes, etc.





Ohshima et al. 2013

Tamura et al. 2008

Locations of dense water formation are distributed along the Antarctic coast.

Need measurements of outflows and properties in many regions

Under-ice and continental shelf Argo, gliders, moorings

CLIVAR and sustained observing systems

Existing sustained

- Argo -> get it under sea ice and up into subice-shelf cavities
- GO-SHIP repeat hydrography -> continue supporting
- XBT/XCTD lines -> continue supporting (supply vessels)
- ADCP lines -> continue supporting (supply vessels)
- Regional surveys such as LTER, CAMLR -> continue supporting
- APB (elephant seal profiles) -> adopt as part of sustained observations data sets

OOI – new sustained

- OOI first S.O. moorings with air-sea fluxes, water column measurements: these are sustained observations already, but only at 2-3 S.O. locations. Perhaps call this "pilot"

Pilot projects

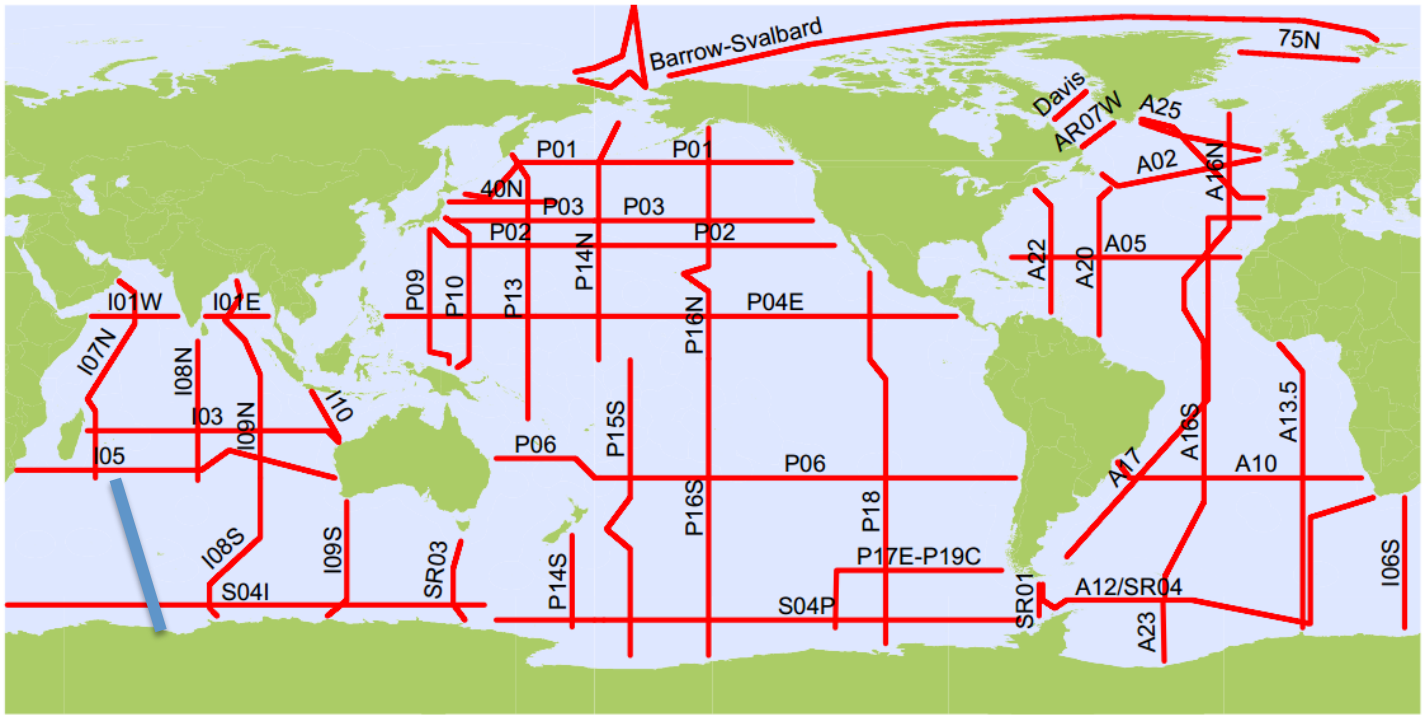
- Under-ice measurements
- Biogeochemical floats and BGC moored observatories
- Under-ice insonification for acoustic tracking of profiling floats, gliders, other autonomous instruments.
- Data-model approaches: State estimation and OSSEs
- CPIES-type arrays similar to CDrake at similarly dynamic locations – Macquarie Ridge, Malvinas, Kerguelen, Agulhas retroflection?
- Gliders, wave gliders, jet kayaks (Straneo), etc.
- Ice-tethered profilers if they can be adapted to fully seasonal sea ice regions

GO-SHIP repeat hydrography

SOOS and GO-SHIP

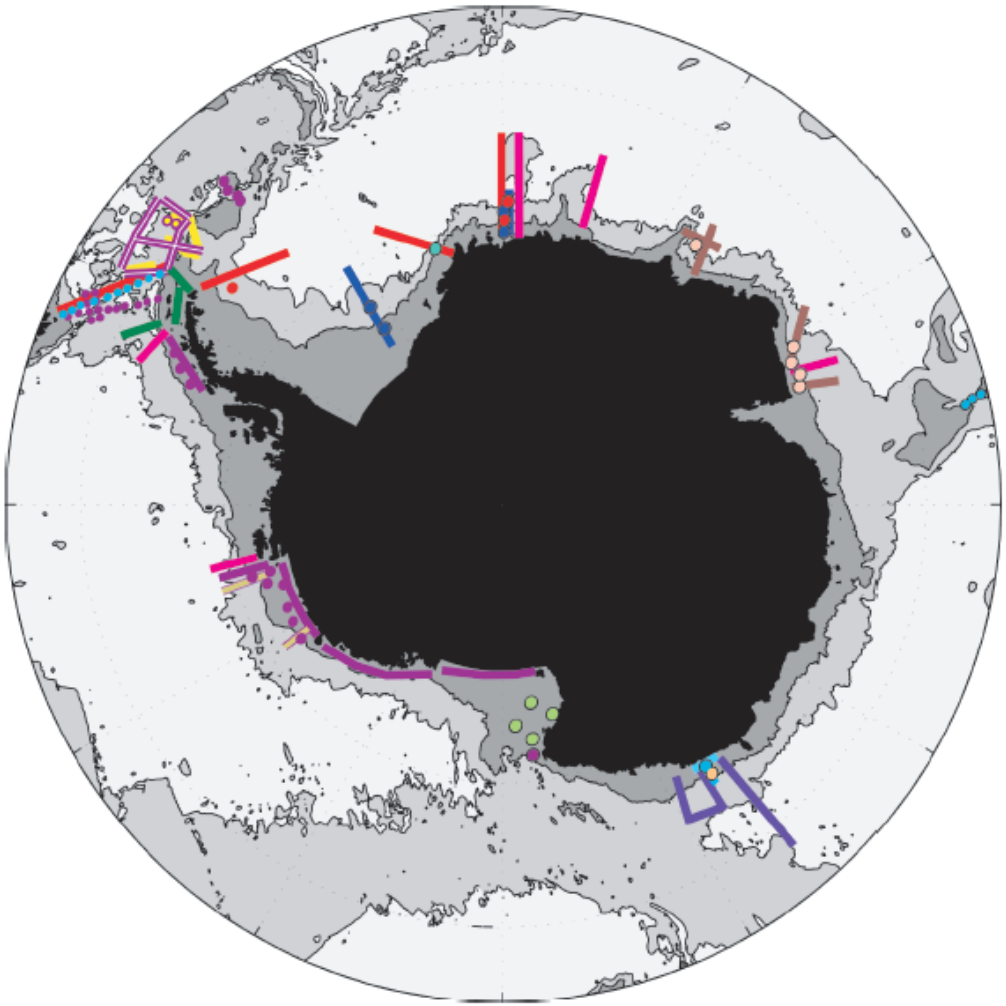
(Existing observing system that needs LOTS of support; also platform for new technologies, new chemistry obs. 18 different PI projects, including one from a postdoc and one from a student, on recent P16S)

http://www.go-ship.org



Major gap in Indian Ocean: Kerguelen Plateau to Prydz Bay. Need for an “I07S”.

SOOS: Continental shelf and slope



Sections (lines) and moorings (circles) completed during the SASSI IPY program.

Ongoing continental shelf programs:

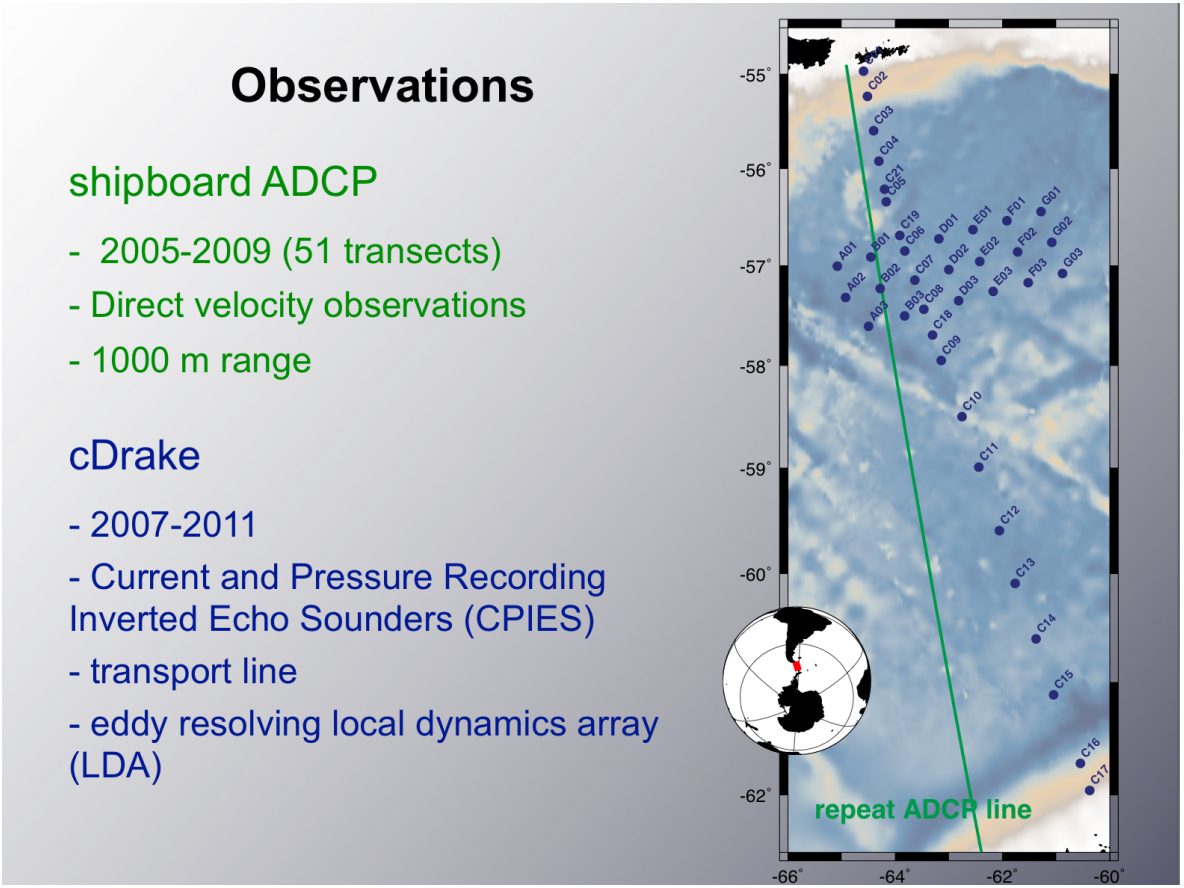
- LTER (west coast of Antarctic peninsula) (US)
- Scotia Arc (UK)
- Prydz Bay (China)
- Kerguelen (France)
- Patagonian (Argentina)

Sustained occupations of these sections and arrays would make a substantial contribution to an under-ice observing system.

“Chokepoint” sustained arrays (ADCP, XBT, PIES)

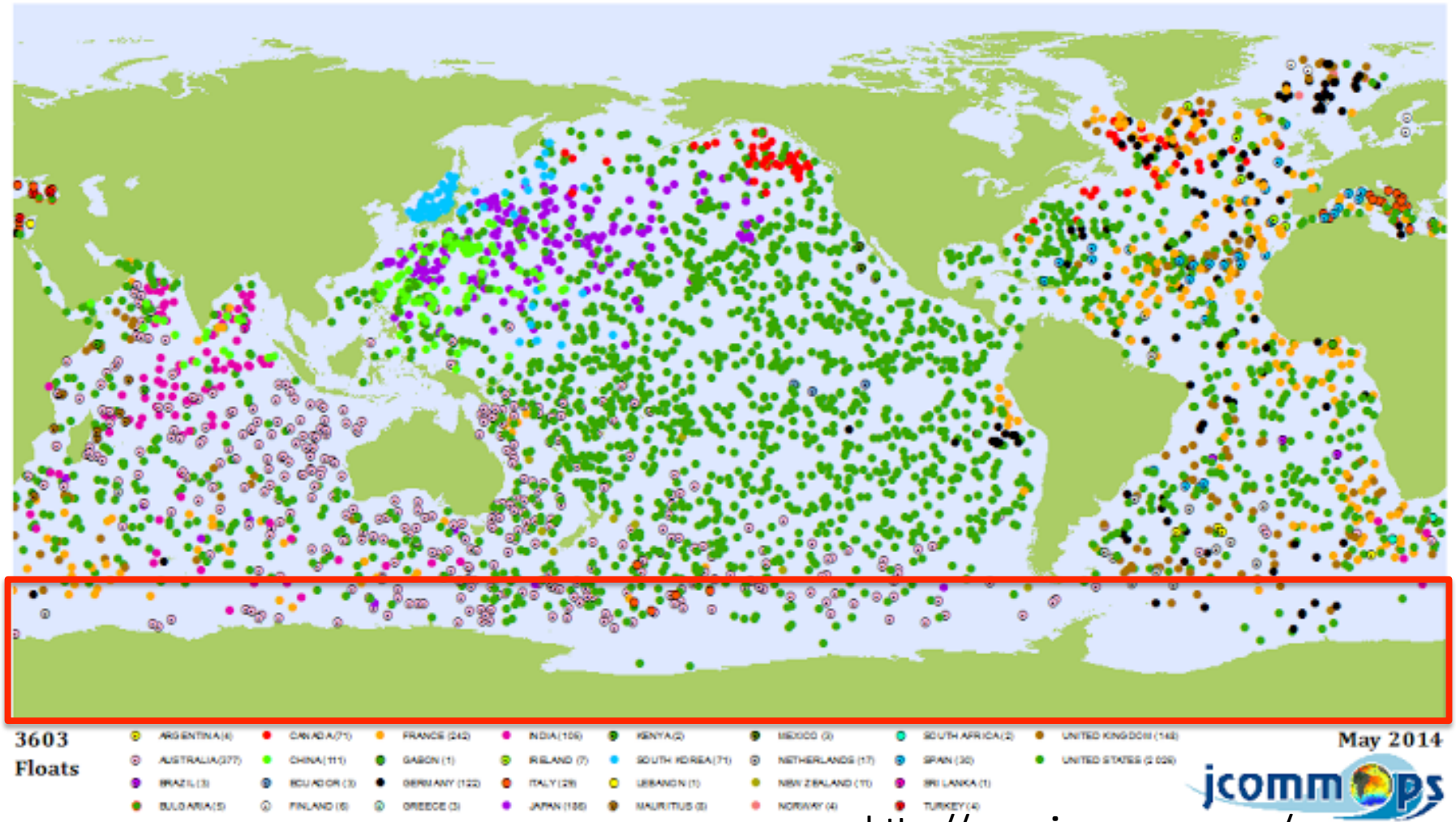
Drake Passage experiment (PIES ended in 2011; underway obs continue)

GoodHope line (Polarstern now recovering its PIES moorings)



Chereskin, Watts, Donohue http://www.cdrake.org/

SOOS: Argo



Under ice regions are very poorly sampled

SOOS: APB (Autonomous Pinniped Bathythermograph)

Profiling from Elephant Seals since 2004

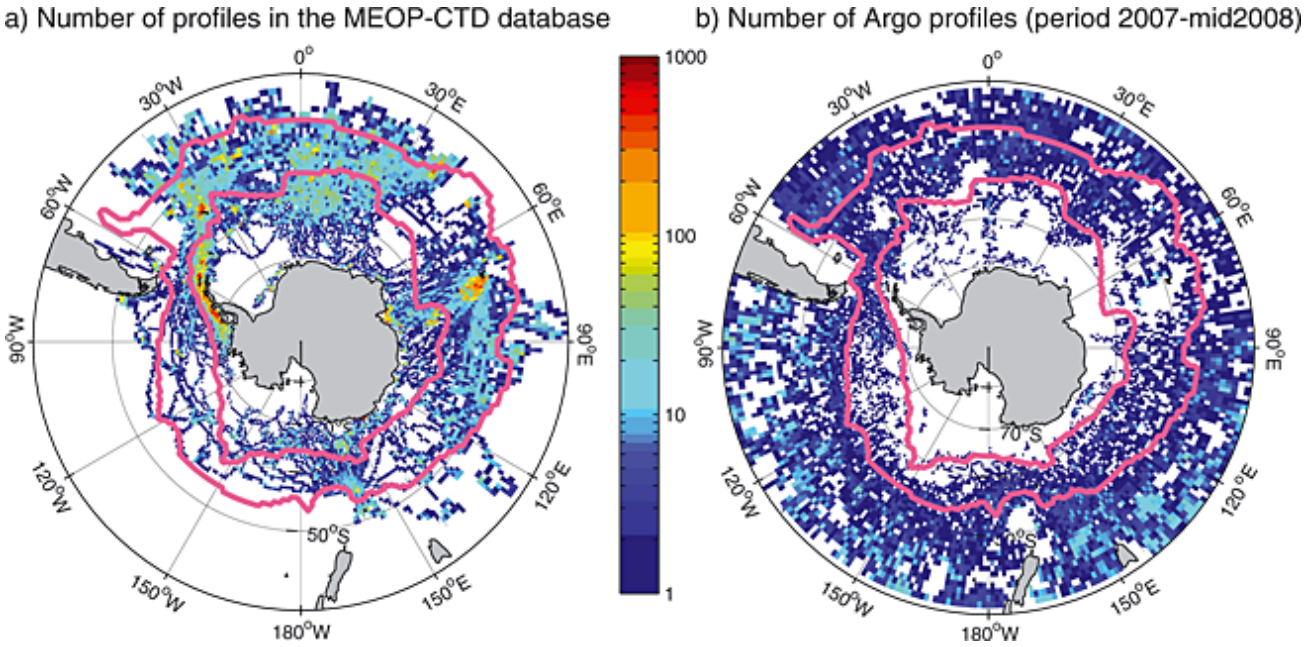
CTD-SRDLs (satellite relay data loggers)

Quality-controlled data base
MEOP (Marine Mammals Exploring the Oceans Pole to Pole)

394 seals for Southern Ocean
- 165,000 profiles

- ± 0.05°C, ± 0.05 psu

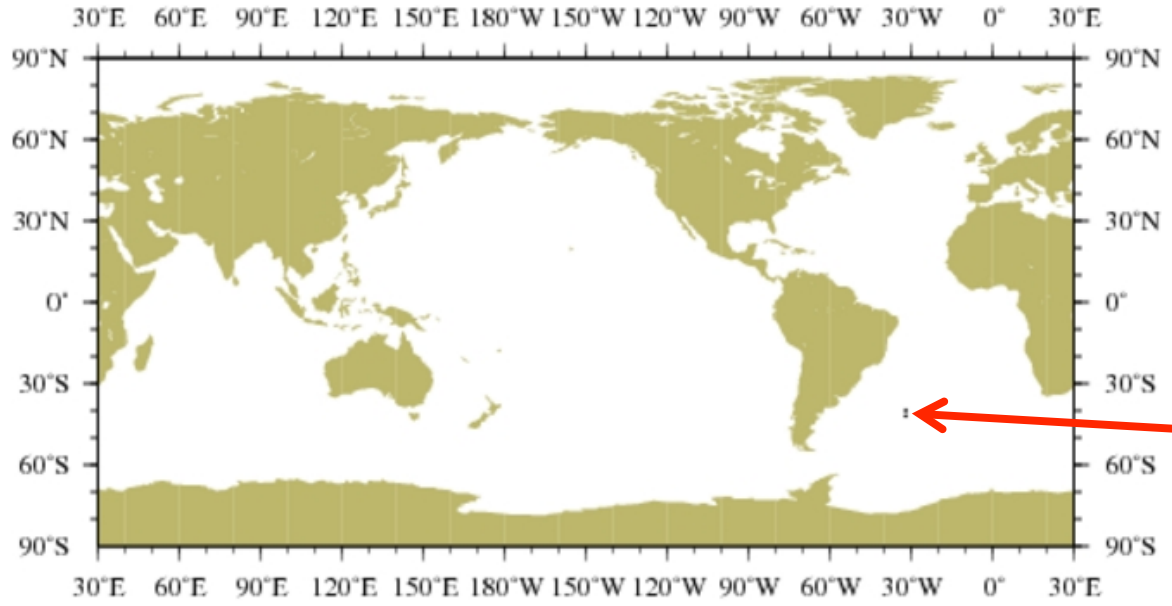
http://www.meop.info/en/



(Roquet et al., GRL 2013)

NOAA NATIONAL OCEANOGRAPHIC DATA CENTER (NODC)
UNITED STATES DEPARTMENT OF COMMERCE

- 254,000 pH profiles from ships in US National Ocean Database.
- 55,584 pH profiles since measurements were standardized during the WOCE/ JGOFS era (since 1990).



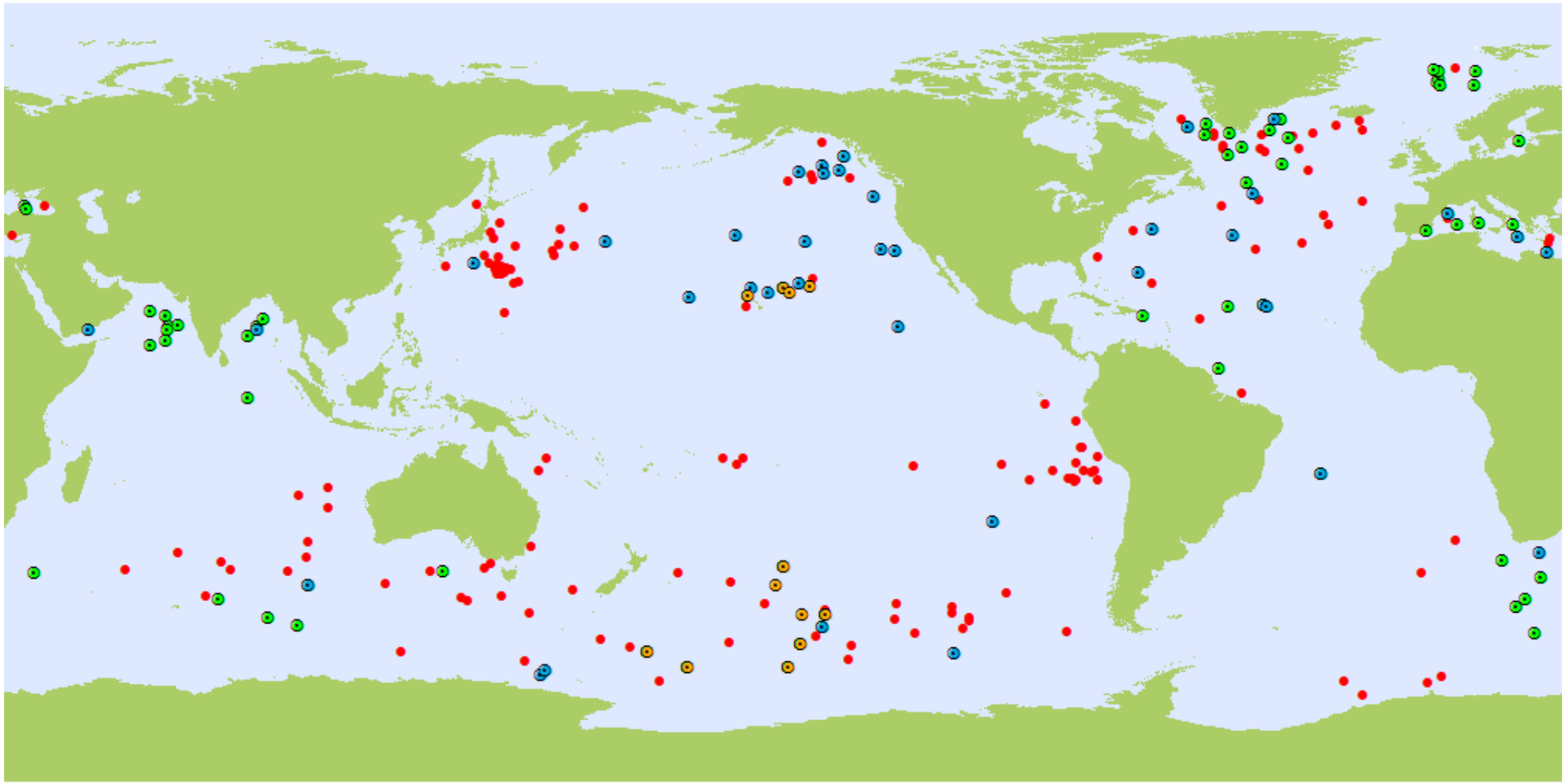
Geographic distribution of casts (2 casts)

NOAA NODC Ocean Climate Laboratory
http://www.nodc.noaa.gov/OCL/

For 1990 – 2014 there are **only 2 pH profiles** found South of 40°S in the database for the Austral Winter (June 21-Sep 22).

COPY OF YOUR SEARCH CRITERIA:

OBSERVATION DATES:	**Year** from 1990 to 2014; **Month** from 6 to 9; **Day** from 21 to 22
GEOGRAPHIC COORDINATES:	**Longitude** from -180.0000 to 180.0000; **Latitude** from -40.0000 to -90.0000
DATASET:	OSD,CTD,XBT,MBT,PFL,DRB,MRB,APB,UOR,SUR,GLD
MEASURED VARIABLES (must):	pH
MEASURED VARIABLES (extract):	pH



Bio-Argo (246)

- Dissolved Oxygen (232)
- Nitrate (46)
- Bio-optics (66)
- pH (12)

May 2014

jcommops

SOCCOM

Argo-type profiling for the future

Argo float profiling for temperature/ salinity has completely transformed ocean observing over the past 10 years.

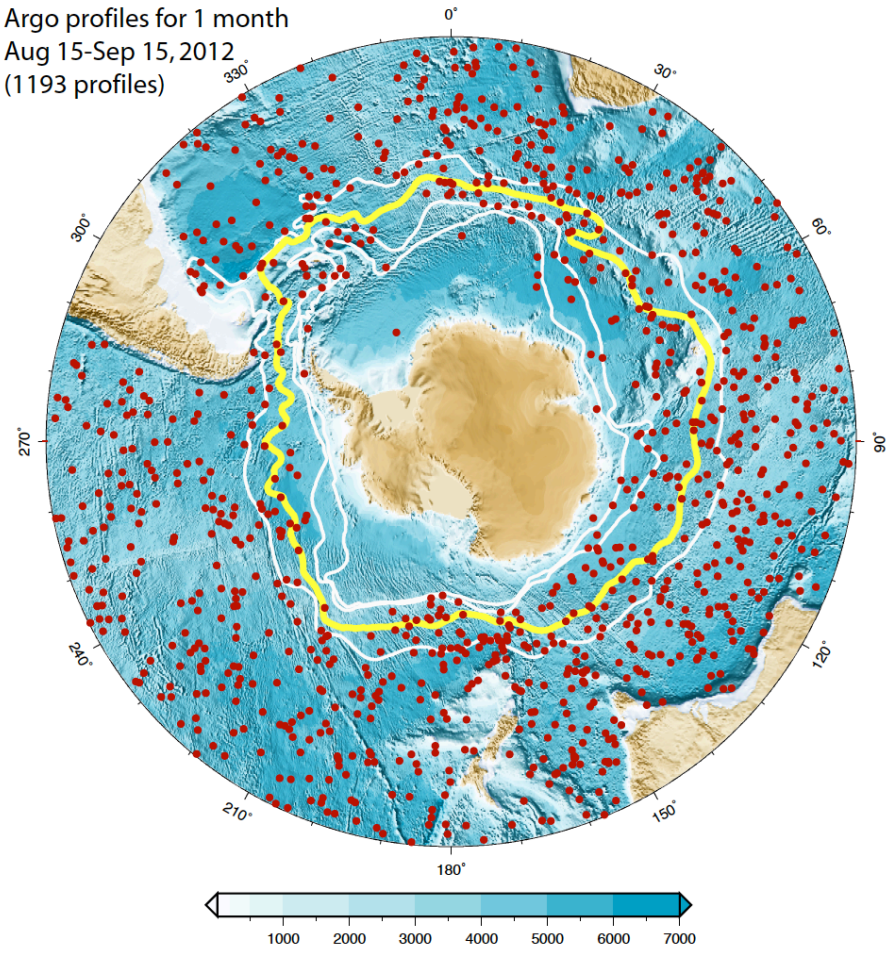
Do the same

UNDER ICE and

THROUGHOUT Southern Ocean

for the carbon system, nitrate and oxygen, and net community production (including sea ice regions) by measuring biogeochemical parameters (pH, nitrate, oxygen, optics)

"SOCCOM" (Southern Ocean Carbon and Climate Observations and Modelling): recommended for funding by NSF DPP, but not yet funded.



Argo-type profiling for the near future

SOCCOM: biogeochemical floats, part of Argo, including under ice

Planned research cruises on which SOCOM floats can be deployed with rosette water sampling for float sensor calibration.

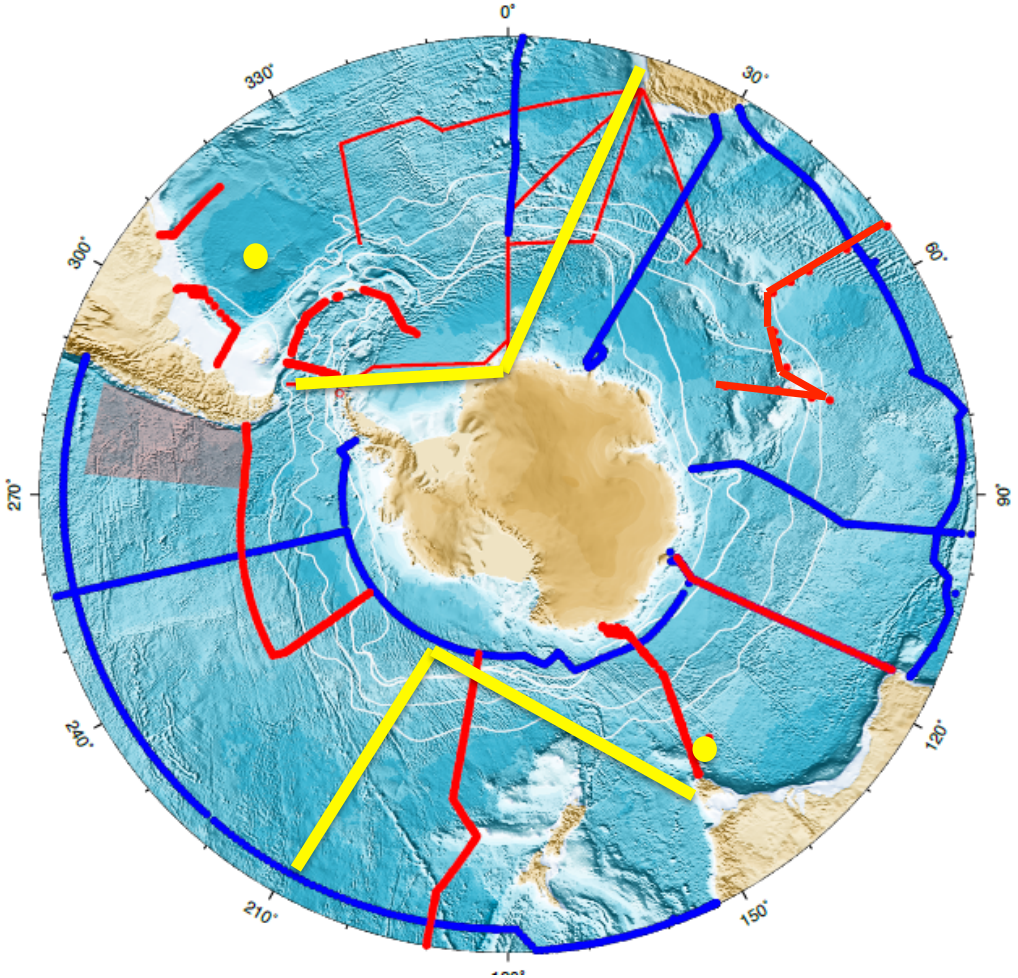
Red – International partners

Blue – US

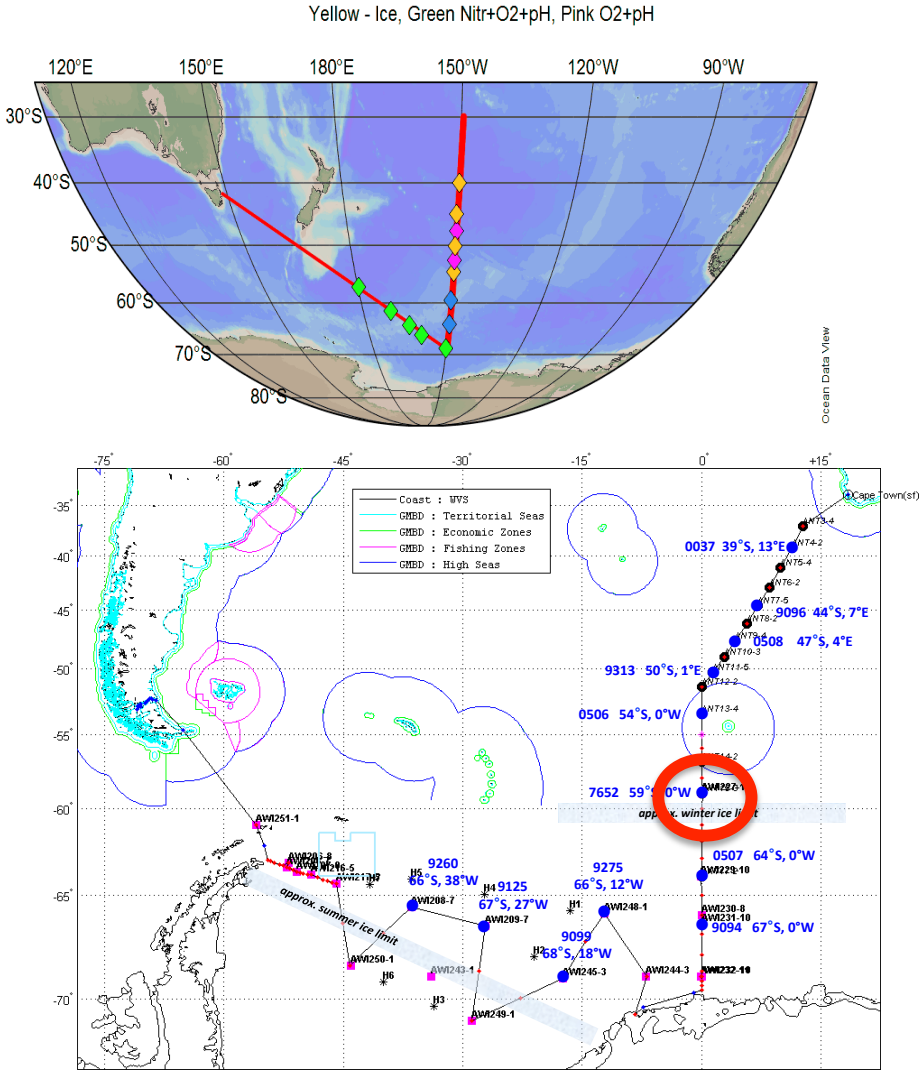
DONE in early 2014

IN PROGRESS NOW

ON TARGET for March 2015



SOCCOM underway: BGC Argo floats



SOCCOM = Southern Ocean Carbon and Climate Observations and Modeling

Pre-SOCCOM floats deployed March 2014

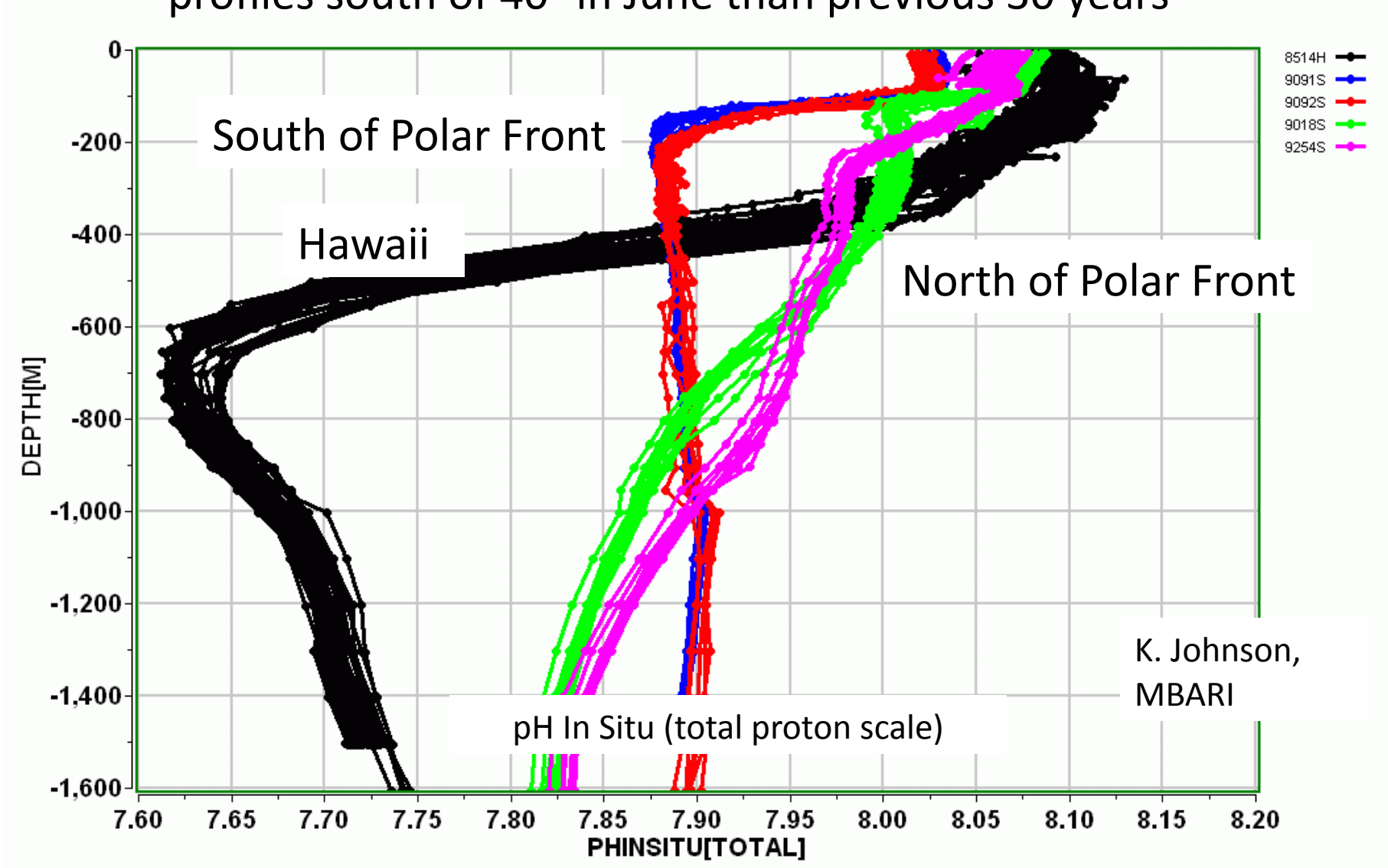
Polarstern deployments going on NOW (Float 5 deployed yesterday and first iceberg spotted!)

Array will grow to be ~200 floats with pH, O_2, NO_3^-, biooptics, 5 to 7 year life, year-round coverage

NSF, NOAA, NASA support

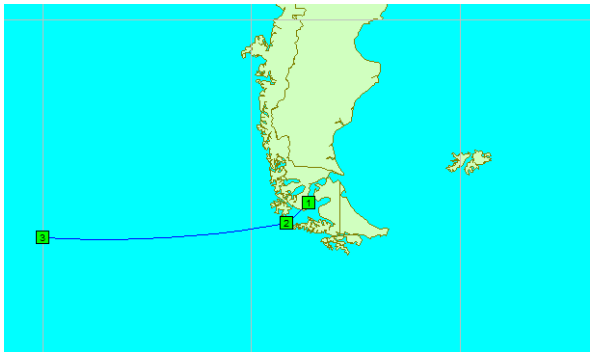
SOCOM floats

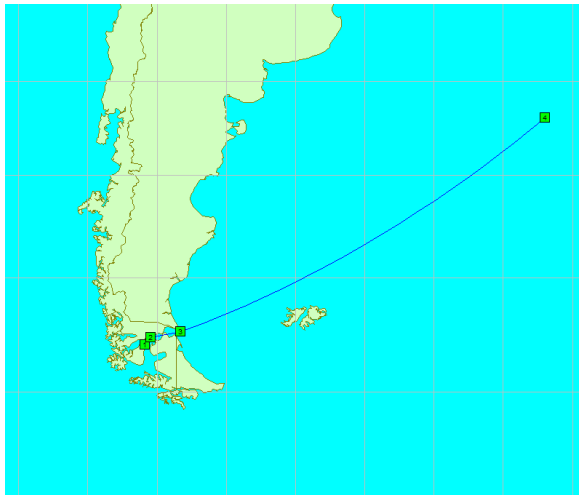
Pacific Pre-SOCCOM floats in the water, working well. More pH profiles south of 40° in June than previous 30 years



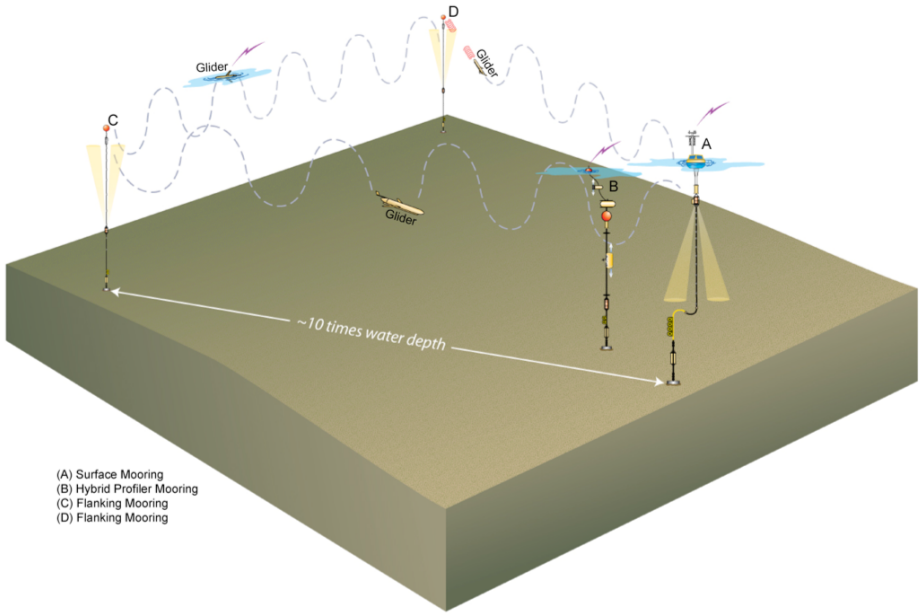
OOI (Ocean Observatories Initiative)

First OOI moorings are going into the Southern Ocean March 2015





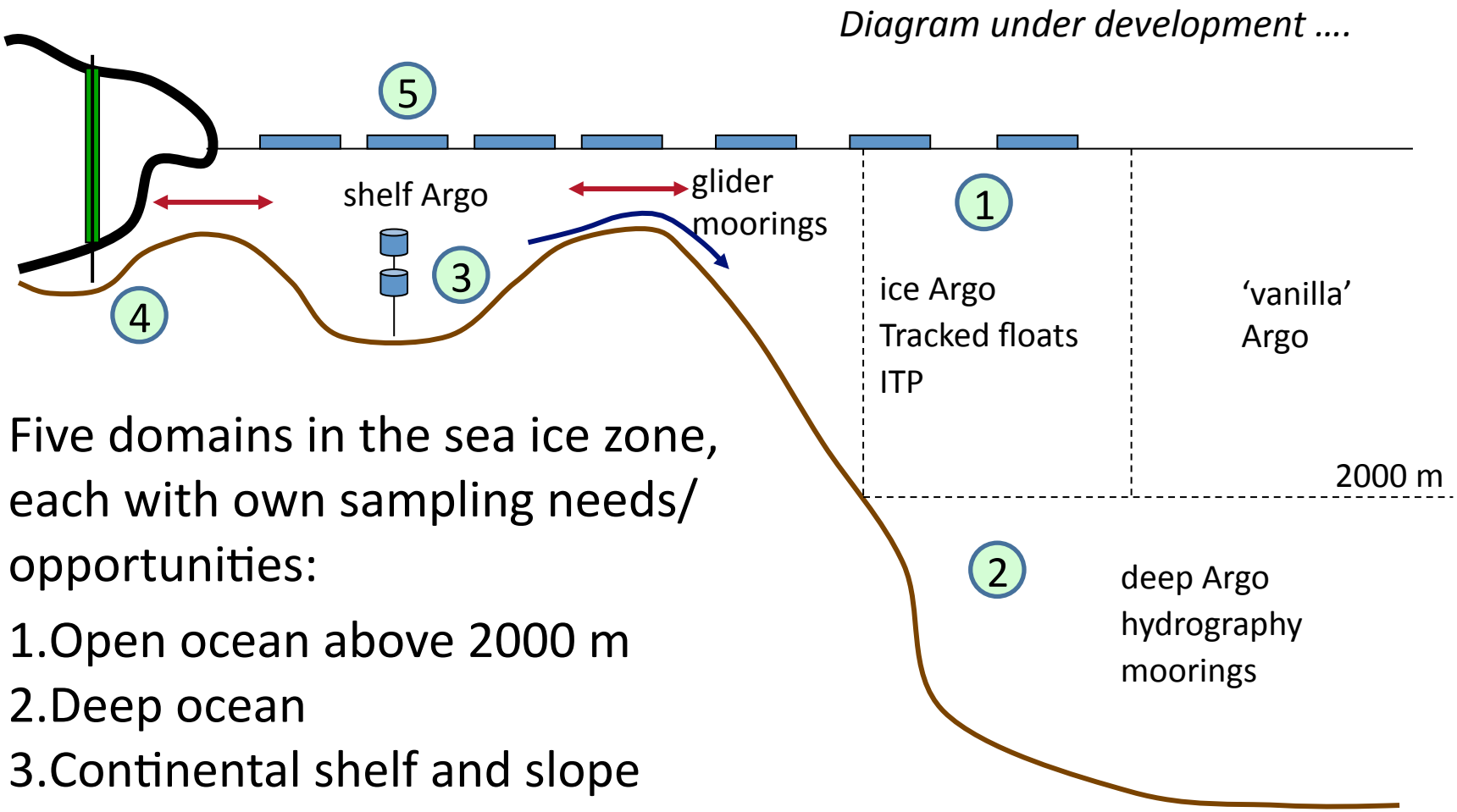
Southern Ocean, SW of Chile



Surface flux mooring

CTDs and pH sensors at various depths
Profiling CTDs
ADCP velocity profiles
3 Gliders sailing between moorings

Observing under the sea ice (from SOOS workshop)

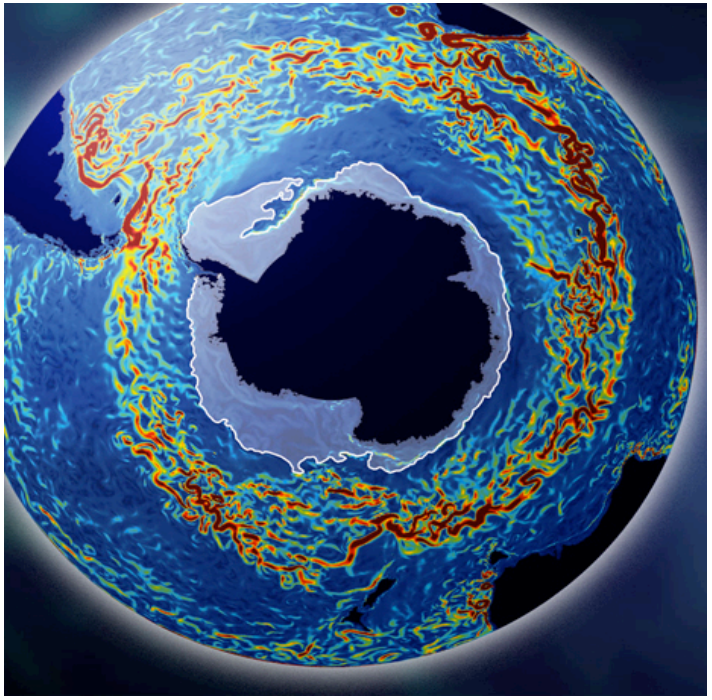


Five domains in the sea ice zone, each with own sampling needs/ opportunities:

1. Open ocean above 2000 m
2. Deep ocean
3. Continental shelf and slope
4. Ice shelf cavity
5. Sea ice and atmosphere

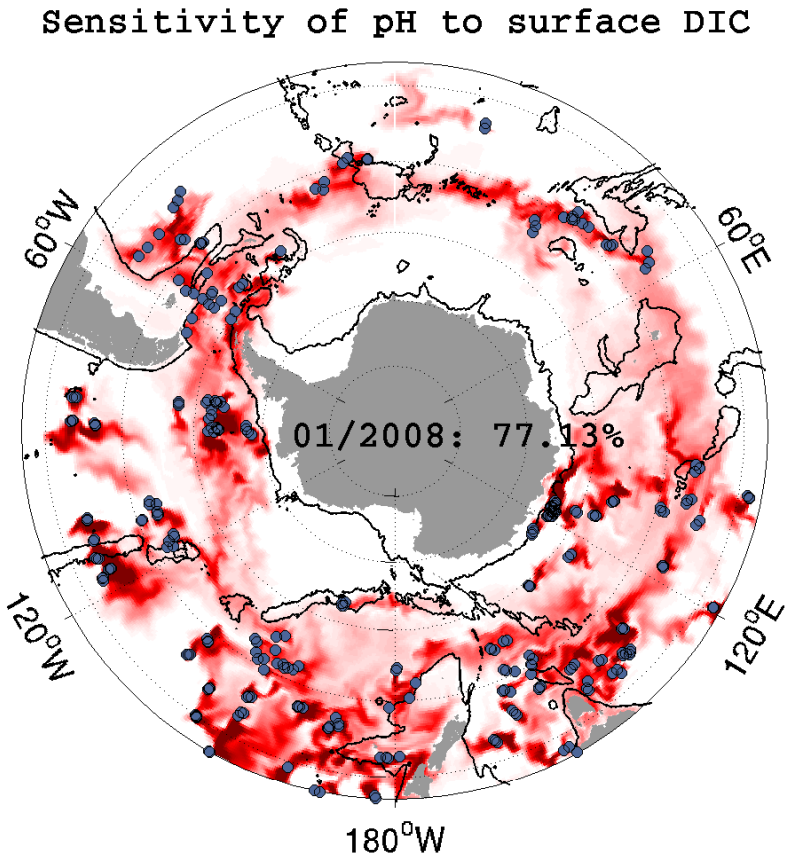
Pairing sustained observations and state estimation

Use of state estimates (ocean reanalysis) to aid with analysis of the broad-scale data



Southern Ocean State Estimate (SOSE)

Use of state estimates and OSSEs to assist with optimizing sampling plans



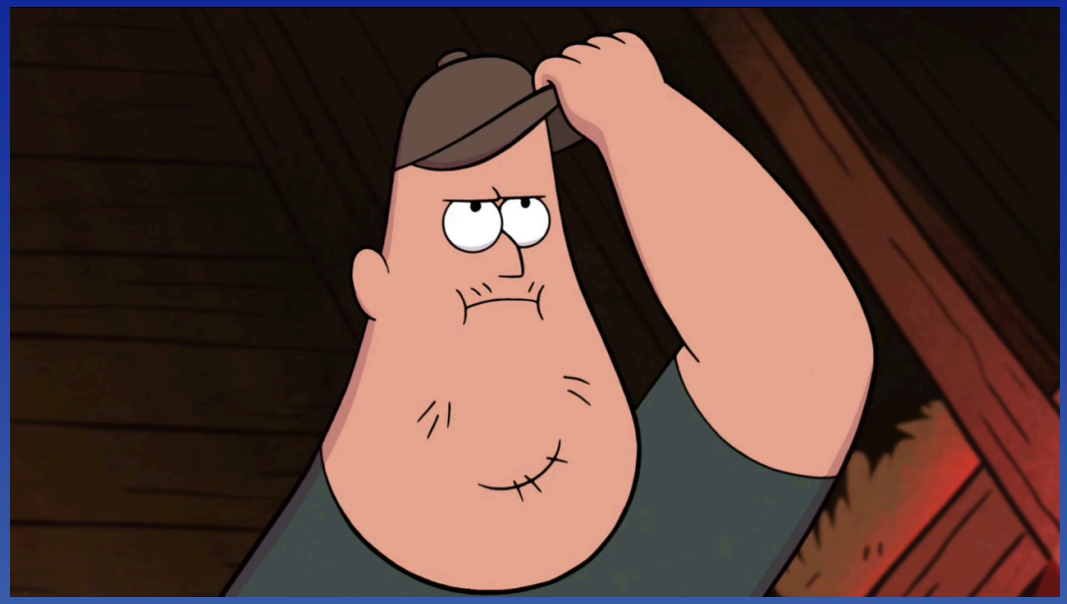
SOSE's map of where pH measured on~100 floats would influence pH field in SOSE

New data/information products

- Biogeochemical Argo-type profile data: will grow enormously in the next several years. Needs for archiving and products similar to T/S Argo.
- Continue to improve data access policies/philosophies/ agreements from all nations and programs that routinely survey Southern Ocean regions.

- Need work plan for developing S.O. priorities. SOOS has done a large amount of this work, in consultation/cross-membership with SOP. SCAR is going through the same process.

What is SOOS?



Not to mention GOOS…

or FOO…or EOV or SOCCO or SOCCOM……

an alphabet soup of **essential** international oceanography coordination

SOOS (Southern Ocean Observing System) Science Themes

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

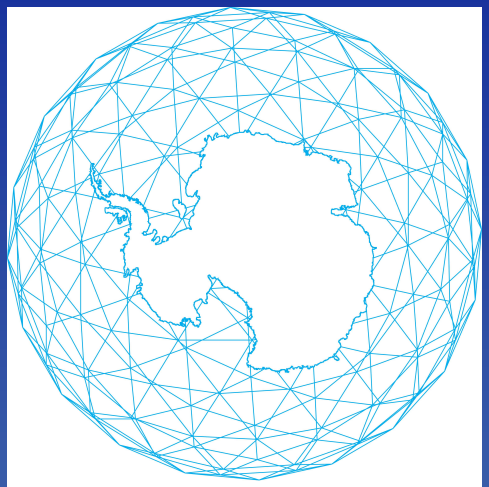
1) Role of Southern Ocean in global freshwater and heat balance
2) Stability of Southern Ocean overturning circulation
3) Stability of Antarctic ice sheet and future contribution to sea-level rise
4) Future of Southern Ocean carbon uptake
5) Future of Antarctic sea ice
6) Impacts of global change on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

Project Office: U. Tasmania, Louise Newman

SOOS structure

SOOS steering committee

Anna Wahlin, co-chair
Oscar Schofield, co-chair
Sebastiaan Swart
Andrew Constable
Steven Ackley (ASPecT – CliC)
Parli Venkateswaran Bhaskar
Angelika Brandt
Daniel Costa (IMBER)
Steve Diggs
Alberto Naveira-Garabato
Jiping Liu
Sanghoon Lee (2015)
Mauricio Mata (WCRP JSC)
Matthew Mazloff (2015)
Mike Meredith
Steve Rintoul (CLIVAR SSG)
Jean-Baptiste Sallee (2015)
Bronte Tilbrook (IOCCP Ocean acidification)
Mike Williams (2015)



International Council for Science
SCOR
Scientific Committee on Oceanic Research

SCAR
THE INTERNATIONAL COUNCIL FOR SCIENCE
SCIENTIFIC COMMITTEE ON ANTARCTIC RESEARCH

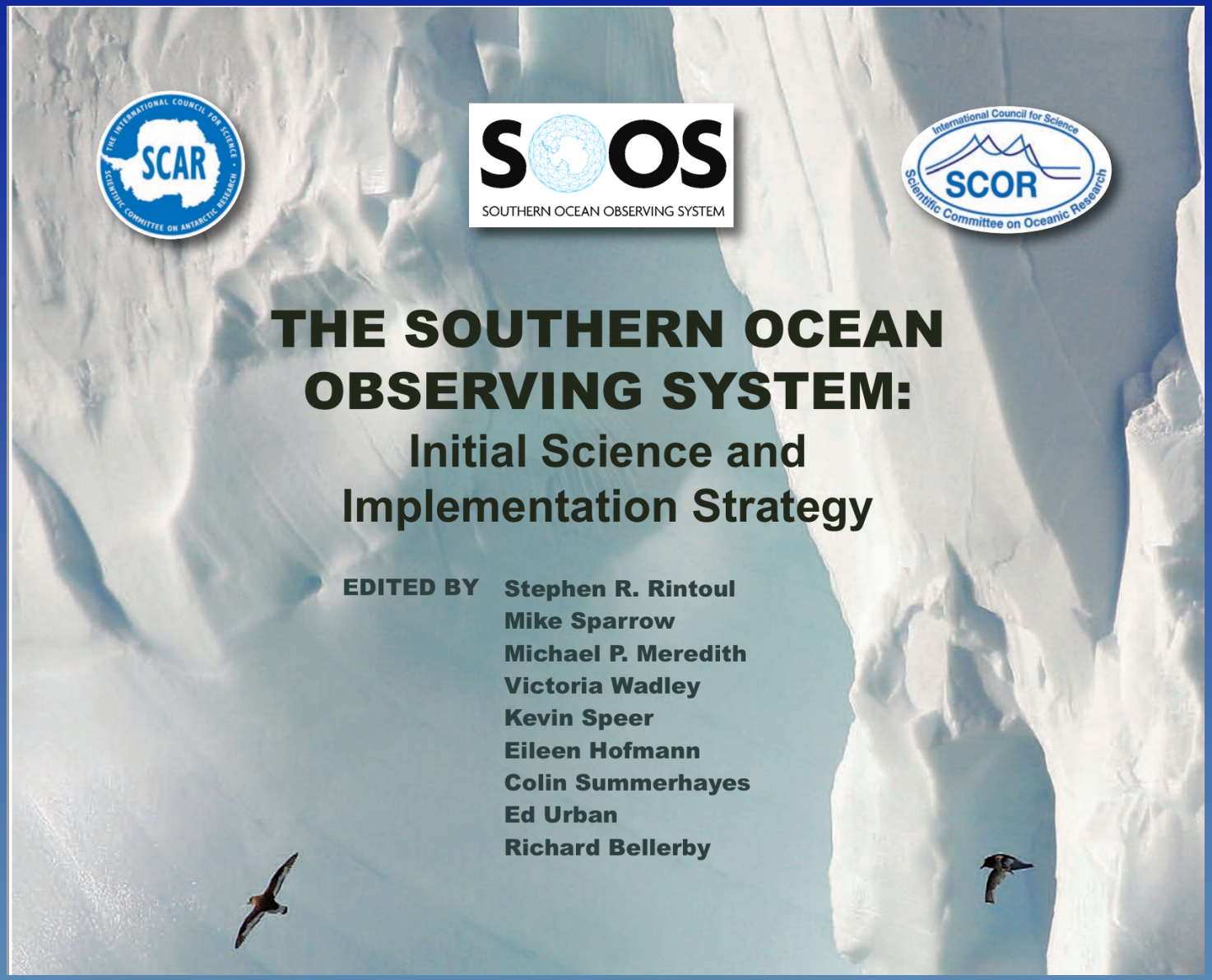
The Global Ocean Observing System
GOOS

WCRP

CliC

CLIVAR

Progress with SOOS implementation



Ongoing SOOS initiatives

- **Observing the Southern Ocean under ice: workshop**
- **Southern ocean air-sea fluxes task group: 2015 workshop**
- Satellite Data Initiative
- Identification of Essential Ocean Variables (EOVs)
- National Activities and Capabilities Initiative
- Standardised Methods and Protocols Initiative
- Field projects are envisioned as part of SOOS
- Affiliated Programmes (APs)

Seeing under the ice: a strategy for observing the Southern Ocean beneath sea ice and ice shelves

Steve Rintoul

CSIRO Marine and Atmospheric Research

Wealth from Oceans National Research Flagship

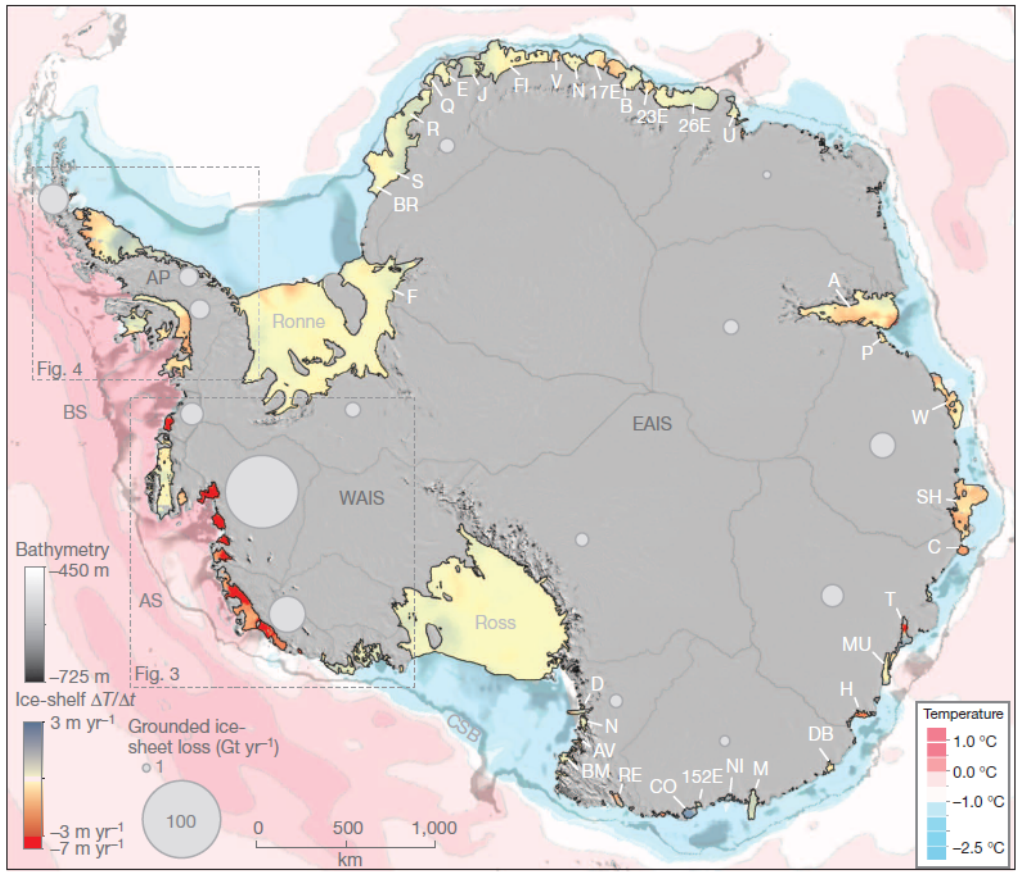
Antarctic Climate and Ecosystems CRC

Hobart, Tasmania , Australia

www.csiro.au

Antarctic ice-sheet loss driven by basal melting of ice shelves

"…the most profound contemporary changes to the ice sheet and its contribution to sea level can be attributed to ocean thermal forcing …"



Pritchard et al. 2012

Ocean – ice shelf interaction

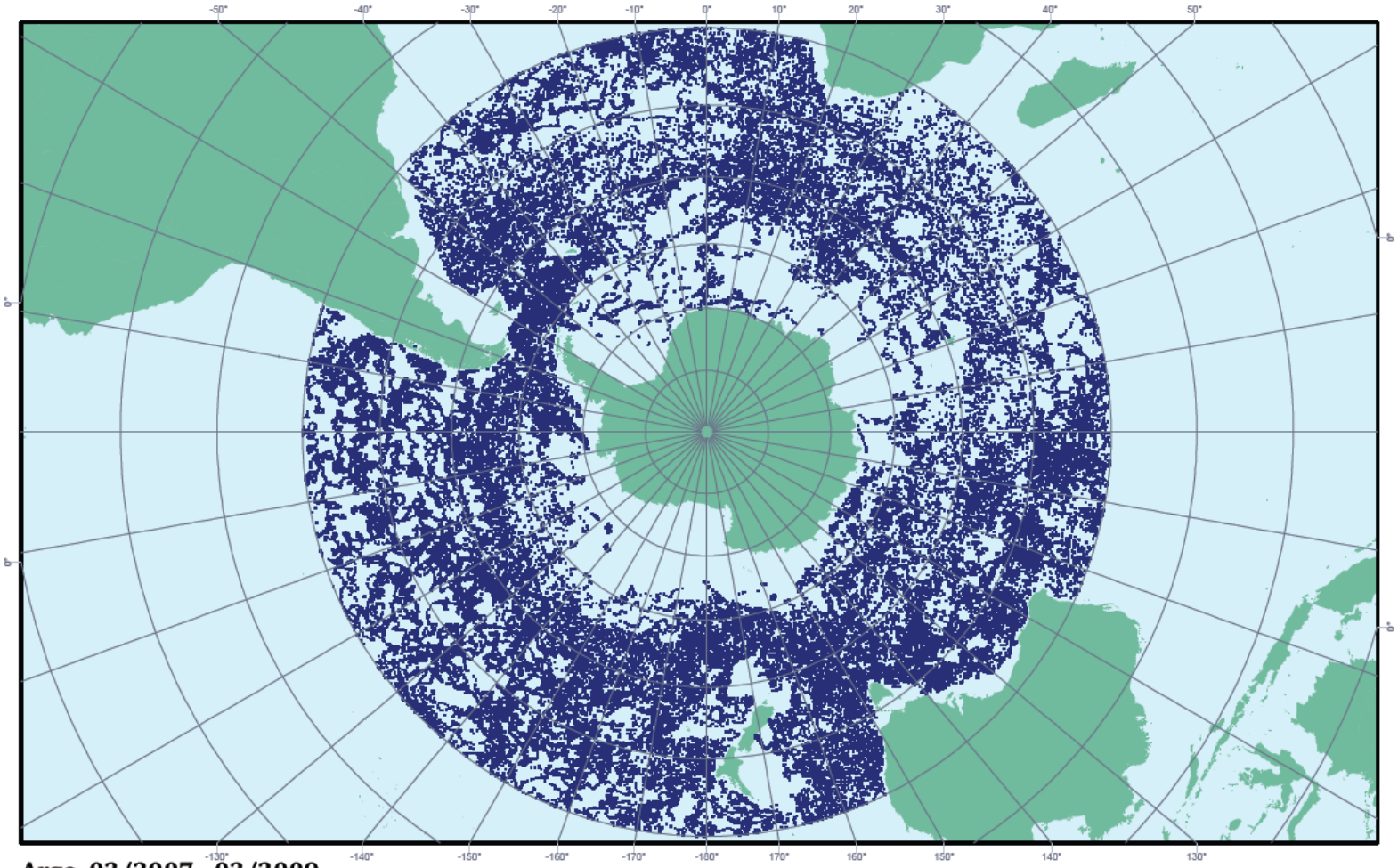
Objectives:

1. To determine the sensitivity of Antarctic ice shelves to changes in ocean circulation and temperature.

2. To assess the affect of basal melt of floating ice shelves on the mass balance of the Antarctic ice sheet and its contribution to sea level rise.

3. To determine the response of the ocean to changes in the freshwater input by the Antarctic ice sheet.

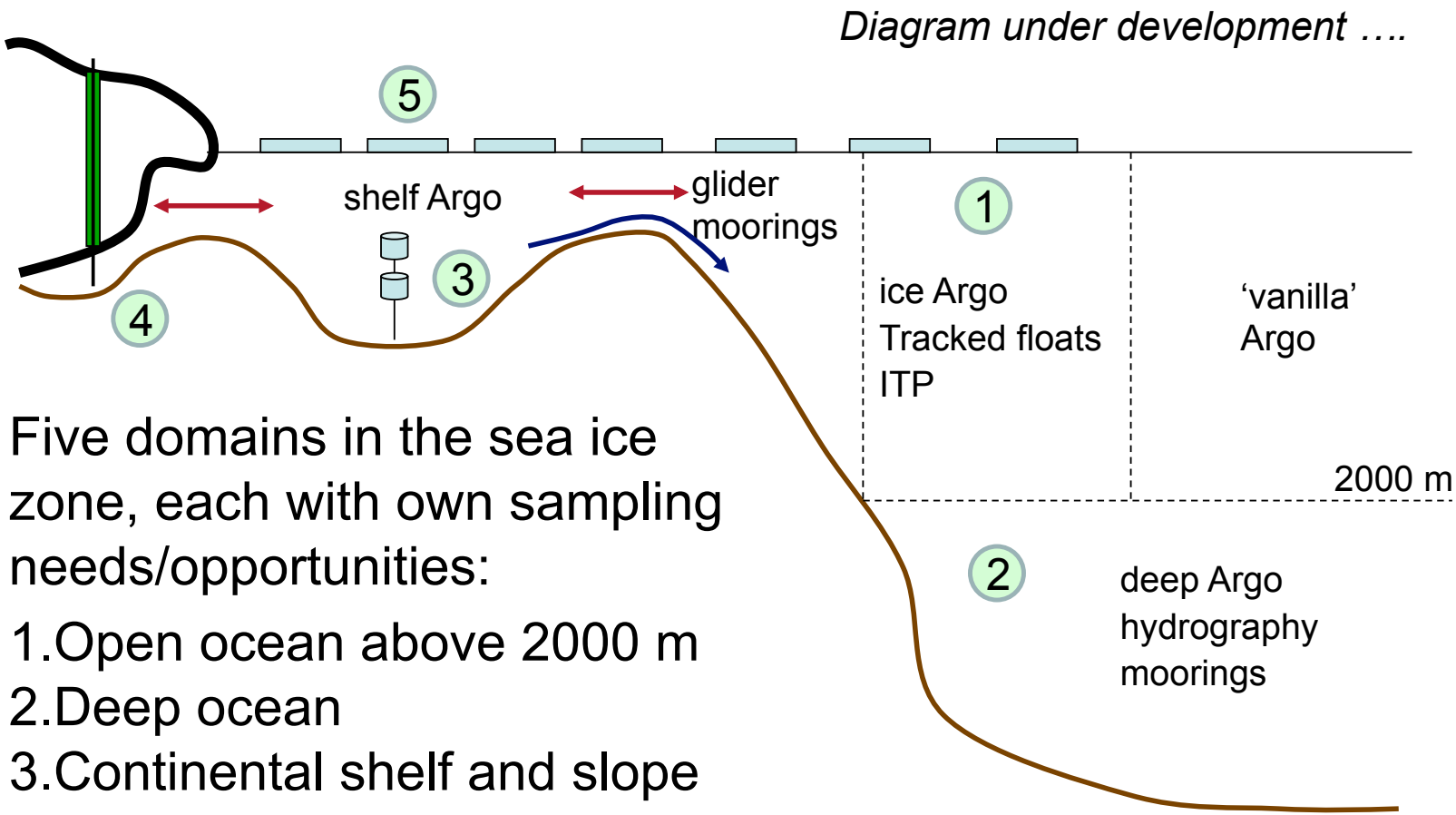
Broad-scale sampling in the upper 2000 m



Argo 03/2007 - 03/2009
61965 profiles from 1353 distinct floats

http://argo.jcommops.org

A strawman strategy for an integrated under-ice observing system



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An example: Southern Ocean air-sea fluxes task group

Workshop in Fall 2015 (Frascati, Italy) to initiate and set the course of the development of an international strategy. [CHAIR: S. GILLE]

SOOS
SOUTHERN OCEAN OBSERVING SYSTEM

- Air-sea exchanges of heat, freshwater and gasses climatically critical, yet barely measured and simplistically parameterised

- No existing international vision of long-term observational / assimilation requirements or strategy for addressing issues and knowledge gaps

SOOS structure

ICSU UNEP IOC WMO

WCRP
|
CLIVAR
CliC

GCOS
|
(ECVs)

GOOS
|
(EOVs) FOO

Science framework

Climate data

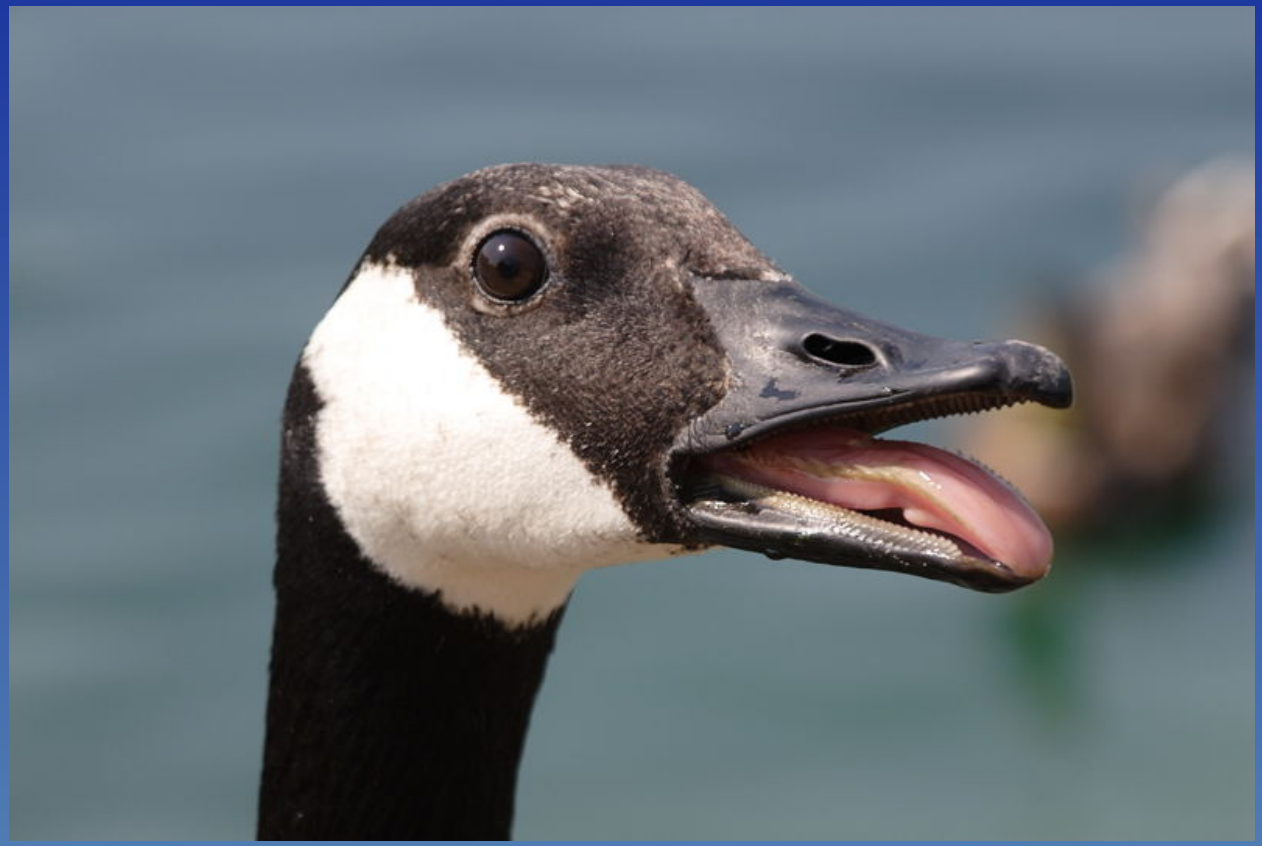
SCAR

International Council for Science
SCOR
Scientific Committee on Oceanic Research

Science
Logistics
Data

SOOS
SOUTHERN OCEAN
OBSERVING SYSTEM

What is GOOS?



What is GOOS?

The Global Ocean Observing System

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The Global Ocean Observing System

GOOS is a permanent global system for observations, modelling and analysis of marine and ocean variables to support operational ocean services worldwide. GOOS provides accurate descriptions of the present state of the oceans, including living resources; continuous forecasts of the future conditions of the sea for as far ahead as possible, and the basis for forecasts of climate change.

>> Subscribe to GOOS e-mail list, including Webinar notifications and GOOS UPDATE

Latest News

Conference: Sustained ocean observing for the next decade

GO-SHIP Argo IOCCP

A combined GO-SHIP/Argo/ IOCCP conference on physical and biogeochemical measurements of the water column

14 - 18 September 2015

Galway, Ireland

The conveners have great pleasure in announcing a science meeting to bring together participants in GO-SHIP, Argo and IOCCP, with the particular purpose of reviewing and stimulating further research that exploits the synergies among the sponsoring programs.

The GAIC2015 conference will be held in Galway, Ireland from 14 to 18 September 2015.

The conference web site can be found here: http://www.gaic2015.org

GOOS alliances

www.ioc-goos.org/index.php?option=com_content&view=article&id=159&lt

global ocean observing system

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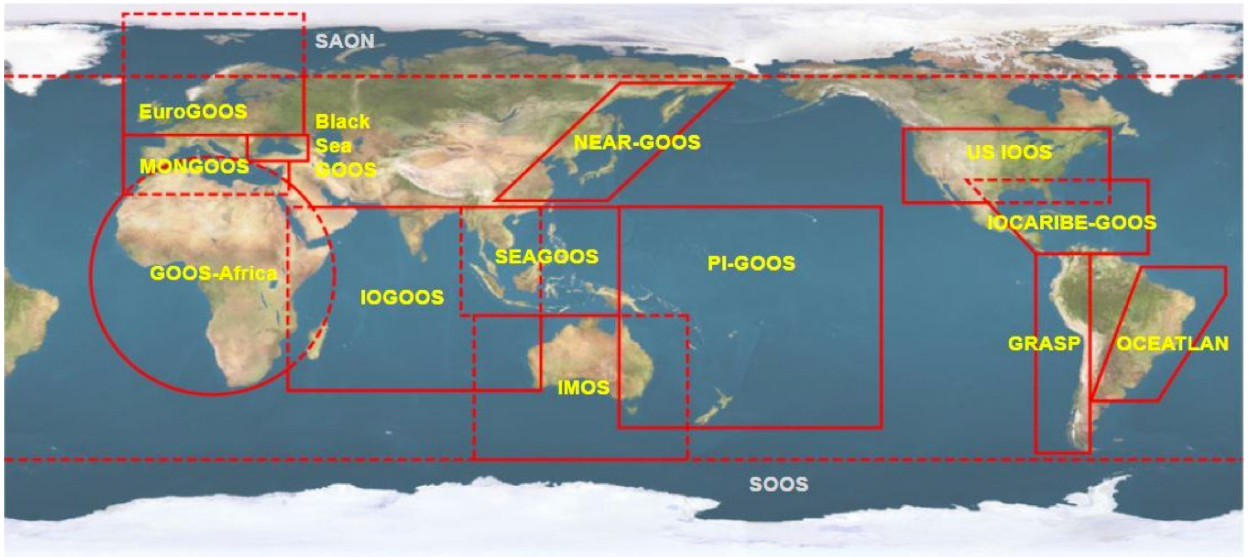
GOOS Regional Alliances Map



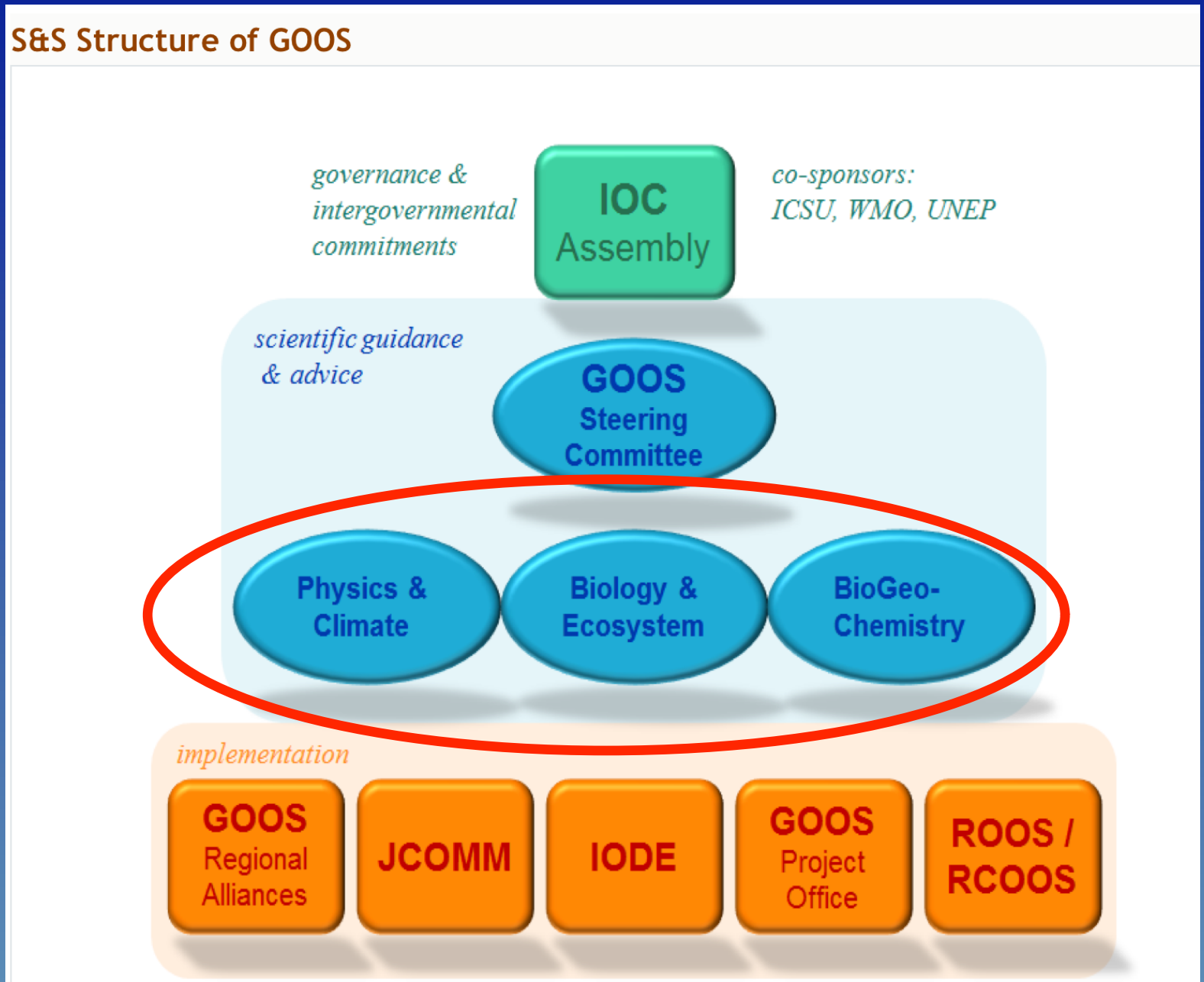
- EuroGOOS
- Mediterranean Ocean Network GOOS
- Black Sea GOOS
- NEAR (North-East Asian Regional)-GOOS
- PI-GOOS
- Indian Ocean GOOS
- IOCARIBE-GOOS
- GOOS for Africa
- USA IOOS
- Southeast Asian GOOS (SEA-GOOS)
- OCEATLAN
- GRASP
- IMOS Australian Integrated Marine Observing System

Other developing regional alliances :

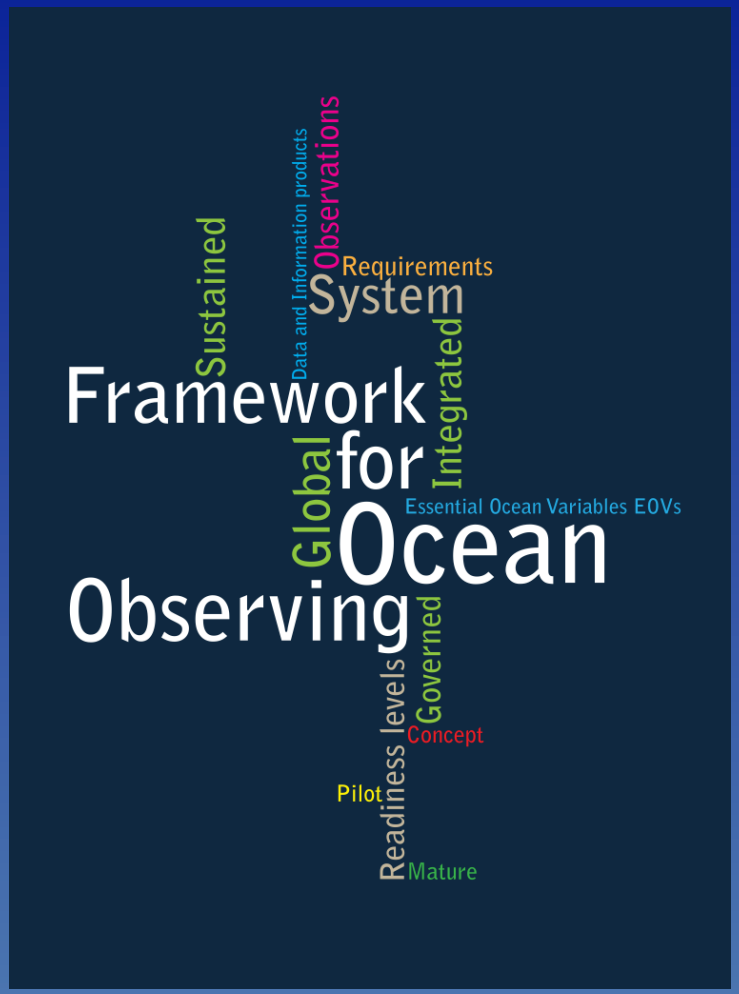
- SAON Sustaining Arctic Observing Networks
- SOOS Southern Ocean Observing System Workshop 2007

List of GOOS Regional Alliance Chairpersons Click Here

GOOS structure



GOOS structure: Framework for Ocean Observing



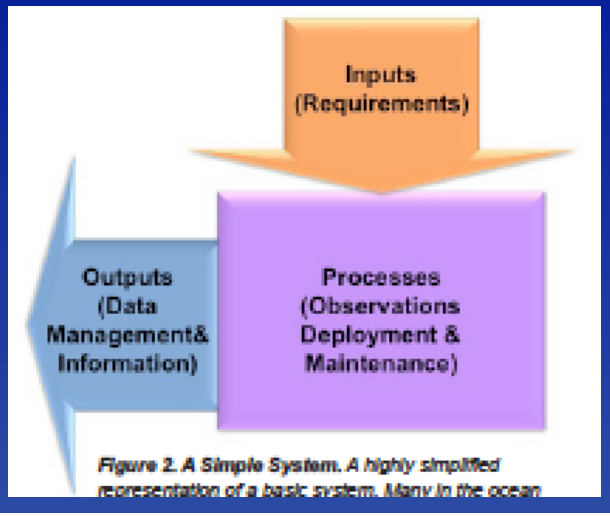
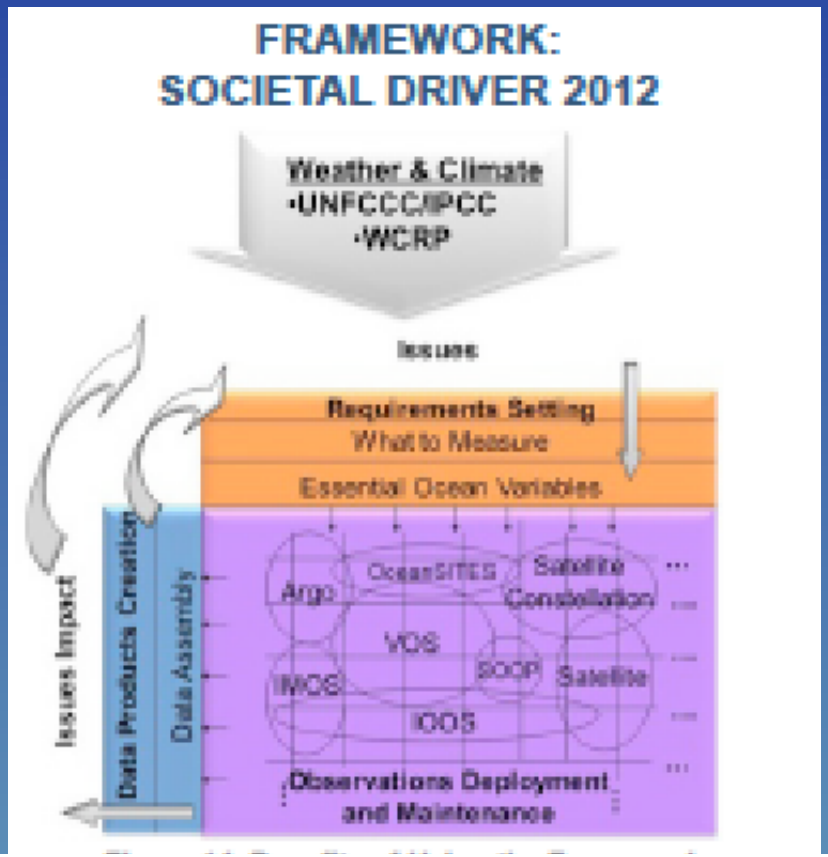


Figure 2. A Simple System. A highly simplified representation of a basic system. Many in the ocean



Eric Lindstrom, John Gunn
co-chairs of committee

GOOS structure: Panels

GOOS Panels

- **Essential Ocean Variables Panels**
  are advisory bodies which supply the GSC with scientific studies and expertise underpinning the strategic goals of GOOS. The Ocean Observations Panel for Climate (OOPC) continues its role advising GOOS and GCOS on global ocean physics essential ocean variables. The Biogeochemistry Panel will naturally be organized by the International Ocean Carbon Coordination Panel (IOCCP). The Biology & Ecology panel is a new creation, which has received support for a new Secretariat hosted by Australia. Biology & Ecosystem and Biogeochemistry Panels had their first formative meetings in Nov. 2013.

Links to the Three different Panels

GOOS Biology and Ecosystems Panel

GOOS Biogeochemistry Panel (IOCCP)

GOOS Physics Panel (OOPC)

GOOS structure: Essential Ocean Variables Panels

International Ocean Carbon Coordination Project

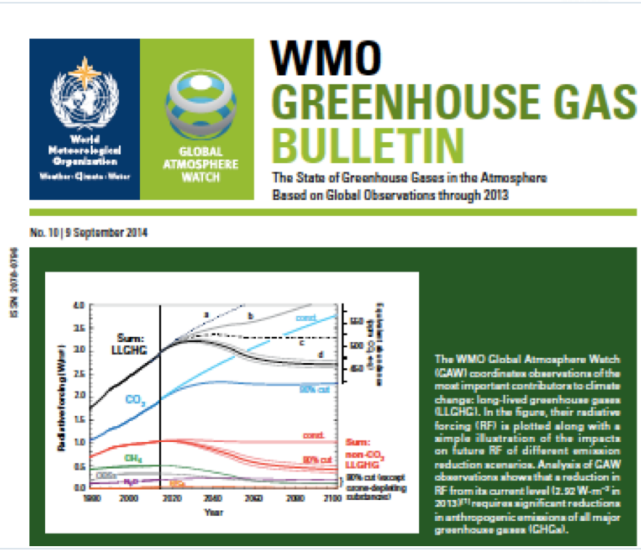
Towards a sustained global observation network for marine biogeochemistry

ABOUT US | CONTACTS | IOCCP CONVEYOR | DOCUMENTS | JOBS

Home

The IOCCP promotes the development of a global network of ocean carbon observations for research through technical coordination and communication services, international agreements on standards and methods, and advocacy and links to the global observing systems. The IOCCP is co-sponsored by the Scientific Committee on Oceanic Research and the Intergovernmental Oceanographic Commission of UNESCO. Read more…

- Underway CO_2 Observations
- Ocean Interior Observations
- Time Series Efforts
- Synthesis Activities
- Ocean Acidification
- Nutrients
- Framework for Ocean Observing
- Data and Information Management



WMO Greenhouse Gas Bulletin reports on Ocean Acidification

Latest WMO Greenhouse Gas Bulletin includes a comprehensive section on Ocean Acidification co-authored by IOCCP's Toste Tanhua, Laura Lorenzoni and Masao Ishii

>>

News

+ more news

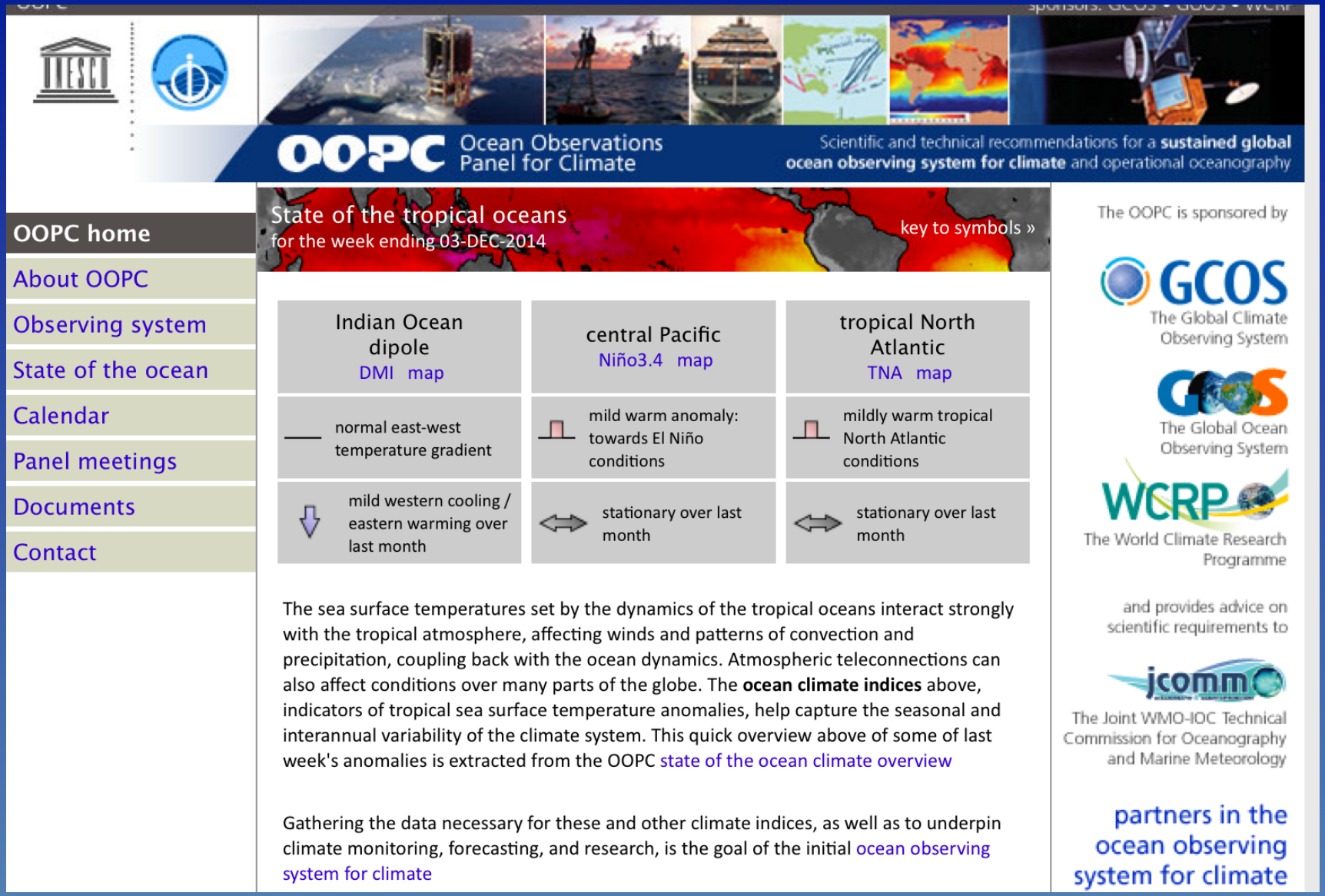
Pre-registration open for the 18th WMO/IAEA Meeting on Carbon Dioxide, Other Greenhouse Gases and related Measurement Techniques (GGMT-2015)

Wednesday, 01 10 2014

The organizers aim to expand the scope of the meeting to include measurements of dissolved

Toste Tanhua, chair **Maciej Telszewski, Project Director**

GOOS structure: Essential Ocean Variables Panels



Mark Bourassa and Toshio Suga, co-chairs
Katy Hill, Technical Secretariat (Geneva)

GOOS structure: Essential Ocean Variables Panels

GOOS Biology and Ecosystems Panel

Following the model successfully employed by GOOS to develop and coordinate global ocean physics observations over the last two decades, the GOOS now includes two new Panels - GOOS Biology and Ecosystems (entirely new), and GOOS Biogeochemistry (led by the SCOR-IOC International Ocean Carbon Coordination Project IOCCP). These panels are guiding extension of global ocean observation systems to include essential biological, ecosystem and biogeochemistry variables. An enhanced information base across this range of ocean system components is seen as an essential contribution towards critical policy development and management decisions on ocean and coastal resource sustainability and health.

The GOOS Biology and Ecosystem Panel will provide technical expertise to:

· identify major scientific and societal challenges that require sustained ocean biology and ecosystem variable observations;

· identify candidate ecosystem and biogeochemical Essential Ocean Variables (EOVs);

· clarify the role of GOOS in developing consensus requirements, coordinating observing networks, and promoting development of a data management system; and

· monitor activities and projects to practically implement the biological and biogeochemistry recommendations in the GOOS Framework for Ocean Observing (FOO) and the Panel for Integrated Coastal Observation (PICO) Plan.

The concept of EOVs adopted by GOOS as a lens for viewing and evaluating the observing system identifies those sustained observations with high impact in the delivery of societal and scientific value, balanced with the feasibility of their sustained monitoring. Identifying the EOVs associated with ocean ecosystem-related societal issues, and in particular identifying the biological / ecosystem EOVs, will assist in evaluating the status of marine ecosystems and in monitoring any future changes. This has been prioritized for action by the FOO and at the last two Sessions of the GOOS Steering Committee.

Two complementary initiatives: the European Commission funded **GEOWOW (GEOSS Interoperability for Weather, Ocean and Water)** and the GEF funded **Transboundary Water Assessment Programme 2013-2014** are providing EOV data for use in the new GOOS Biology and Ecosystem Panel discussions, and ultimately, ocean ecosystem data useful for marine products and policy advice.

Nic Bax and Sam Simmons, co-chairs
Seeking Project Officer (to be based in Australia)

GOOS structure: OOPC's Essential Ocean Variables

OOPC's EOVs are generally adopted as ECVs by GCOS

Atmosphere surface:

Air temperature
Precipitation
Air pressure, sea level pressure (SLP)
Surface radiation budget
Wind speed and direction
Water vapour

Ocean surface:

Sea surface temperature (SST)
Sea surface salinity (SSS)
Sea level
Sea state
Sea ice
Current
Ocean colour (for biological activity)
Carbon dioxide partial pressure (pCO_2)

Ocean subsurface:

Temperature
Salinity
Current
Nutrients
Carbon
Ocean tracers
Phytoplankton

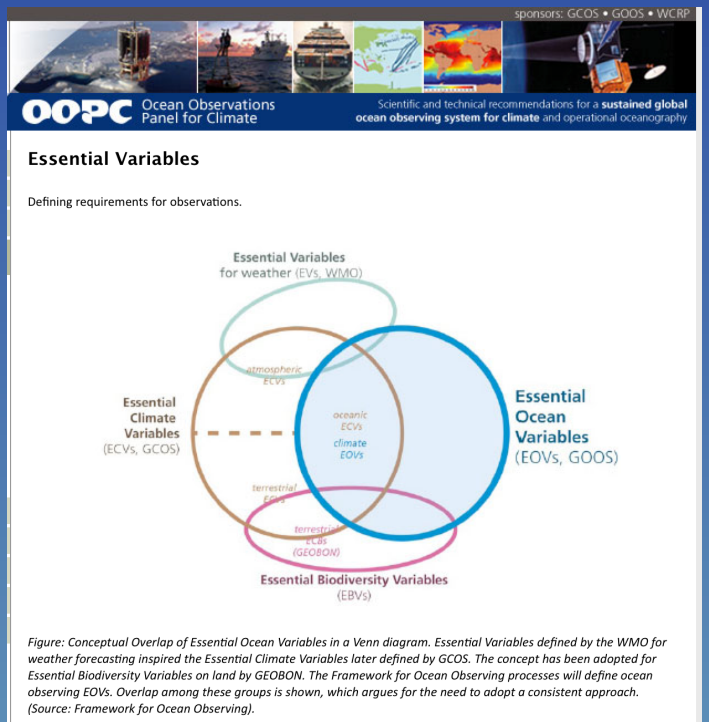


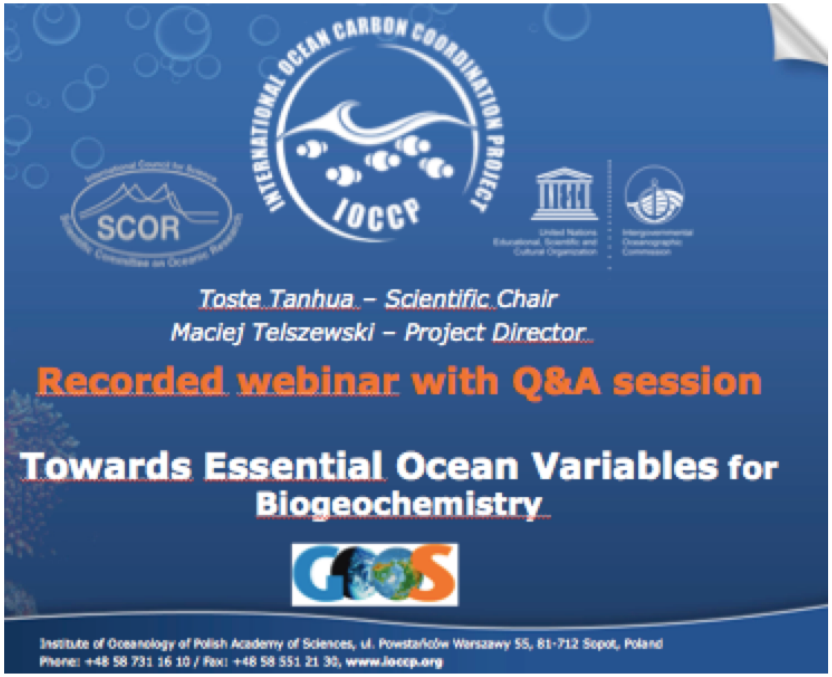
Figure: Conceptual Overlap of Essential Ocean Variables in a Venn diagram. Essential Variables defined by the WMO for weather forecasting inspired the Essential Climate Variables later defined by GCOS. The concept has been adopted for Essential Biodiversity Variables on land by GEOBON. The Framework for Ocean Observing processes will define ocean observing EOVs. Overlap among these groups is shown, which argues for the need to adopt a consistent approach. (Source: Framework for Ocean Observing).

GOOS structure: IOCCP's Essential Ocean Variables

Framework for Ocean Observing

During the webinar given on 17 June 2014 we presented our work on biogeochemical EOV's and asked the community for further input. If you haven't had a chance to watch and interact with us at the time, feel free to watch the recorded version (click on the slide below) and contact us with additional input.

Framework for Ocean Observing - Implementation for Biogeochemistry



Toste Tanhua
Responsible
SSG Member

GOOS structure: IOCCP's Essential Ocean Variables

To kick-start the process, the Global Ocean Observing System (GOOS) sponsored, through IOCCP, an expert meeting which was carried out side by side with the Biology and Ecosystem Panel meeting. The First Technical Workshop for Biology and Ecosystem and Biogeochemistry Panels was held in Townsville, Australia 13-16 November 2013. During this workshop the GOOS Biogeochemistry Panel sought advice from technical experts to assist with:

- identification of major scientific and societal challenges that require sustained observations of ocean biogeochemistry variables;
- identification of candidate biogeochemical Essential Ocean Variables (EOVs);
- defining the state of readiness of set requirements, existing observing system elements and existing data streams for all proposed EOVs on the various frequency and resolution levels;
- identifying monitoring activities and projects to practically implement the biological and biogeochemistry recommendations in the GOOS Framework for Ocean Observing (FOO), the Panel for Integrated Coastal Observation (PICO) Plan and the upcoming update of the Global Climate Observing System's Implementation Plan.

Input of a wider community was invited before, during and after the town hall meeting organized during the OSM'14 in Honolulu. In order for the FOO implementation to become a truly open and transparent process we would like to continue these community consultations. The town hall meeting in Honolulu and GOOS webinar gave us an opportunity to provide you with a short status update but most importantly we seek your opinion on a biogeochemical EOV proposal drafted over the last 6-8 months. To help you get involved we post the draft EOV Workshop report together with 9 Specification Sheets, one for each proposed EOV. As you will see, it is still very much work in progress and your expert knowledge will be highly appreciated.

Technical Experts Workshop for GOOS Biogeochemistry Panel Draft Report
Draft EOV Specification Sheet - Oxygen
Draft EOV Specification Sheet - Macro Nutrients
Draft EOV Specification Sheet - Carbonate System
Draft EOV Specification Sheet - Transient Tracers
Draft EOV Specification Sheet - Suspended Particulates
Draft EOV Specification Sheet - Particulate Matter Export
Draft EOV Specification Sheet - Nitrous Oxide
Draft EOV Specification Sheet - Carbon Isotope, 13C
Draft EOV Specification Sheet - Dissolved Organic Matter

Southern Ocean observing systems & global organizations?

What have I just tried to tell you about international organization for the Southern Ocean carbon, biogeochemistry, and physics?

1. Framework and practicalities for the observing system (variables, methods, accuracies) lies within GOOS and its panels (IOCCP, OOPC, new BEP)

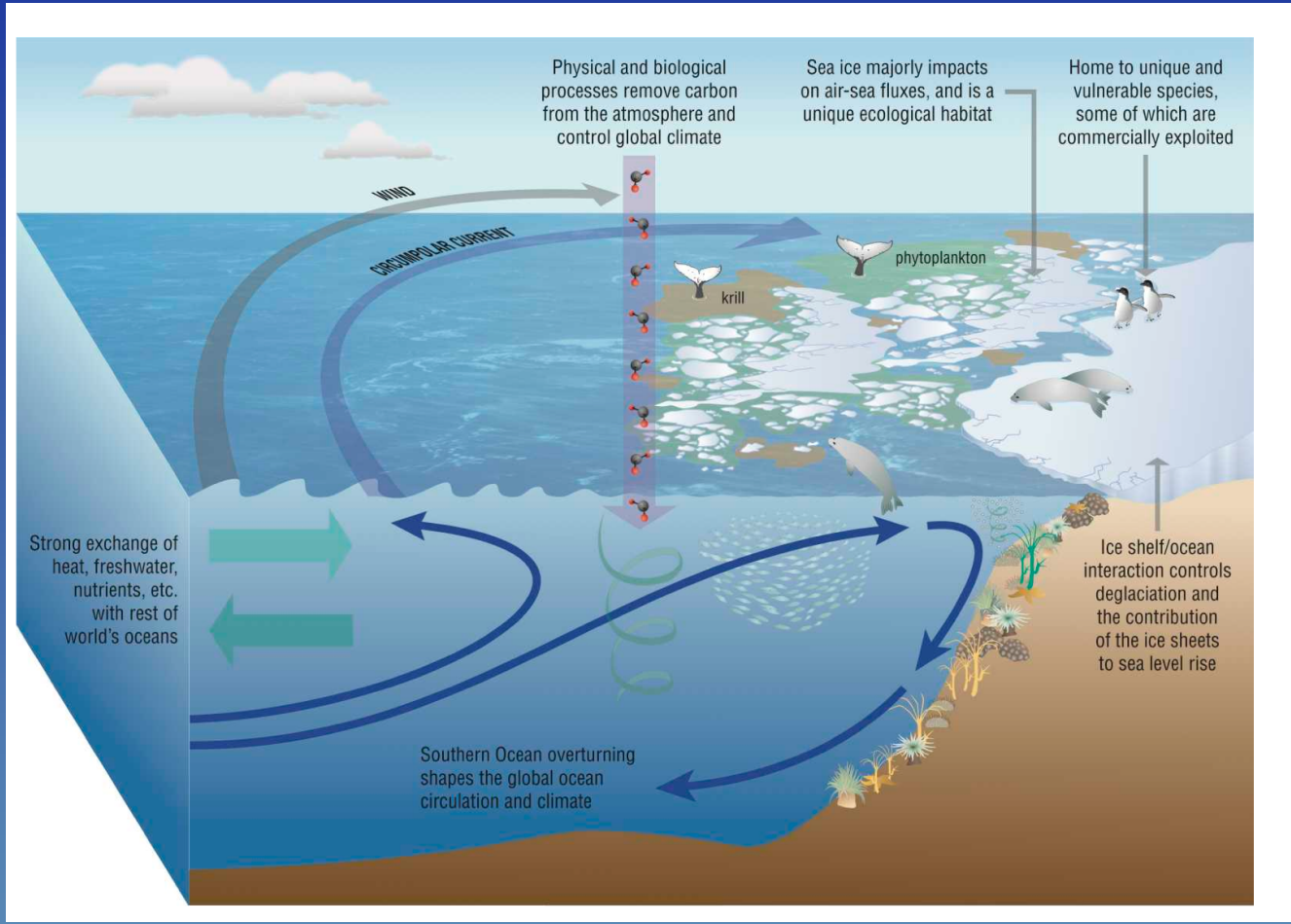
2. Science framework for the Southern Ocean lies within several organizations
SOOS is very active now
SCAR is active in overall visioning
WCRP: CliC, CLIVAR

SCAR vision 2013

The vision for a Southern Ocean Observing System

Meredith, Schofield, Newman,Urban, Sparrow (Current Opinion in Environmental Sustainability, 2013)

Science schematic



SCAR vision 2013

The vision for a Southern Ocean Observing System

Meredith, Schofield, Newman,Urban, Sparrow (Current Opinion in Environmental Sustainability, 2013*)*

Observing system schematic