The under ice observational gap

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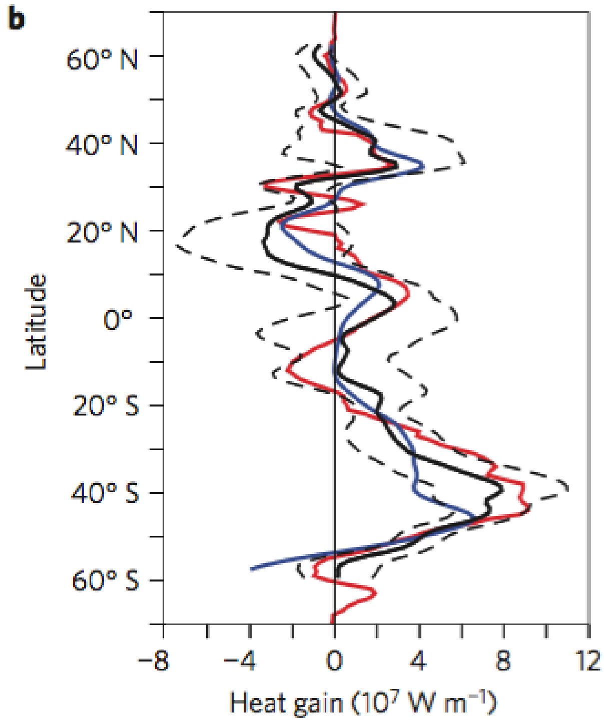
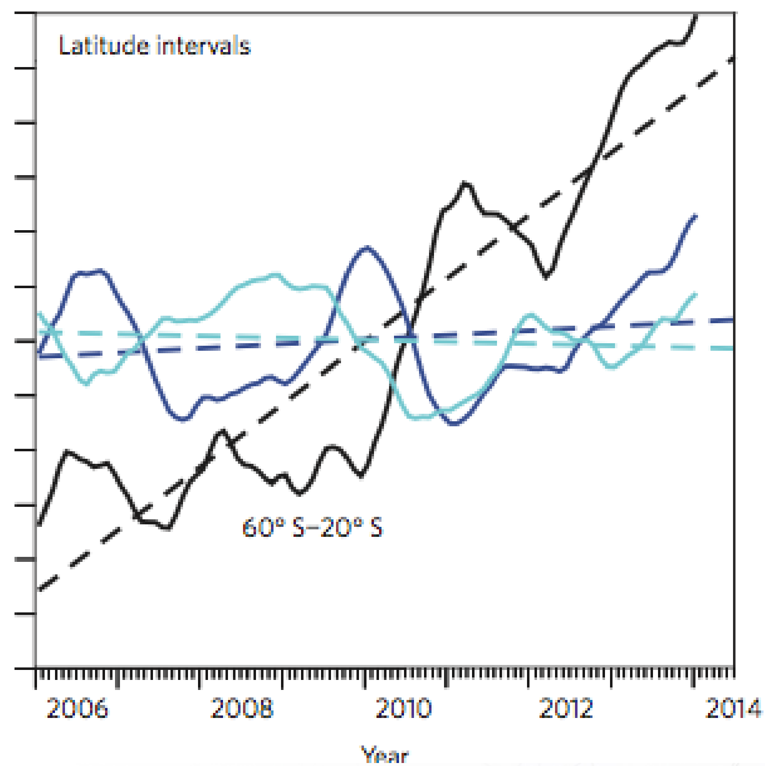
SOUTHERN OCEAN OBSERVING SYSTEM

INSTITUTE FOR MARINE AND ANTARCTIC STUDIES

High latitudes are vitally important for climate and have very large uncertainties, in particular ice covered regions





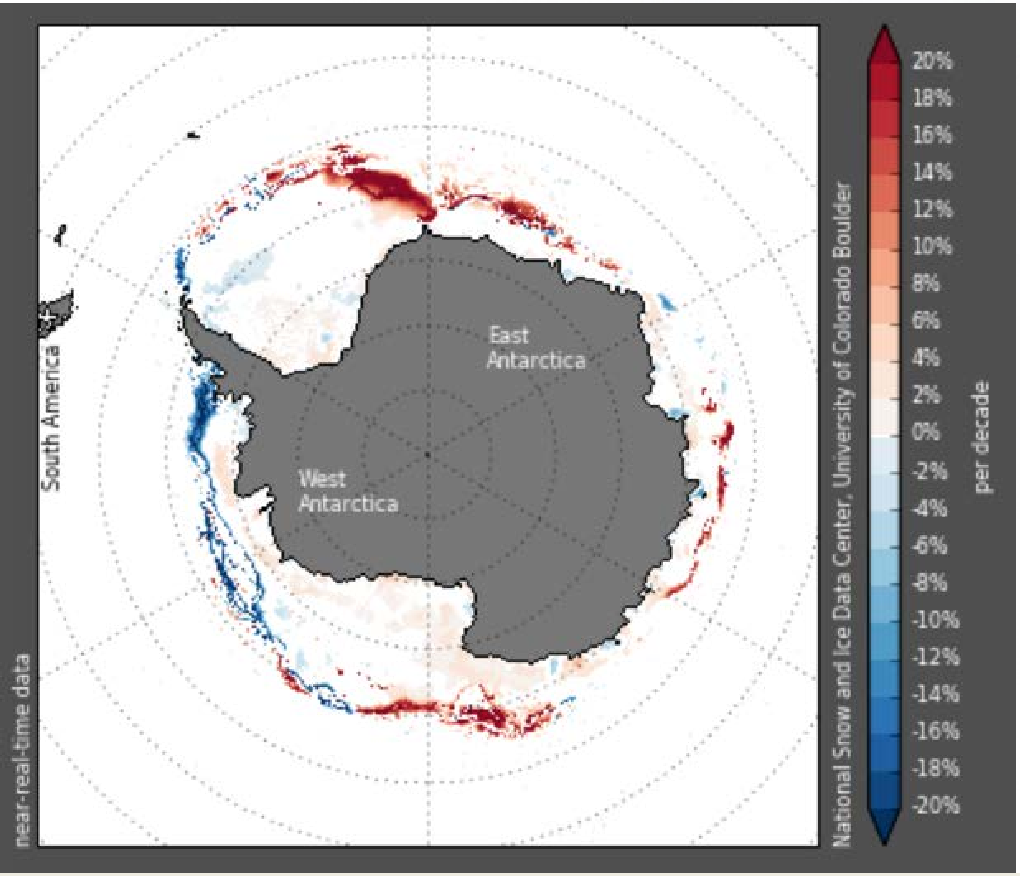
LETTERS
PUBLISHED ONLINE: 2 FEBRUARY 2015 | DOI: 10.1038/NCLIMATE2513

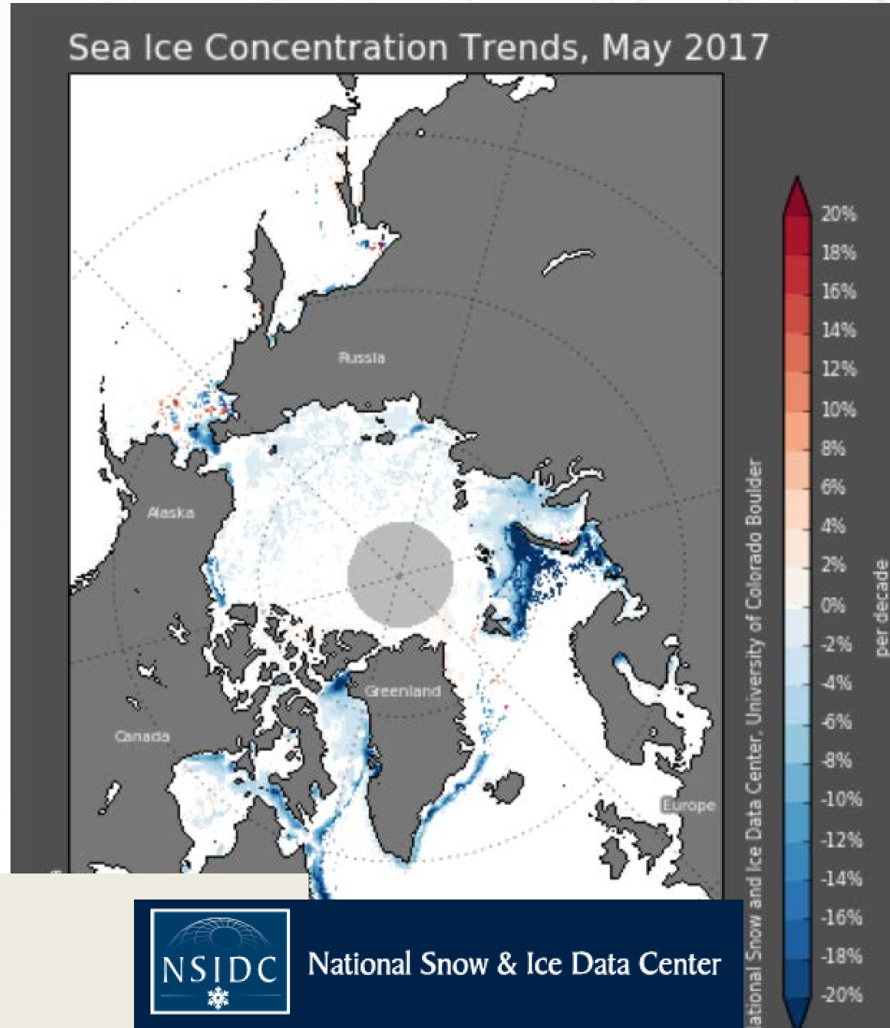
Unabated planetary warming and its ocean structure since 2006

Dean Roemmich[1]*, John Church[2], John Gilson[1], Didier Monselesan[2], Philip Sutton[3] and Susan Wijffels[2]

Vol 5, March 2015
DOI: 10.1038/NCLIMAT2513

Sea ice: Can observe its extent in a sustained fashion

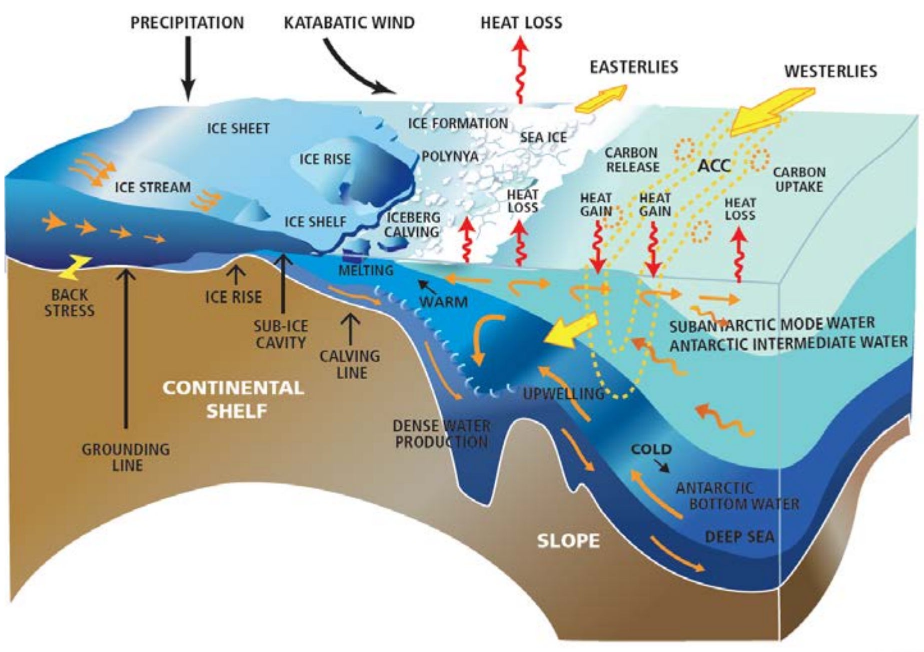




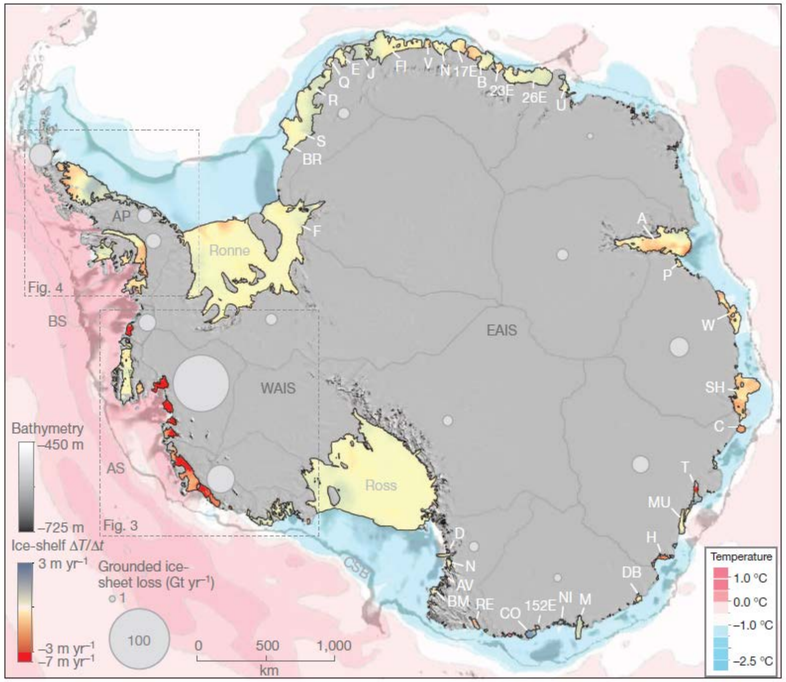
- **Changes in sea ice extent observed**
- **Also changes in thickness?**
- **Satellites need ground truthing**
- **Satellites need to keep flying – currently risk of loosing AMSR instrument**

NSIDC National Snow & Ice Data Center

Sea level rise: Ability to predict changes in Antarctic Ice Sheet



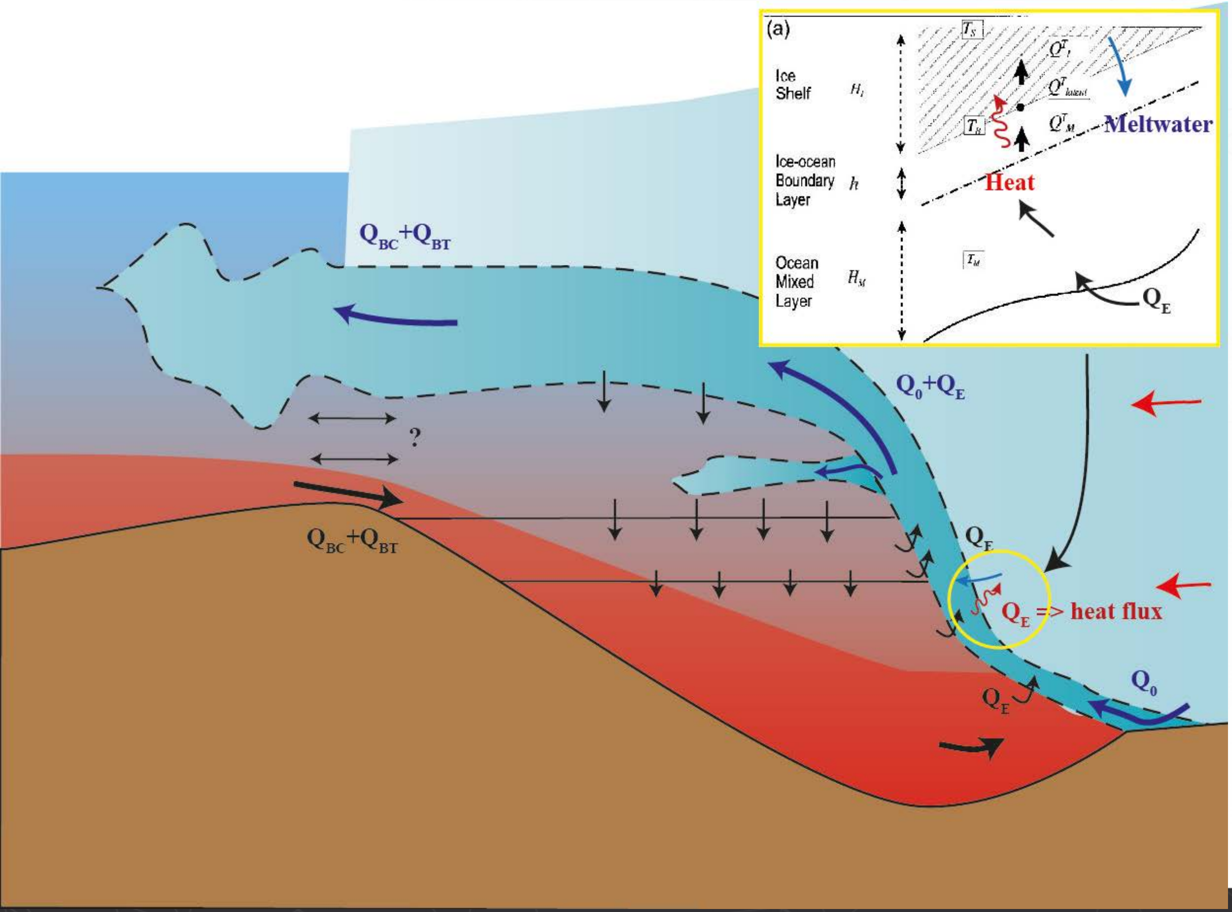
National Research Council of the National Academies (USA), 2011).

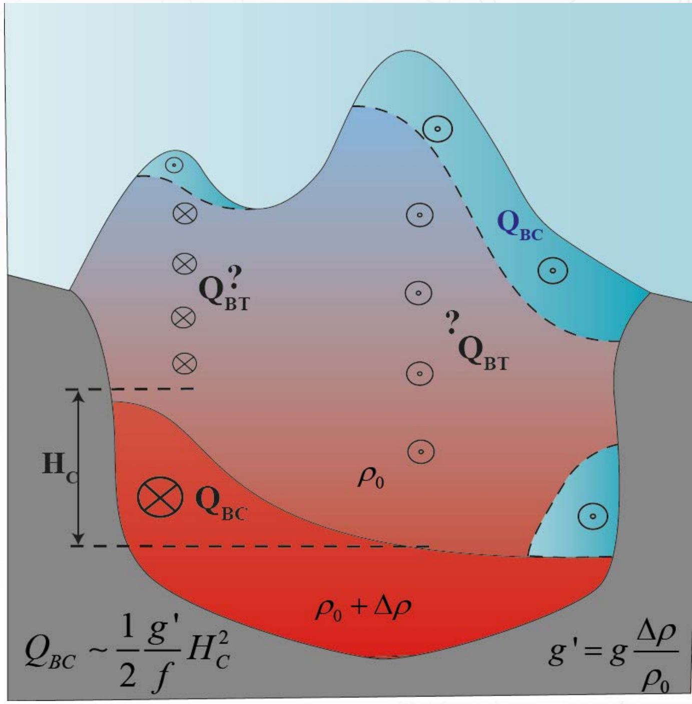


Pritchard et al. (2012)

- **Many key high latitude processes remain poorly understood due to a lack of observations**
- **Need year round observations to answer some of the key science questions**

The ice-shelf / ocean system



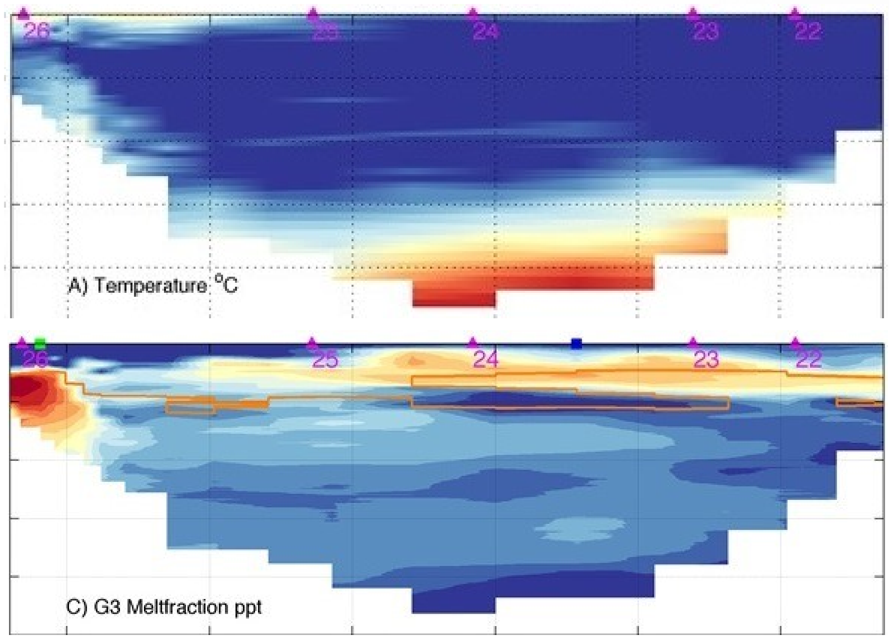


Inflow of warm water into cavity, outflow of meltwater
Geostrophic flow into and out of cavity

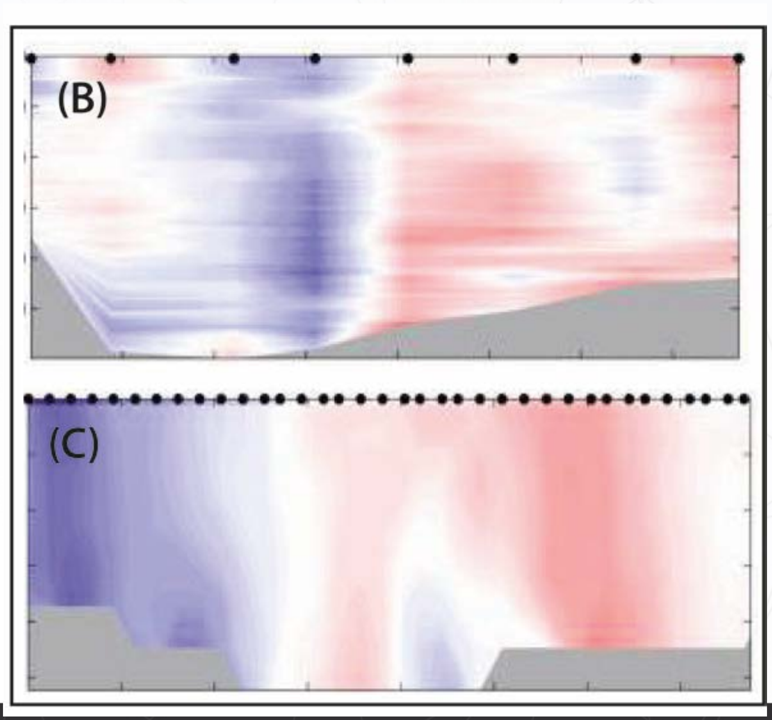
How is the distribution inside cavity?
Small-scale variations of bathymetry and ice vitally important for dynamics
Ecosystems inside? Biogeochemistry?

Baroclinic plus barotropic fow towards and away from cavity in deep troughs

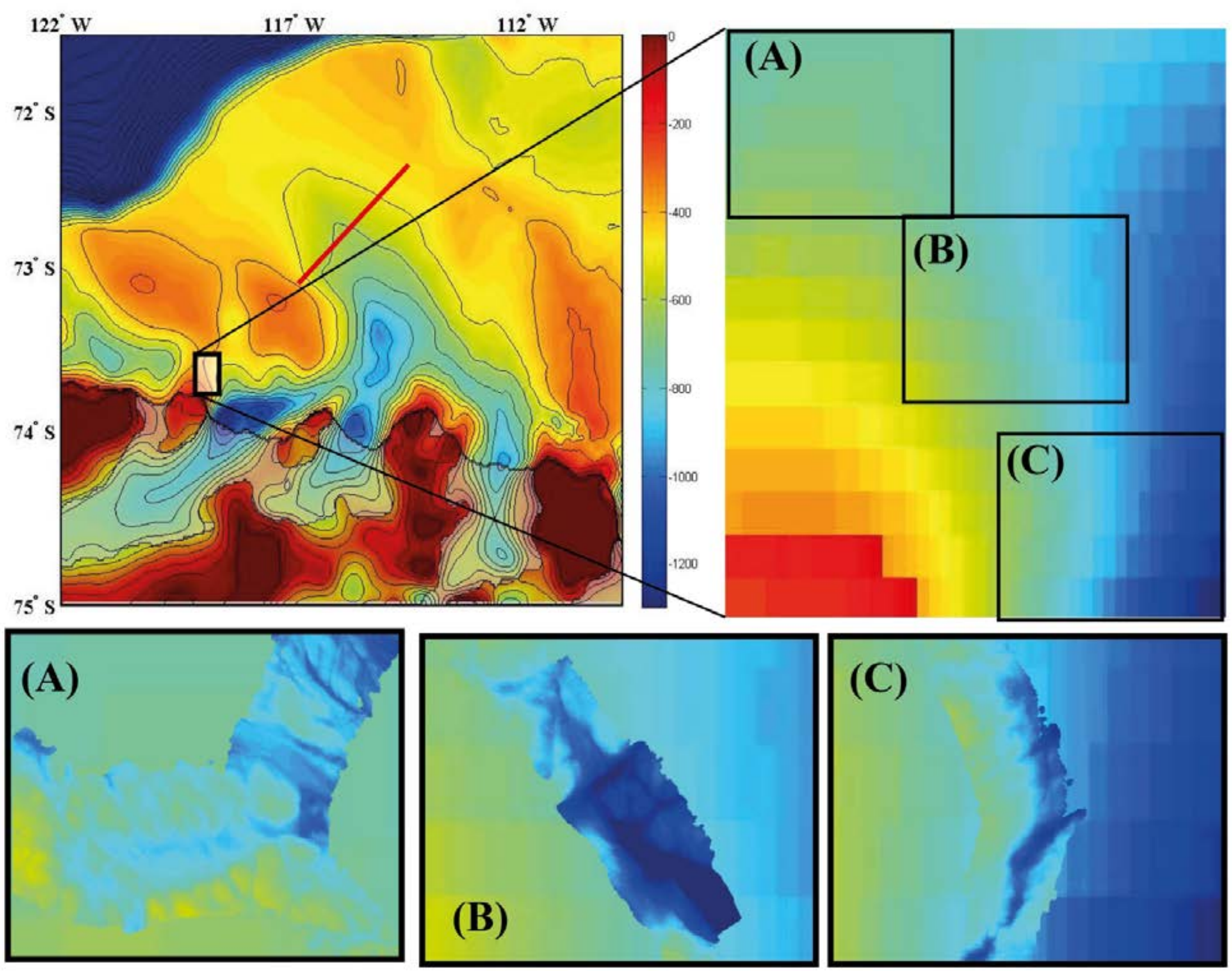
What does it look like inside cavity?
How much of the flow (barotropic and barocinic components) enter into cavity? And how is it steered then?
(Bathymetry not parallell to water column thickness!)



Miles et al, 2016: DSR part II (KOPRI Amundsen special issue)

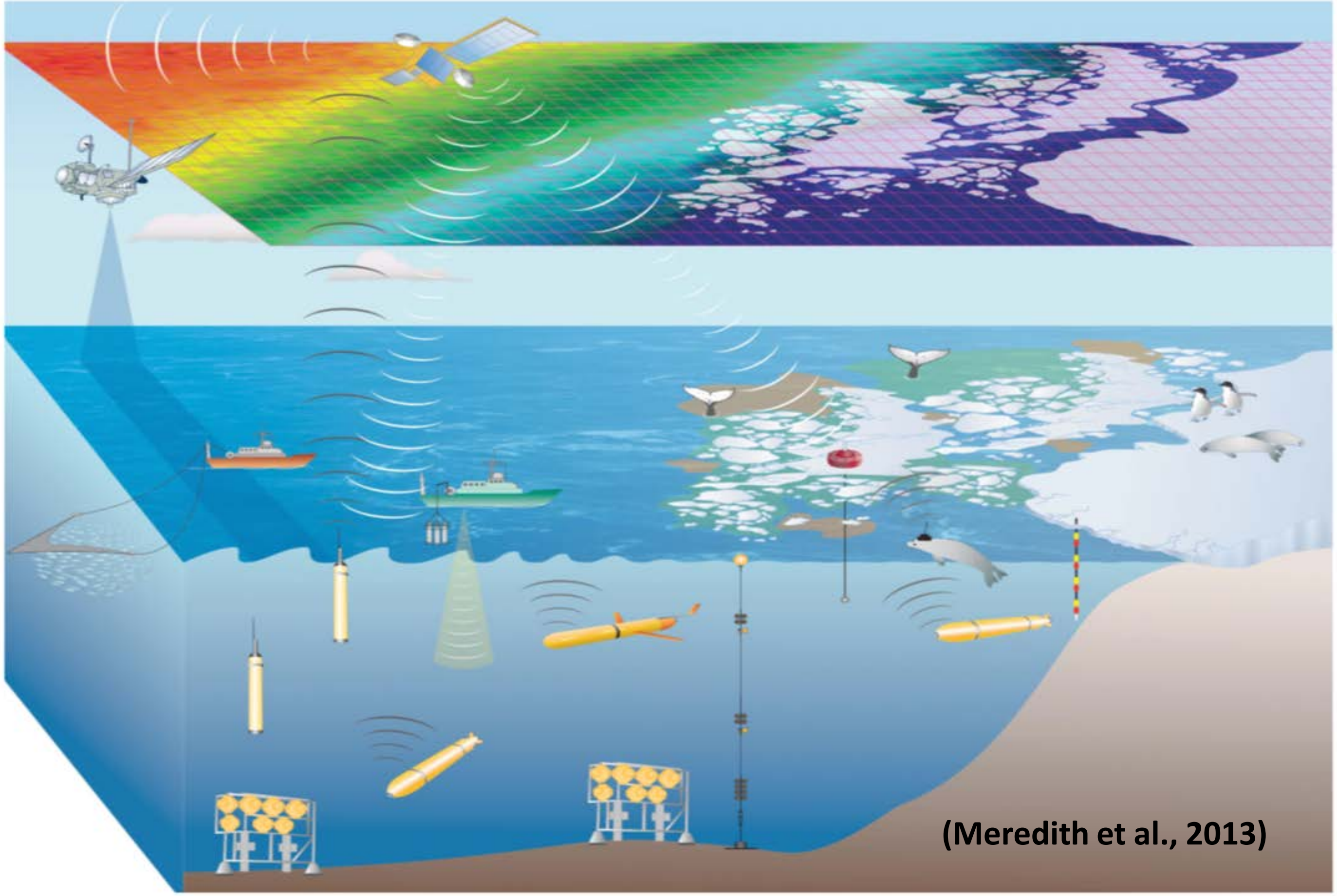


Need bathymetry everywhere, also below sea ice and glacial ice



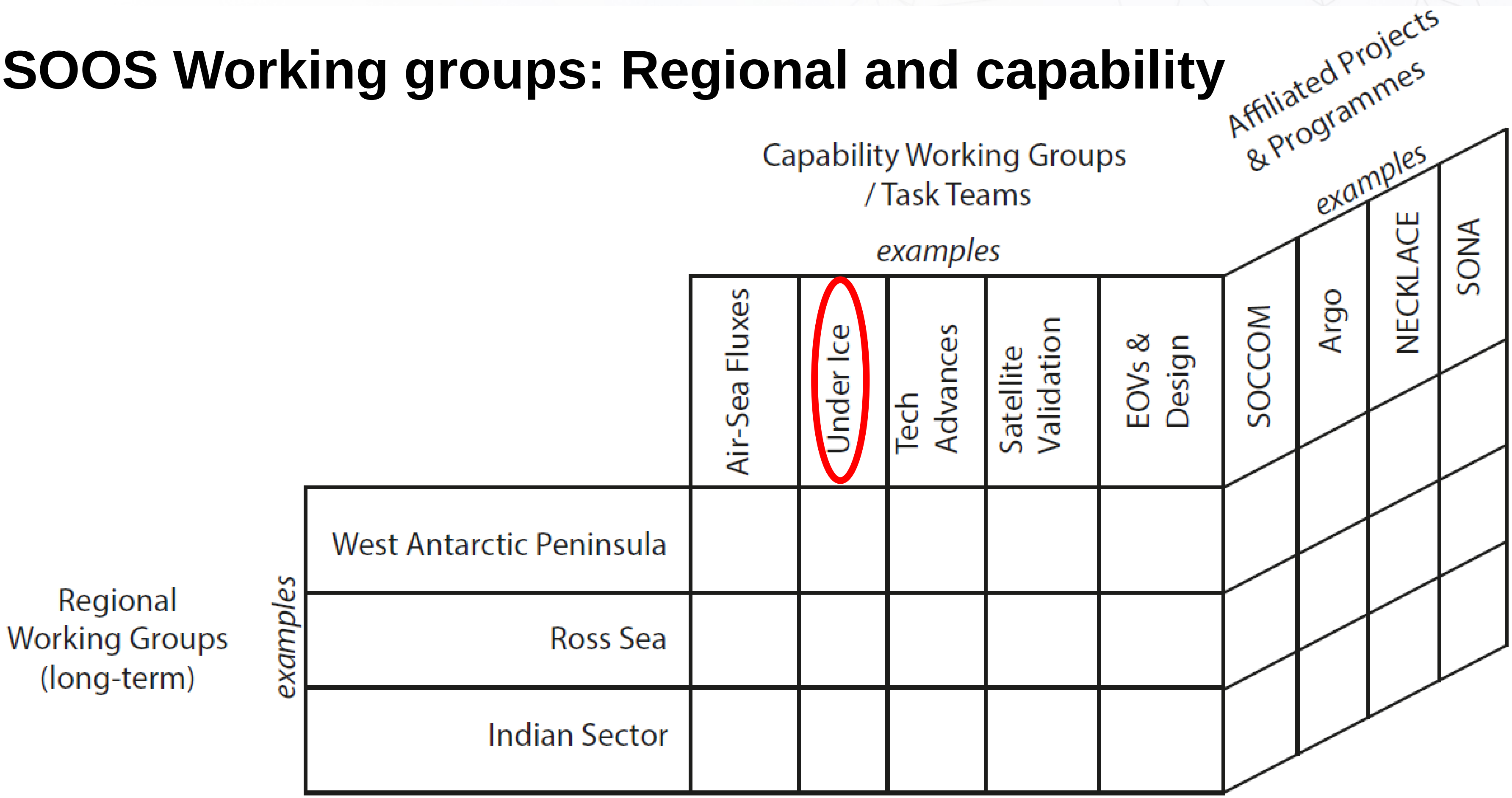
Southern Ocean Observing System

Long-term vision (20 years): A sustained, multi-disciplinary observing system for the Southern Ocean



(Meredith et al., 2013)

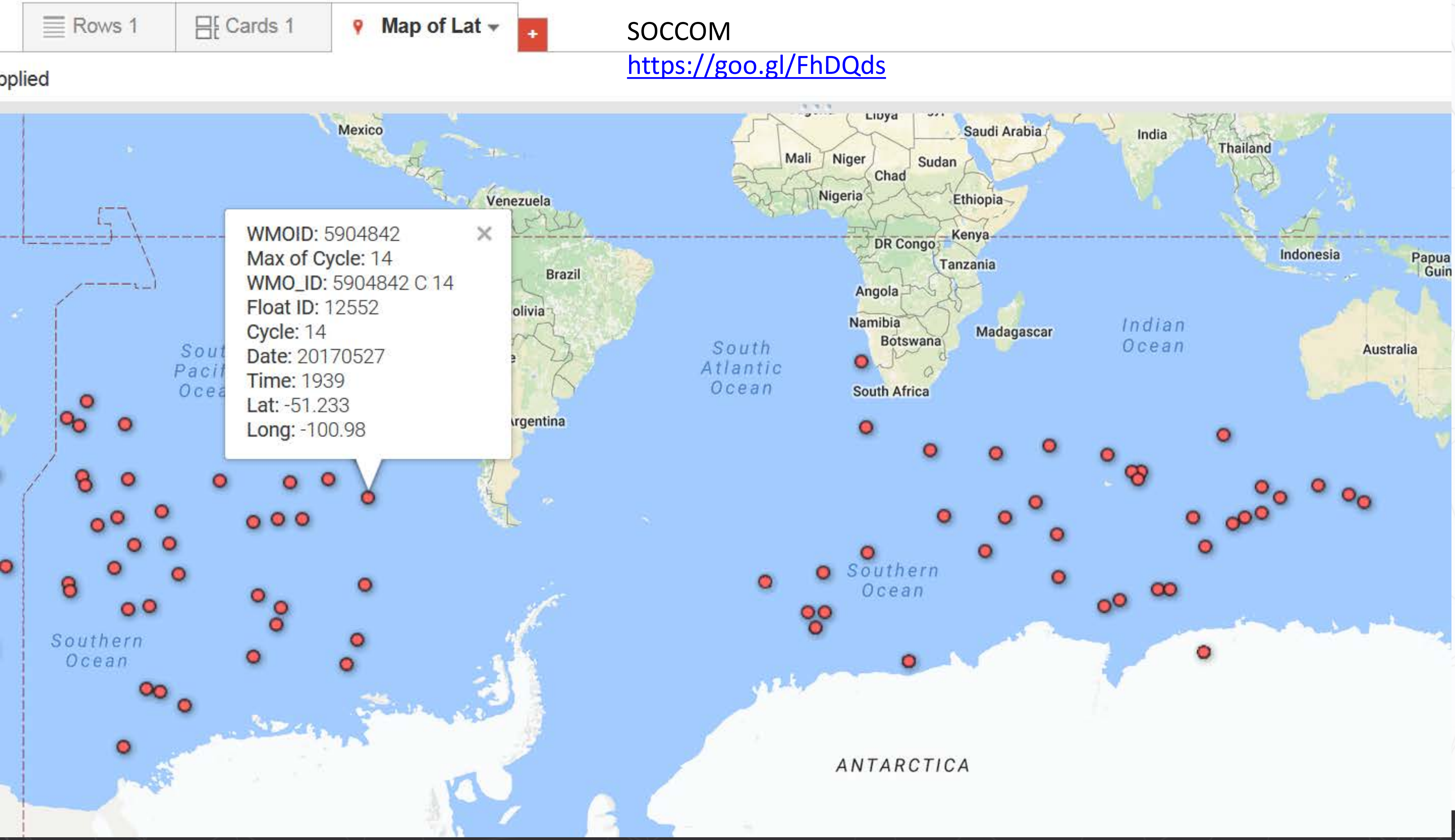
SOOS Working groups: Regional and capability



Weddel Sea, Amundsen & Bellingshausen Sea, deep ocean (circumpolar) starting up

Seal data (MEOPS)
https://goo.gl/nyFOMl

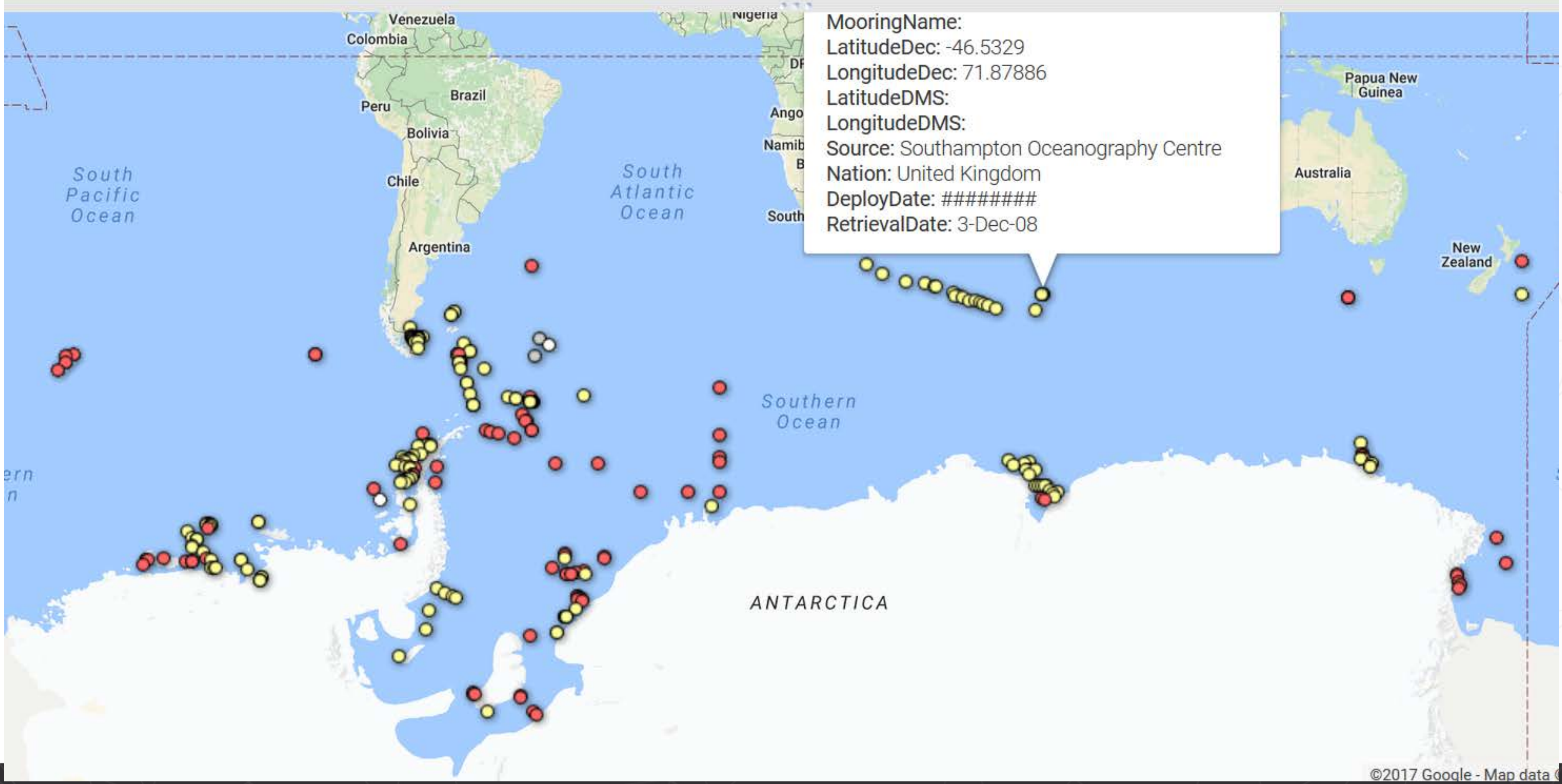
SOCCOM
https://goo.gl/FhDQds



- Edited on 2017 June 6

Rows 1 | Cards 1 | Map of LatitudeDec

Moorings
https://goo.gl/LlEHkB



Necklace (Apres)
https://goo.gl/rWeJEs

Fig. 1. Map of Southern Ocean NECKLACE locations. Red = currently deployed, yellow = retrieved, turquoise = planned.

Mooring map on the SOOS website: http://www.soos.aq/activities/soos-at-sea/moorings
To edit the underlying spreadsheet: https://goo.gl/S3xfdH
NECKLACE map on the SOOS website: http://www.soos.aq/activities/soos-at-sea/necklace
To edit the underlying spreadsheet: https://goo.gl/HP0fHL

NECKLACE: https://goo.gl/rWeJEs
Moorings: https://goo.gl/LlEHkB
SOCCOM: https://goo.gl/FhDQds
MEOP: https://goo.gl/nyFOMl
Argo: https://goo.gl/Dcm1rw

2 additional slides….

Swedish AUV Wallenberg

Timeline:
Delivery March 2018
Tests science missions (Swedish scientists but can accommodate others, please contact if interested): 2018
Missions will start in 2019. Araon Amundsen Sea 2019/2020

Dimensions:

- Length: approx. 6,5m
- Diameter: 875 mm
- Weight: 1600 - 1800 kg

Depth Ratings:

- 3000 m

Power Supply:

- 4x (max 6)Rechargeable and swappable Lithium Polymer batteries

Underwater Communications:

- HiPAP USBL
- Command Link
- Data Link

Surface Communications:

- GPS
- WiFi
- RF
- Iridium

Pay Load Sensors:

- CTD & O2 (Seabird, dual system)
- CO_2
- Nitrate
- Eco-puck (3-channel optical sensor: Cholophyll, turbidity, ++)
- General payload area, 60 cm long: 6 RS232 connectrs plus ethernet/LAN

Endurance:

- 4 Batteries
  26 hours at 4 knots
  41 hours at 3 knots

Swedish AUV (Wallenberg foundation):

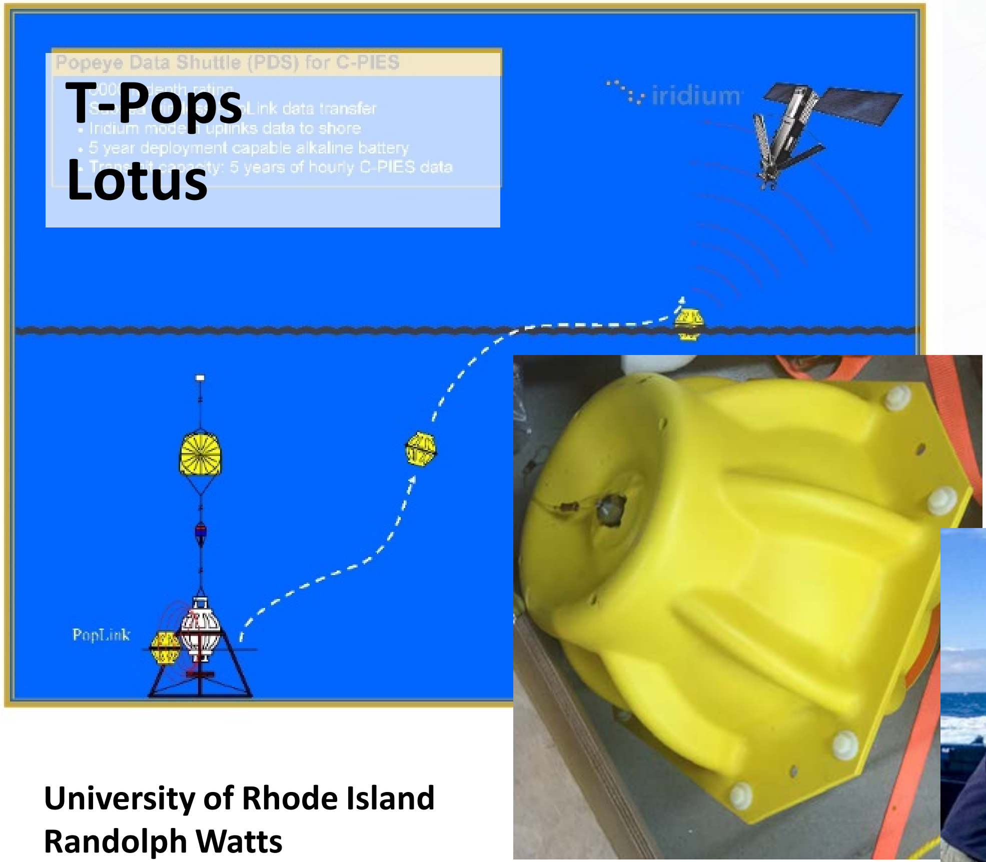
- **3000 m depth rating**
- **200 – 300 km range**
- **Navigation: UL & DL DVL (RDI 300 kHz), Honeywell HG 9900 IMU**
- **Collison avoidance: Imagenex forward looking sonar with Kongsberg algorithms for action (soft altitude changes)**
- **HiPap USBL for communiation & positioning in ship's range**

Navigation

IMU	Honeywell HG9900 NOTE: HG9900 IMU requires an export license from the United States State Department. If this license is not obtained in proper time, a Kongsberg Seatex MRU5+ IMU is offered instead.
Compass	Leica DMC
DVL	Teledyne RDI Workhorse Navigator 300 kHz or other make with similar performance.
Altimeters	Kongsberg Mesotech 200/675 kHz forward and down looking
Forward Looking Sonar/Anti-Collision System	Imagenex sonar and KM algorithms for improved contour following and obstacle avoidance
CTD	SAIV CTD
USBL	HiPAP Transponder
Depth Sensor	DigiQuartz 8CB4000
GPS Receiver	AUV: Novatel

Modes of Operation:	Estimated Navigation Error	
	Real-Time	Post-Processed
Autonomous: No updates, straight line	0.08% of DT (CEP50)	<= 0.08% of DT (CEP50)
Autonomous: GPS fix every 1-2 hrs	2-10 m	1-4 m
Autonomous: NavP UTP ranging (not included)	5 m	2 m
Supervised: HiPAP USBL updates	0.5-6 m (depending on depth and GPS accuracy)	0.5-4 m

T-Pops
Lotus



Royal Technological University (Sweden)
Jakob Kuttenkeuler
40% success rate

University of Rhode Island
Randolph Watts
Will look for company to manufacture on license
50% success rate
Bug draining batteries