

Observational gaps in the ocean and cryosphere

Mike Meredith

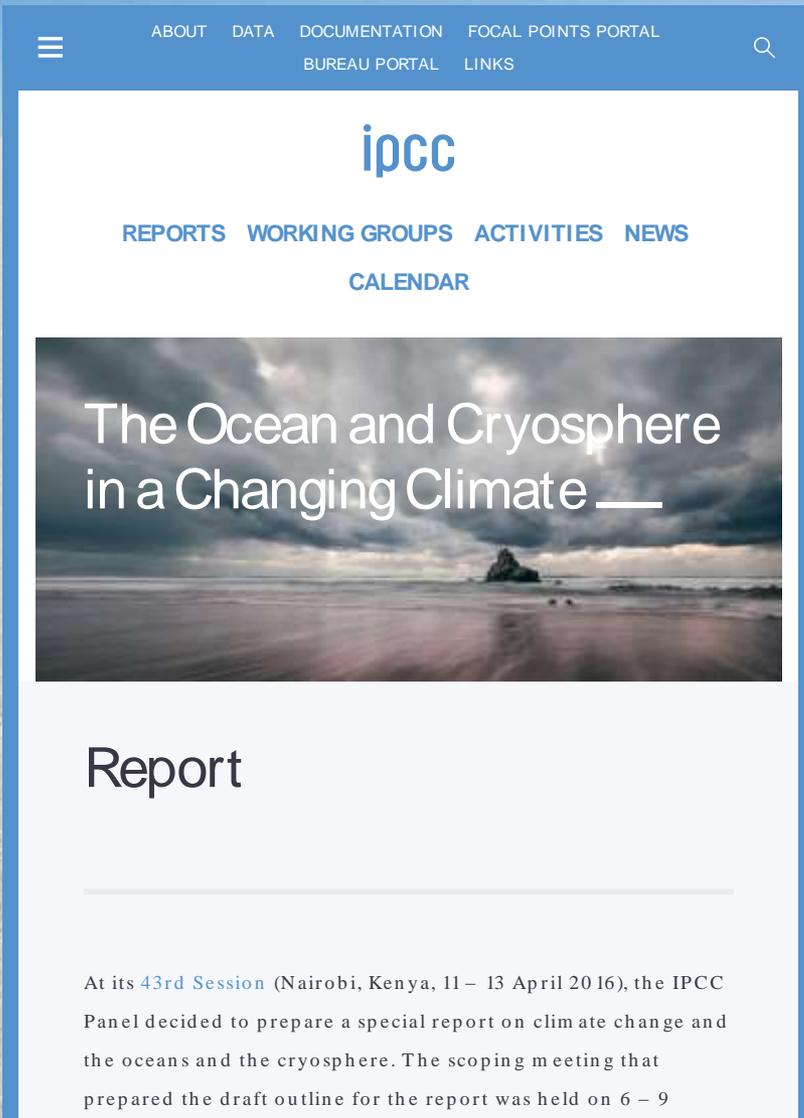
British Antarctic Survey, Cambridge, U.K.

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IPCC Special Report on the Ocean and Cryosphere in a Changing Climate

- Provide a focussed, cross-cutting assessment of:-
 - The role of the oceans and cryosphere in the climate system
 - Risks, vulnerabilities, impacts and implications
 - Resilience pathways and adaptation options
- Present new and updated information for decision-makers to inform the design and implementation of appropriate policies and actions.

<https://www.ipcc.ch/report/srocc/>



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IPCC Special Report on the Ocean and Cryosphere in a Changing Climate

Summary for Policymakers (~10 pages)

Technical Summary (~20 pages)

Chapter 1: Framing and Context of the Report (~15 pages)

Chapter 2: High Mountain Areas (~30 pages)

Chapter 3: Polar Regions (~50 pages)

Chapter 4: Sea Level Rise and Implications for Low Lying Islands, Coasts and Communities (~50 pages)

Chapter 5: Changing Ocean, Marine Ecosystems, and Dependent Communities (~65 pages)

Chapter 6: Extremes, Abrupt Changes and Managing Risks (~20 pages)

Case Studies, Frequently Asked Questions and Boxes (~20 pages throughout chapters)

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ABOUT DATA DOCUMENTATION FOCAL POINTS PORTAL
BUREAU PORTAL LINKS

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REPORTS WORKING GROUPS ACTIVITIES NEWS
CALENDAR

The Ocean and Cryosphere in a Changing Climate

Report

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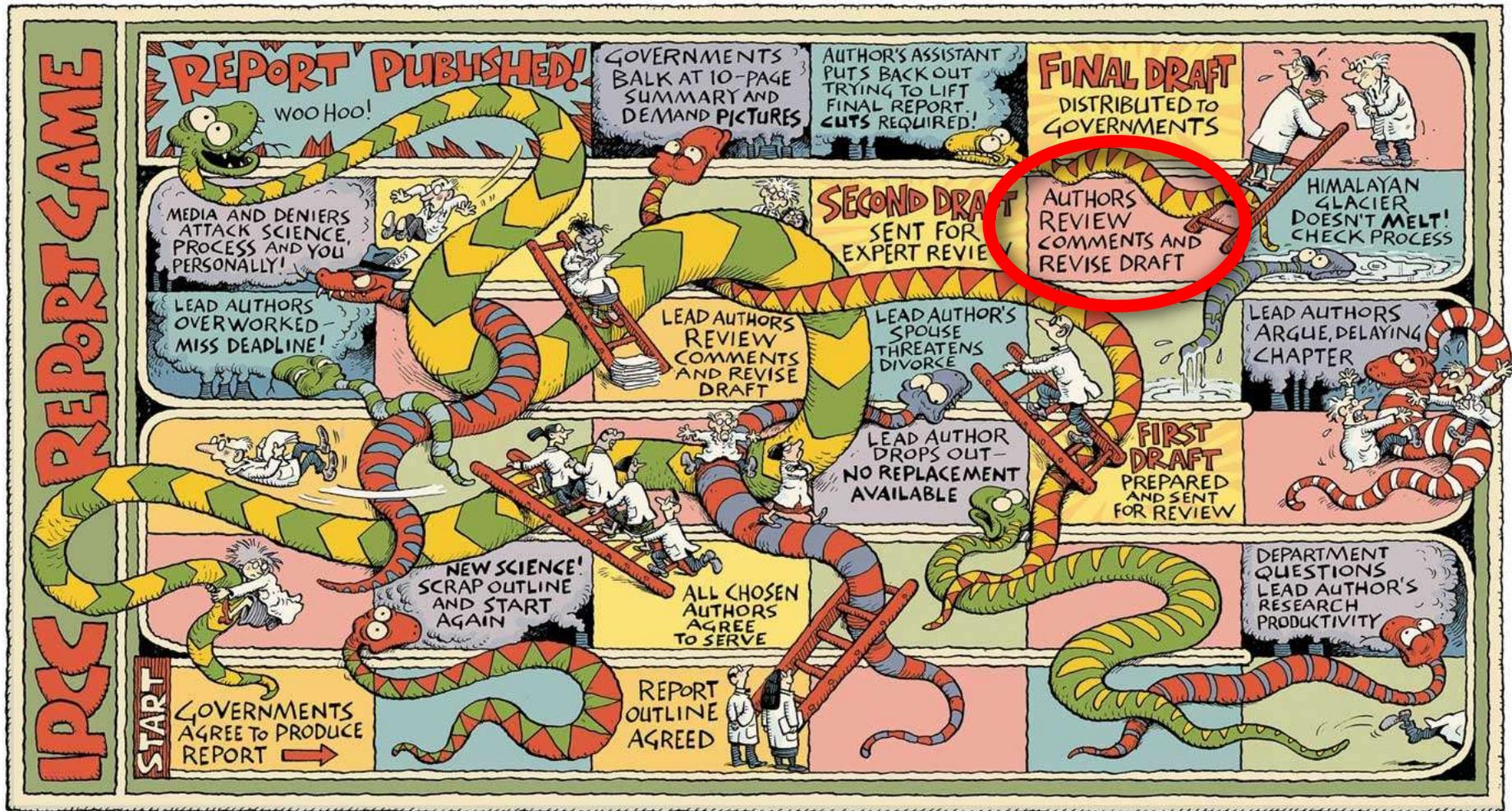
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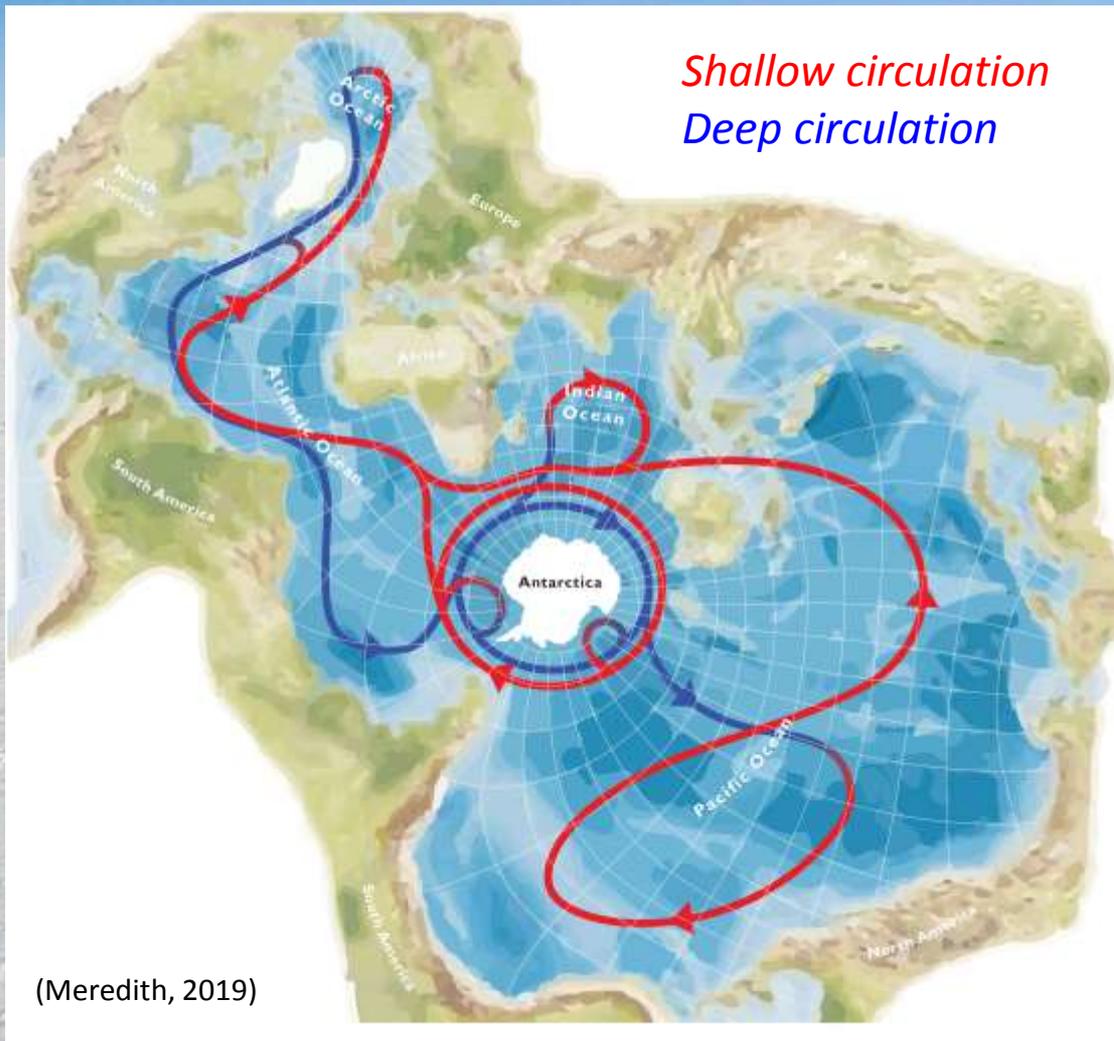
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IPCC Special Report on Ocean and Cryosphere in a Changing Climate (SROCC)



Where we are on the IPCC “Snakes and Ladders” game

Final approvals and release in **September 2019** (same week as OceanObs19);
embargoed until then.



A key starting point ...

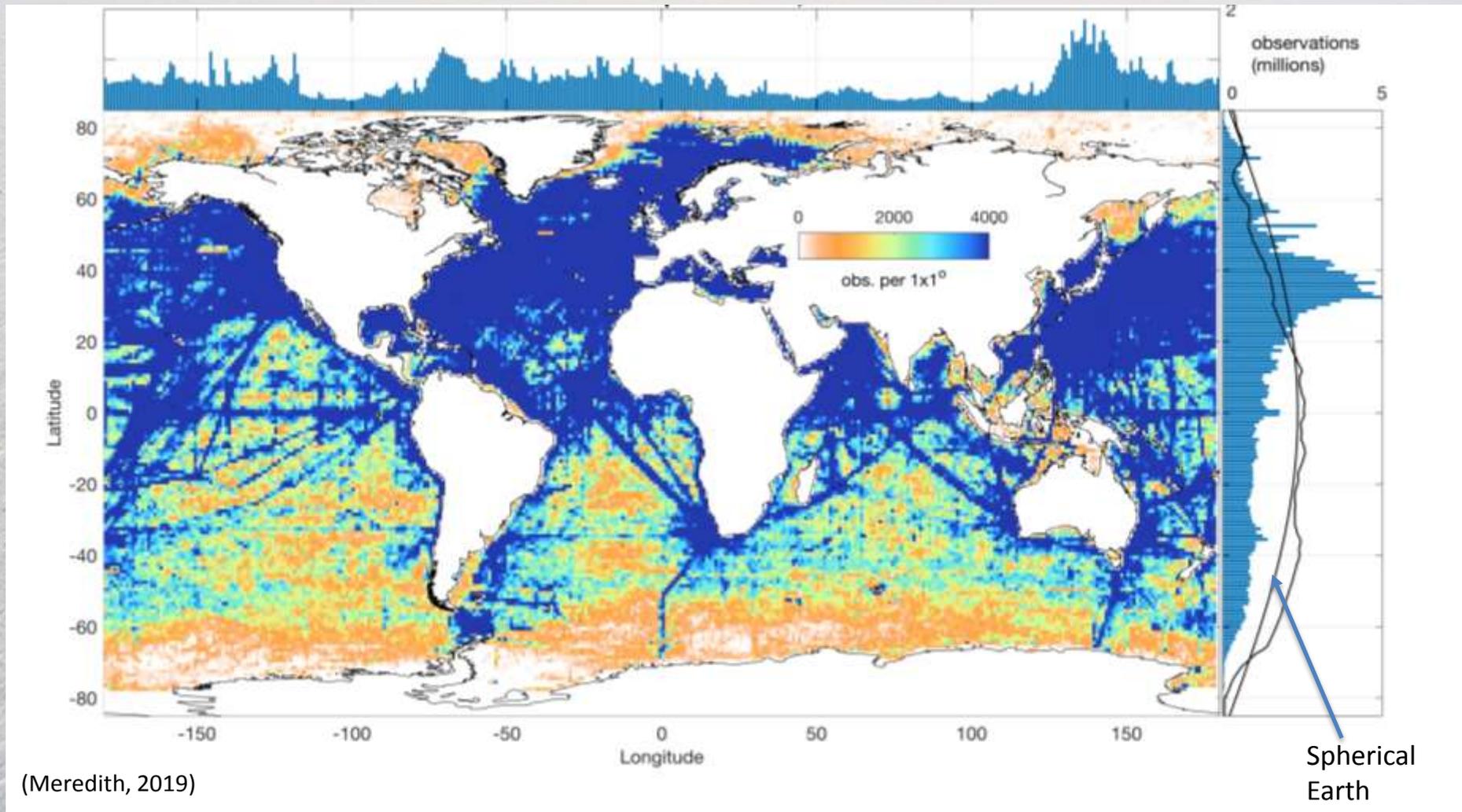
Oceans provide connectivity spanning the remotest regions of the planet.

Ocean circulation does this, and is (comparatively) well measured at the surface and arguably at 1000m depth, plus some key chokepoints (RAPID, SAMOC, etc).

(An outstanding challenge remains – to fully resolve the four-dimensional ocean circulation. How?)

Polar regions have disproportionately strong influence.

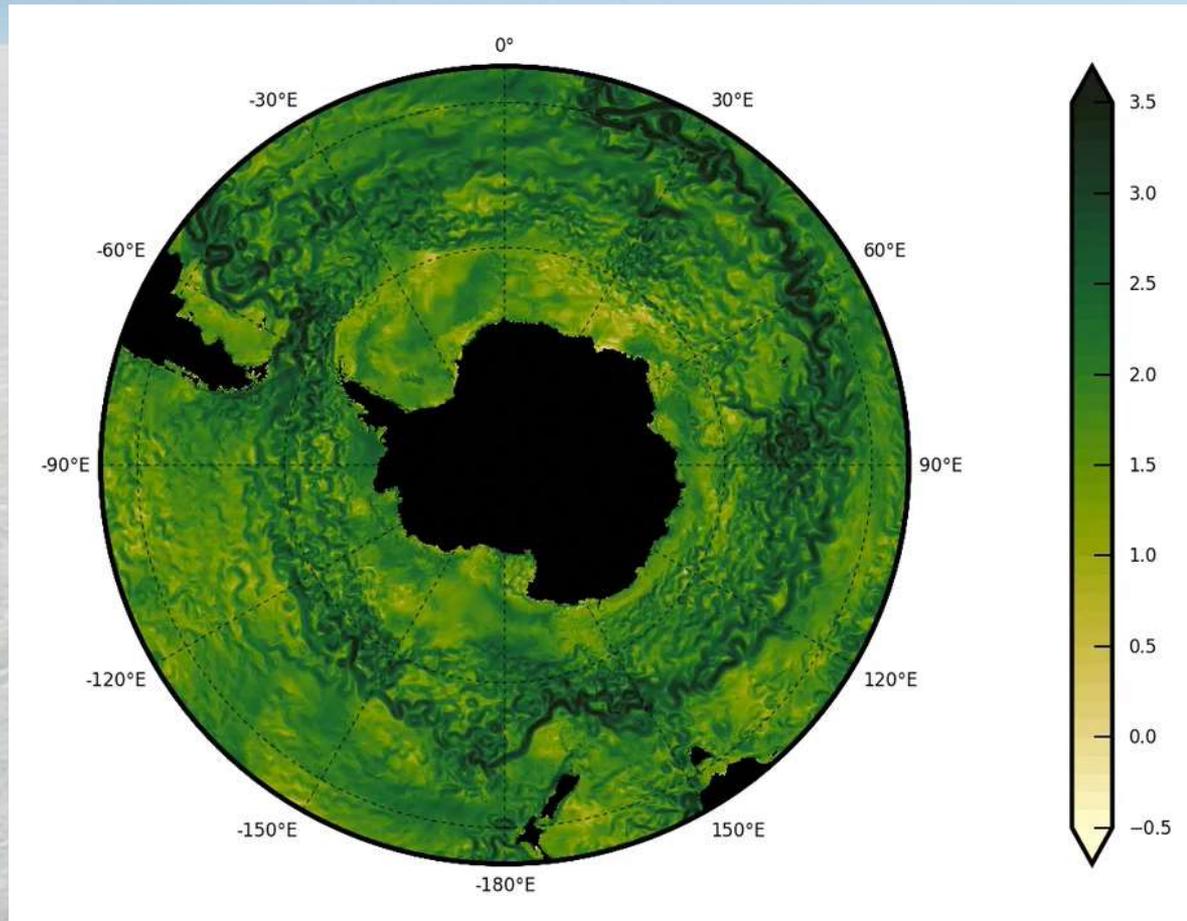
Polar regions under-represented in water column data ...



(Meredith, 2019)

(Distribution of ocean temperature measurements, 1955-2017)

Should data distribution be even?

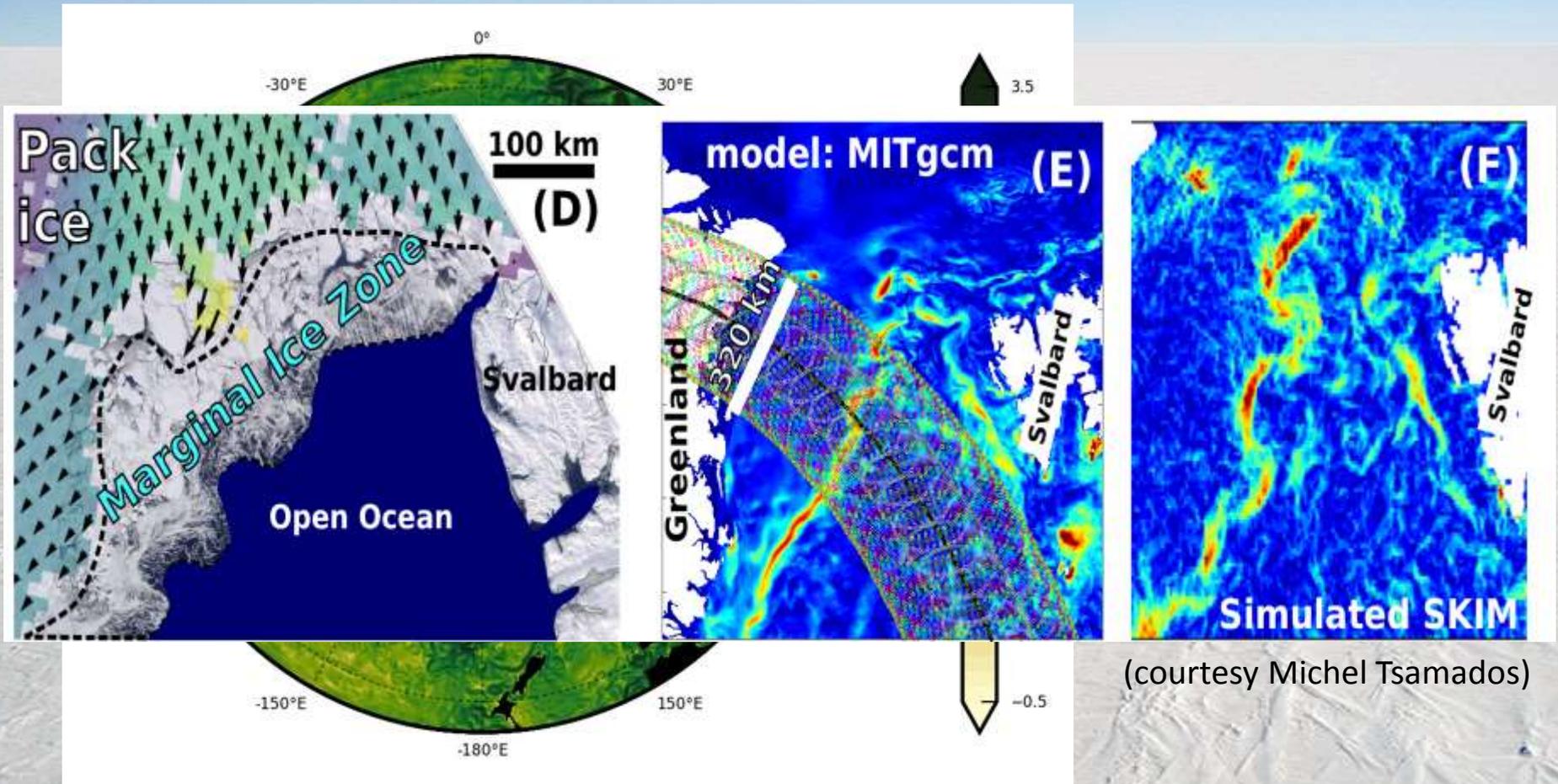


Eddy Kinetic Energy in ORCHESTRA model (courtesy Dave Munday)

Smaller scales need resolving as move towards poles (also boundary currents etc). Not easily tractable using even present satellite altimeters, which resolve only part of mesoscale field.

Next-generation altimeters (e.g. proposed ESA mission SKIM) would allow significant advances.

Should data distribution be even?

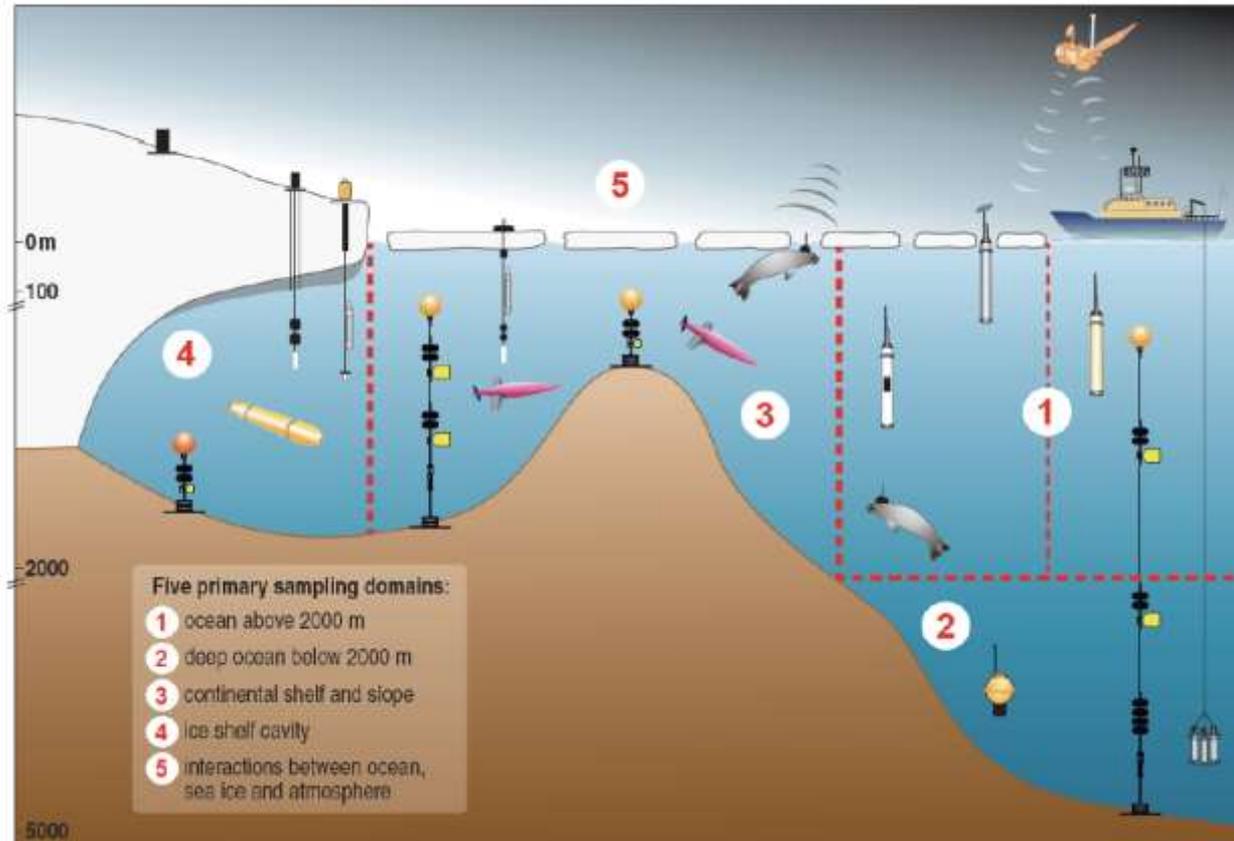


(courtesy Michel Tsamados)

Smaller scales need resolving as move towards poles. Not easily tractable using even present satellite altimeters, which resolve only part of mesoscale field.

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So there is a data problem in the Polar Oceans ...

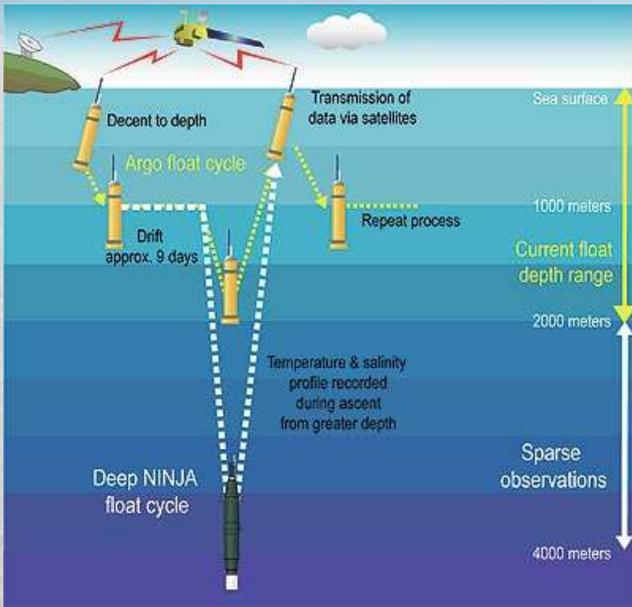


If Polar Oceans are divided into 5 sampling domains, only half of domain 1 is (arguably) sufficiently sampled.

Physical measurements still predominate (but...)

Seasonal bias still dominates for most non-physical measurements.

Enhancements to “conventional” Argo ...

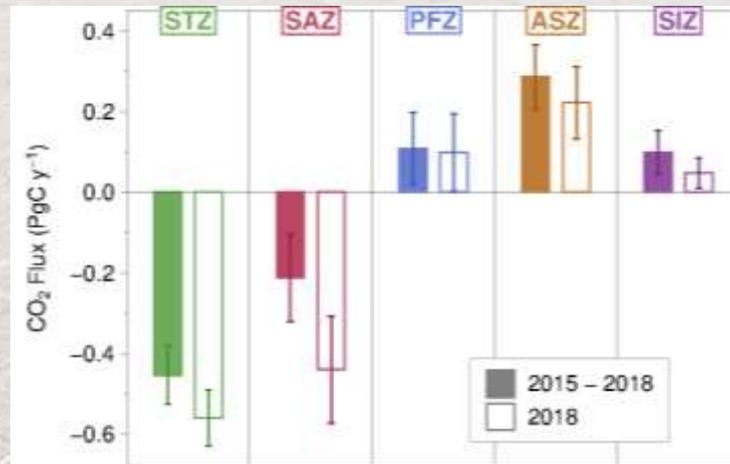
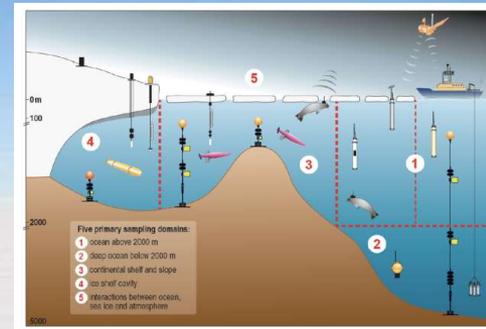


Deep Argo ...

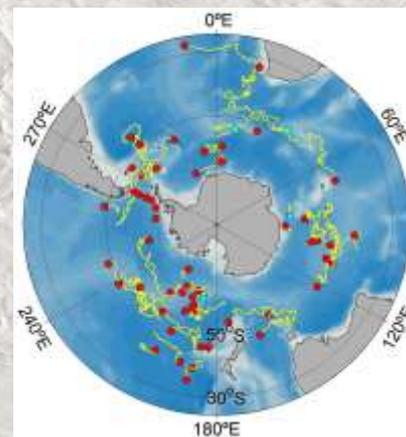
“Argo 2025” design is for 4700 floats

- 2500 conventional core floats
- 1200 deep floats
- 1000 biogeochemical floats

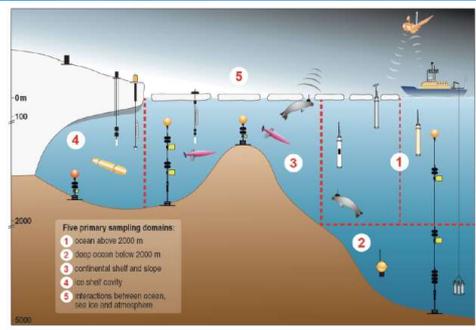
Cost will be ~3x current cost; need strategy for funding and sustaining.



(e.g. Gray et al. 2018)



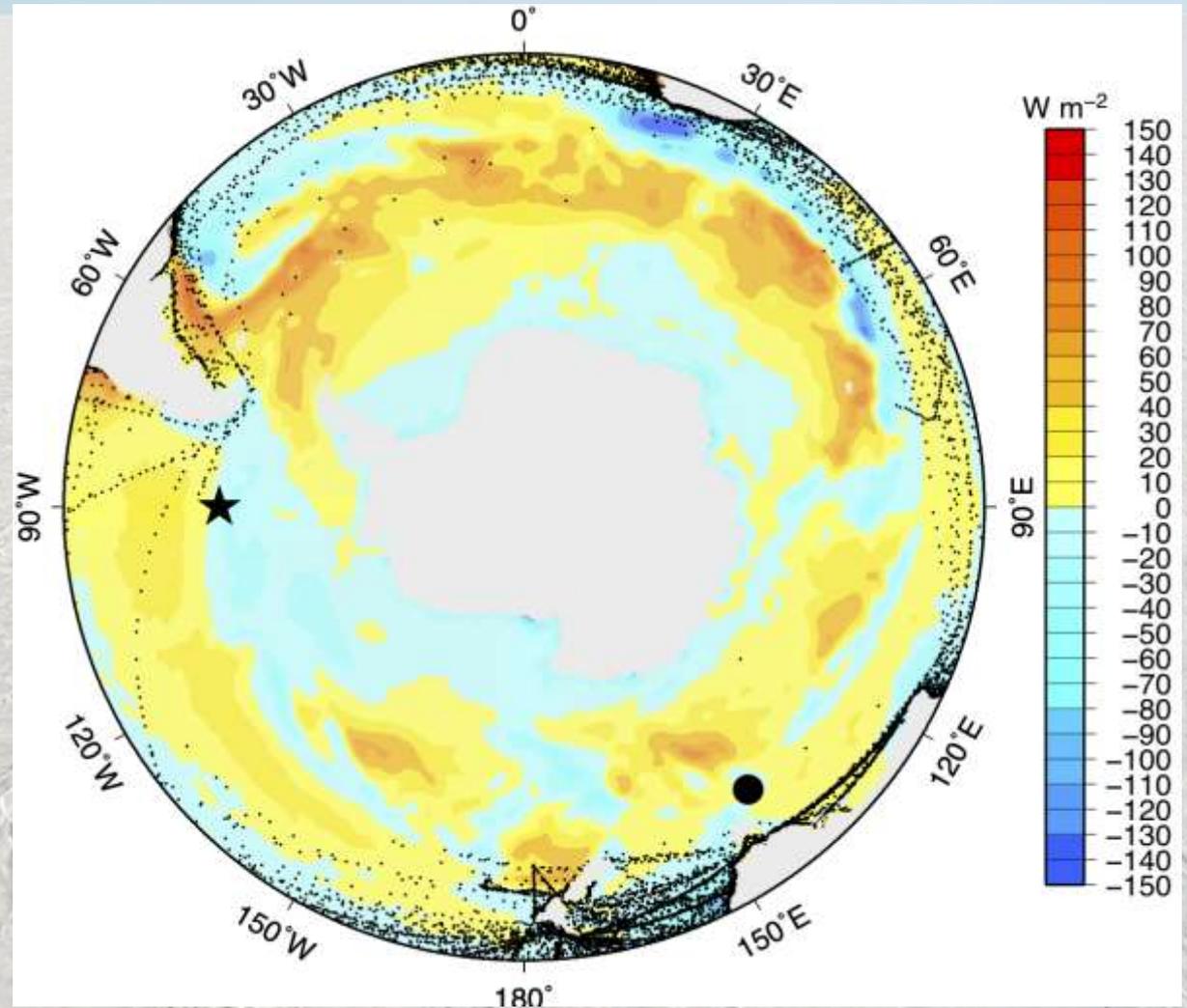
Biogeochemical sensors on large float arrays



Heat flux from ERA-Interim, and data used as constraints.

Surface fluxes – key variables, but poorly constrained over high latitude oceans

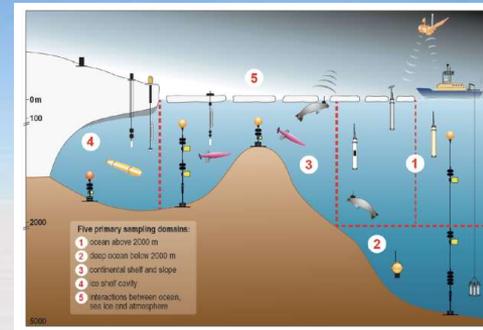
Coverage is especially poor in seasonally and perennially ice-covered regions, although these are some of the key areas (deep ocean ventilation etc)



(courtesy Sarah Gille)

Sub-ice shelf measurements are critical

“Conventional” access by hot water drilling



Sampling the boundary layer

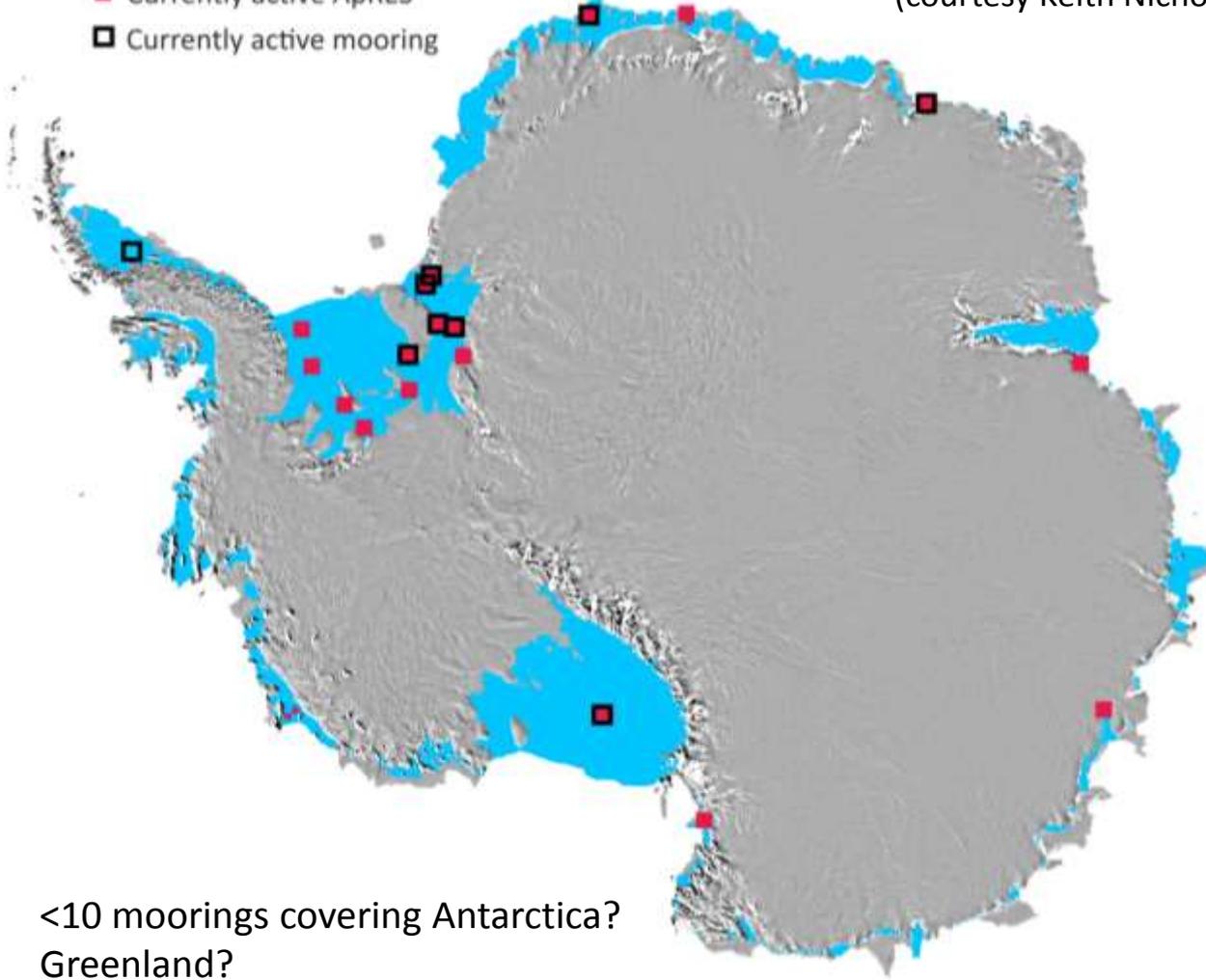


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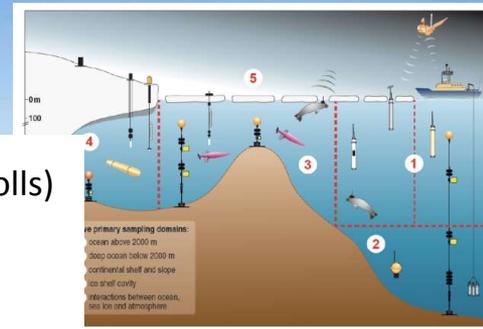
“C

- Currently active ApRES
- Currently active mooring

(courtesy Keith Nicholls)



<10 moorings covering Antarctica?
Greenland?

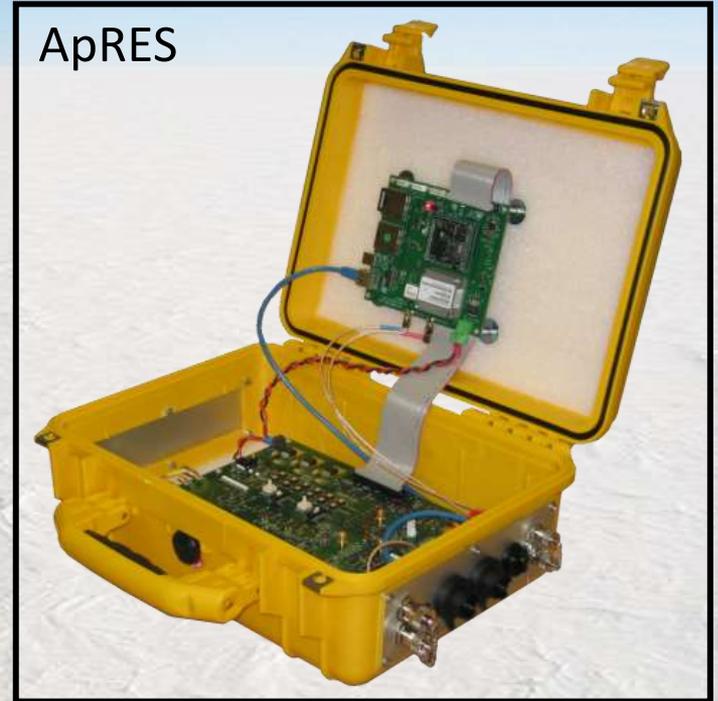


Innovative observations for ice/ocean interactions

AUVs



ApRES



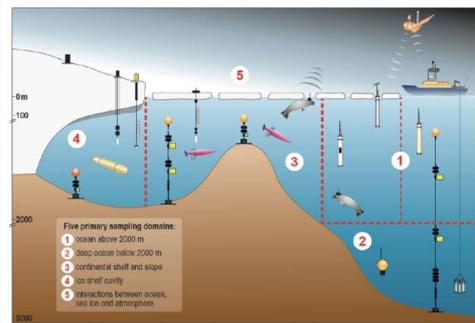
Tagging of mammals

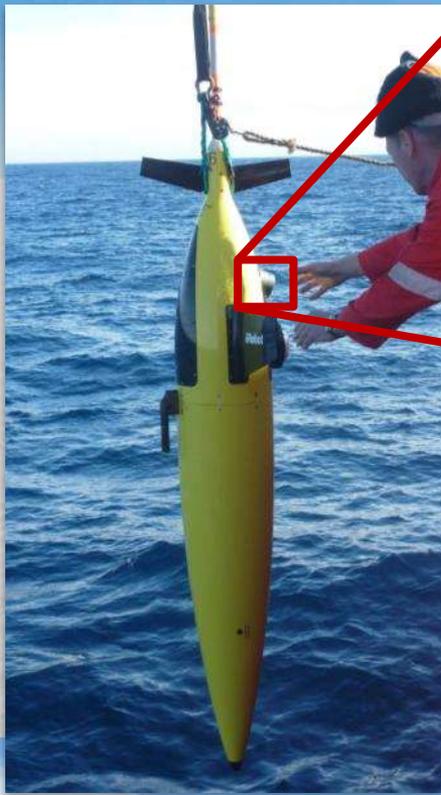


... are required to track changes in the ocean forcing on the ice sheets, also ice shelf response.

Ice shelves buttress the ice sheet, and control glacier flow and discharge.

How to sustain?





Argo array has changed our view of the physical upper ocean, and is beginning to do the same for (some) biogeochemistry...

Other/smarter autonomous vehicles are now maturing, and can carry advanced non-physical sensors e.g. acoustics for zooplankton biomass.

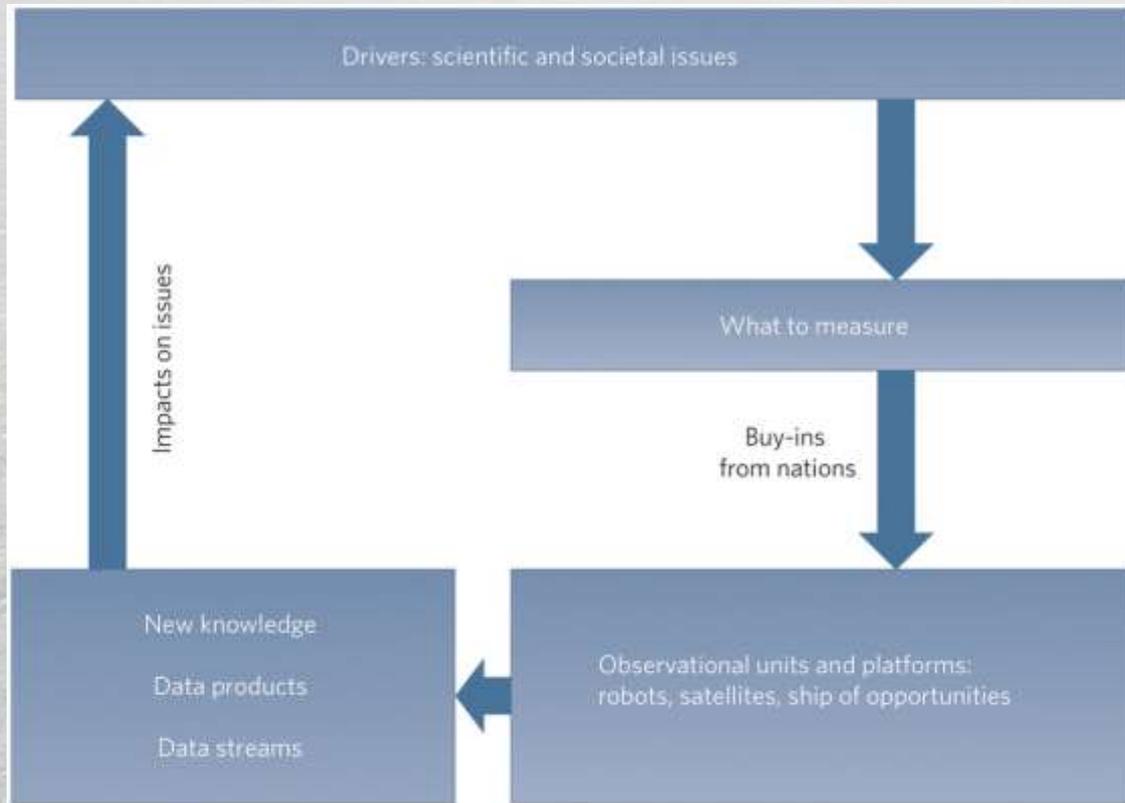
Swarms of such vehicles under ML/AI control could be central to future sustained ocean monitoring.

Surface vehicles to address dearth of flux data, especially high latitudes.

Requires strong international cooperation/coordination, exceeding that even of Argo. Possible?

Priorities are to make vehicles and sensors full-depth, year-round, ice-capable and smart.

How to sustain...?

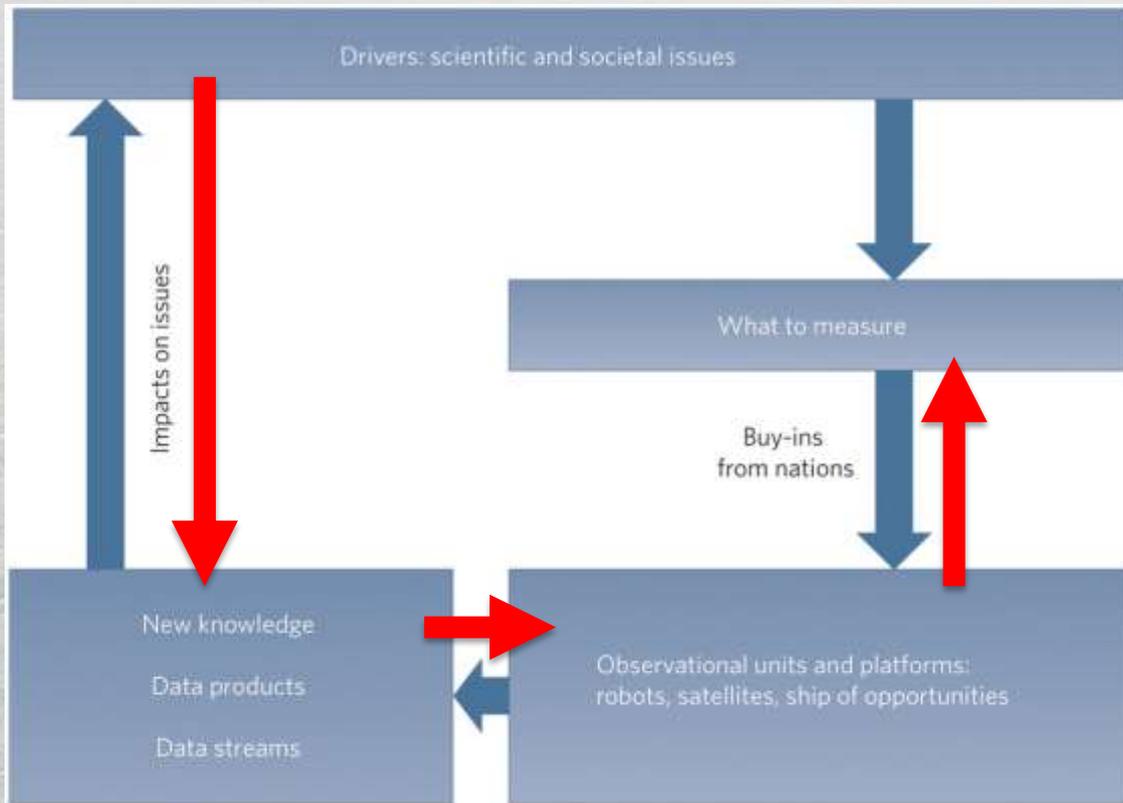


“Scientific and societal issues determine variables to measure, attracting investment from nations through their research institutions. The outcome of the observations, that is, data, products and new knowledge, inform both existing and new issues, and a feedback loop that keeps the observation system 'fit for purpose'.”

- Cai et al., *Nature Climate Change*, 2015

- True, but reflects the scientists' perspective ...
- “Owners/end-users” have a near-reverse feedback loop
- Difference between “useful”, “useable”, and “used”

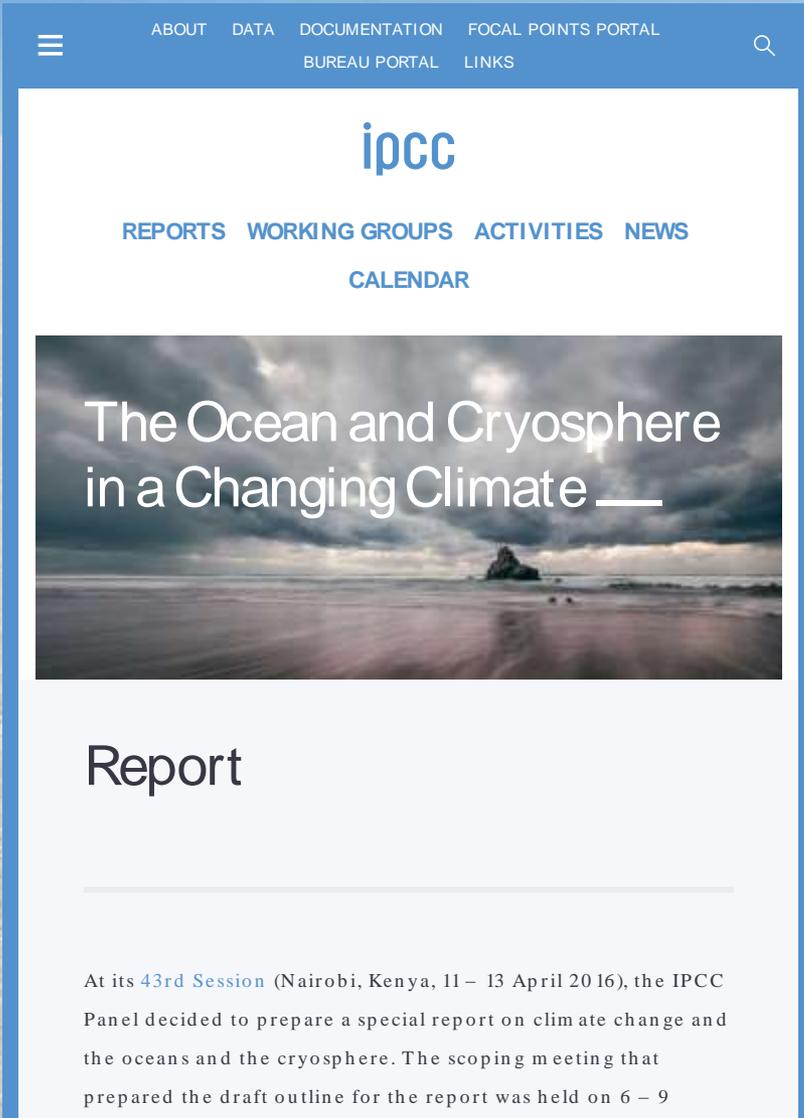
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The hope is that SROCC (about which I have told you nothing) contributes toward making the case for sustained observations of the ocean/cryosphere, by delivering an integrated assessment of current knowledge (and gaps) to policymakers, to inform on the choices they can make.

To be published **September 2019...**

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