SOCCOM

Southern Ocean Carbon and Climate Observations and Modeling

The grand challenge

Scientific rationale: the role of the Southern Ocean in carbon and climate

The Southern Ocean south of 30°S accounts for

- Nutrients supporting three-quarters of biological production north of 30°S
- Half of the current anthropogenic carbon dioxide uptake by the oceans (43 ± 3% in CMIP5 models)
- About 75% ± 22% of excess heat uptake by the oceans (in CMIP5 models)
- Closure of the meridional overturning circulation

Model simulations suggest

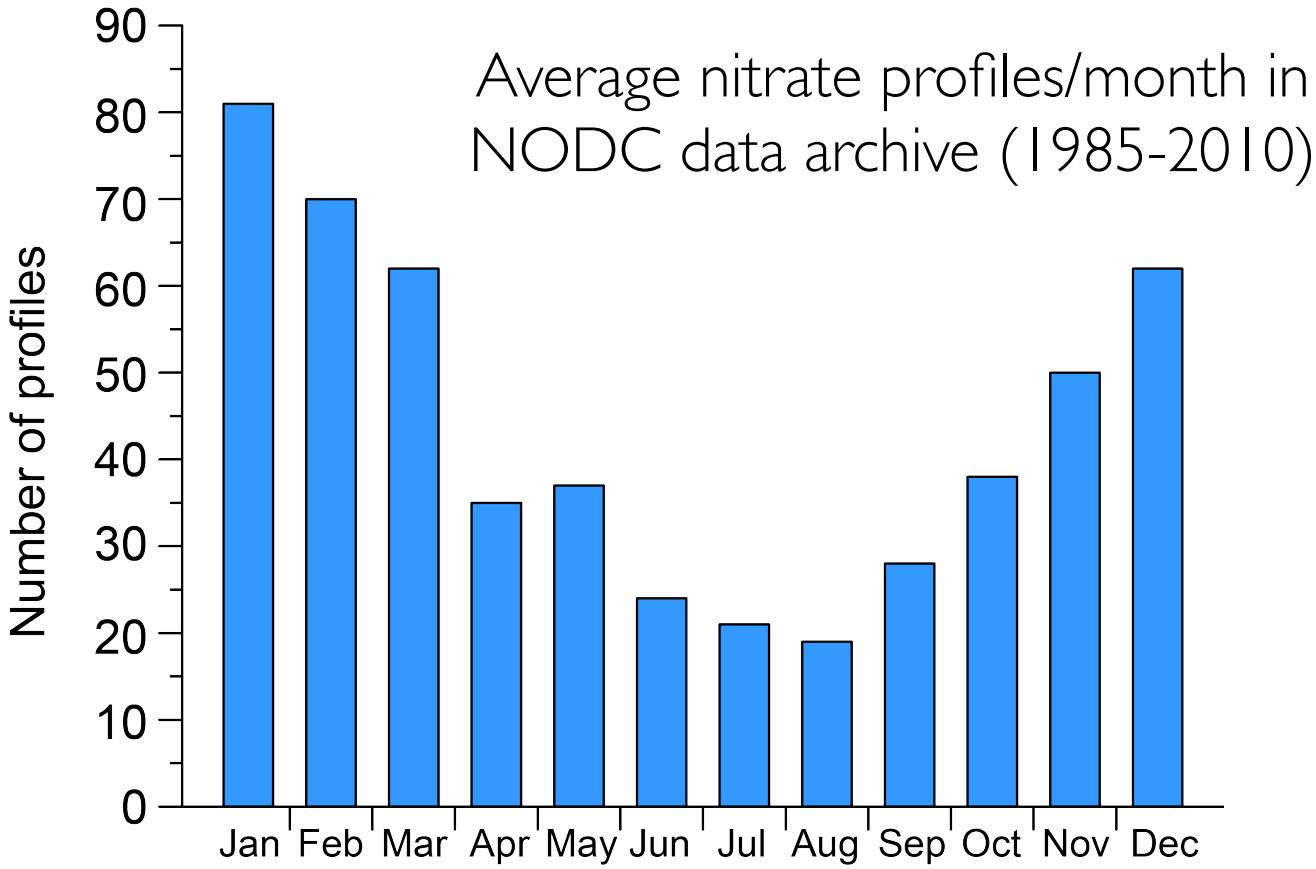
- Aragonite will undersaturate in ~16 years (2030)
- Major changes in Southern Ocean circulation and mixing may occur in response to climate change

The grand challenge

- Despite its critical importance, the Southern Ocean is the least understood region of the world ocean.
  - The overturning circulation is highly uncertain
  - Eddy fluxes are poorly quantified.
  - Current climate models are unable to resolve eddies (recent eddy rich exceptions at GFDL & NCAR)

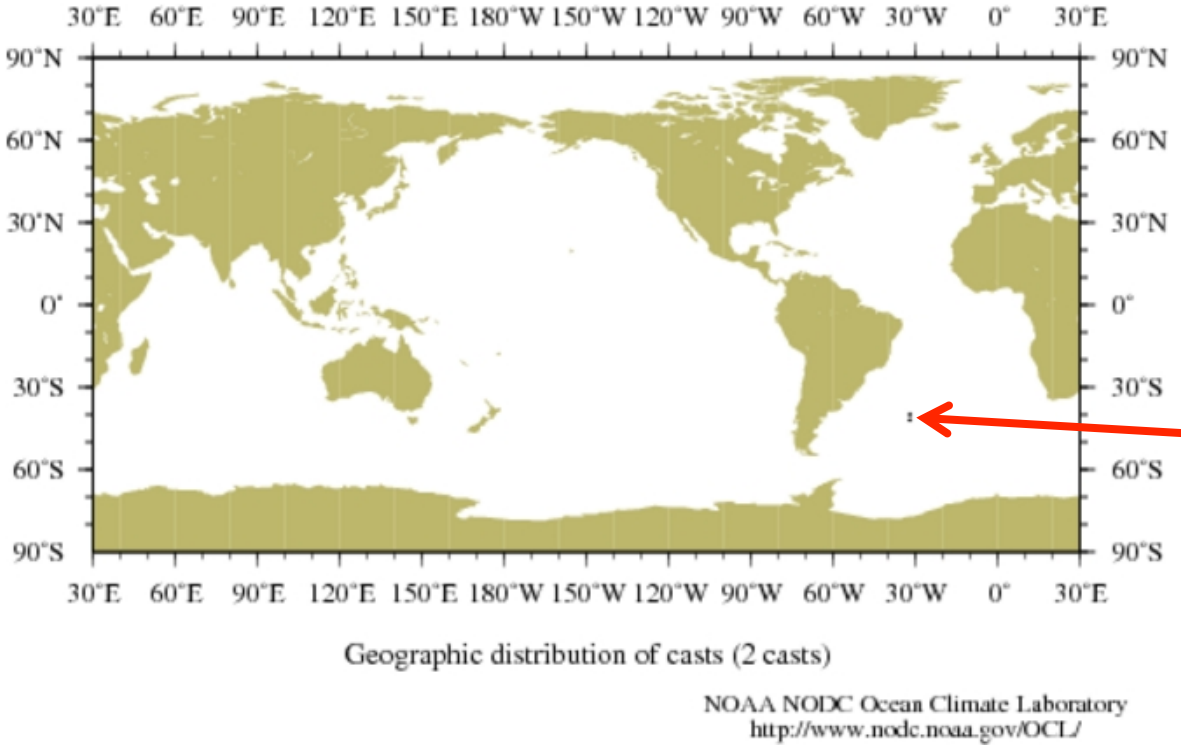
- And yet
  - It is the least observed region of the world ocean
  - We are sorely lacking in experts on the Southern Ocean
  - The public is largely unaware of the importance of this region

Nutrient profiles south of 30°S



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).

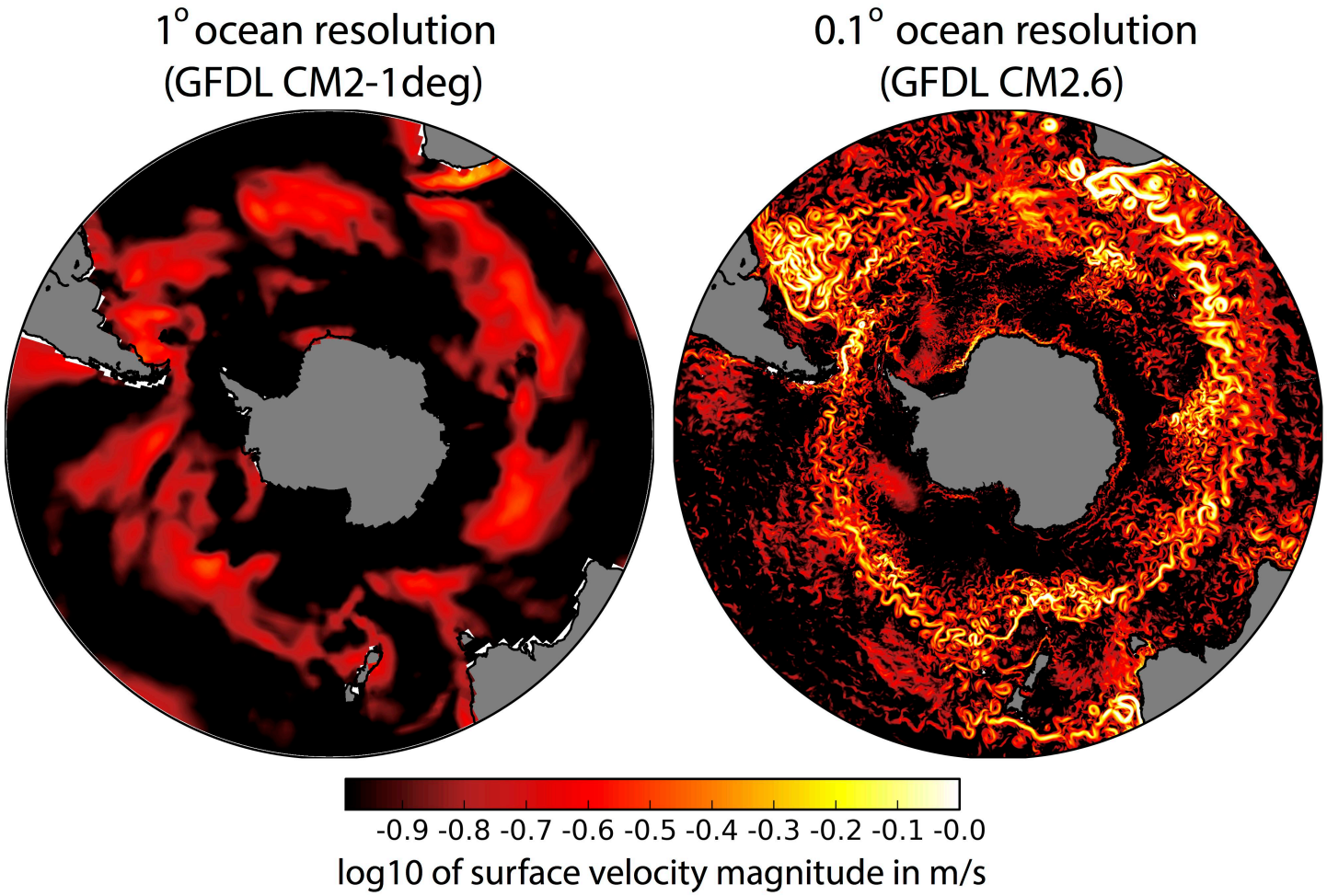


For 1990 – 2014 there are **only 2 pH profiles** found South of 40°S in the database for the Austral Winter (June 21- Sep 22).

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

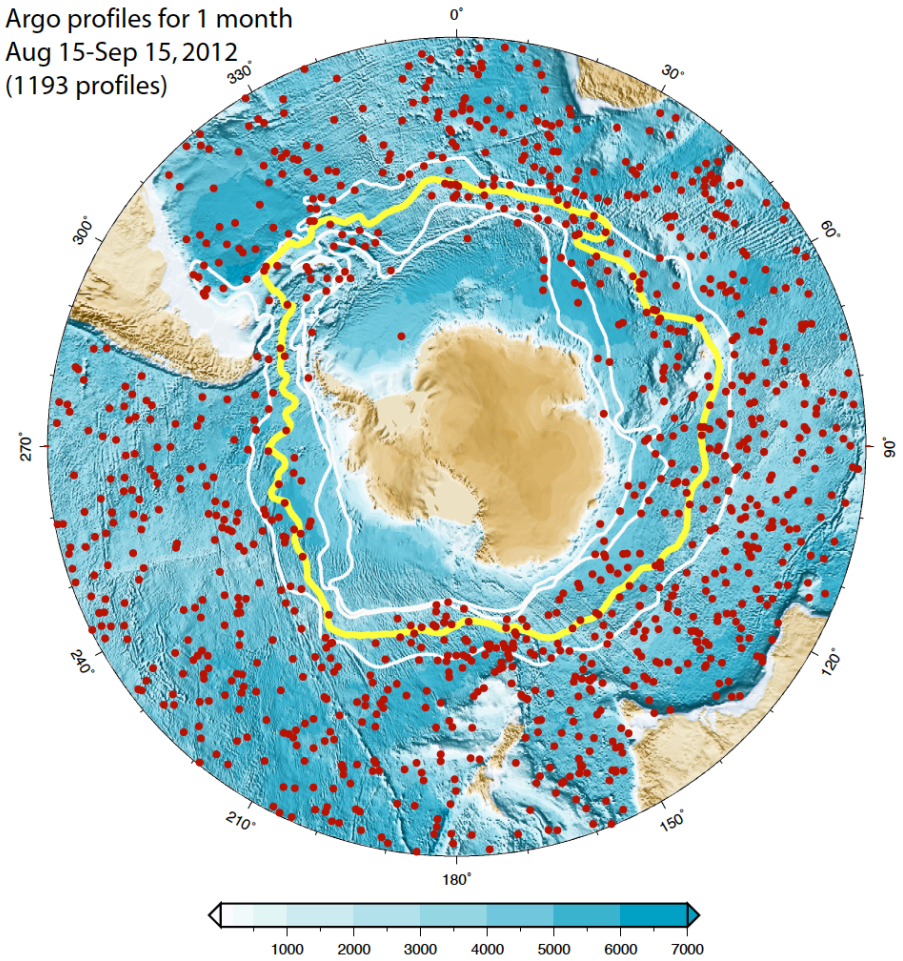
Current IPCC class climate models have 1° horizontal resolution



Morrison (pers. comm.)

The opportunity

(1) A paradigm shift – Transformative observing system



- Argo floats (currently measuring only temperature & salinity)
- New sensors for pH, nitrate, oxygen, and optics

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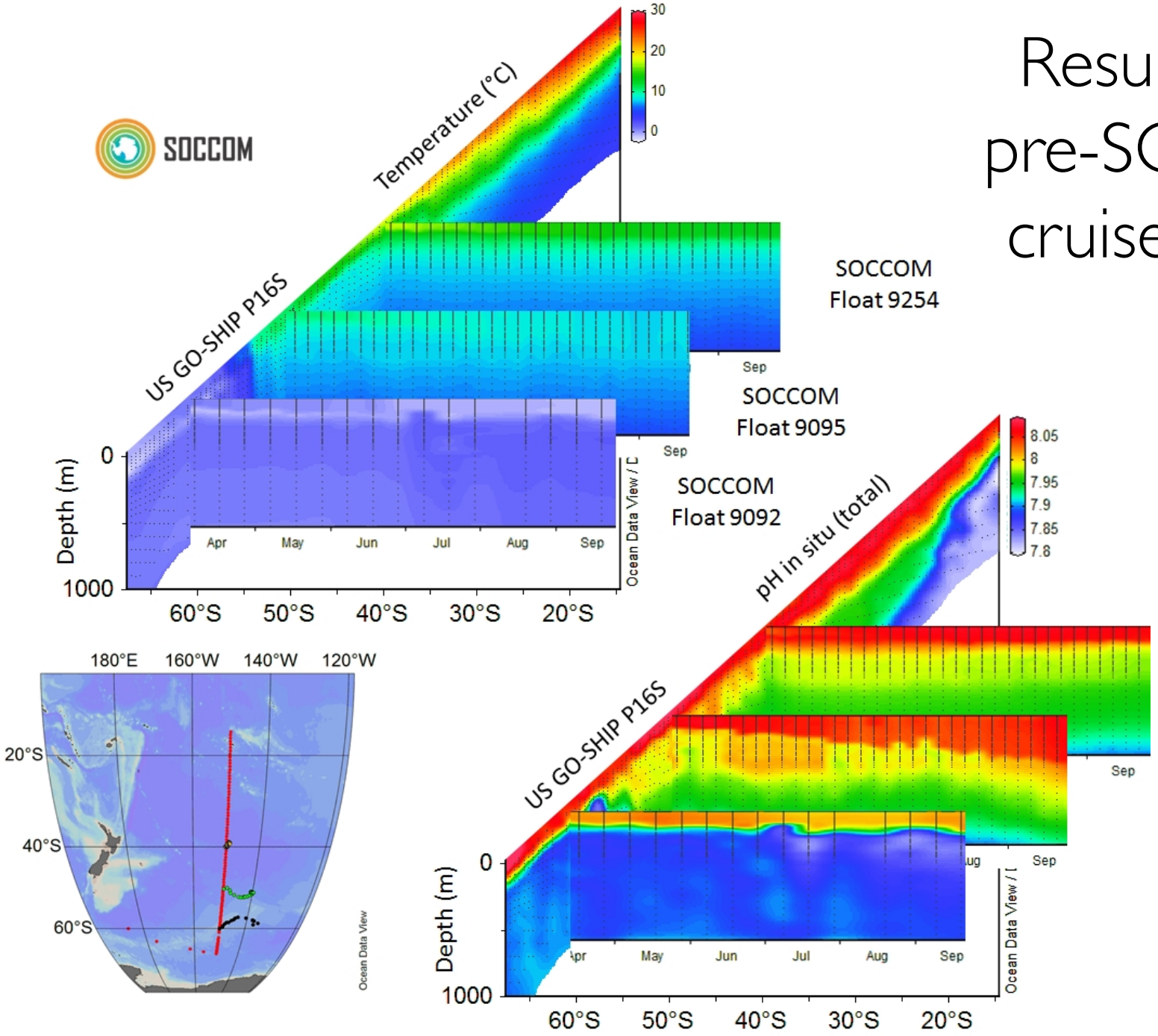
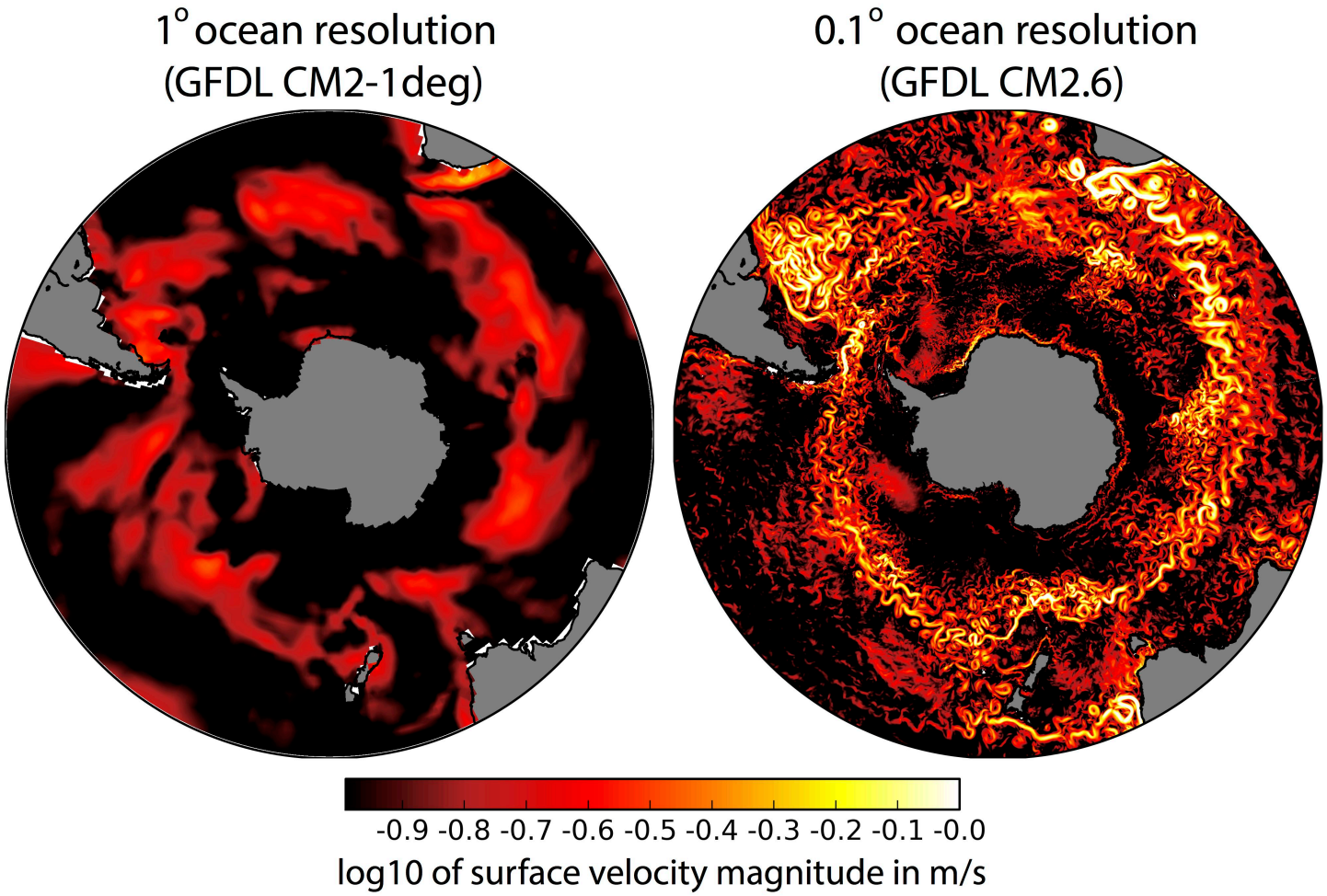
Results from pre-SOCCOM cruise (2014)

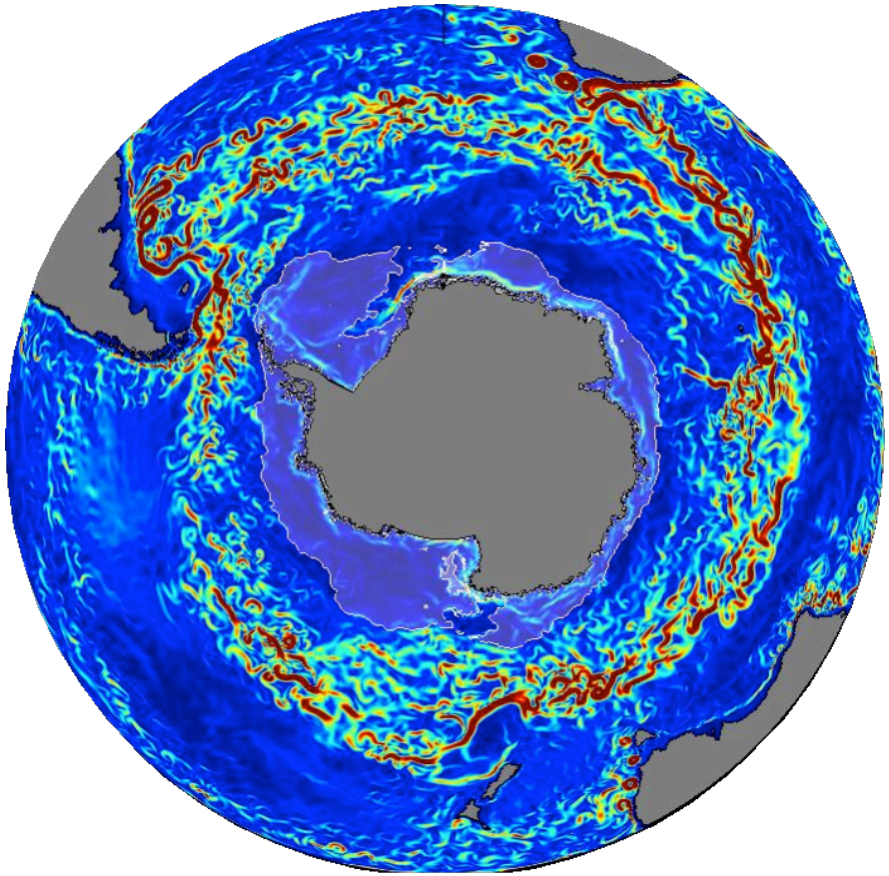


(2) Eddy rich-high resolution climate models



Morrison (pers. comm.)

(3) Transformative analysis methods



- Southern Ocean State Estimation using data assimilation to produce full 4D estimates of ocean properties

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What is SOCCOM?

Research goals

- Quantify and understand the role of all regions of the Southern Ocean in carbon cycling, acidification, nutrient cycling, and heat uptake, on seasonal, interannual, and longer time scales.
- Develop the scientific basis for projecting the contribution of the Southern Ocean to the future trajectory of carbon, acidification, nutrient cycling, and heat uptake.

Our mission

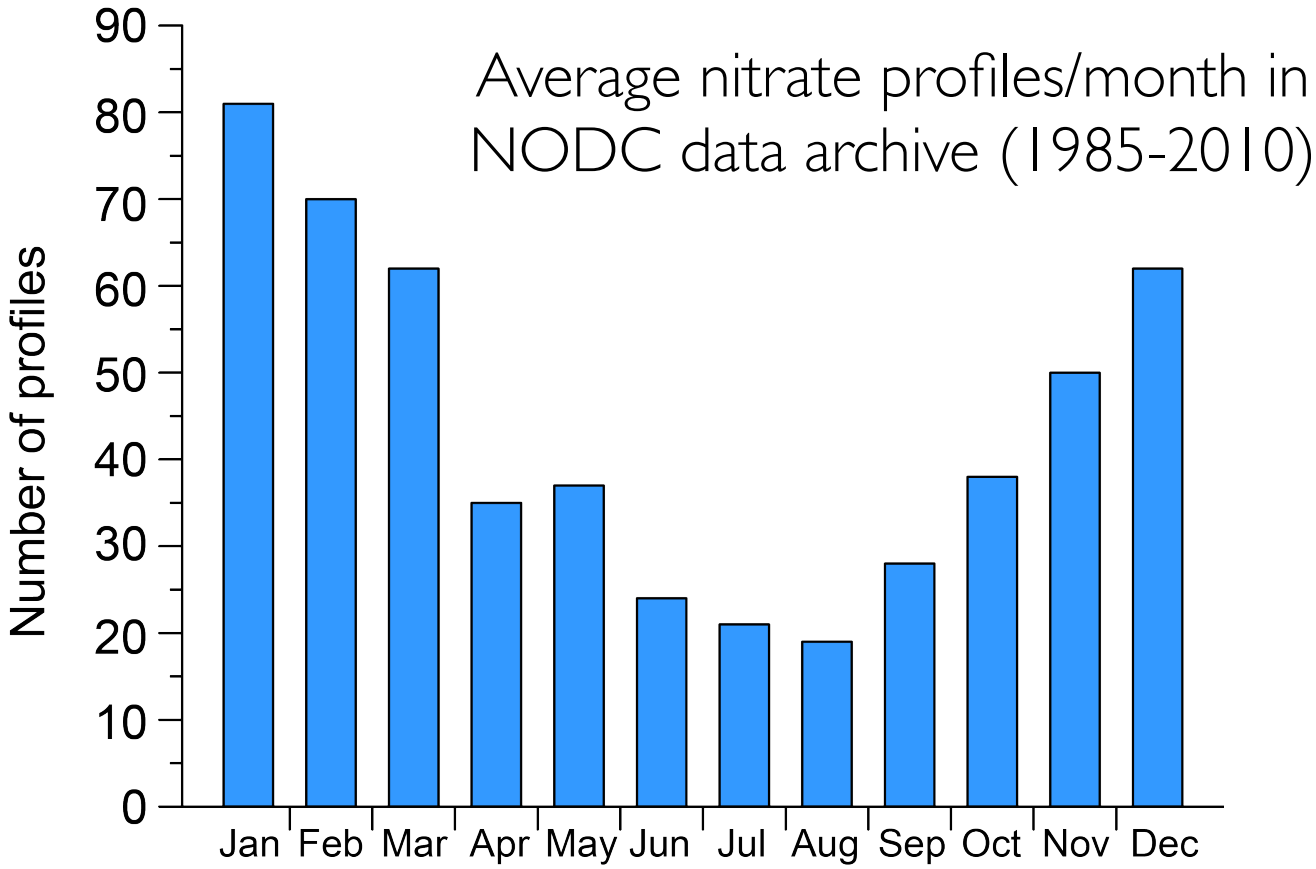
To pursue our vision we have brought together a multi-institutional, trans-disciplinary team organized along three overarching themes:

- innovative and sustained *observations* of the carbon cycle — Theme I
- eddy rich high resolution Earth System Models — Theme II
- a comprehensive *outreach* program — Broader Impacts

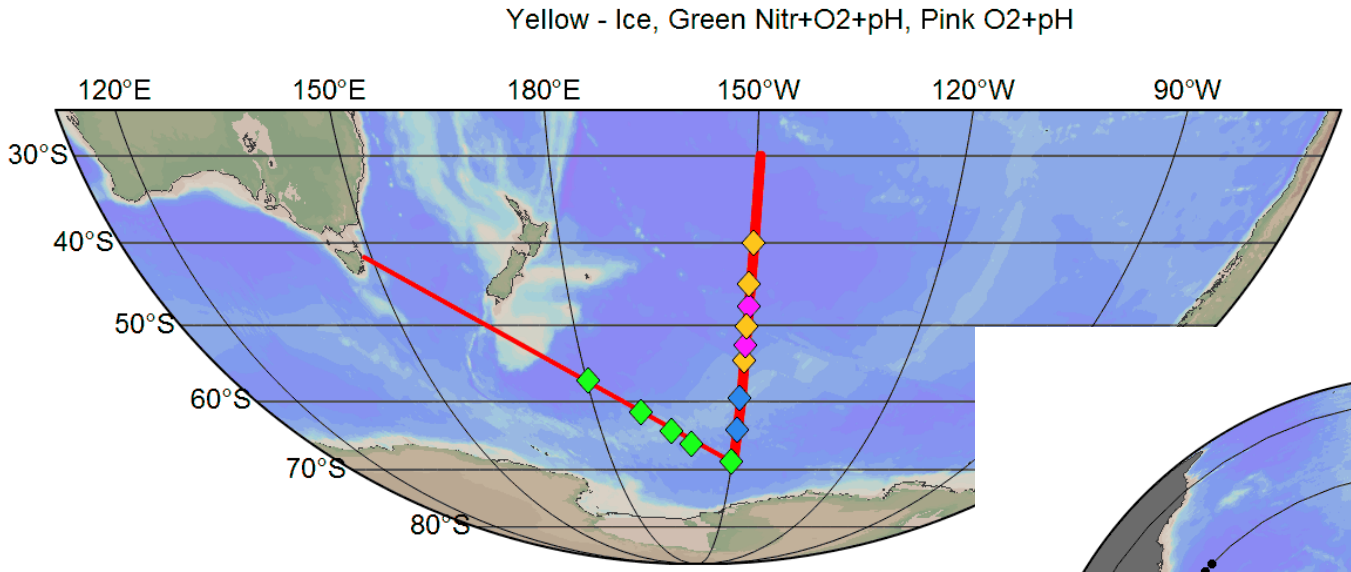
Research Objectives

- **Objective 1: (Theme 1):** To develop a new observing system for carbon, nutrients, and oxygen based on ~200 biogeochem floats
- **Objective 2: (Theme 1, Theme 2):** To produce an unprecedented 3-dimensional space and time resolved estimate of Southern Ocean biogeochemistry based on SOSE
- **Objective 3: (Theme 2):** To create new assessment tools for high-resolution and Earth System Model simulations.
- **Objective 4: (Theme 2):** To encourage the climate modeling community to use the newly created assessment tools by developing a protocol for an international, model intercomparison program (SOMIP).
- **Objective 5: (Theme 1, Theme 2):** To promote the development of improved parameterizations for the next generation of climate models.

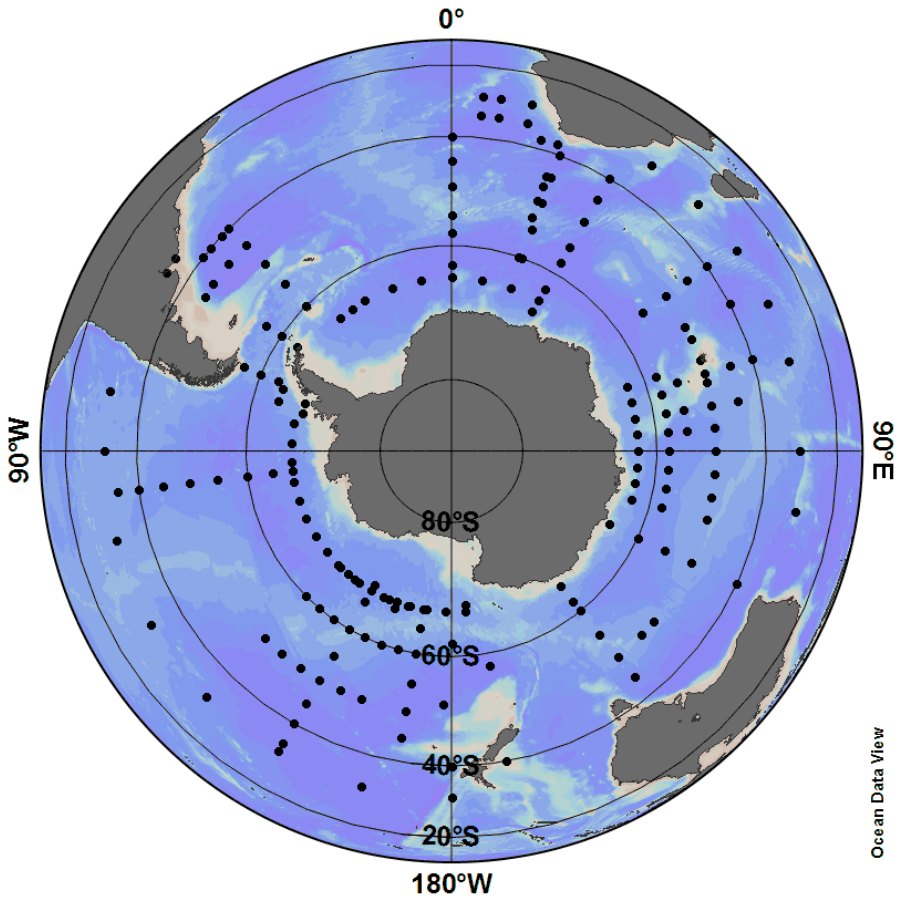
Nutrient profiles south of 30°S



Pre-SOCCOM BGC floats deployed



SOCCOM array will be circum-polar. Deployments will depend on collaborative cruise opportunities. Coordinated by Lynne Talley, SIO.



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SOCCOM Directorate

Director
Jorge Sarmiento, Princeton

Associate Director
Ken Johnson, MBARI

Project Manager
Roberta Hotinski, Princeton

Executive Board

	Theme I Observations	Theme II Modeling	Broader Impacts
Lead	Lynne Talley, UCSD	Joellen Russell U. Arizona	Heidi Cullen, Climate Central
Co-Lead	Steve Riser, U. Washington		

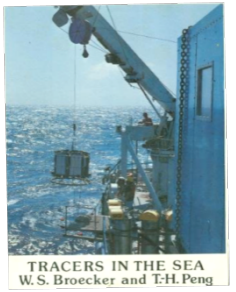
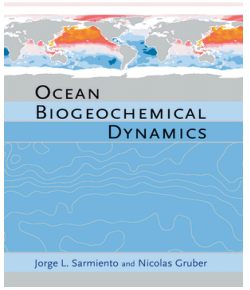
Foreign Advisory Committee

Name	Organization
Steve Rintoul (chair)	CSIRO/Australia
I. Ansorge	U. Of Cape Town, South Africa
H. Claustre	LOV, France
N. Gruber	ETH, Switzerland
A. Körtzinger	IFM-GEOMAR, Germany
M. Meredith	BAS, United Kingdom
A. Piola	UBA, Argentina
O. Pizarro	U. Concepción, Chile
P. Sutton	NIWA, New Zealand

Sources of support

Agency	Program manager	Contribution
NSF/PLR	Peter Milne	Core support ($3.5M/yr)
NOAA/CPO	Stephen Piotrowicz	50% of Argo equivalent floats
NOAA/GFDL	(V. Ramaswamy)	Mesoscale eddying coupled climate model simulations
NASA	Paula Bontempi	Optical sensors for Argo floats

Vision is compelling, ambitious, and complex

Decade	Program		
1970s	GEOSECS	2-D	
1990s	JGOFS and WOCE	3-D	
2010s	Biogeochem-Argo	4-D	?

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