DIMES Summary

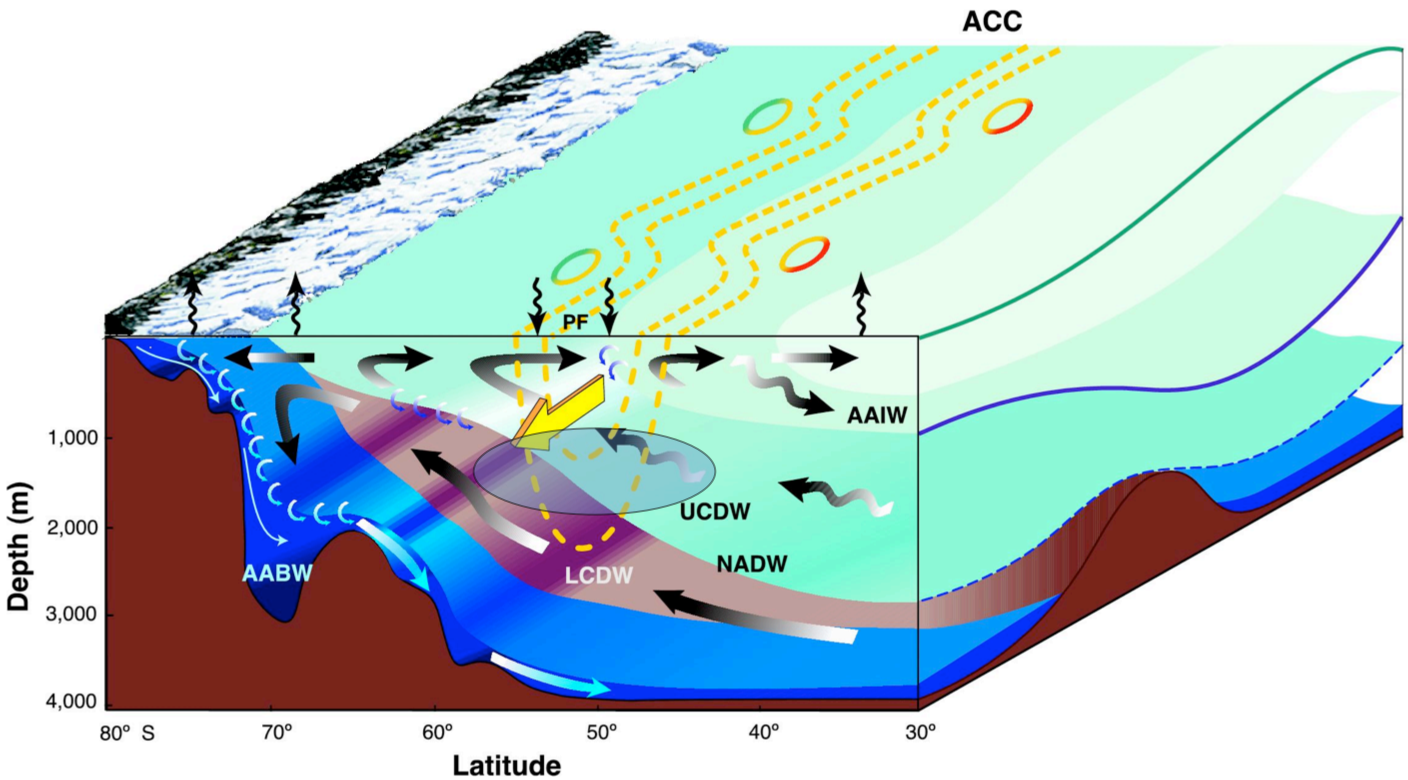
Baylor Fox-Kemper (not a PI)

On behalf of DIMES team

With Input from Gille, Speer, Ledwell, & Ferrari

DIMES: Diapycnal and Isopycnal Mixing Experiment in the Southern Ocean

- A US + UK experiment
- Diapycnal diffusion and isopycnal dispersion and eddy fluxes
- Improve eddy parameterizations in models of the MOC for climate variability



Insititutions:

WHOI

MIT

FSU

SIO

APL/UW

UEA

BAS

NOC Southampton

SAMS (Scotland)

UIO (Norway)

http://dimes.ucsd.edu/

DIMES Investigators

John Toole, Lou St. Laurent, Rick Krishfield, Ken Decoteau, Dave Wellwood, on Fine and Microstructure

Breck Owens, Kevin Speer, Nico Wienders, Peter Lazarevich, Sarah Gille, Marina Frants, Joe LaCasce, Raf Ferrari, John Taylor, John Marshall, on RAFOS Floats and isopycnal eddy transport.

James Girton, Byron Kilbourne, Andreas Thurnherr, Angel Angulo, Xinfeng Liang, Tim Duda, Luc Rainville, on fine-structure with EM-APEX, LADCP, Shearmeters

Alberto Naveira Garabato, Mike Meredith, Nathan Cunningham, Harry Bryden, Mark Inall, Brian King, David Smeed, Katy Sheen, Alex Brearley, Emily Shuckburgh, JB Sallee, Dave Stevens, Martin Wadley, Karen Heywood on Hydrography, Energy Transport to Mixing, Isopycnal Stirring.

Andy Watson, Marie-Jose Messias on Mixing and Stirring from the Tracer

Funding and Support from:

NSF

NERC

BAS

Ships*:*

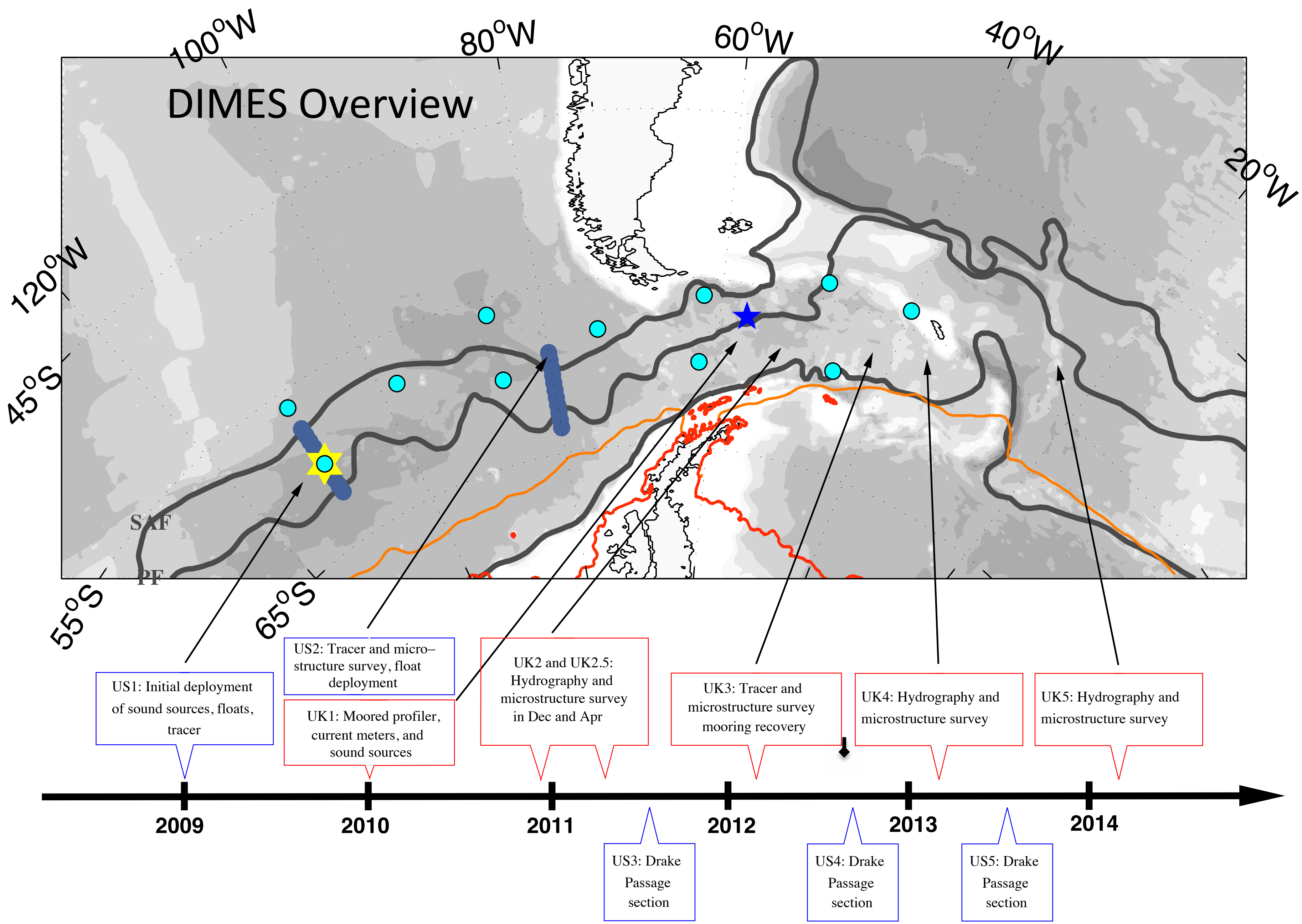
R/V Roger Revelle

R/V Thomas G Thompson

RRS James Cook

RRS James Clark Ross

R/V Laurence M. Gould

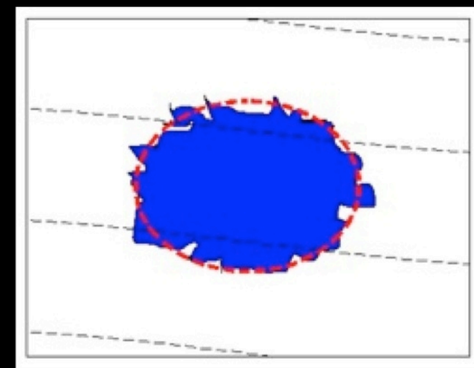


DIMES Overview
100°W
80°W
60°W
40°W
20°W
120°W
45°S
55°S
65°S
SAF
PF
US1: Initial deployment of sound sources, floats, tracer
US2: Tracer and micro–structure survey, float deployment
UK1: Moored profiler, current meters, and sound sources
UK2 and UK2.5: Hydrography and microstructure survey in Dec and Apr
UK3: Tracer and microstructure survey mooring recovery
UK4: Hydrography and microstructure survey
UK5: Hydrography and microstructure survey
2009
2010
2011
2012
2013
2014
US3: Drake Passage section
US4: Drake Passage section
US5: Drake Passage section

Different approaches to estimating K

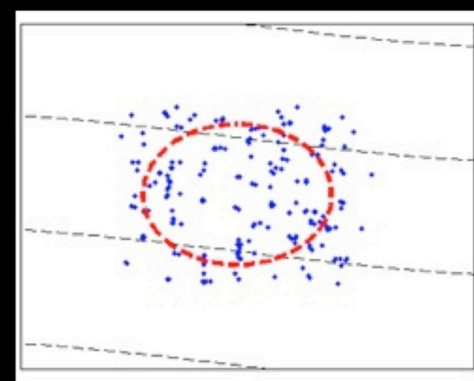
- Tracer release experiments (moment method)

$$K_{Tracer} = \frac{1}{2}\frac{\mathrm{d}\sigma_y^2}{\mathrm{d}t}, \qquad \sigma_y^2 = \int (y - y_c)^2 c \, \mathrm{d}A$$



- Float release experiments (Taylor's formula)

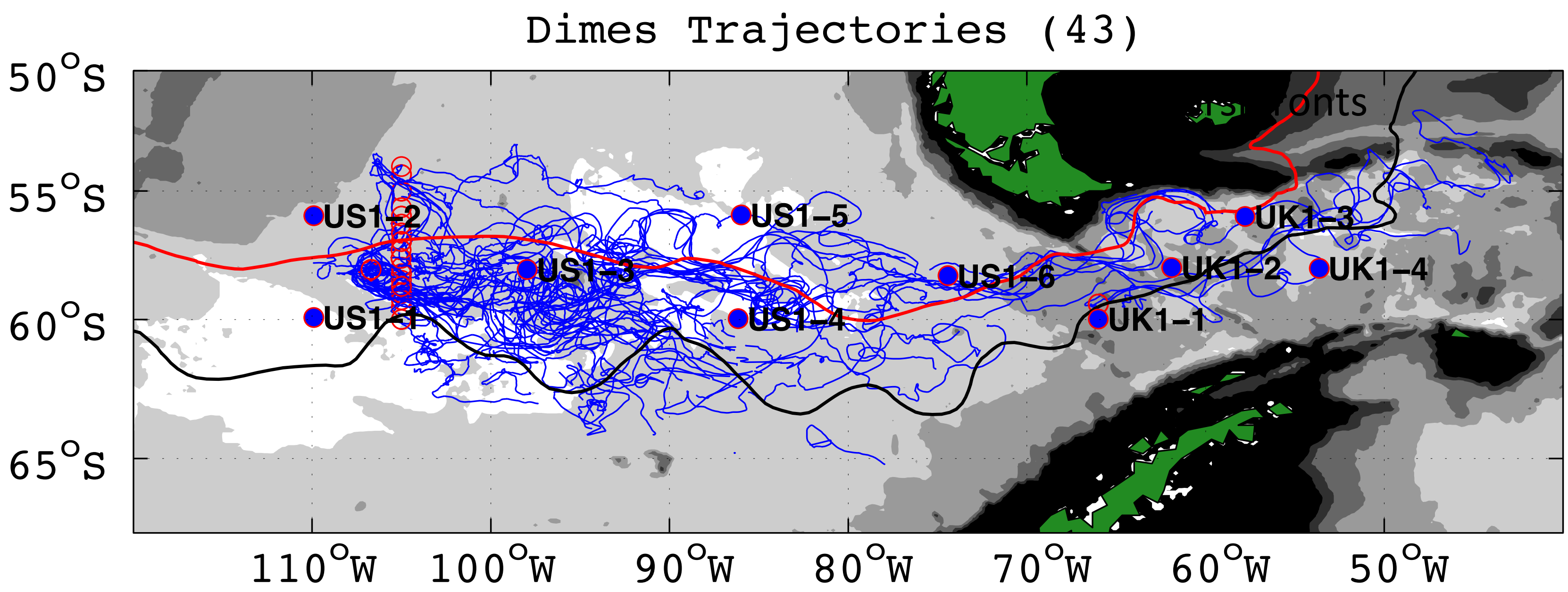
$$K_{Taylor} = \frac{1}{2}\frac{\mathrm{d}}{\mathrm{d}t}\left\langle (y(t) - y_0)^2 \right\rangle = \int_0^t \left\langle v(t)v(t') \right\rangle \mathrm{d}t'$$



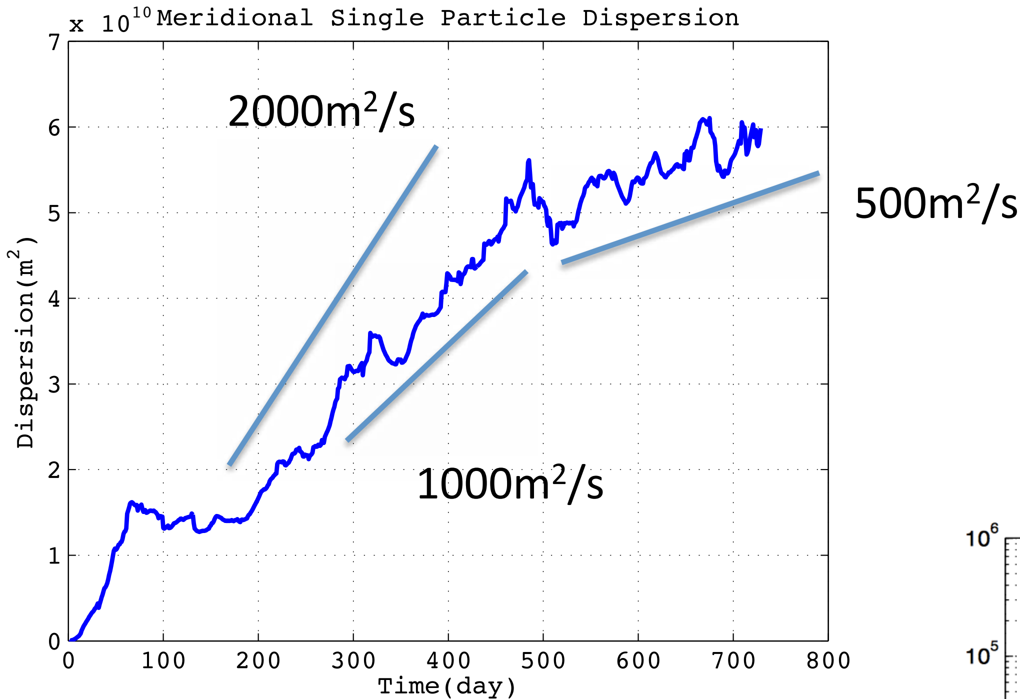
Tracer: Ledwell, Watson, Messias

Floats: Owens, Lazarevich, LaCasce, Gille, Ferrari, Marshall, Sallee

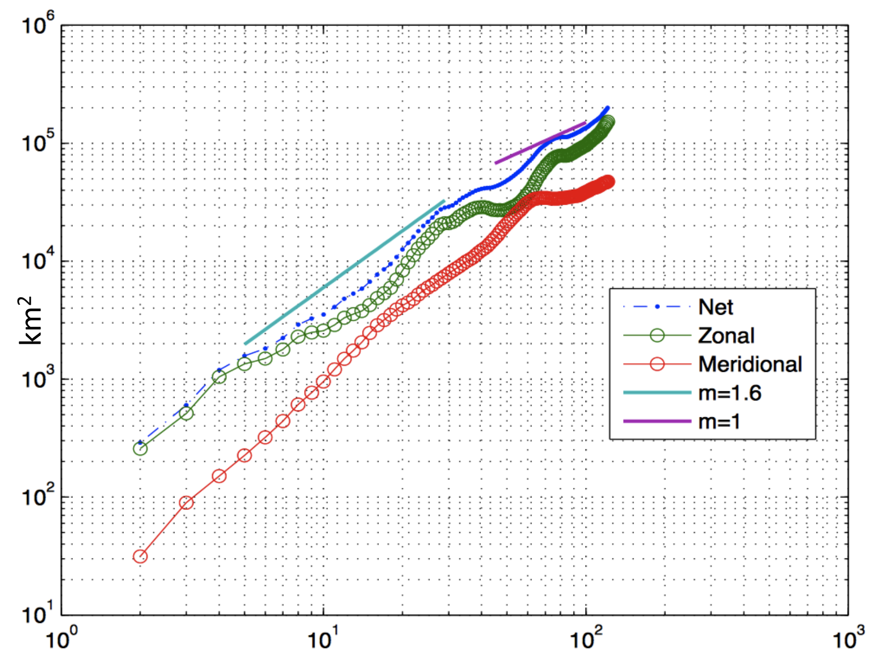
2. DIMES Trajectories as of Sept 2011



Float Dispersion



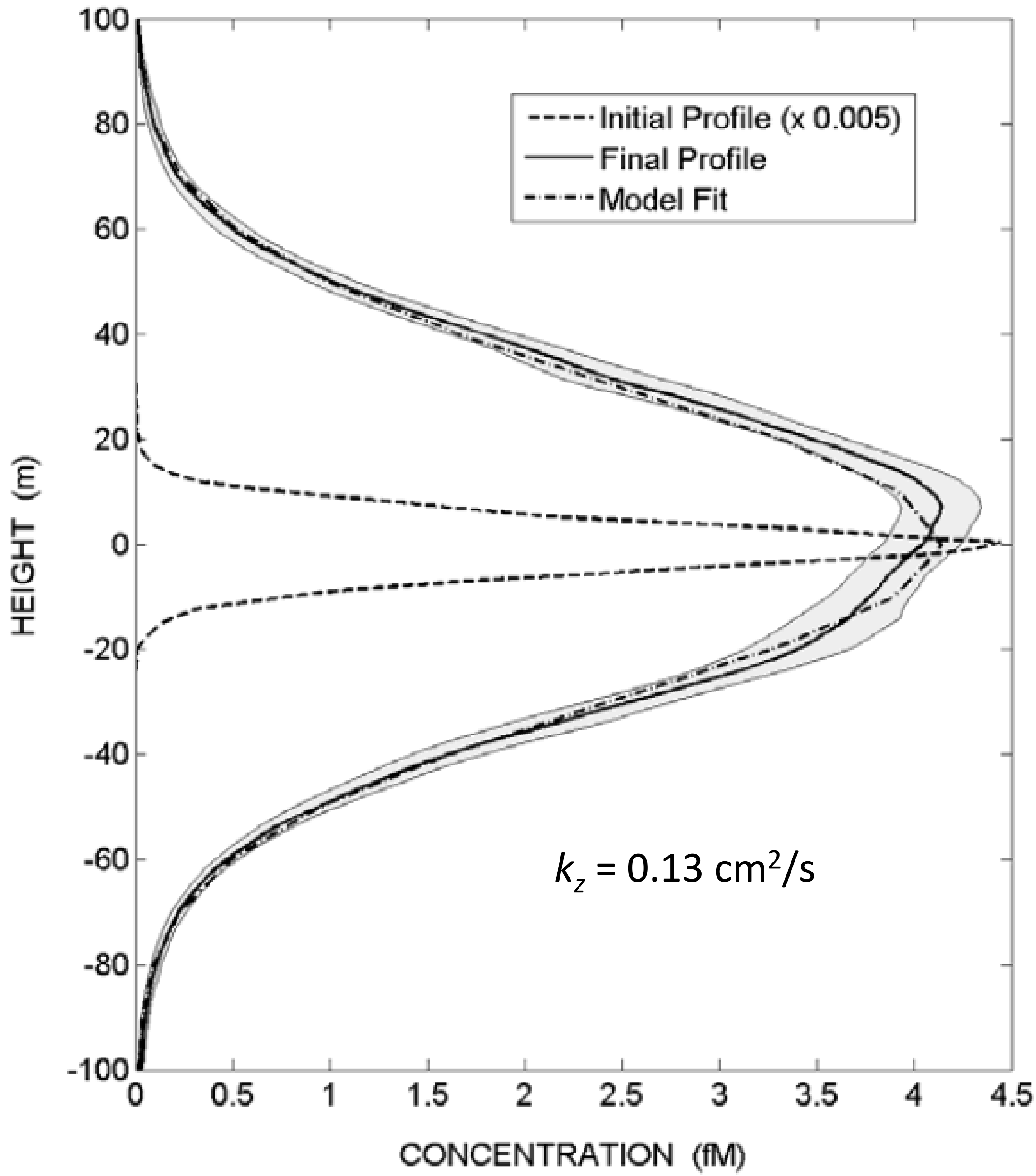
Pair dispersion

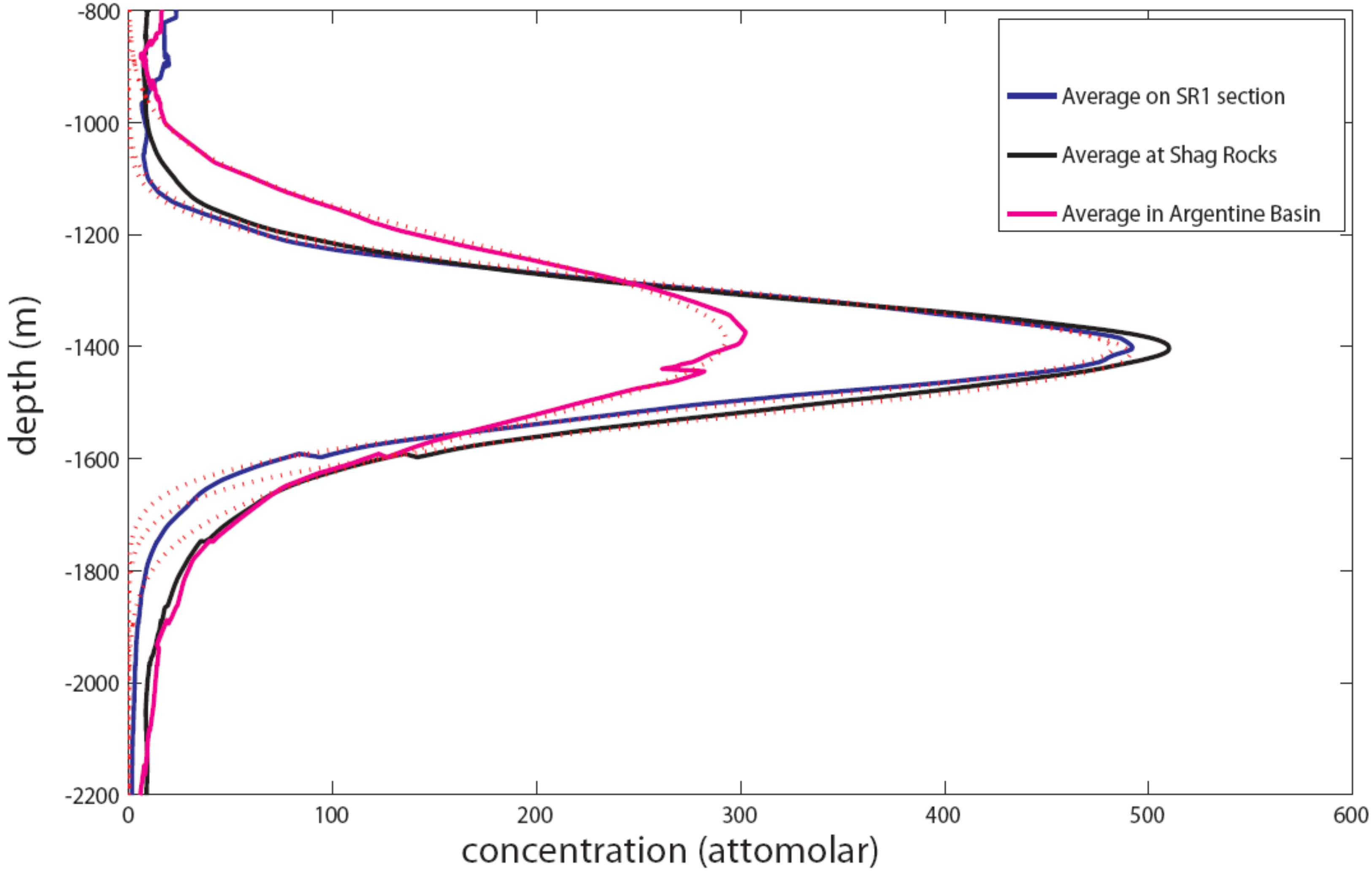


Pair dispersion on log-log scale

Power law from 5-20 d, 10km?

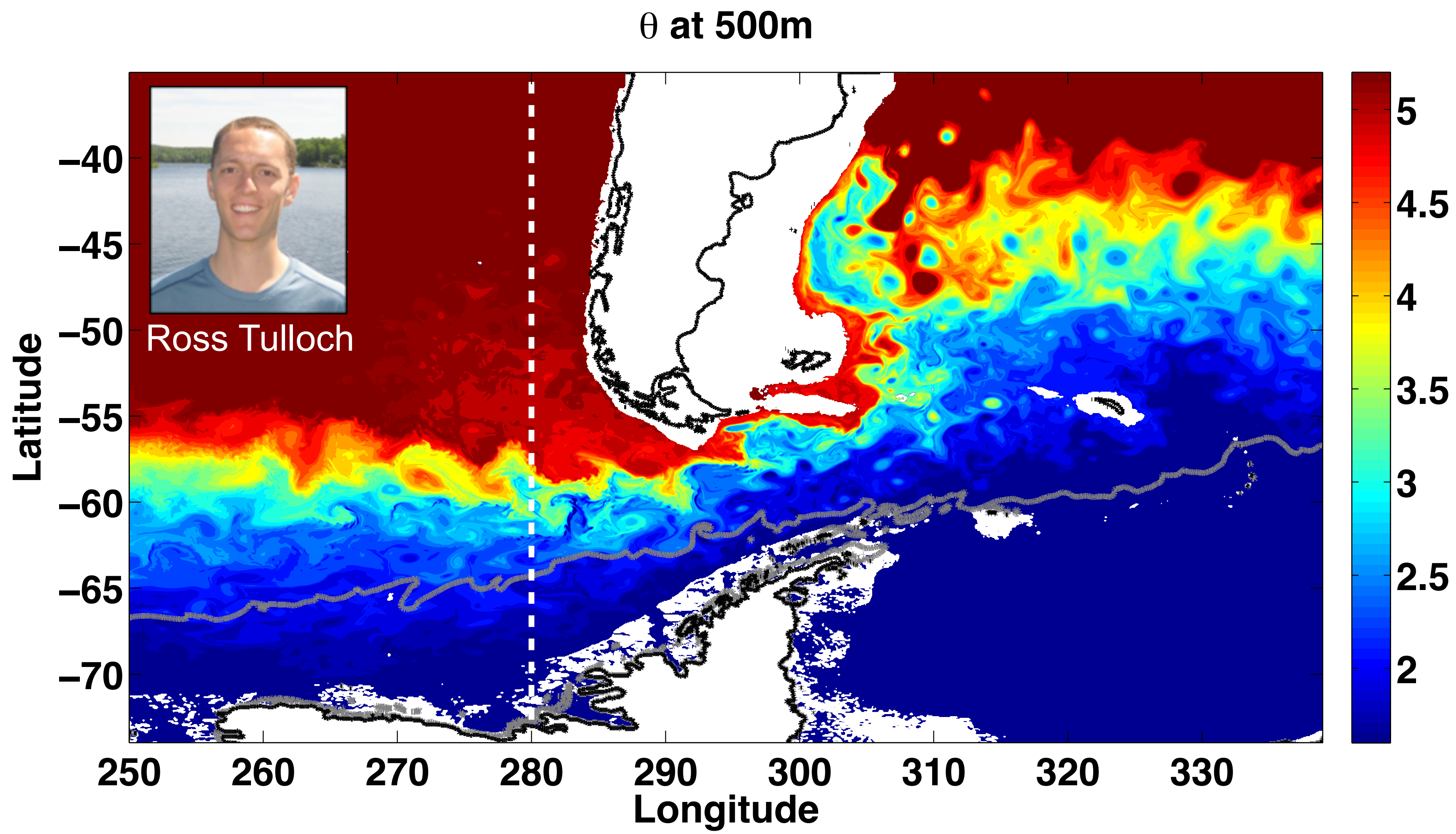
Tracer Release: Initial & 12-month profiles



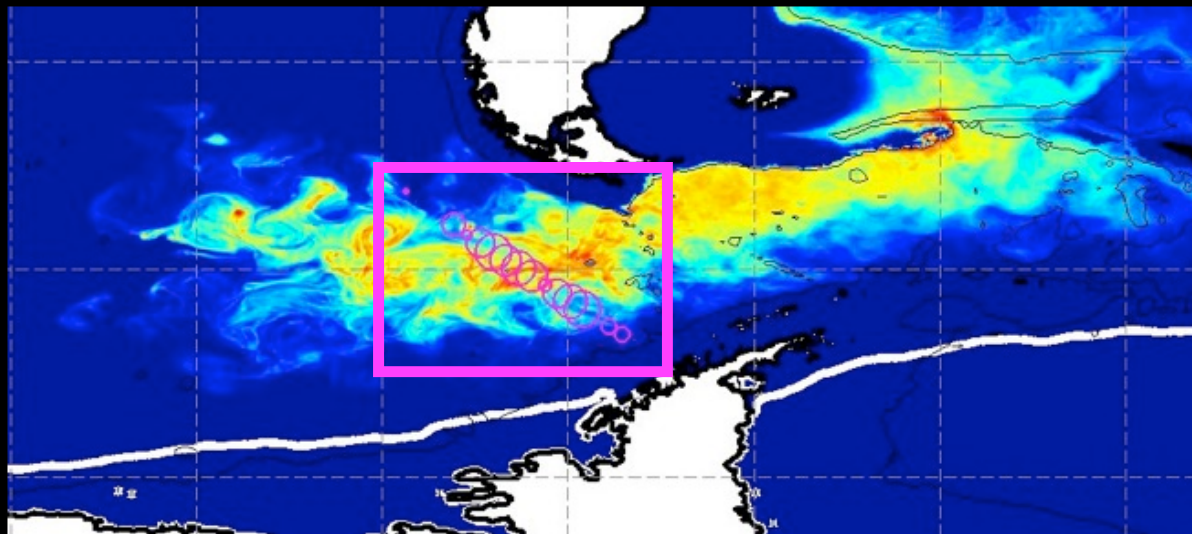

Average on SR1 section
Average at Shag Rocks
Average in Argentine Basin
depth (m)
concentration (attomolar)
-800
-1000
-1200
-1400
-1600
-1800
-2000
-2200
0
100
200
300
400
500
600

Numerical model of the DIMES region

- MIT General Circulation Model, 3km resolution, 50 vertical levels
- Forced with reanalysis surface fluxes and 1ºx1º ECCO-OCCA hydrography at lateral boundaries

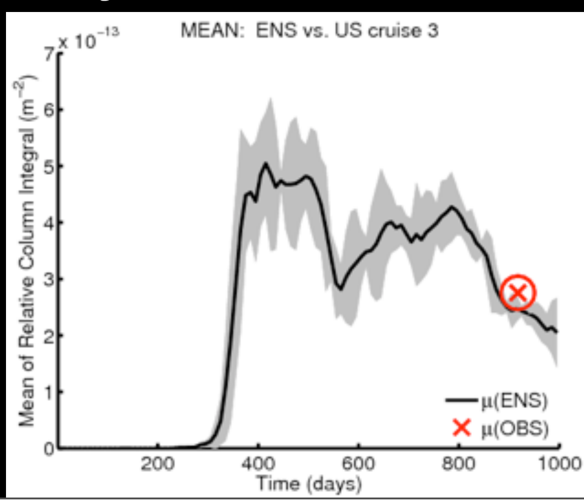


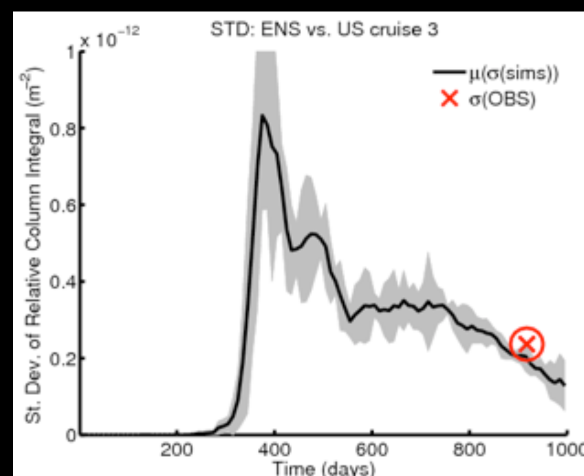
Validation of numerical model: US3



$$\mu = \sum_{grid} \int c_i \, \mathrm{d}z \Big/ \iiint c \, \mathrm{dV}$$

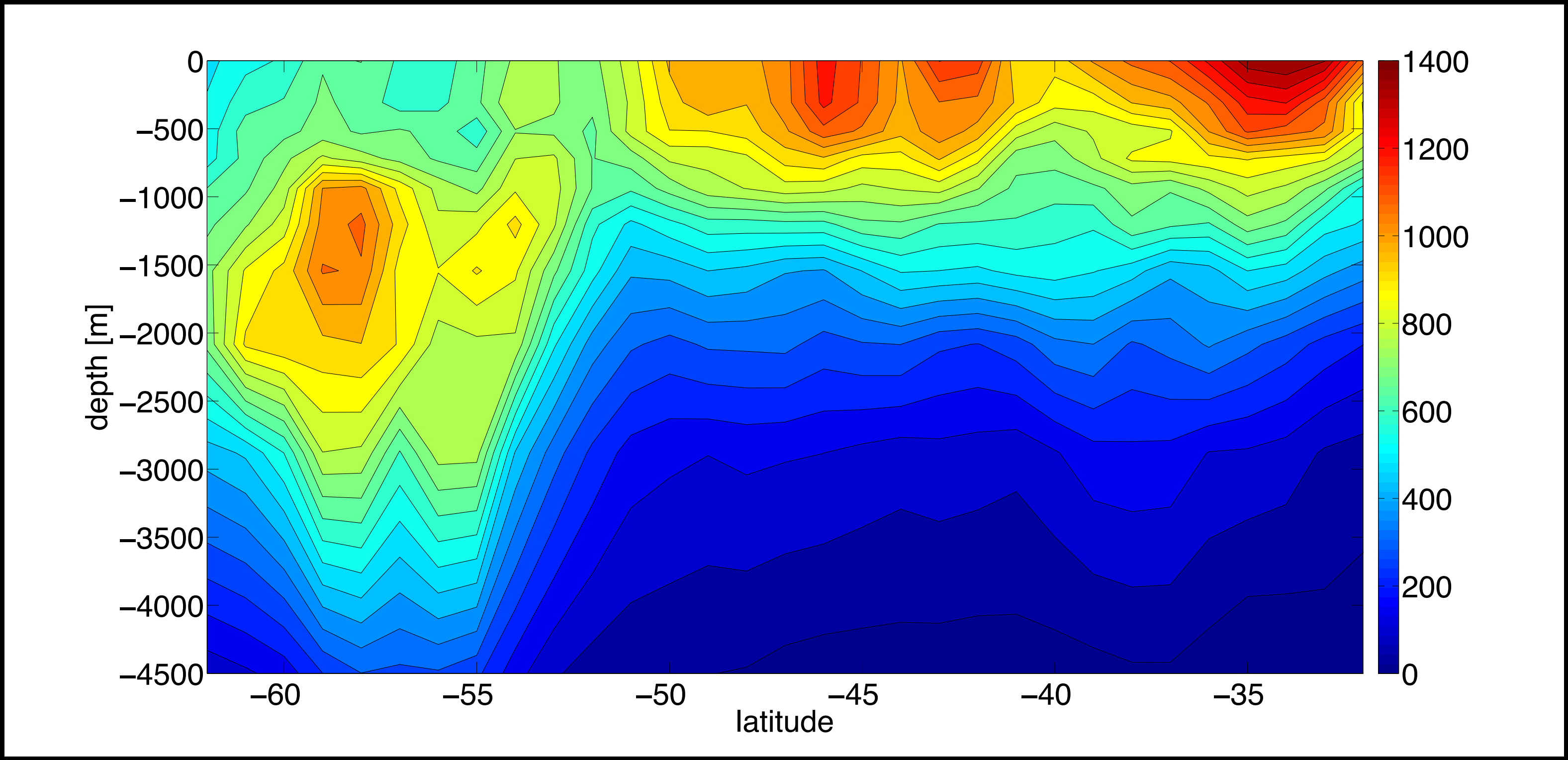
$$\sigma = \sqrt{\sum_{grid} \int (c'_i)^2 \, \mathrm{d}z \Big/ \iiint c \, \mathrm{dV}}$$





Eddy diffusivity

- K estimates upstream of Drake Passage based on numerical tracer releases with a simplified numerical model (Klocker et al. 2012)
    - K is suppressed in the upper ocean in the ACC latitude band
    - suppression is not as strong as previously estimated



Conclusions

$k \sim 10^{-5}$ m^2/s west of Drake Passage

$k > 10^{-4}$ m^2/s in Drake Passage

Topography plays a big role

Overall enhancement of k in the ACC above background levels is modest in the context of the global Meridional Overturning Circulation

Isoneutral k is difficult from floats alone—combined with models or altimetry <600m^2/s on 27.9 neutral surface

http://dimes.ucsd.edu. The web site is managed by the CLIVAR & Carbon Hydrographic Data Office (CCHDO)