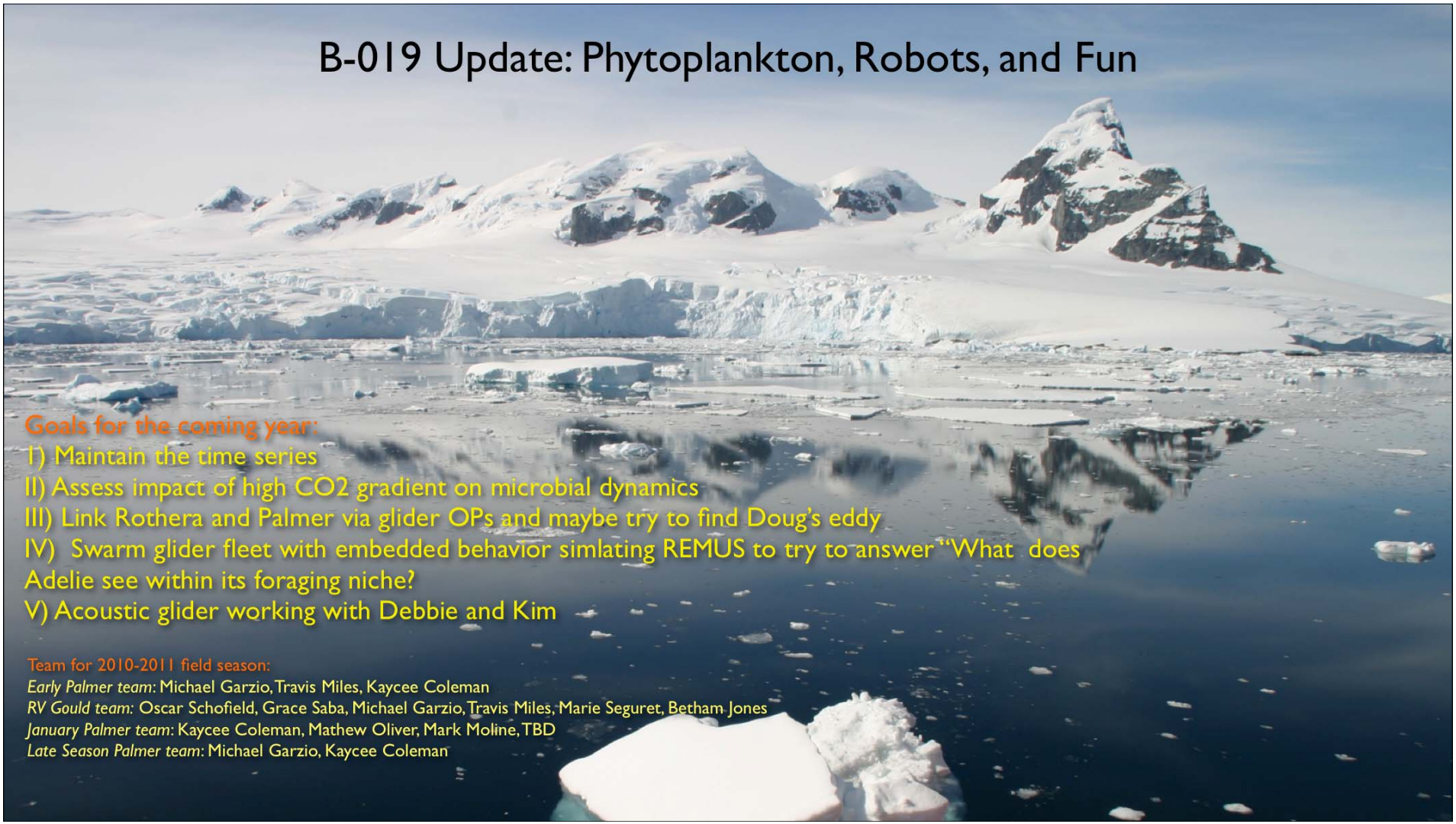
B-019 Update: Phytoplankton, Robots, and Fun



Goals for the coming year:

I) Maintain the time series

II) Assess impact of high CO2 gradient on microbial dynamics

III) Link Rothera and Palmer via glider OPs and maybe try to find Doug's eddy

IV) Swarm glider fleet with embedded behavior simlating REMUS to try to answer "What does Adelie see within its foraging niche?

V) Acoustic glider working with Debbie and Kim

Team for 2010-2011 field season:

Early Palmer team: Michael Garzio, Travis Miles, Kaycee Coleman

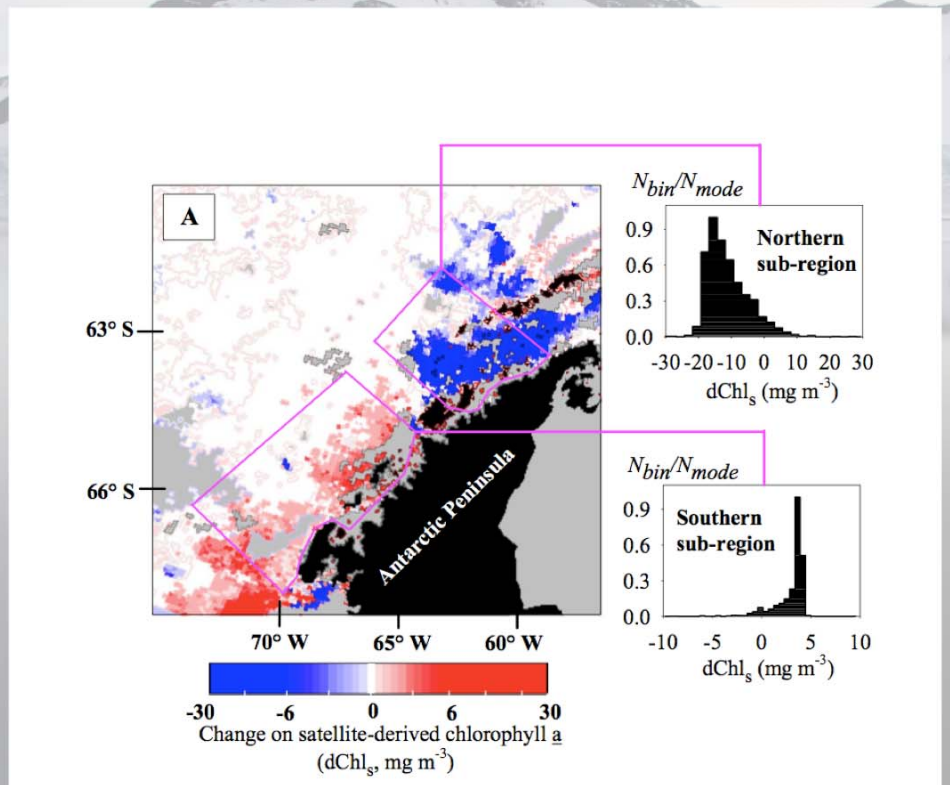
RV Gould team: Oscar Schofield, Grace Saba, Michael Garzio, Travis Miles, Marie Seguret, Betham Jones

January Palmer team: Kaycee Coleman, Mathew Oliver, Mark Moline, TBD

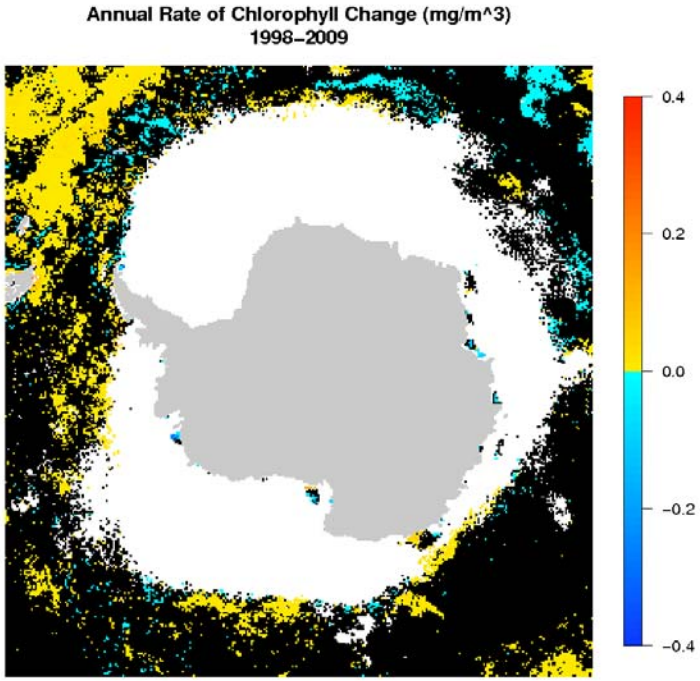
Late Season Palmer team: Michael Garzio, Kaycee Coleman

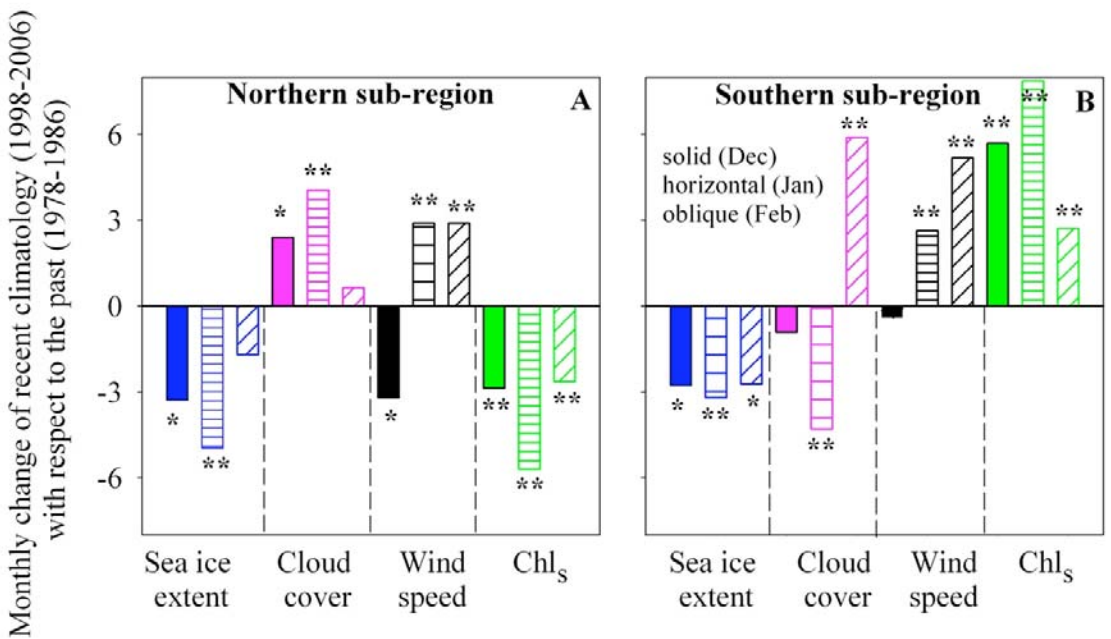
Phytoplankton Dynamics

Over thirty years, we see large changes in phytoplankton productivity (overall decline)



Over decade trends are less clear

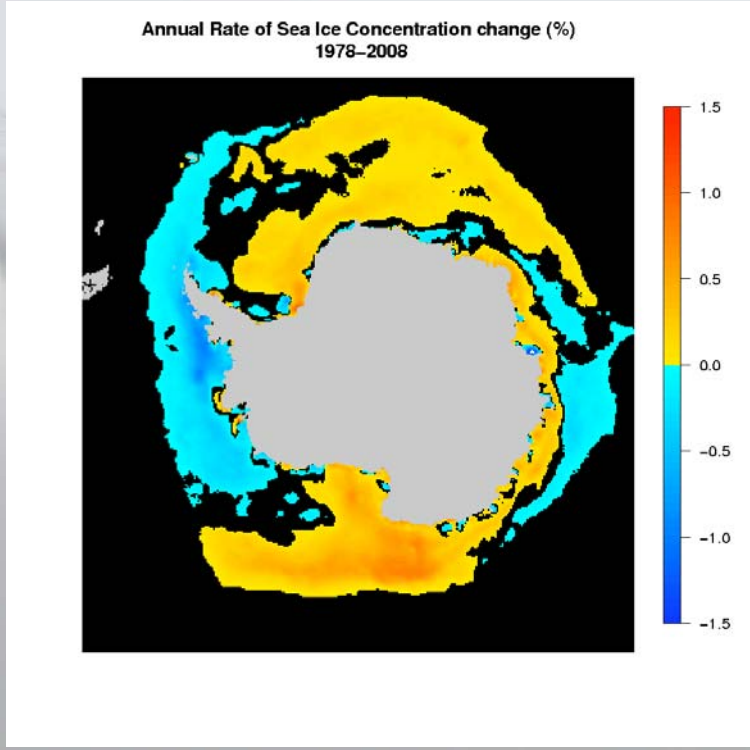




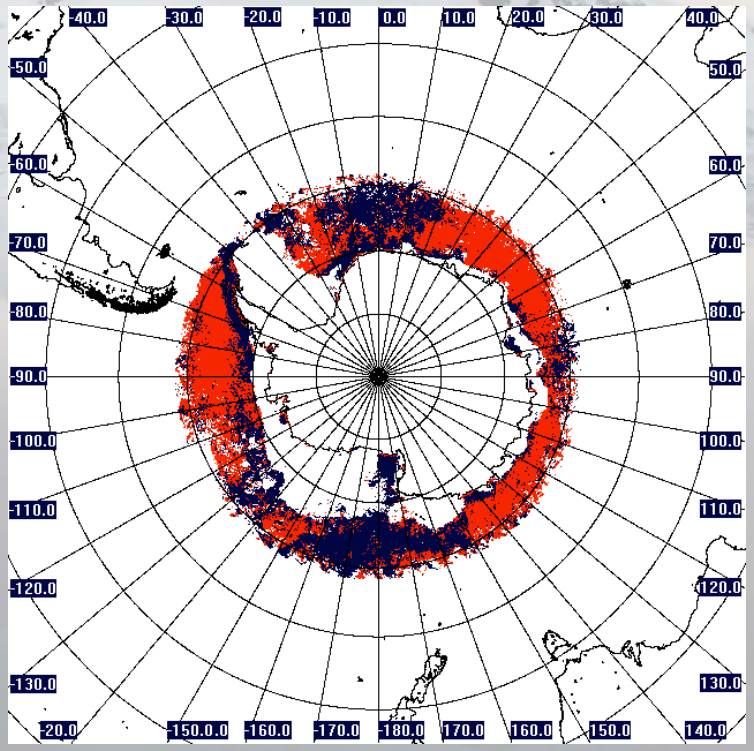
The changes driven by a decline in sea ice, wind and sun

Regions of Sea Ice Change most associated with large cells

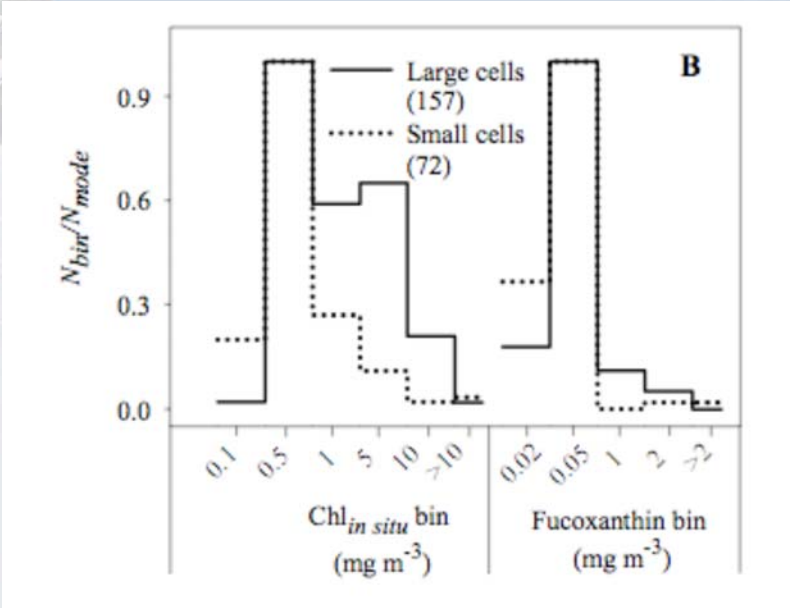
Sea ice trends



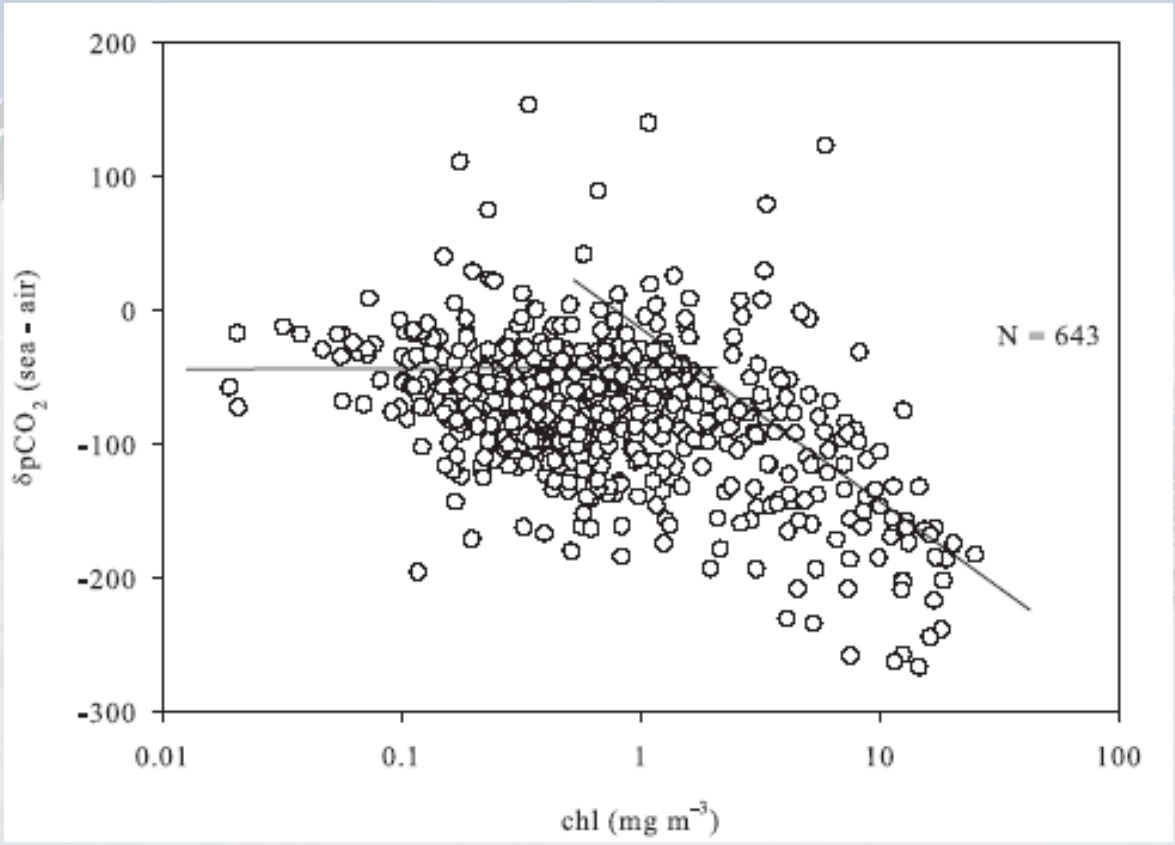
Red < 20 microns
Blue > 20 microns



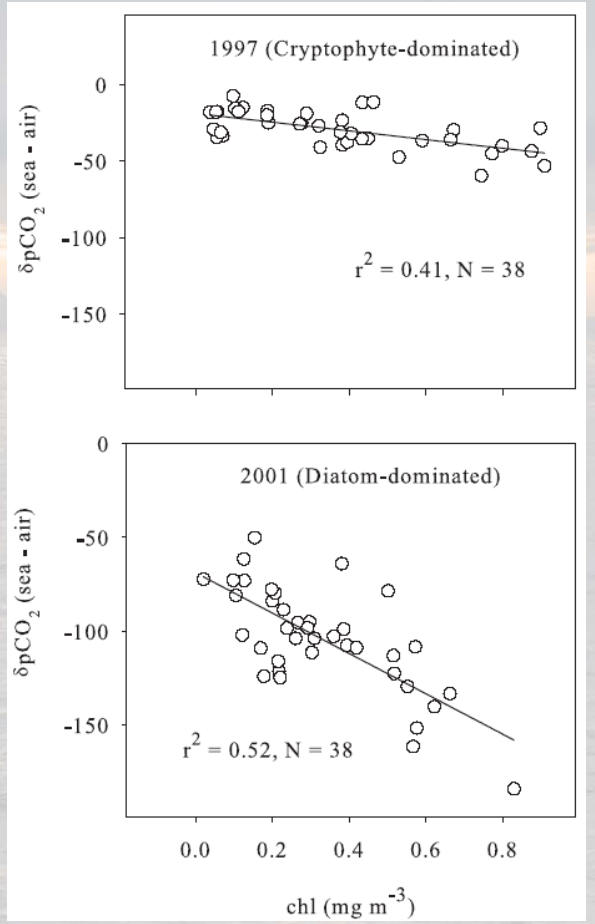
When chlorophyll is high, phytoplankton cells are big and are largely diatoms



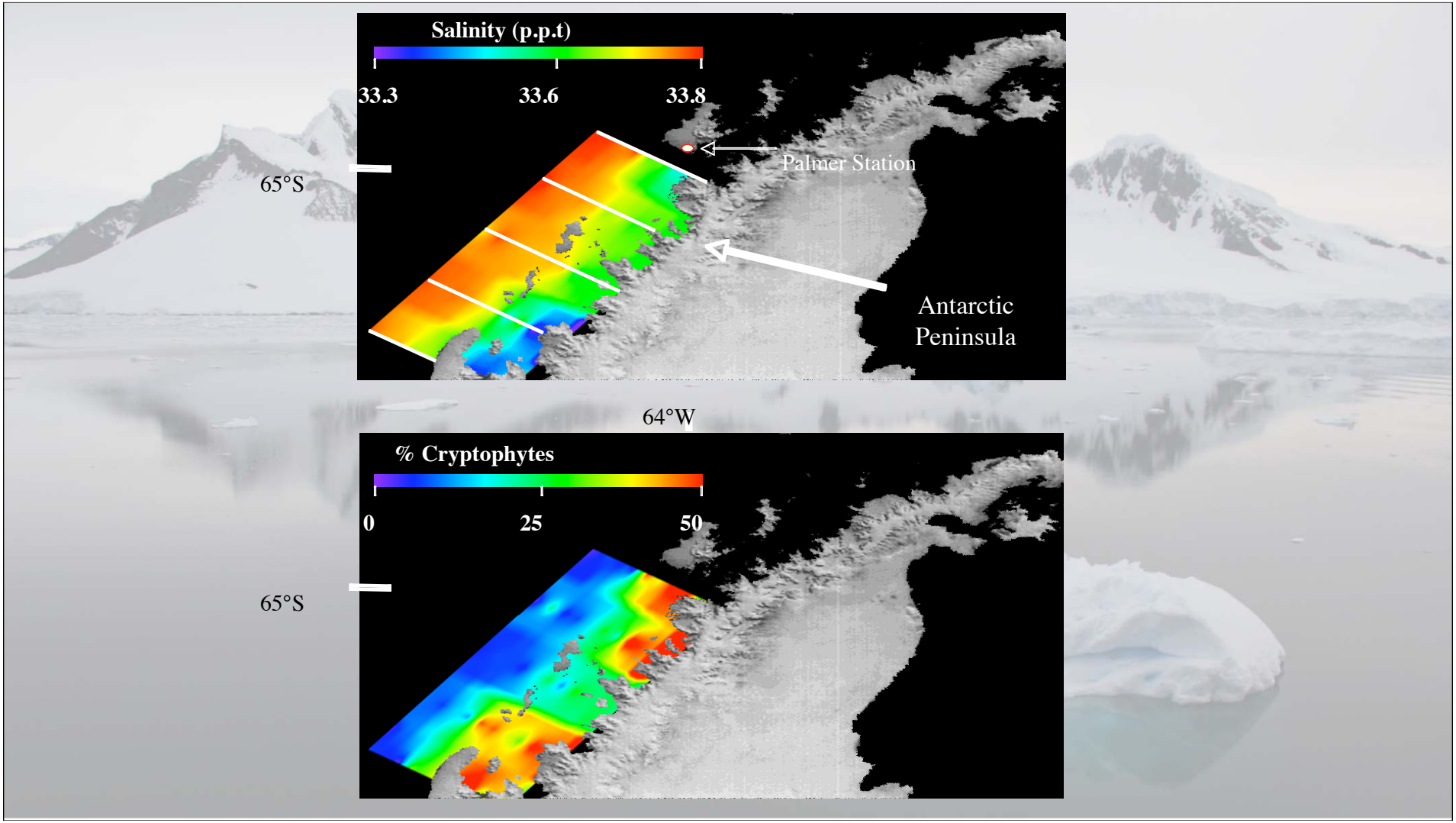
Change in biomass impact on biogeochemistry



CO_2 uptake varies with phytoplankton community

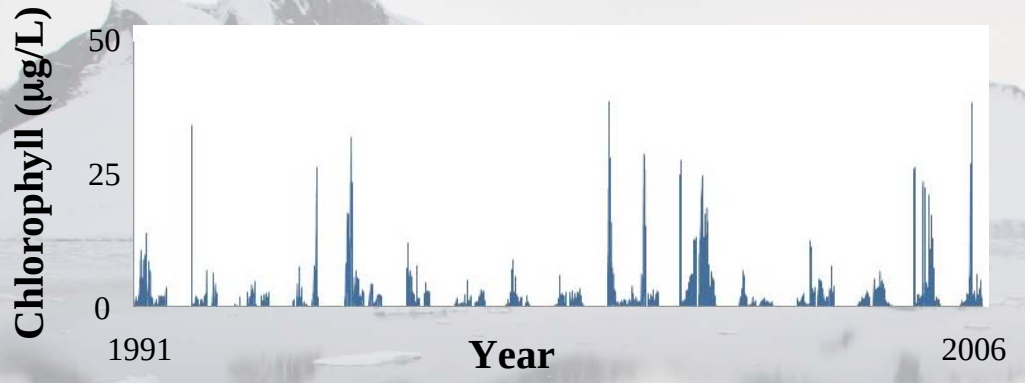


Montes Hugo in prep


Salinity (p.p.t)
33.3
33.6
33.8
Palmer Station
65°S
Antarctic
Peninsula
64°W
% Cryptophytes
0
25
50
65°S

Phytoplankton Dynamics Annual Cycle

I) Palmer Station and Ship time series show large degree of interannual variability



% of variability in Chl that can be explained

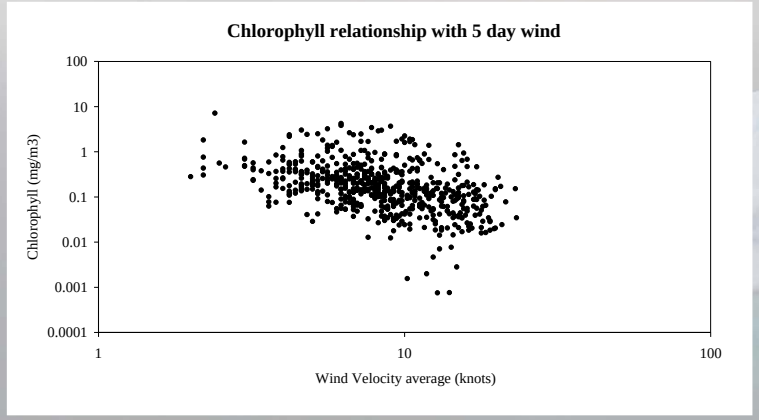
Diatoms (63%)

Cryptophytes (32%)

Prasinophytes (5%)

Prymnesiophytes (2%)

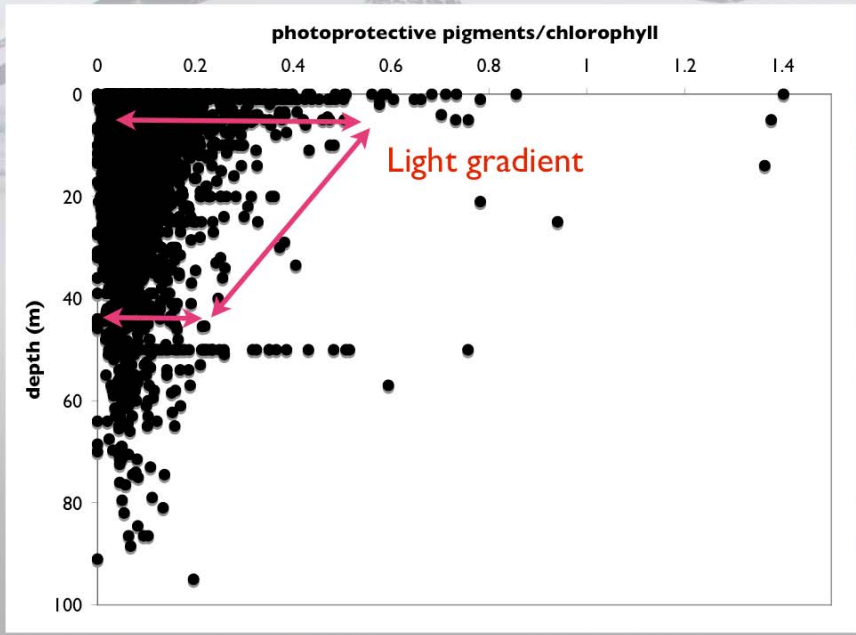
II) Wind is the best, albeit poor, environmental factor influencing annual chlorophyll



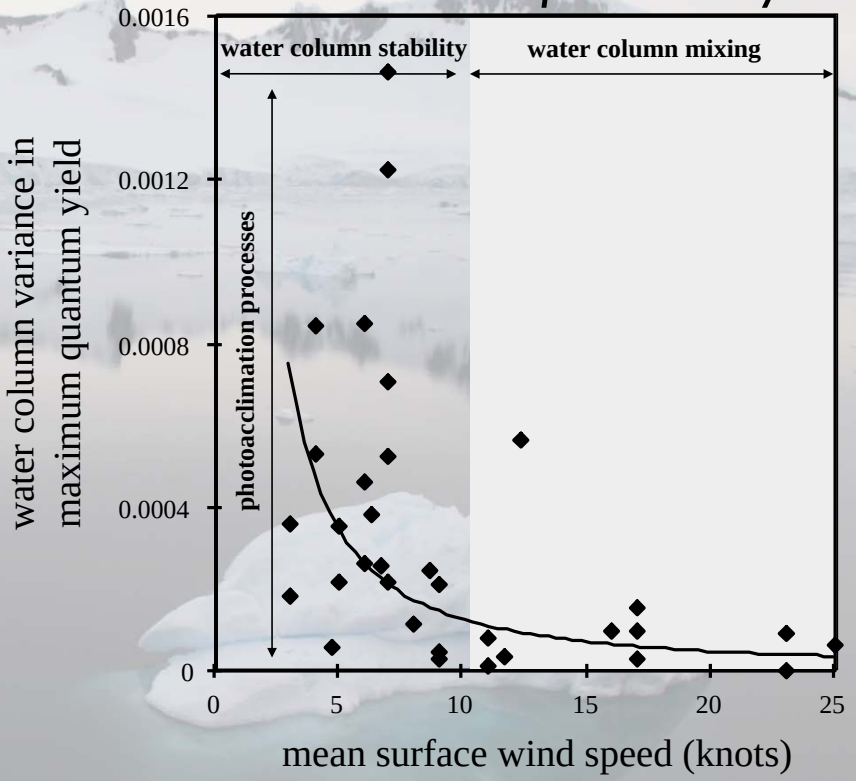
Phytoplankton Dynamics

III) Physiological signature is consistent with the idea of mixing and dark ocean is a key prcess

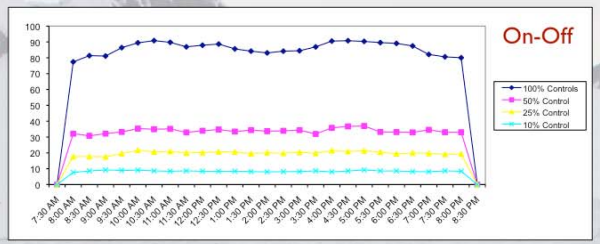
pigmentation

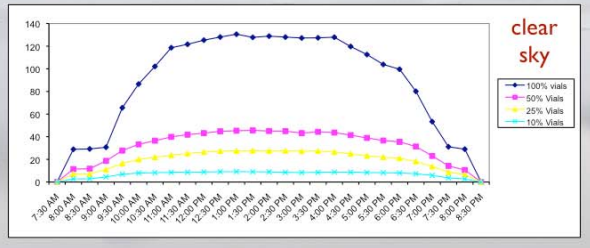


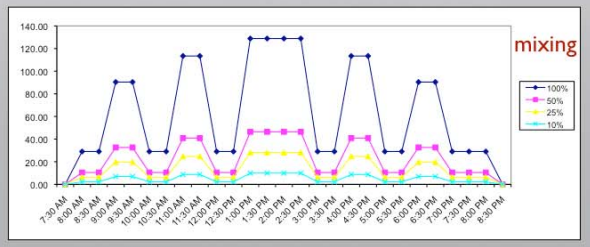
water column productivity

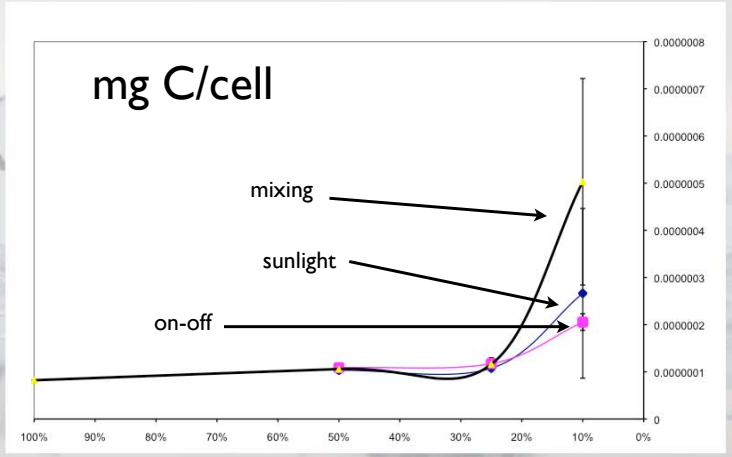


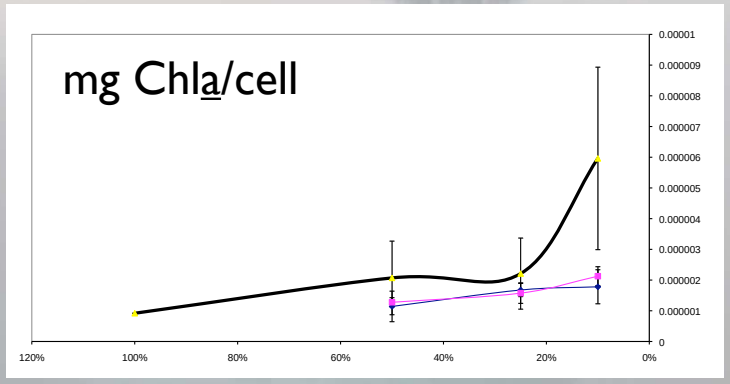
Is it the absolute flux of light over the course of the day that is important or is the dynamics of the light important?





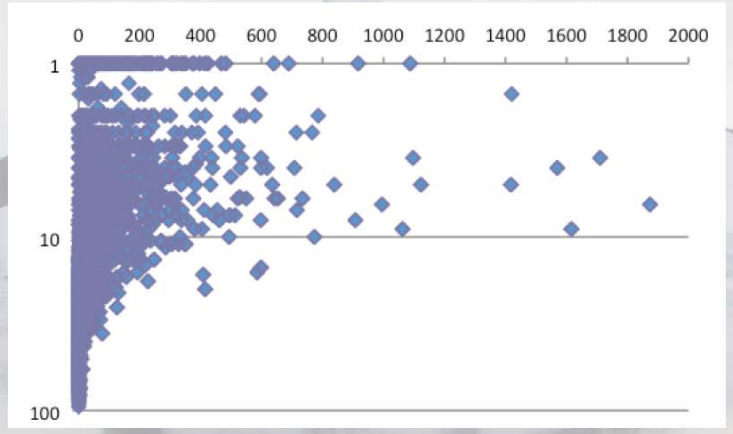




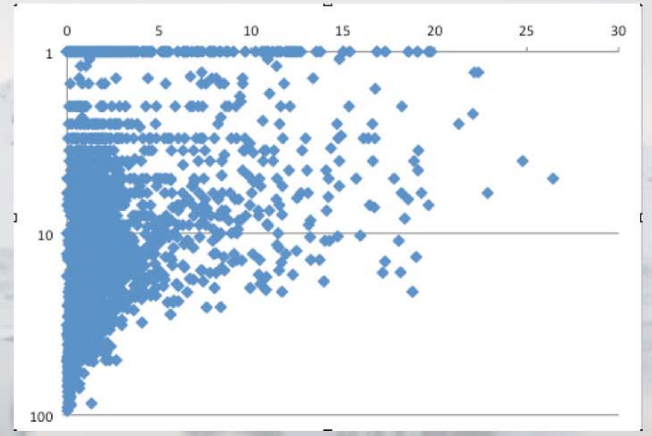


Palmer Station Data

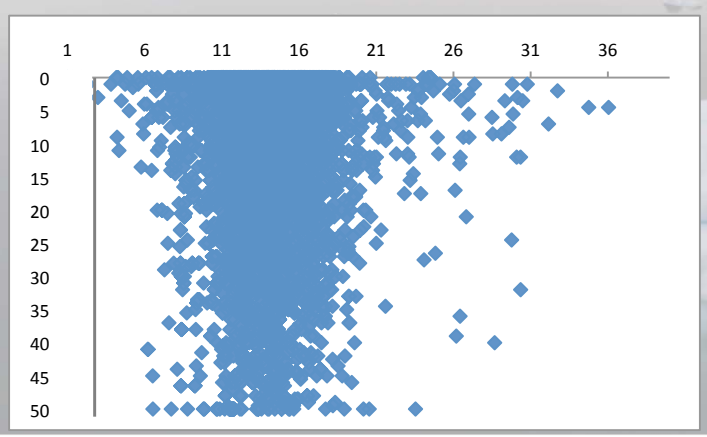
Primary productivity (mg C day^{-1})



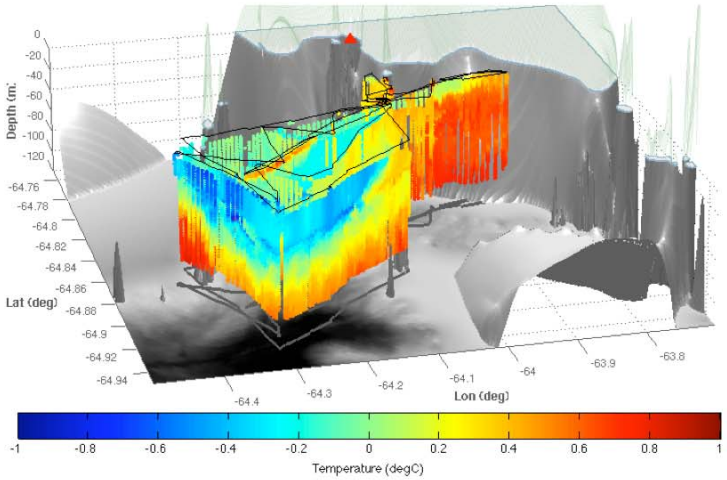
Chlorophyll a (mg Chl m^{-3})

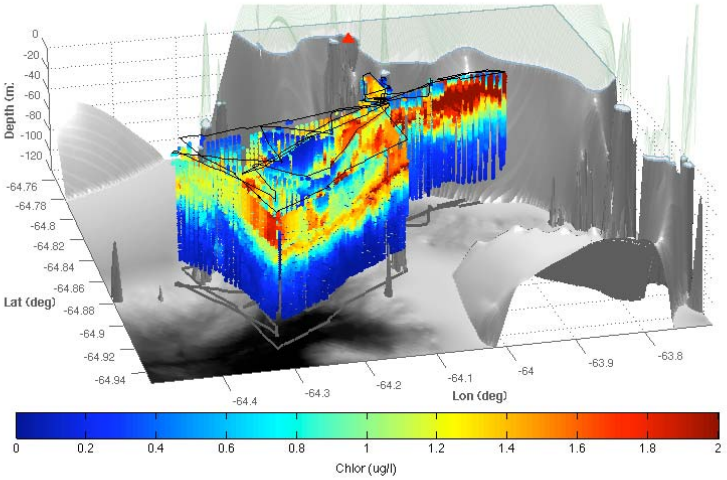


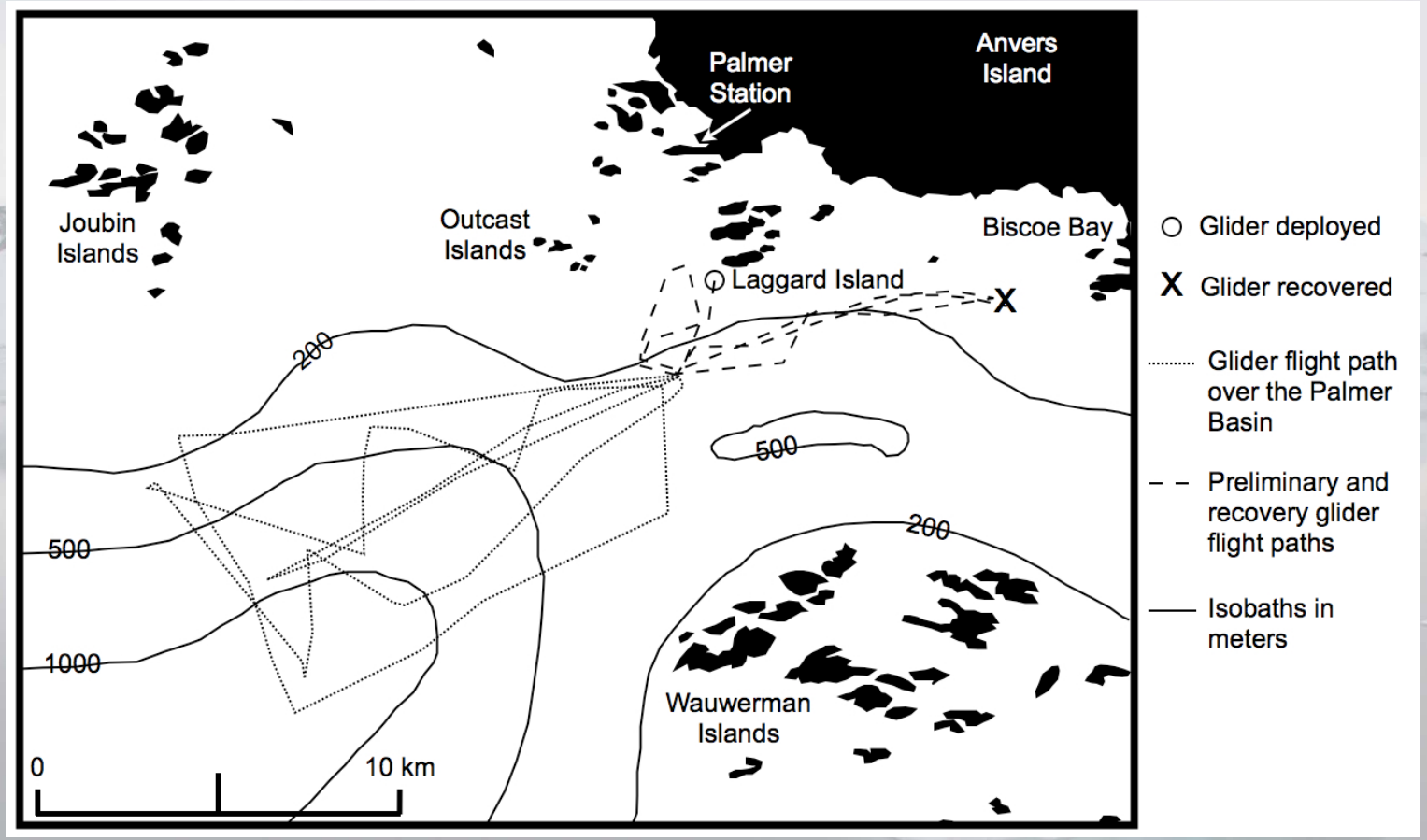
N/P

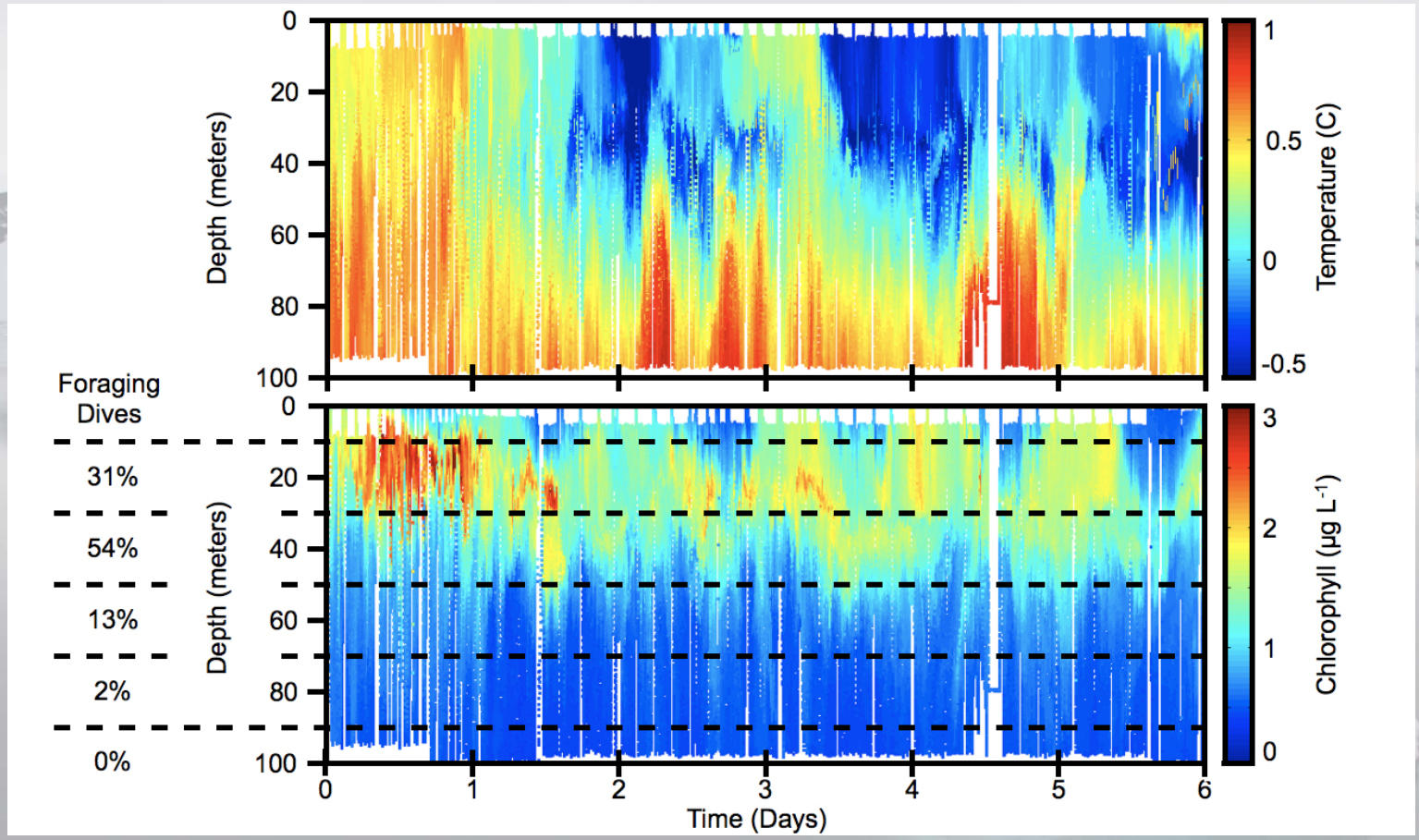


Enhanced productivity is associated with the warm upwelled water

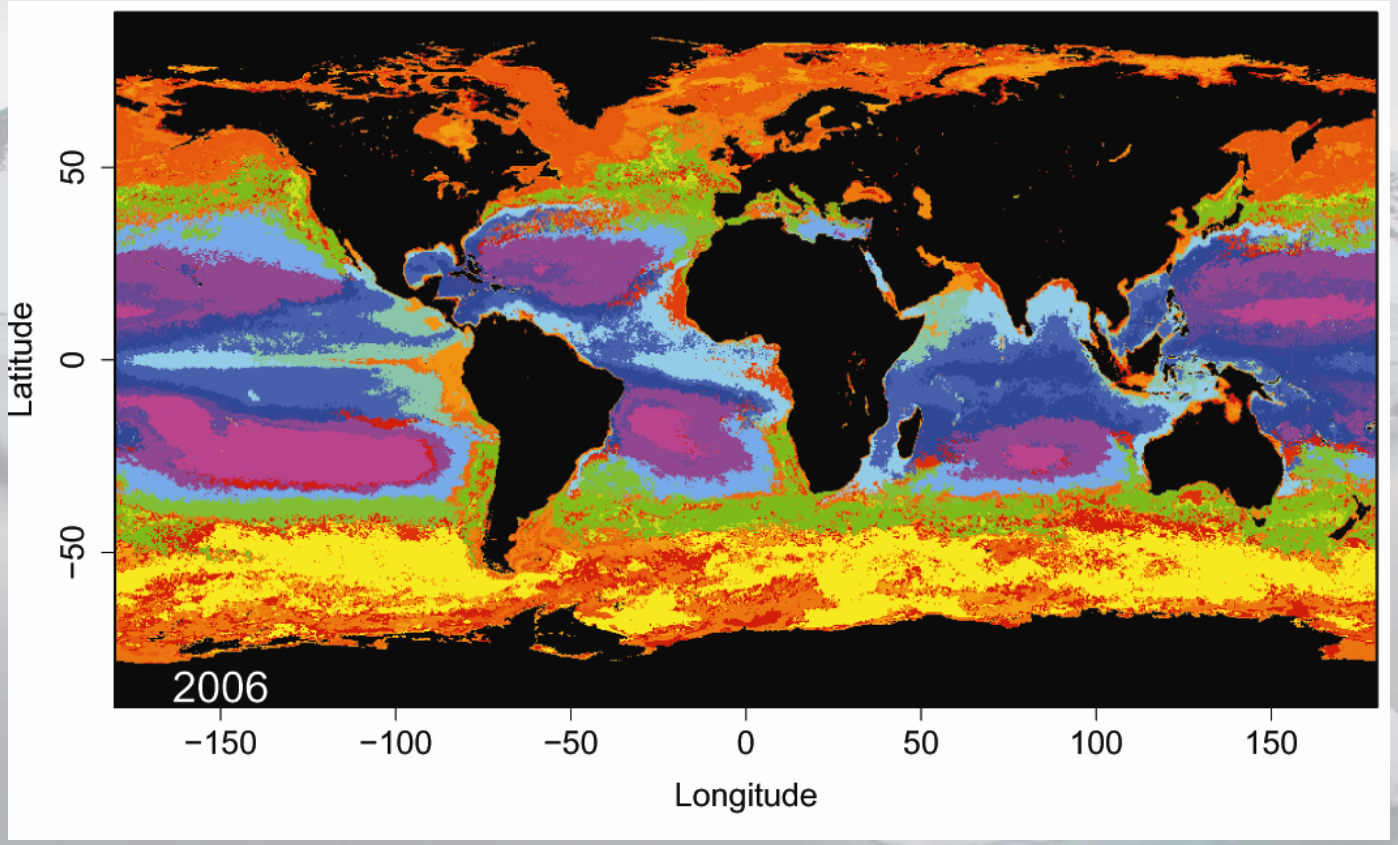





Palmer Station
Anvers Island
Joubin Islands
Outcast Islands
Biscoe Bay
Laggard Island
X
200
500
500
1000
200
Wauwerman Islands
0
10 km
Glider deployed
Glider recovered
Glider flight path over the Palmer Basin
Preliminary and recovery glider flight paths
Isobaths in meters


Depth (meters)
0
20
40
60
80
100
1
0.5
0
-0.5
Temperature (C)
Foraging Dives
31%
54%
13%
2%
0%
Depth (meters)
Chlorophyll (µg L-1)
3
2
1
0
0
1
2
3
4
5
6
Time (Days)

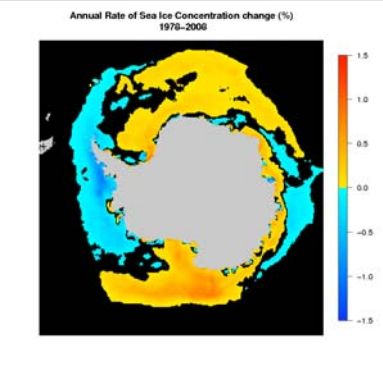
NASA Biodiversity program (Oliver, Schofield, Kohut, Irwin, Fraser)



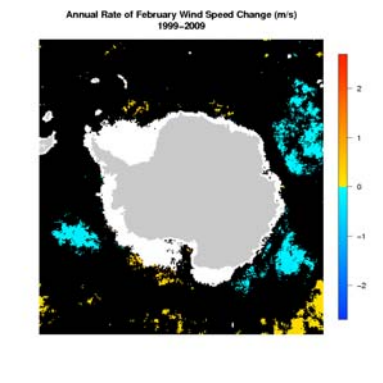
Use a range of new remote sensing tools to discriminate water masses, and combine with a range GAM models for penguins to optimize adaptive sampling gliders.

Development of GAM model for penguins rookeries. We analyze sea ice, wind, temperature, and chlorophyll in and around penguin rookery areas in WAP to determine which variables are most important for modeling the rookery environment.

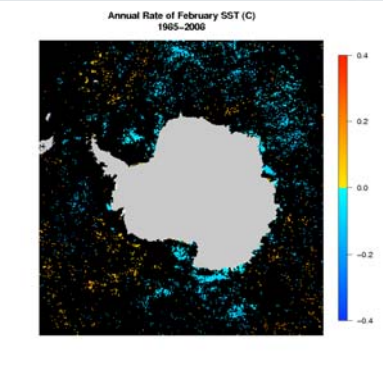
10 year analysis annual trends



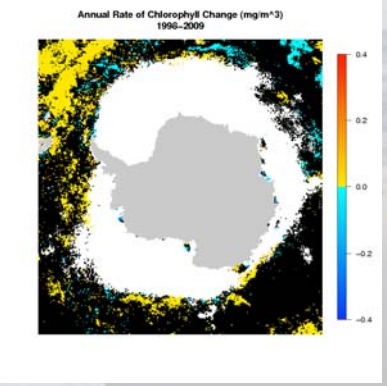
ice decline



wind no change

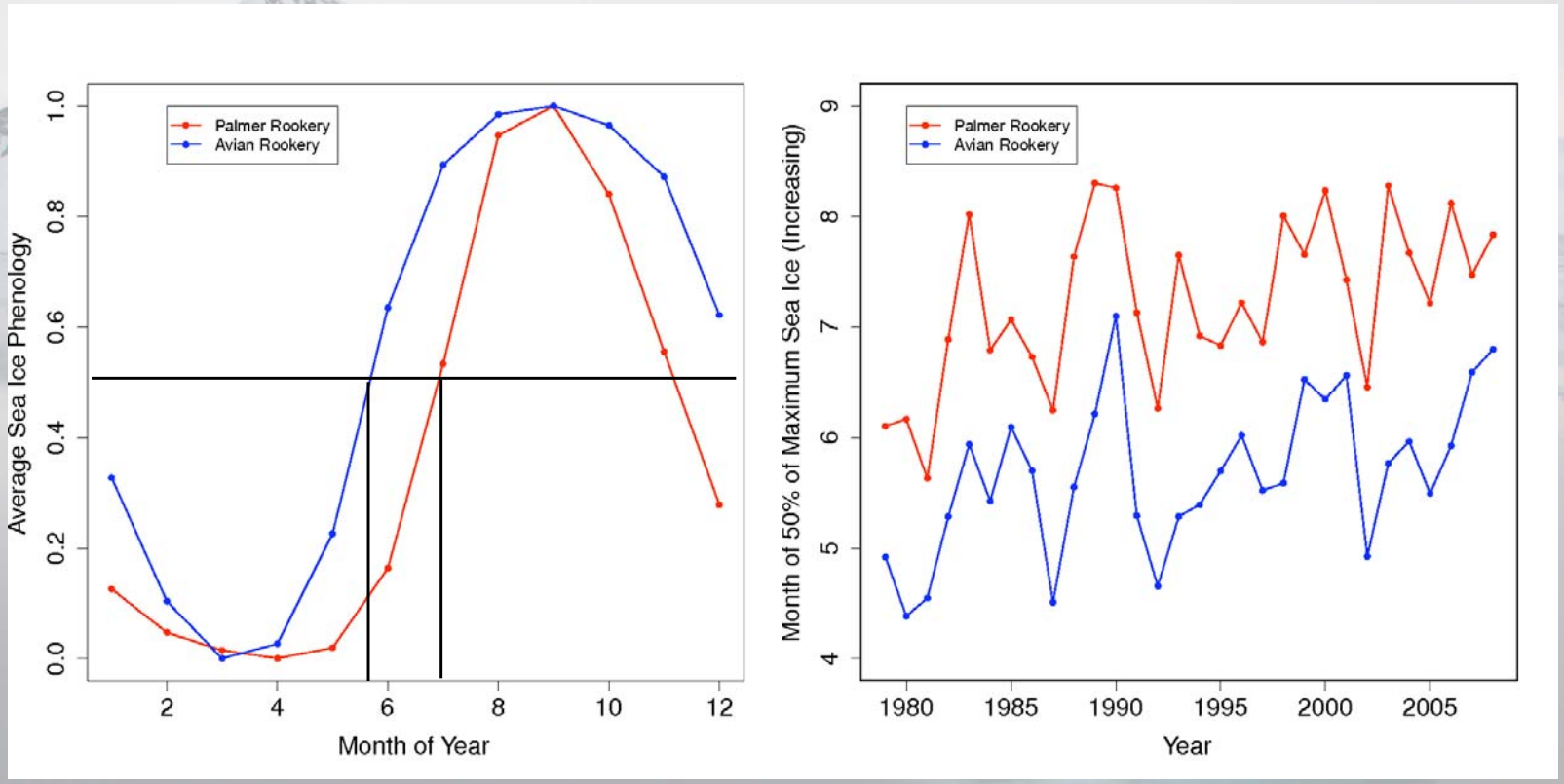


SST no change

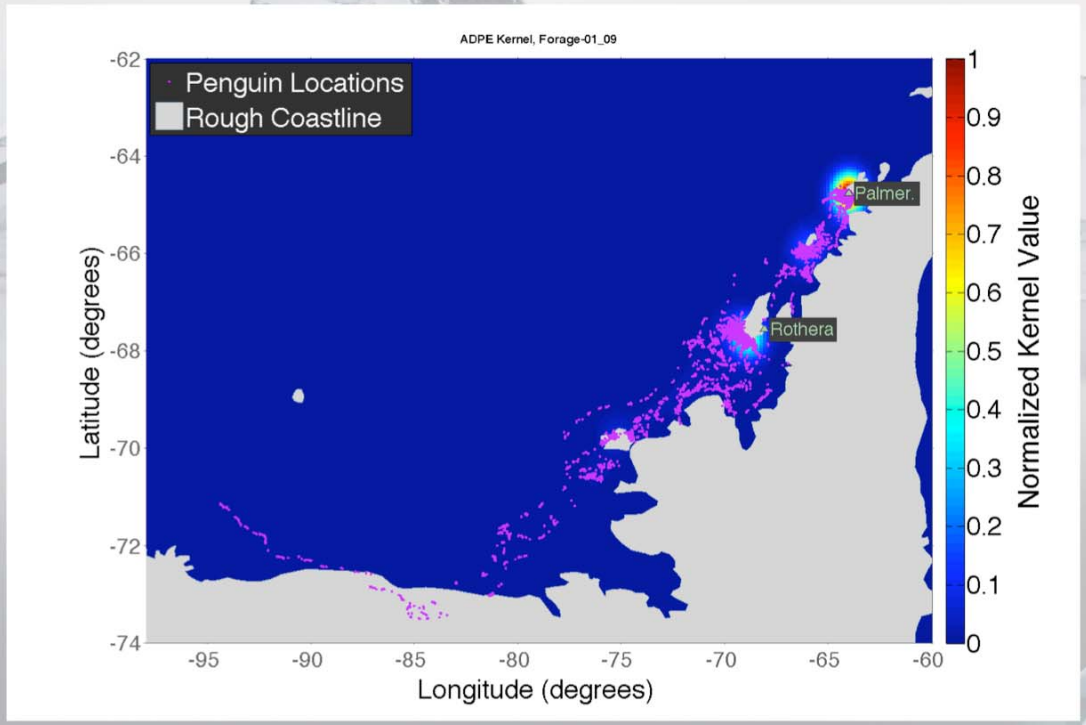


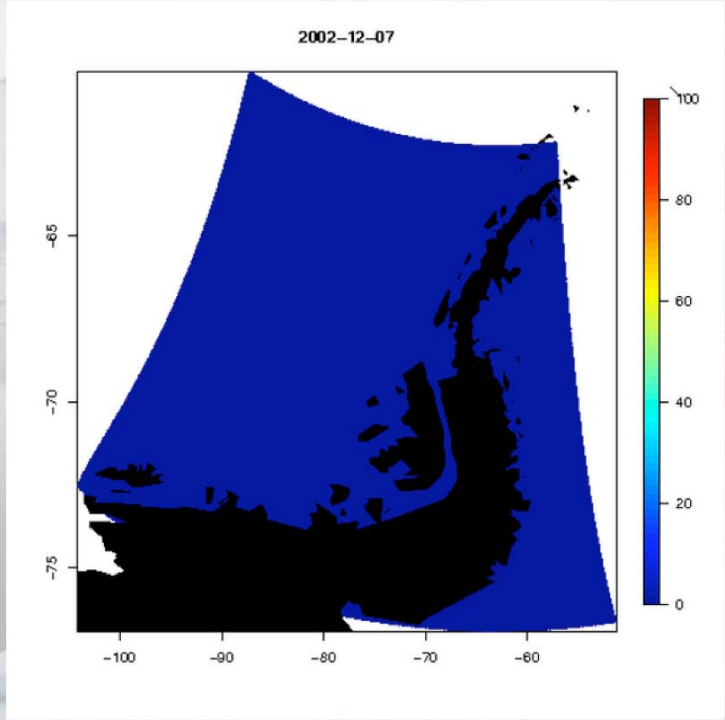
Chl hint increase

Timing of the sea ice extent



Using Bill's radio-tagged penguins define the kernel foraging and relate to the remote sensing data base



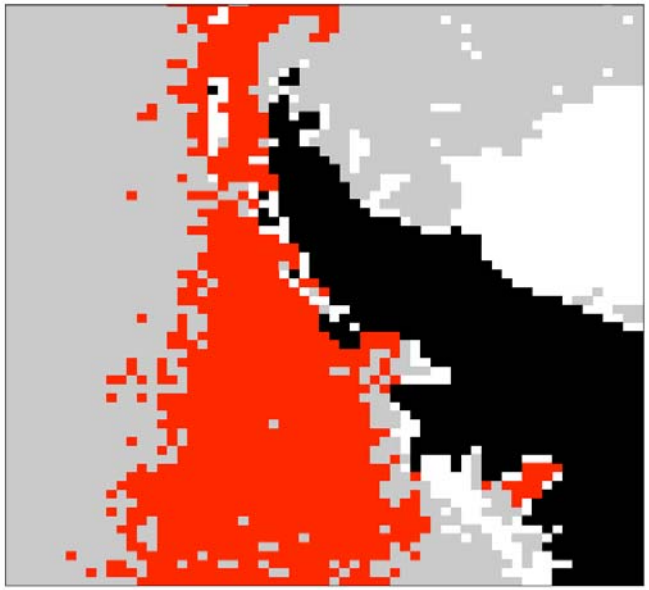


Adelie Penguin Pelagic Habitat Variation

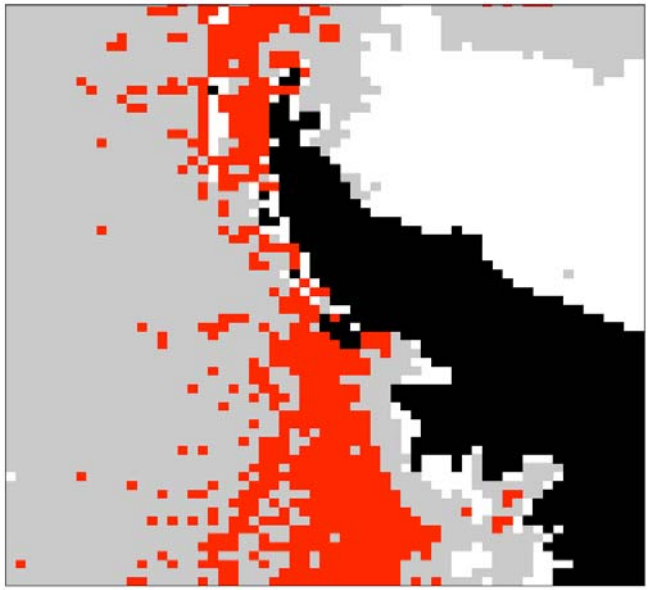
Sea Ice Coverage (%)	SST (C)	Chlorophyll (mg/m^3)
0 - 27%	-0.2 - 2	0.07-2.4

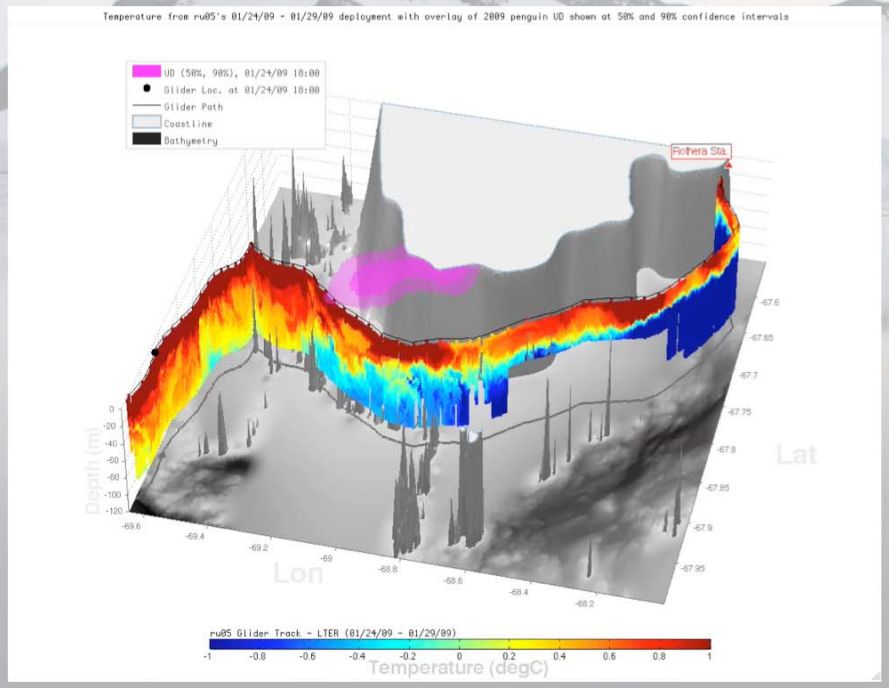
Results suggests the pelagic niche for the Adelie is changing

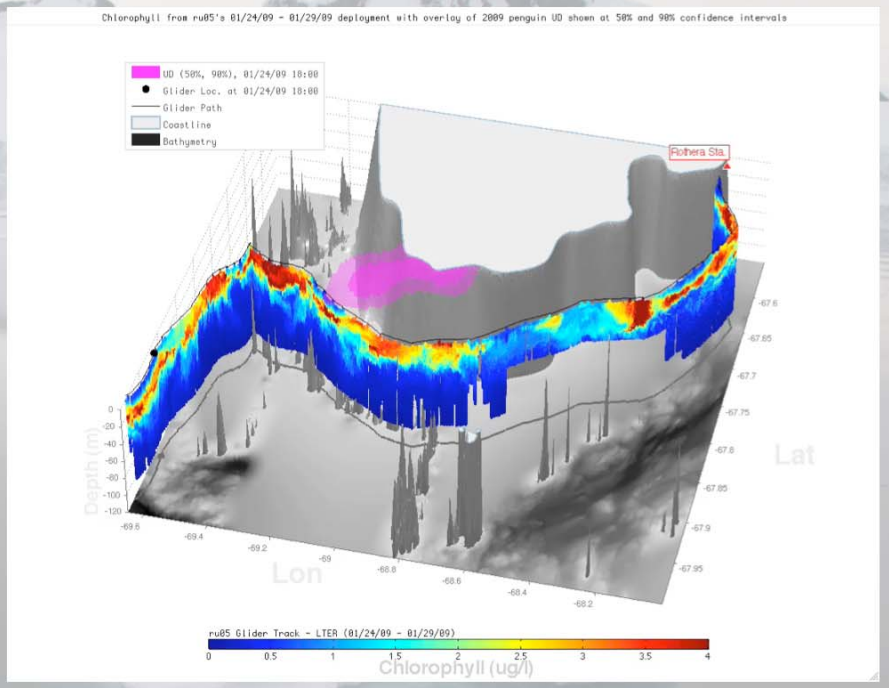
Satellite Defined Adelie Penguin Defined Environment (red) 2000–2003



Satellite Defined Adelie Penguin Defined Environment (red) 2005–2008




Temperature from ru05's 01/24/09 - 01/29/09 deployment with overlay of 2009 penguin UD shown at 50% and 90% confidence intervals
UD (50%, 90%), 01/24/09 18:00
Glider Loc. at 01/24/09 18:00
Glider Path
Coastline
Bathymetry
Rothera Sta.
Depth (m)
Lon
Lat
ru05 Glider Track - LTER (01/24/09 - 01/29/09)
Temperature (degC)

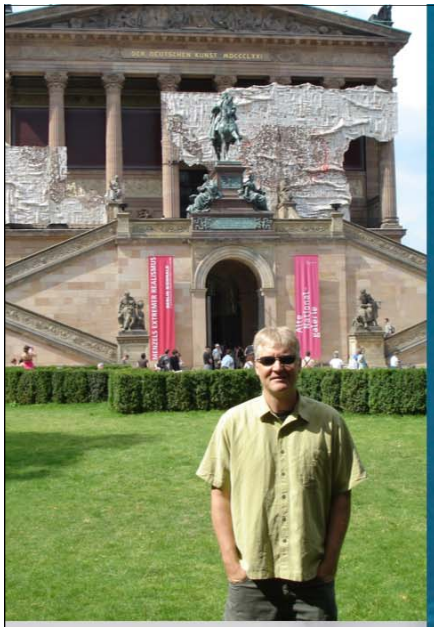

Chlorophyll from ru05's 01/24/09 - 01/29/09 deployment with overlay of 2009 penguin UD shown at 50% and 90% confidence intervals
UD (50%, 90%), 01/24/09 18:00
Glider Loc. at 01/24/09 18:00
Glider Path
Coastline
Bathymetry
Rothera Sta.
Depth (m)
Lon
Lat
ru05 Glider Track - LTER (01/24/09 - 01/29/09)
Chlorophyll (ug/l)

Glider Operations for 2009-2010 field season

5 gliders in 2010 (& 1 in Amudsen and 2 in ROSS):

-1000 m meter glider, outfitted with CTD/backscatter/fluorescence
2 missions: First glider to be deployed in late November, fly to Rothera from Palmer. Survey will be looking for warm ACC water

- Four 200 m gliders. One glider outfitted with CTD, backscatter, chlorophyll and CDOM fluorescence. They will survey the canyon area prior to the RV gould arrival. The FIRE glider will be deployed at Palmer. As well as the ADCP glider. We will also add a REMUS (coming). One on the Gould.

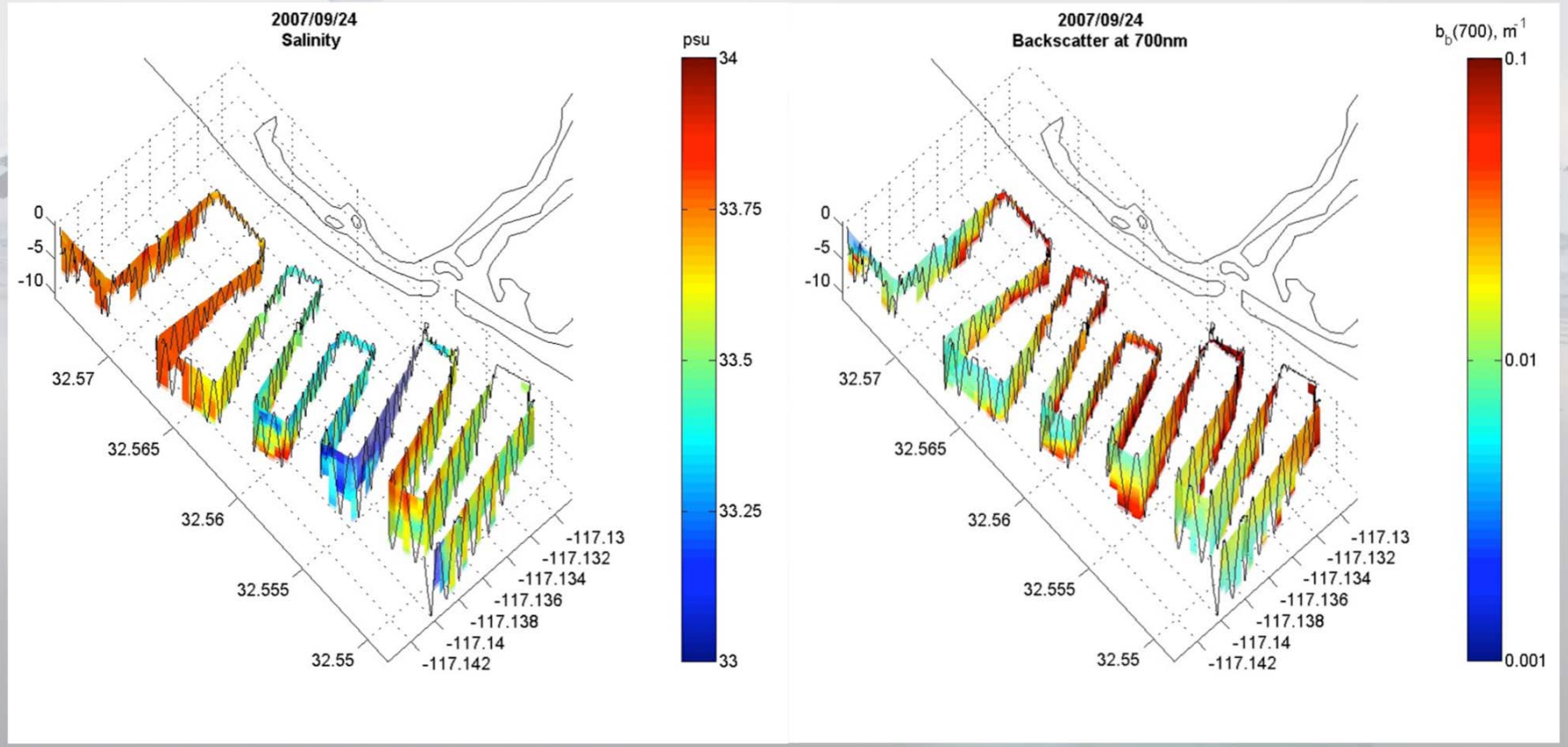


Moline SEGR :
REMUS
addition to
Palmer efforts

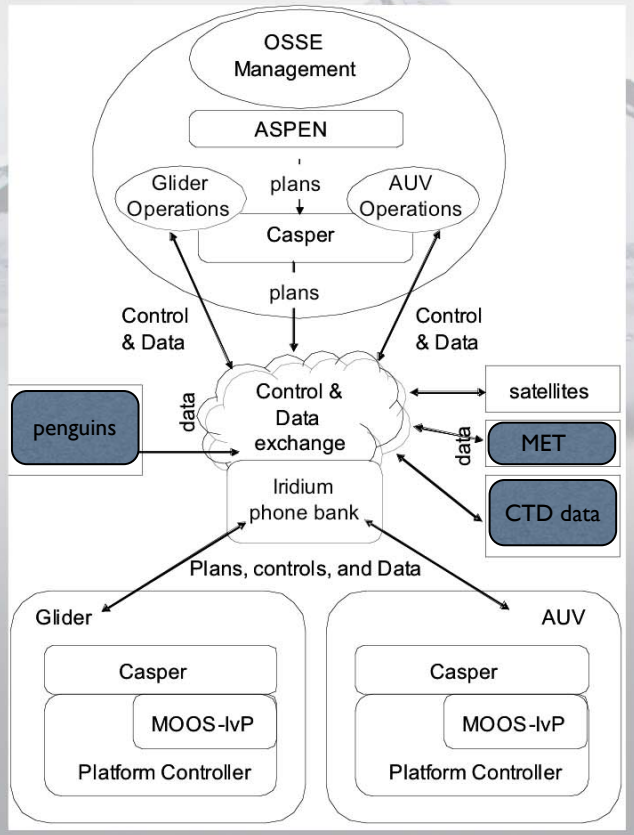
REMUS-100

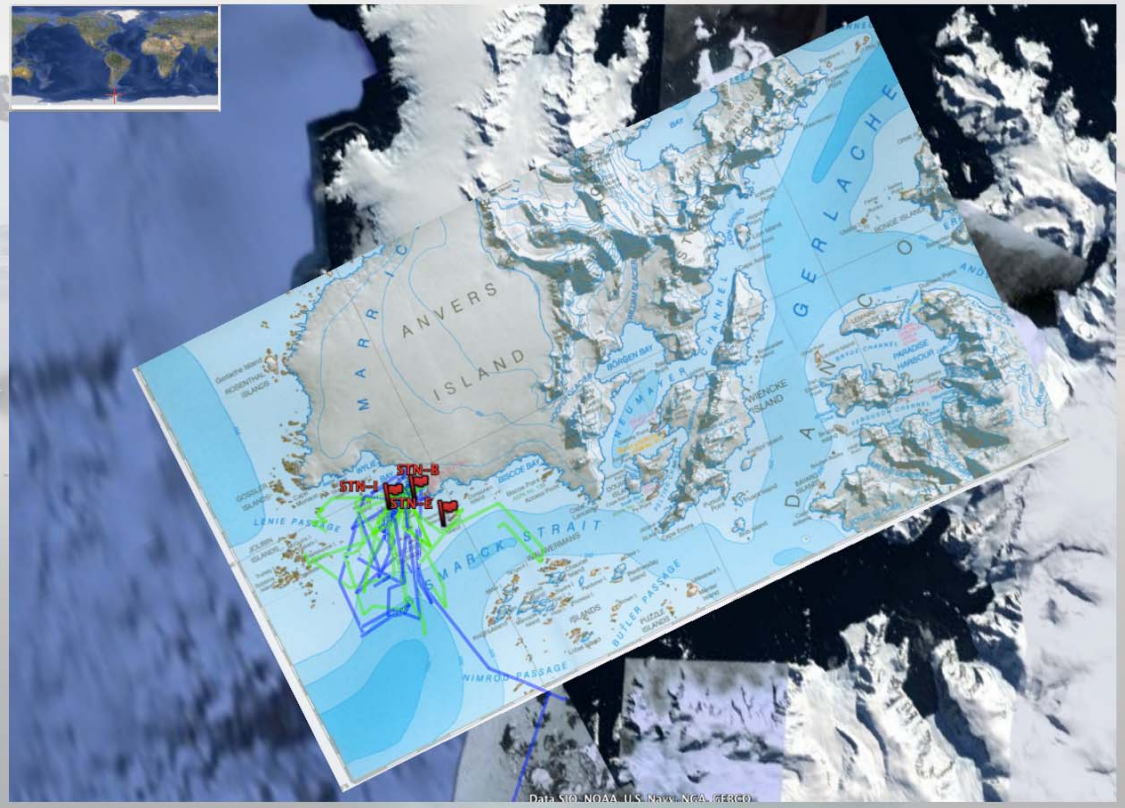
- CTD
- ADCP
- Altimeter
- Fluorometer

REMUS will provide high resolution volumetric data out over the canyon



OOI planning & prosecution cyberinfrastructure





LTER Papers efforts for 2010/2011

2009-2010 Finished Papers

Montes-Hugo, M., Doney, S. C., Ducklow, H., Fraser, W., Martinson, D., Stammerjohn, S. E., Schofield, O. 2009. Recent changes in phytoplankton communities associated with rapid regional climate change along the Western Antarctic Peninsula. Science. 323, 1470 (2009), DOI: 10.1126/science.1164533

Montes-Hugo, M., Ducklow, H., Schofield, O. 2009. Contribution by different marine bacterial communities to particulate beam attenuation. Marine Ecology Progress Series. 379: 13-22. Doi:10.3354/meps07883.

Schofield, O., Ducklow, H. W., Martinson, D. G., Meredith, M. P., Moline, M. A., Fraser, W. R. 2010. How do polar marine ecosystems respond to rapid climate change? Science 328, 1520 DOI: 10.1126/science.1185779

Montes-Hugo, M. A., Ducklow, H., Stammerjohn, S., C. Sweeney, S. Coney, D. Martinson, R. Frouin, M. Maltrud, Schofield, O. 2010. Spring wind patterns and transient changes on summer DIC and chlorophyll a concentration in surface waters of the Western Shelf of the Antarctic Peninsula. Journal of Geophysical Research. doi:10.1029/2009JC005267

Kahl, A., Fraser, W., Schofield, O. 2010. Autonomous gliders reveal water column features associated with Adélie penguin foraging. Integrative and Comparative Biology doi: 10.1093/icb/icq098

Papers in press or submitted:

Johnsen, G., Moline, M. A., Peterson, L. H., Pinckney, J., Pozdnyakov, D.V., Egeland, E. S. Schofield, O. 2010. Optical monitoring of phytoplankton bloom pigment signatures. In Phytoplankton Pigments: Updates on Characterization, Chemotaxonomy and Applications in Oceanography. Roy, S., Egeland, E. K., Llewellyn, C., Johnsen G. (Eds). Cambridge University Press, Cambridge UK. (In press)

Ducklow, H., A. Clarke, R. Dickhut, S.C. Doney, H. Geisz, K. Huang, D.G. Martinson, M.P. Meredith, H.V. Moeller, M. Montes-Hugo, O. Schofield, S.E. Stammerjohn, D. Steinberg, and W. Fraser, Marine pelagic ecosystems: the West Antarctic Peninsula, in Antarctica: An Extreme Environment in a Changing World, ed. A.D. Rogers, Wiley (In press)

Buesseler, K., McDonnell, A., Ducklow, H., Schofield, O., Steinberg, D. New evidence for higher export over the continental shelf of the Antarctic Peninsula. Geophysical Research Letters (submitted)

Martinson, D. G., Fraser, W., Jones, C., Stammerjohn, S. E., Schofield, O., Glenn, S., Kohut, J., Kerfoot, J. Climate warming impact to marine ecosystems in the northwestern Antarctic Peninsula waters: Elimination of the near-surface frigid water barrier. Journal of Geophysical Research. (to be submitted)

Papers in Prep. on my list

Schofield, O. et al. Physical forcing of phtyoplankton productivity at Palmer Station

Garzio M. et al. Bio-optics in nearshore coastal waters in Southern Ocean

Moline and Schofield Dawn in age of robotic arrays

Oliver et al. Shifting pelagic habitats for higher trophic levels along the West Antarctic Peninsula

LTER Palmer has maintained a 17 year time series along the West Antarctic Peninsula

Current team

PI Hugh Ducklow (MBL)
Bacteria-Biogeochemistry

Bill Fraser (Polar Associates)
- Penguins & Fish

Karen Baker (Scripps)
- Data management
& Informatics

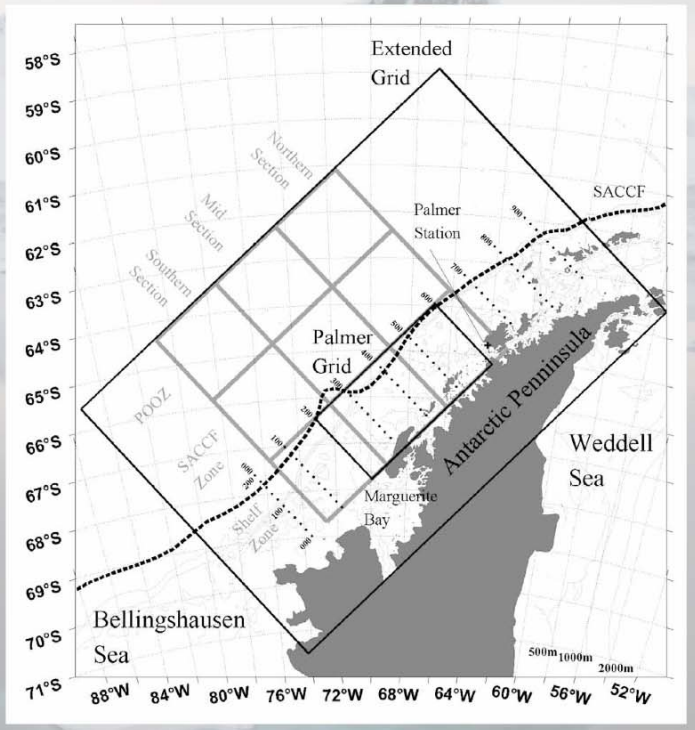
Scott Doney (WHOI)
- Ocean Modeling

Beth Simmons (Scripps)
- Education &
Outreach

Oscar Schofield (Rutgers) - Phytoplankton
Doug Martinson (LDEO) - Ocean Physics
Debbie Steinberg (VIMS) - Zooplankton

Sharon Stammerjohn (UCSC)
- Climate and Ice

Our Current grid

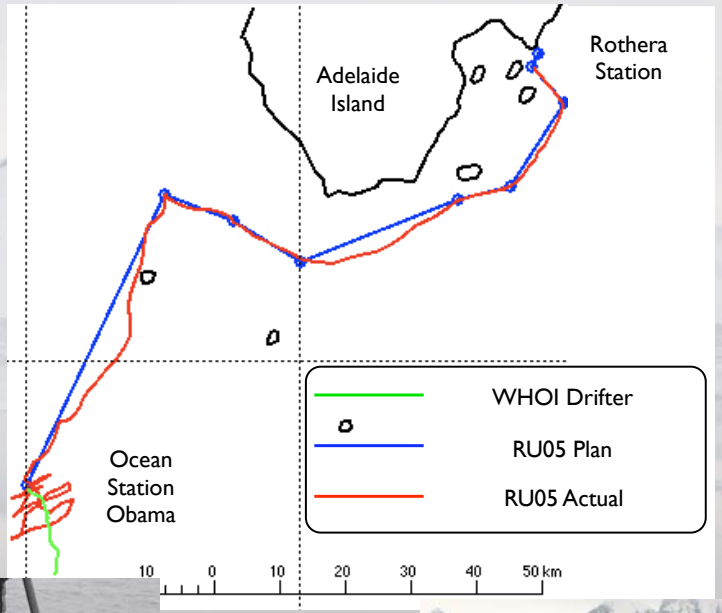


Acknowledgements to past LTER PIs: Ray Smith, Barbara Prezelin, Robin Ross, Langdon Quetin, Dave Karl, Maria Vernet, Eileen Hoffman, John Klinck

Old Day Communication

HAM Operator Coms Palmer Station 1988

Brave New Day



RV Gould

Rothera Base

Real time comms

Rutgers COOLroom