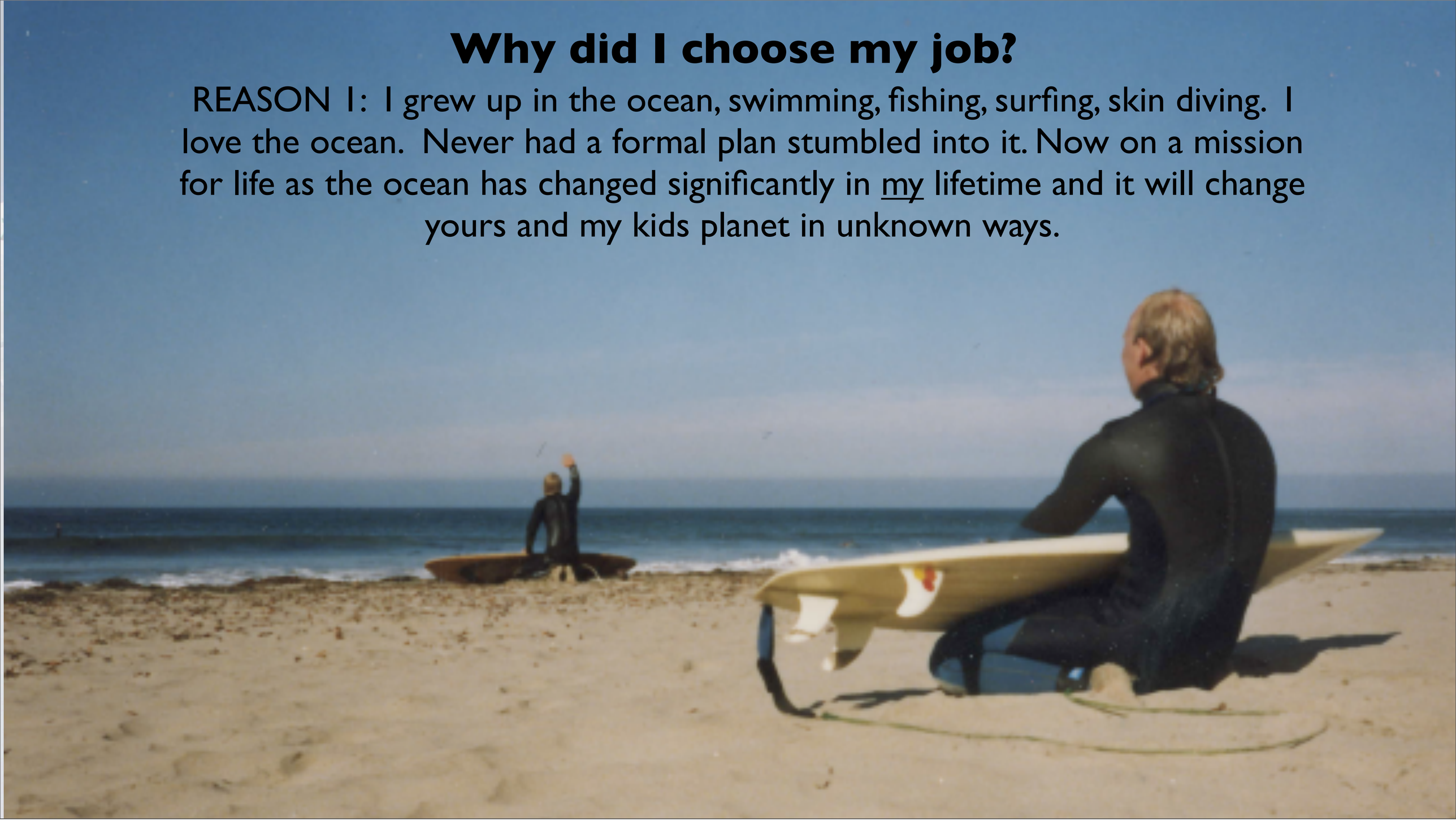
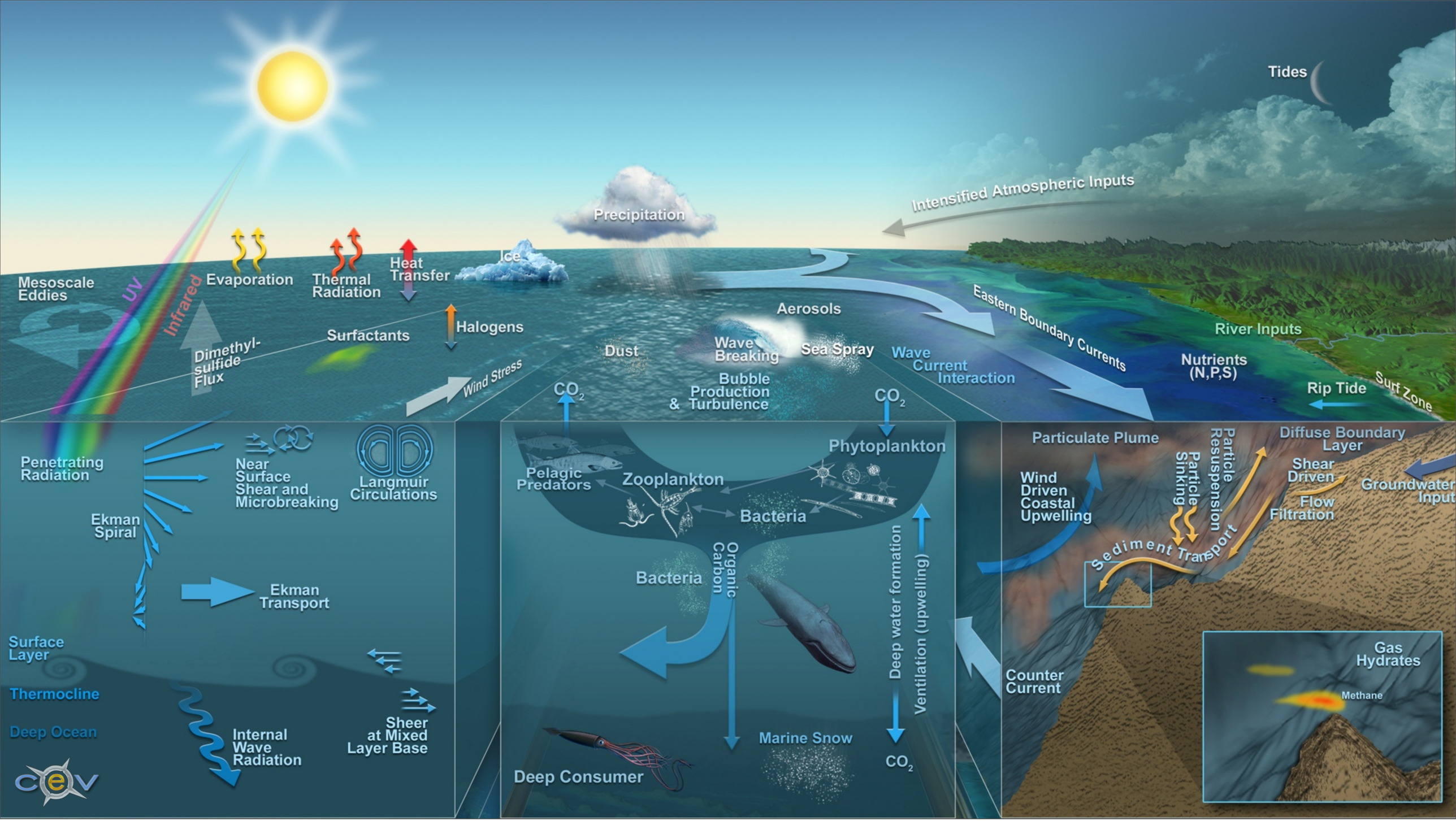
HOT DAYS ALONG THE WEST ANTARCTIC PENINSULA

thanks to Grace Saba

Why did I choose my job?

REASON 1: I grew up in the ocean, swimming, fishing, surfing, skin diving. I love the ocean. Never had a formal plan stumbled into it. Now on a mission for life as the ocean has changed significantly in my lifetime and it will change yours and my kids planet in unknown ways.




Tides
Precipitation
Intensified Atmospheric Inputs
Mesoscale Eddies
UV
Infrared
Evaporation
Thermal Radiation
Heat Transfer
Ice
Halogens
Surfactants
Dimethyl-sulfide Flux
Wind Stress
Dust
Aerosols
Wave Breaking
Sea Spray
Bubble Production & Turbulence
Wave Current Interaction
Eastern Boundary Currents
River Inputs
Nutrients (N,P,S)
Rip Tide
Surf Zone
CO_2
CO_2
Penetrating Radiation
Near Surface Shear and Microbreaking
Langmuir Circulations
Ekman Spiral
Ekman Transport
Surface Layer
Thermocline
Deep Ocean
Internal Wave Radiation
Sheer at Mixed Layer Base
Phytoplankton
Pelagic Predators
Zooplankton
Bacteria
Bacteria
Organic Carbon
Deep water formation
Ventilation (upwelling)
Marine Snow
Deep Consumer
CO_2
Particulate Plume
Wind Driven Coastal Upwelling
Particle Sinking
Particle Resuspension
Diffuse Boundary Layer
Shear Driven
Flow Filtration
Groundwater Input
Sediment Transport
Counter Current
Gas Hydrates
Methane

Spreading Mid-Ocean Ridges
Microbes & Deep Biosphere
Crustal Magma Chamber
Down flow zones
Brittle-Ductile Boundary
Heat Source
Magma Generation
Topographic Turbulence
Hydrothermal Recharge
Deep-Sea Ecology
Hydrothermal Discharge
Benthic/Pelagic Exchange
Sediments
Ocean Crustal Aquifer
Lithospheric Heat
Updip Limit
Accreted Sediments
Shallow Earthquakes
Locked Zone
Downdip Limit
Free Sliding
Deep Earthquakes
Ocean Crust
Lithosphere
Subduction Zone
Continental Crust
Asthenosphere
Crust
Mantle
Liquid Outer
Melting
Mantle Convection
Thursday, August 1, 13

Global Carbon Cycle

Photosynthesis

Respiration

Gas Exchange Between
Air and Ocean

Net Accumulation
in Ocean

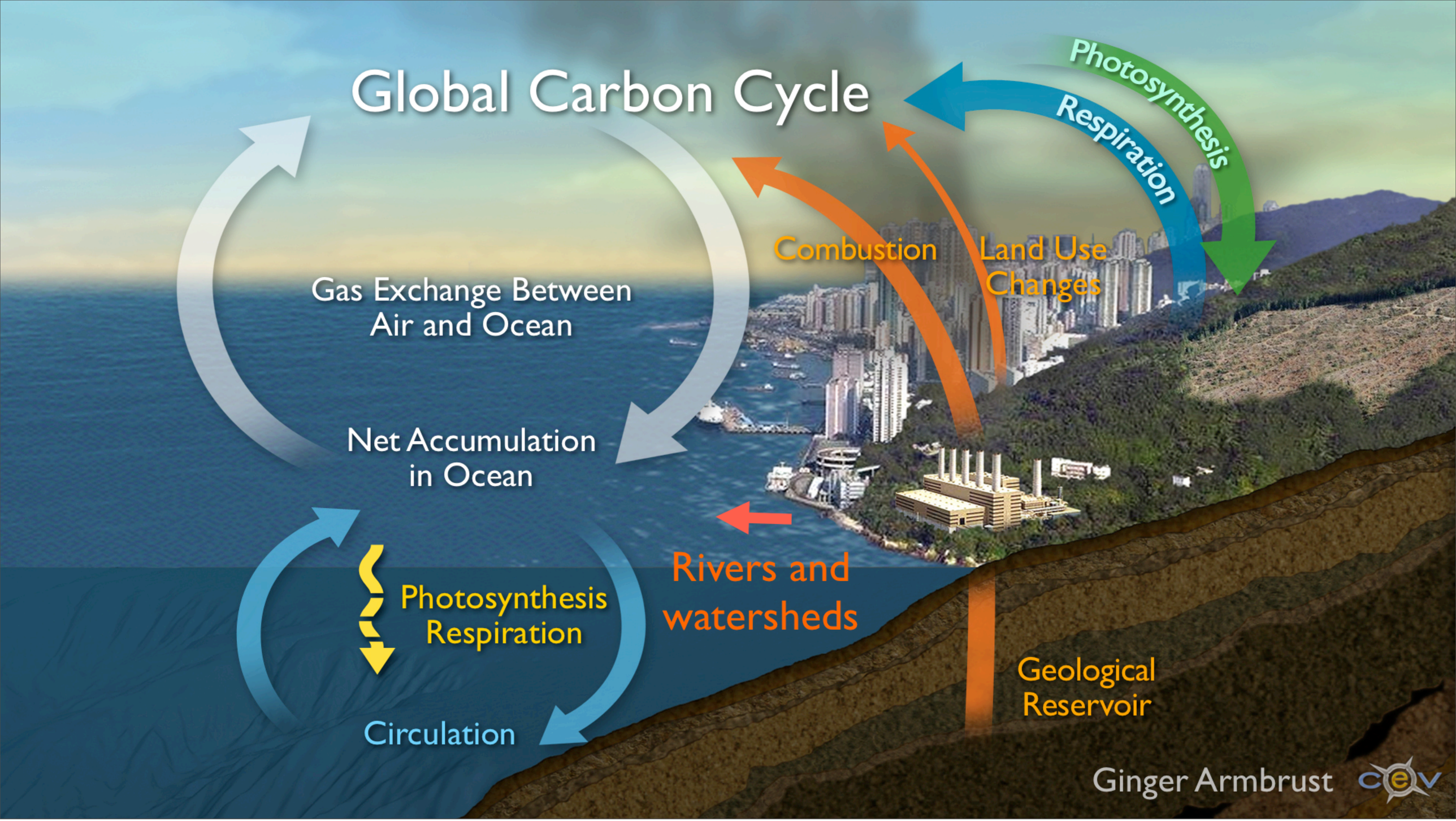
Rivers and
watersheds

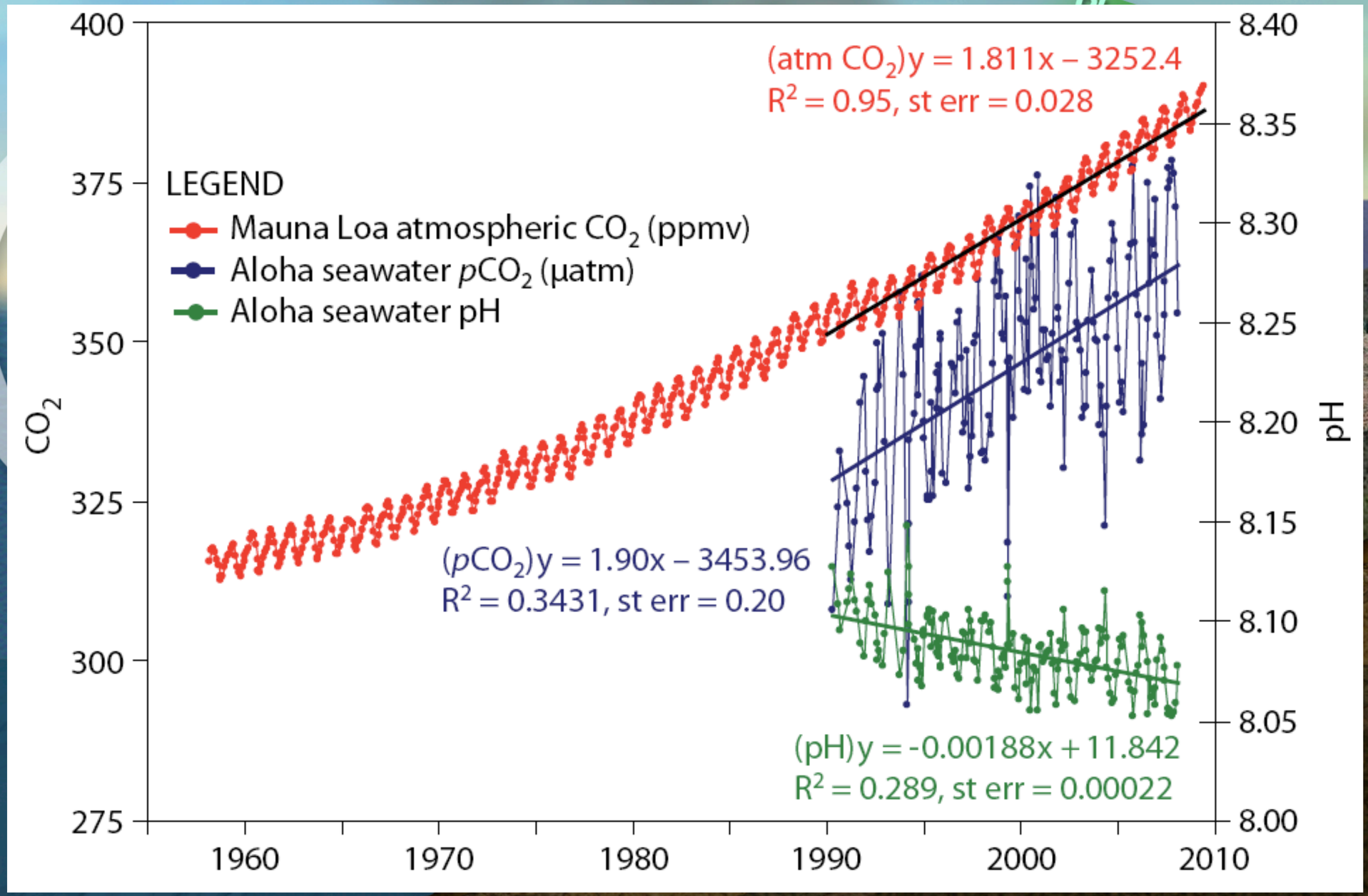
Photosynthesis
Respiration

Circulation

Ginger Armbrust

Global Carbon Cycle





Ginger Armbrust

The man!

Polar Biol (1992) 11:525–531

Polar Biology
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Increases in Antarctic penguin populations: reduced competition with whales or a loss of sea ice due to environmental warming?

William R. Fraser*·, Wayne Z. Trivelpiece*, David G. Ainley and Susan G. Trivelpiece***

Point Reyes Bird Observatory, 4990 Shoreline Highway, Stinson Beach, CA 94970, USA

Received 25 June 1991; accepted 6 August 1991

Summary. A central tenet of Antarctic ecology suggests that increases in Chinstrap Penguin (*Pygoscelis antarctica*) populations during the last four decades resulted from an increase in prey availability brought on by the decrease in baleen whale stocks. We question this tenet and present evidence to support the hypothesis that these increases are due to a gradual decrease in the frequency of cold years with extensive winter sea ice cover resulting from environmental warming. Supporting data were derived from one of the first, major multidisciplinary winter expedition to the Scotia and Weddell seas; recent satellite images of ocean ice cover; and the analysis of long-term surface temperature records and penguin demography. Our observations indicate there is a need to pay close attention to environmental data in the management of Southern Ocean resources given the complexity of relating biological changes to ecological perturbations.

Introduction

Populations of many krill-eating, Southern Ocean predators have exhibited significant changes during the last four decades. Notable among these, have been increases in the abundance of Chinstrap Penguins (*Pygoscelis antarctica*), which breed mainly on the Antarctic Peninsula and islands of the Scotia Sea (Watson 1975). At many colonies, numbers have increased 6–10% per annum (Laws 1985), and at some localities fivefold increases have occurred in the last 20 years (Rootes 1988). Chinstraps have also expanded their range southward along the western side of the Antarctic Peninsula (Parmelee and Parmelee 1987; Poncet and Poncet 1987) into areas historically dominated by the closely related adelie Penguin (*P. adeliae*; Fig. 1). A central tenet of Antarctic ecology explains these population changes in terms of a presumed increase in food availability that resulted from the decrease in baleen whale stocks due to commercial whaling (Sladen 1964; Emison 1968; Conroy 1975; Croxall and Kirkwood 1979; Croxall and Prince 1979; Croxall et al. 1984). This tenet is based on the fact that the dominant component in the summer diets of both Chinstraps and whales is the Antarctic krill (*Euphausia superba*). Although this tenet has been widely accepted, the possible mechanism by which a decrease in whales could have led to an increase in Chinstraps has not been questioned (cf. Horwood 1980). Indeed, the long-standing view has simply been that whaling led to a "krill surplus" that was used by krill-eating predators when competitive release altered the existing patterns of consumption (Laws 1985).

Although this whale reduction hypothesis has clearly been useful in guiding research on trophic interactions in the Southern Oceans, it is now apparent that increases in Chinstrap populations have not been mirrored by their sympatric, most closely related congener, the Adelie Penguin. Adelies share a significant portion of their range on the Antarctic peninsula and islands of the Scotia Arc with Chinstraps (Watson 1975). Alike in size and general appearance, both exhibit broad ecological similarities, not the least of which is a predominance of krill in their summer diets (Volkman et al. 1980; Trivelpiece et al. 1987, 1990; Trivelpiece and Trivelpiece 1990). Yet, when compared to Chinstraps, population increases in Adelies have not been as substantial, and at many sites appear to represent nothing more than recovery after human disturbance and exploitation (Poncet and Poncet 1987). Adelies, in fact, have declined noticeably at several localities on the Antarctic Peninsula, a change considered "unexplainable" by Poncet and Poncet (1987). This raises an interesting challenge to the whale reduction hypothesis: If the decrease of baleen whale stocks actually led to a krill surplus, why have populations of the ecologically similar Adelies residing in the same geographical areas shown such different responses?

Here we propose that the answer to this question does not rest with the idea of a krill surplus. Instead, we suggest

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Offprint requests to: W. R. Fraser

Key point: If the decimation of baleen whale populations did in fact lead to a "krill surplus", why were krill-dependent , top predator populations exhibiting such dichotomous trends?

The man!

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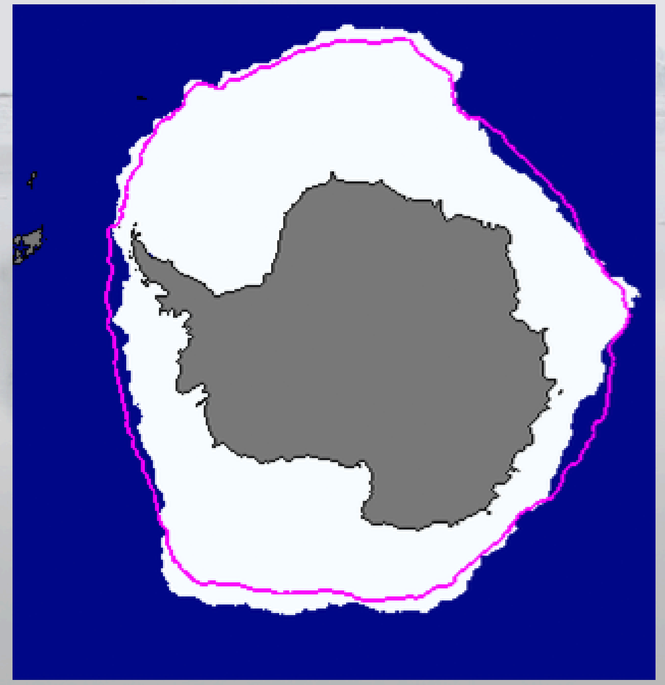
"...the day bird people have something to tell us about climate warming is perhaps the day logic in climate science is abandoned..."

Anonymous Reviewer, Nature

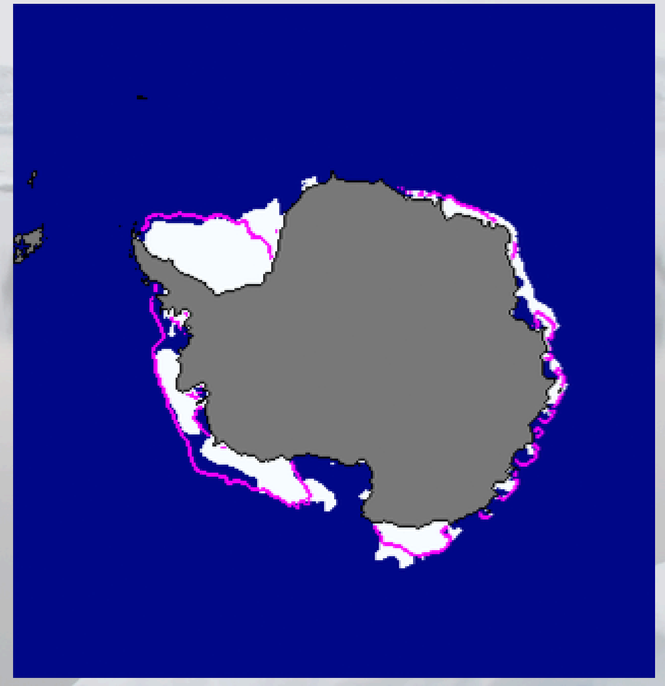
"...a paper that creates this kind of controversy should be positive for science and the journal..."

G. Hempel, Editor, Pol. Biol.

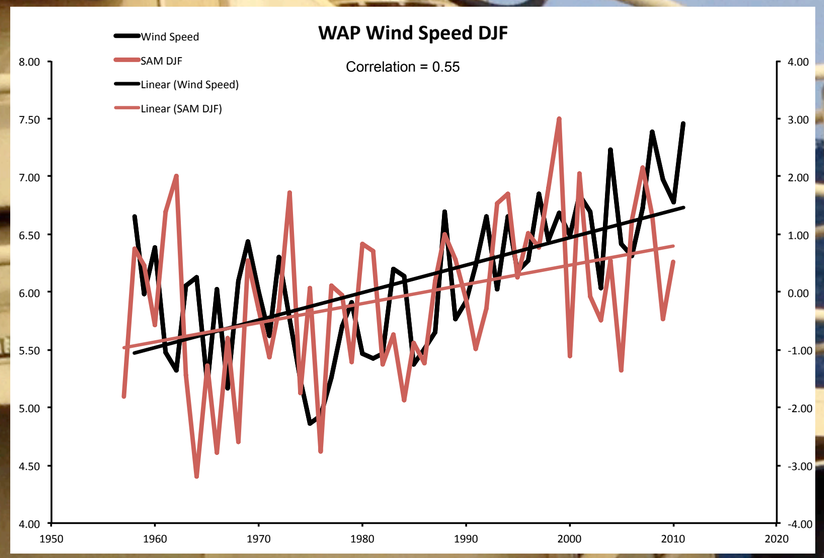
The central hypothesis when the LTER began was that sea ice timing and magnitude structure the productivity and composition of the Antarctic ecosystem. The ice dynamics are driven by large-scale interactions of the atmosphere and ocean.

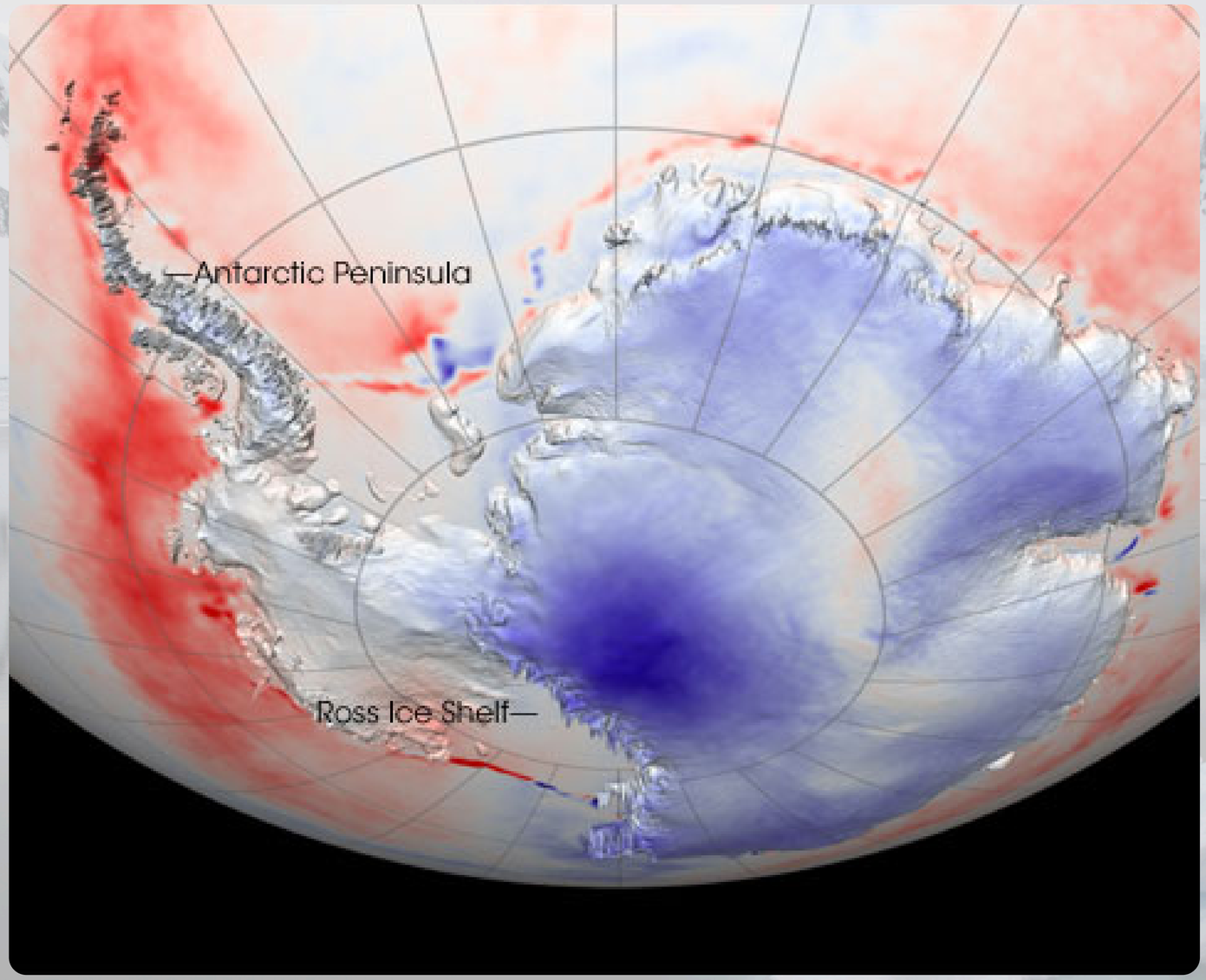


Winter 2007



Summer 2007


WAP Wind Speed DJF
Correlation = 0.55
Wind Speed
SAM DJF
Linear (Wind Speed)
Linear (SAM DJF)
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
1950
1960
1970
1980
1990
2000
2010
2020

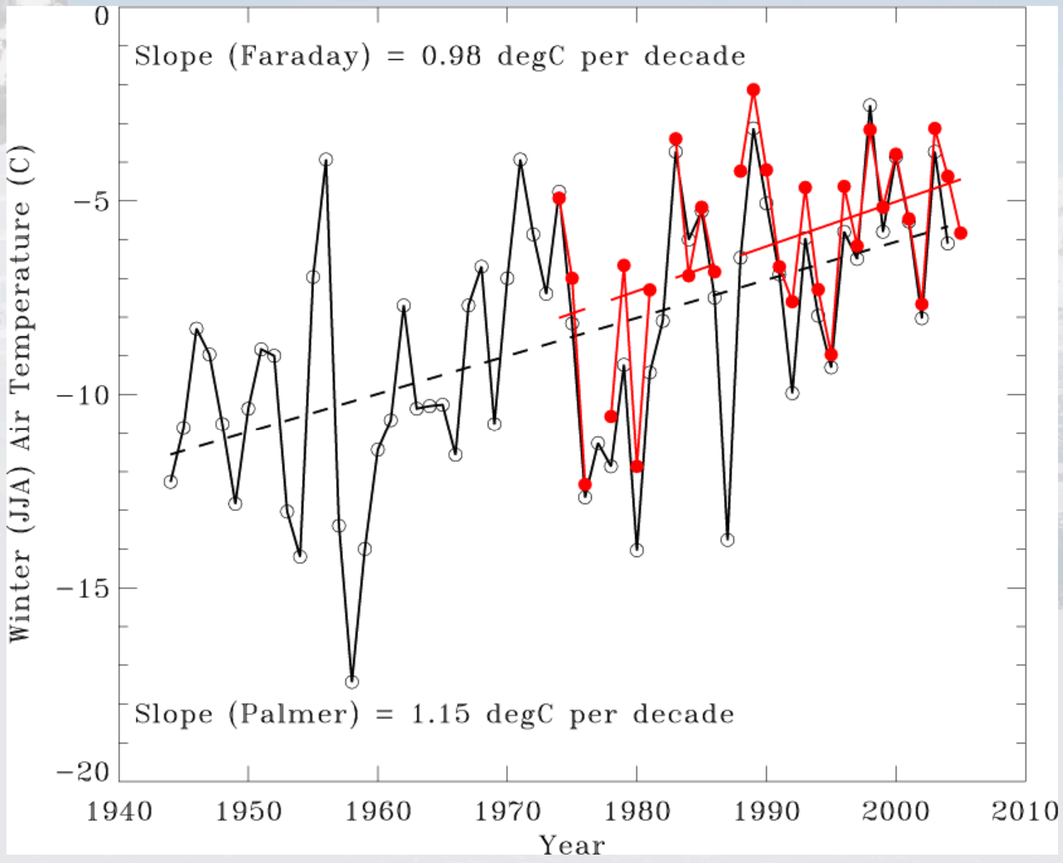


Temperature Trends (degrees C per year)

-0.2 0.2

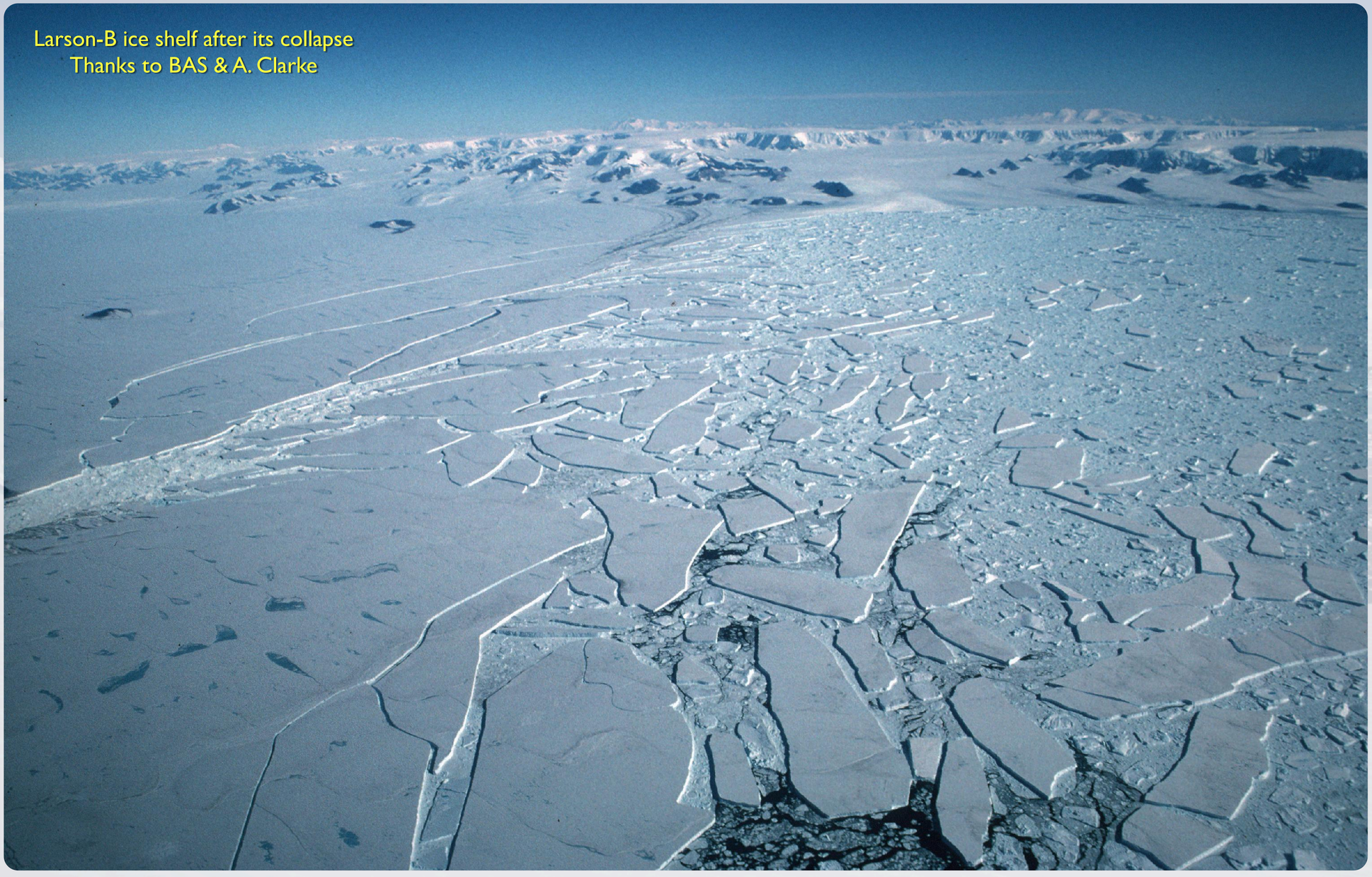
The WAP peninsula is experiencing the largest winter warming on Earth

Mean Winter Temperatures



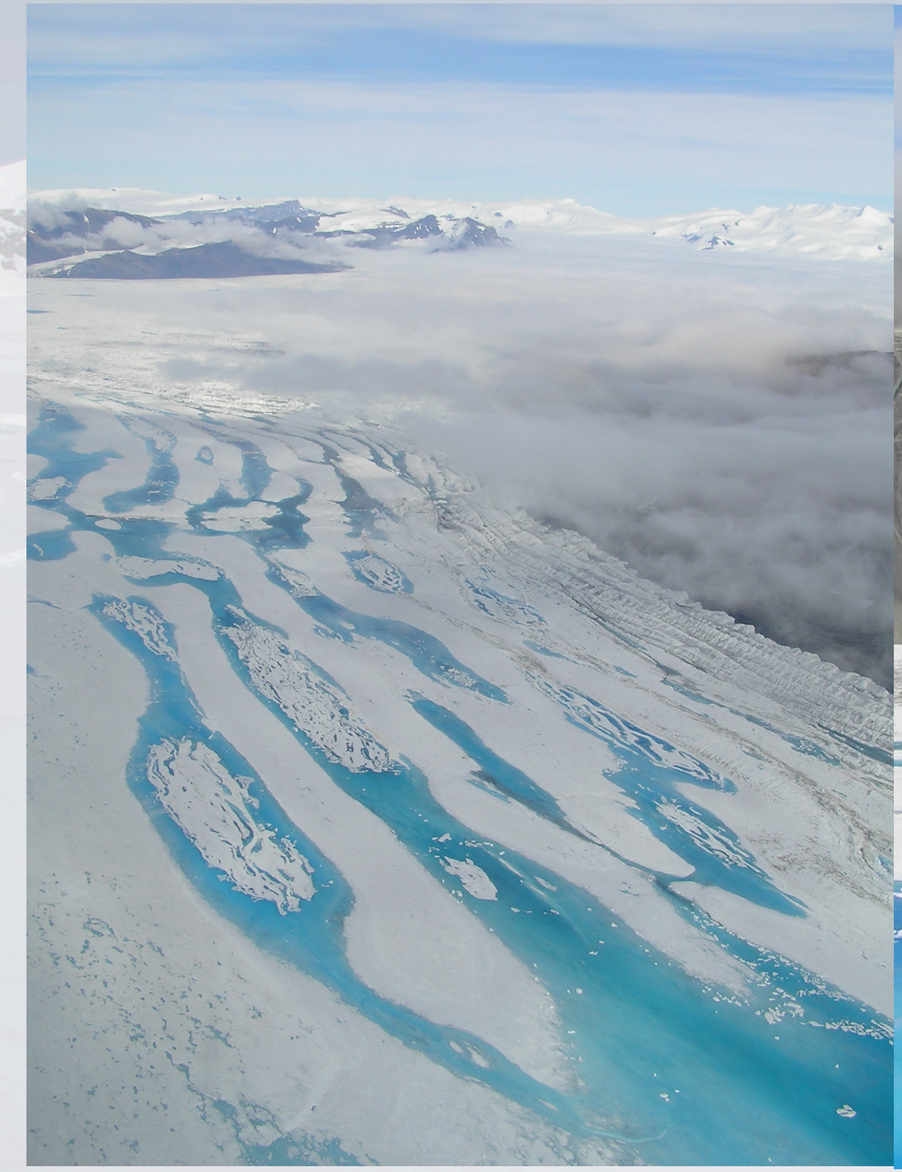
Black is British Faraday & Ukraine Vernadsky Station
Red is US Palmer Station

The WAP peninsula is experiencing the largest winter warming on Earth

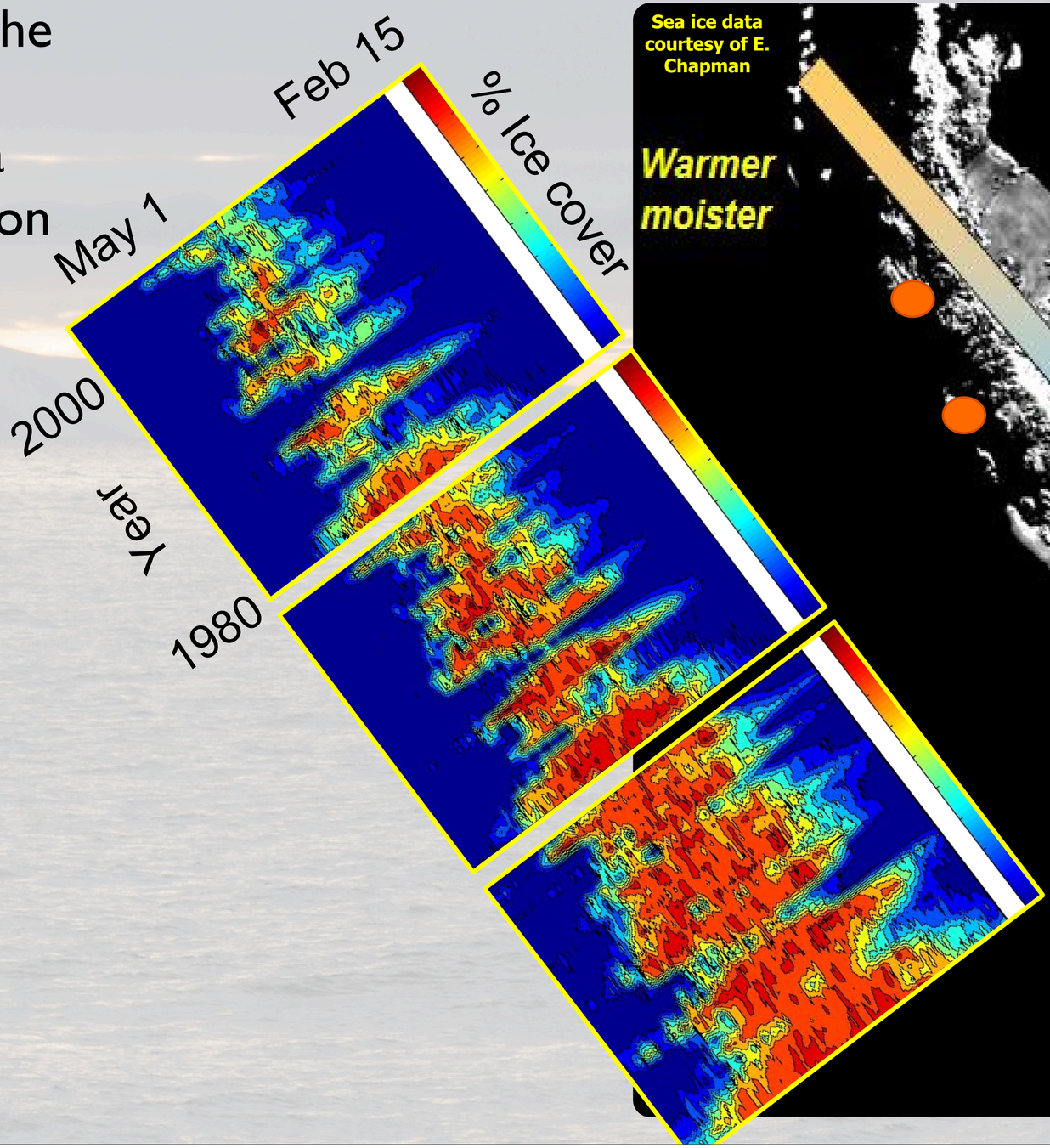


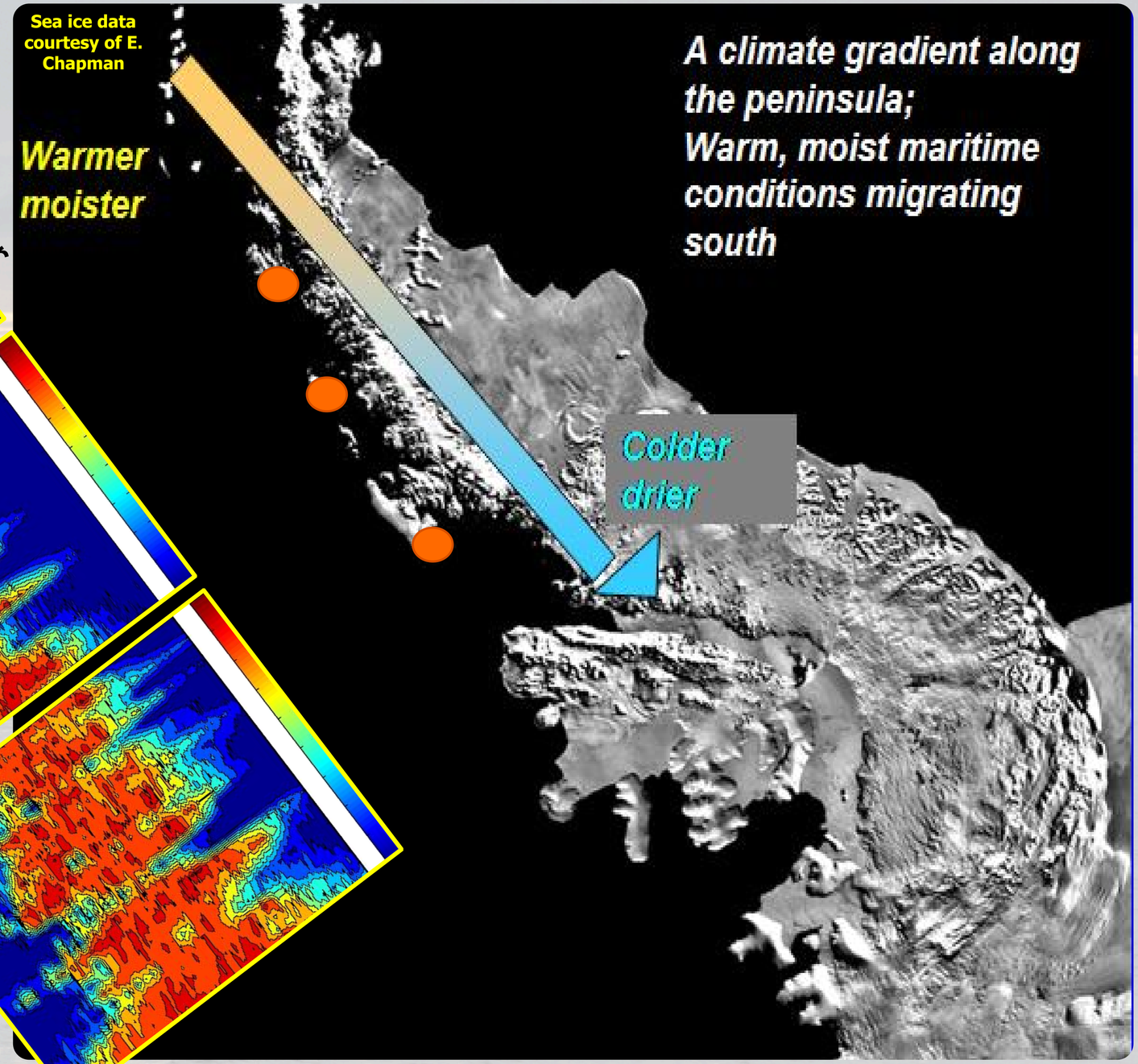
Melt pools on surface of King George VI Sound

(from a BAS twin otter, January 2004)



Seasonal ice has declined over the few decades resulting to a climate migration to the South





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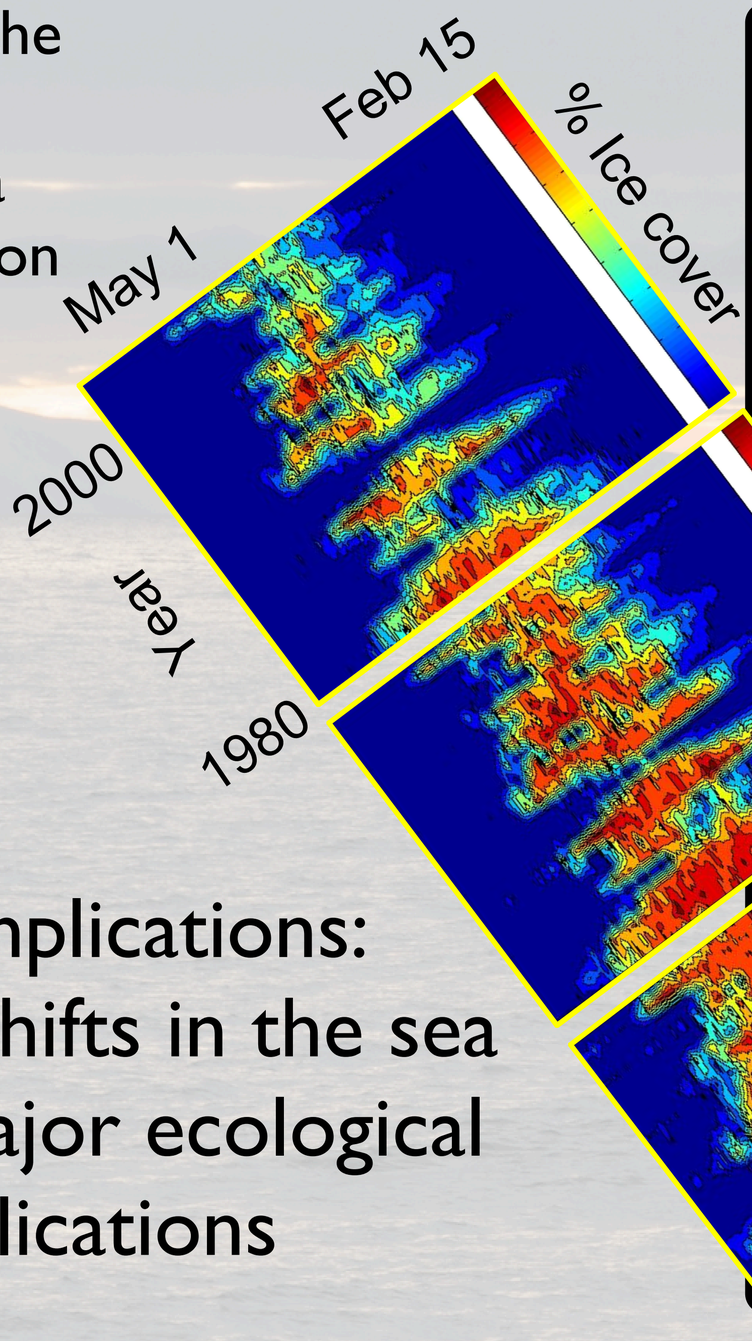
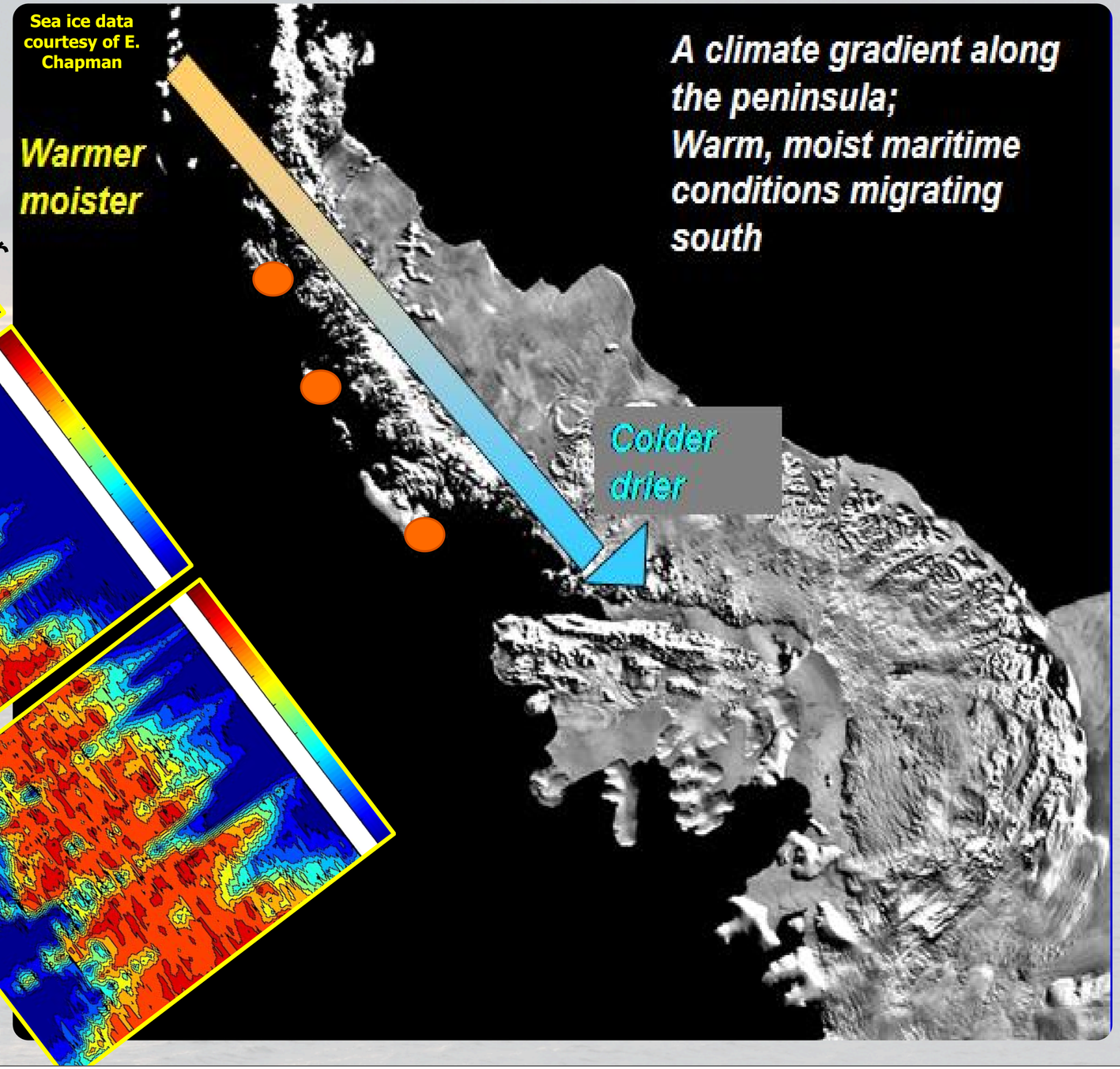




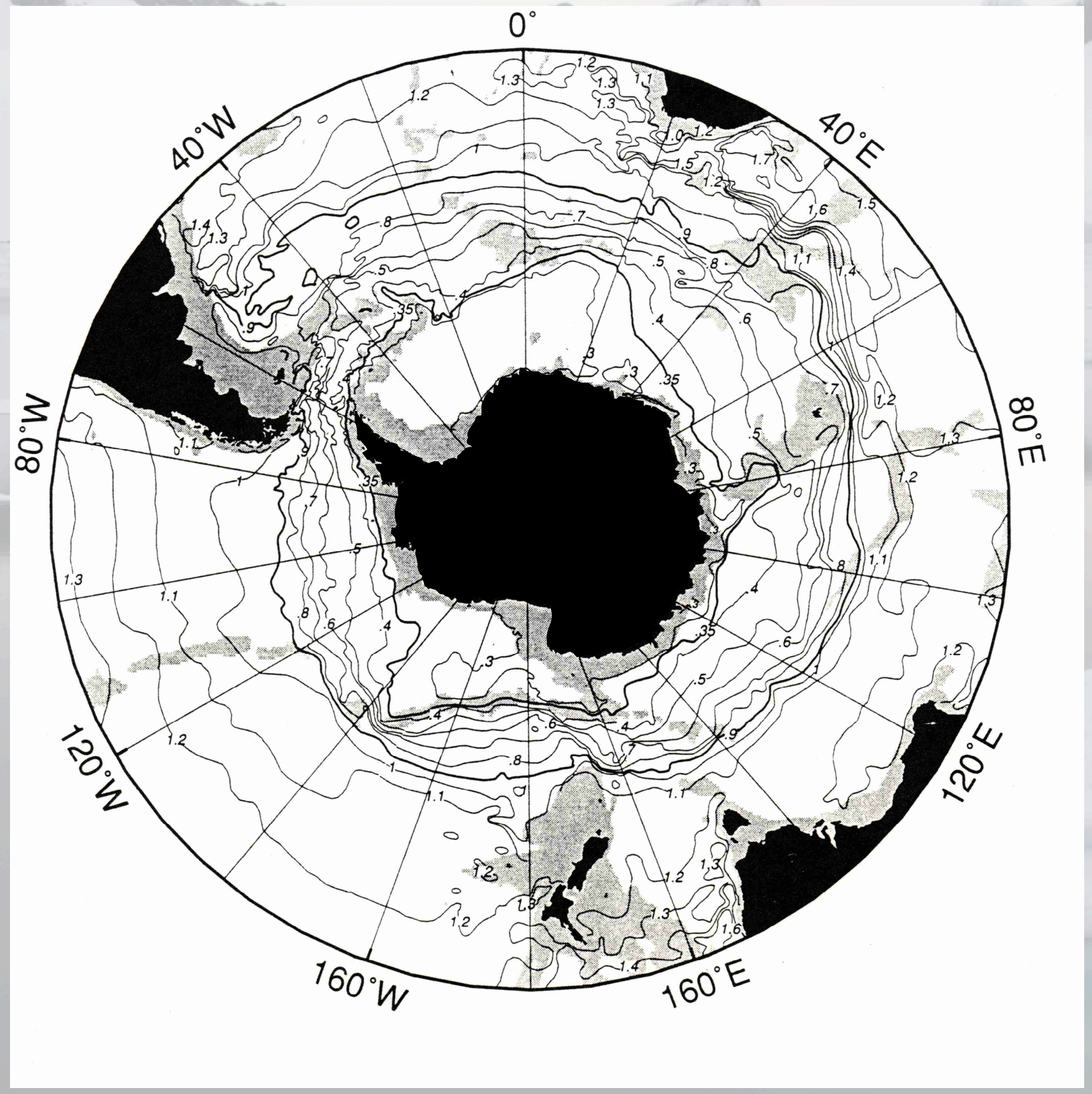
Key Implications:
Regional shifts in the sea ice has major ecological implications

Palmer Station in the present

photo by Bill Fraser

Plants at Palmer Station, the greening of Antarctica

Heat input from Antarctic Circumpolar Current (ACC - world's largest ocean current = ~30,000 Niagara Falls). The heat is driven onto the shelf by intensification of upwelling-favorable winds.



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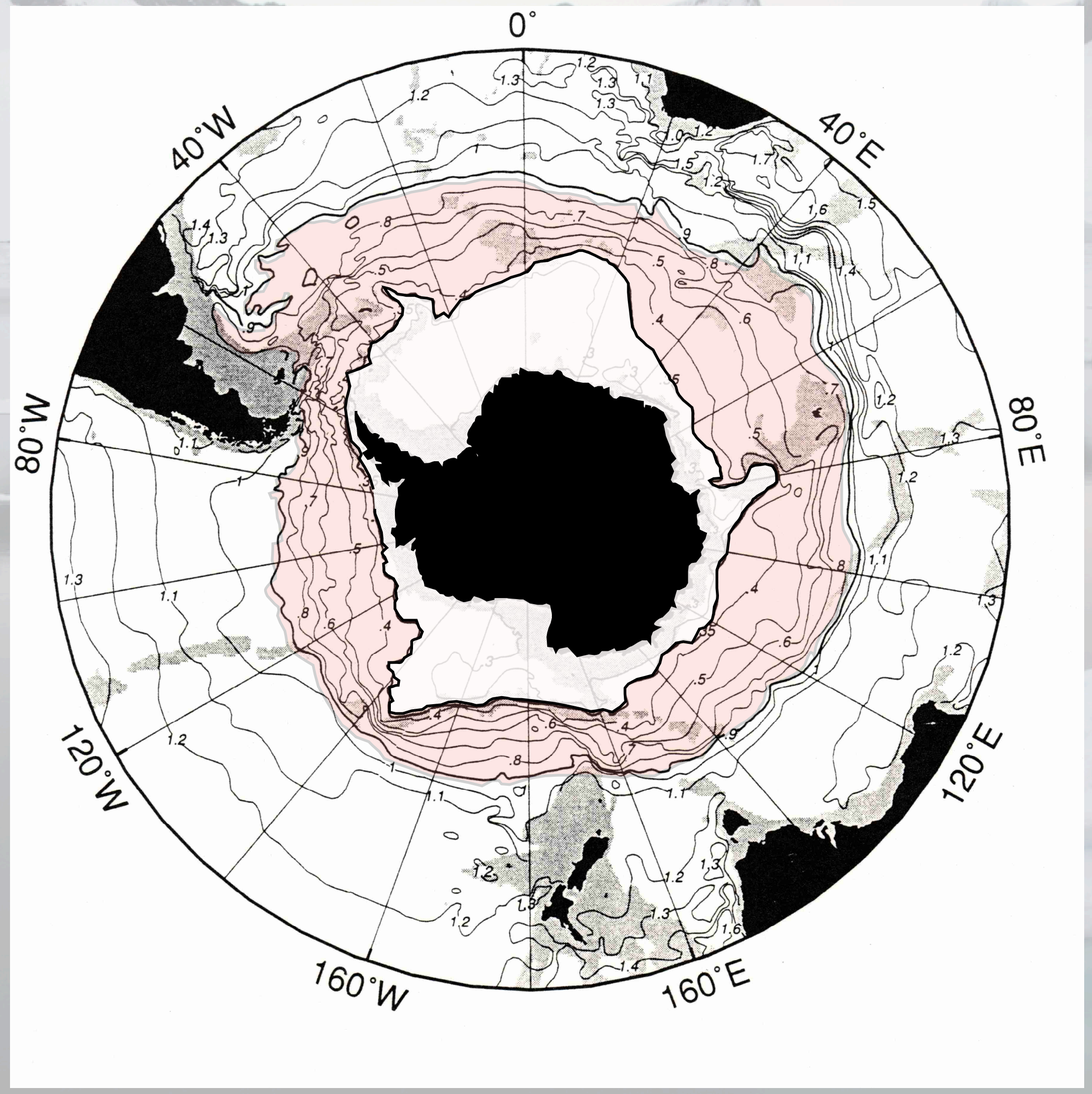

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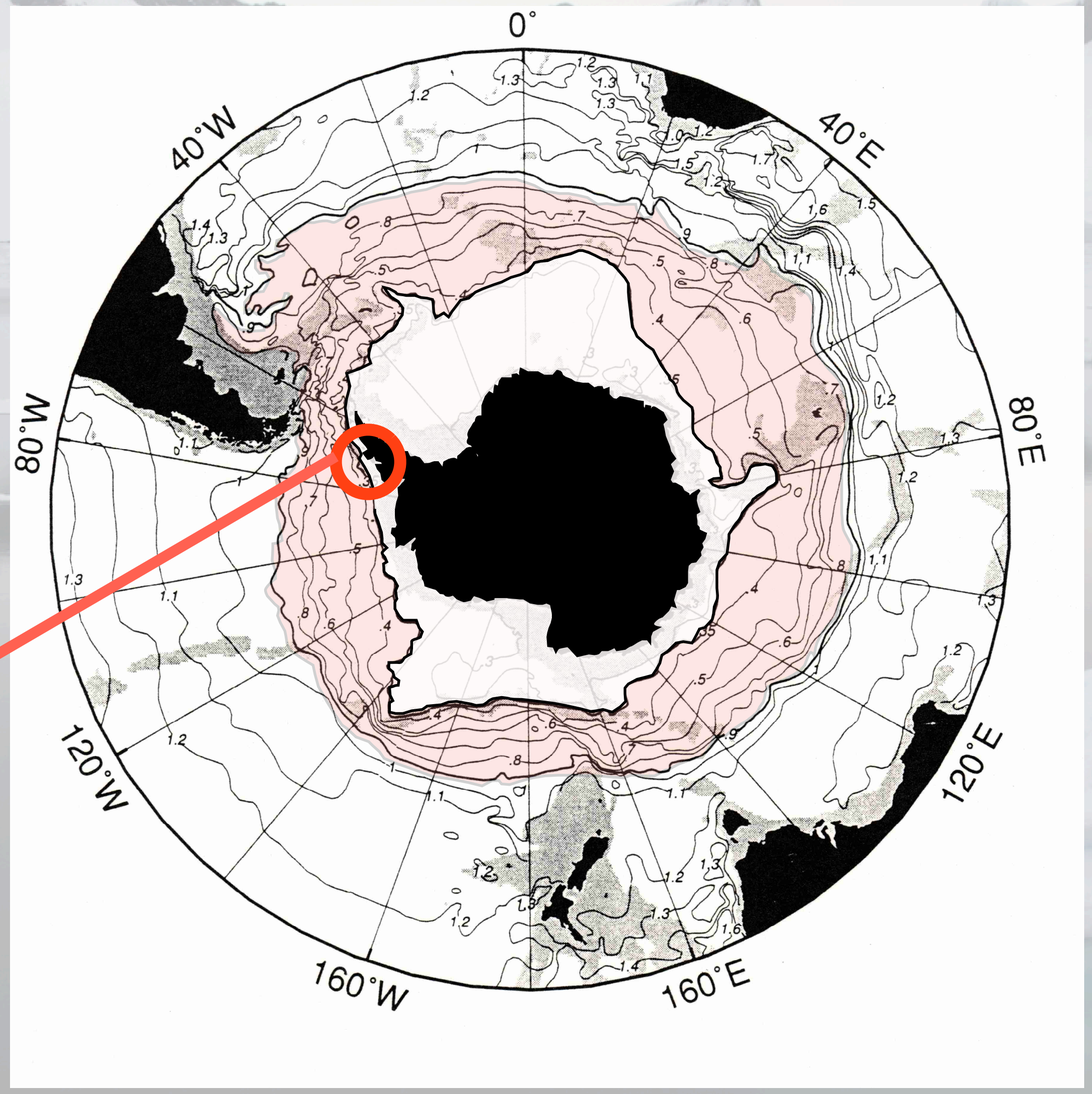
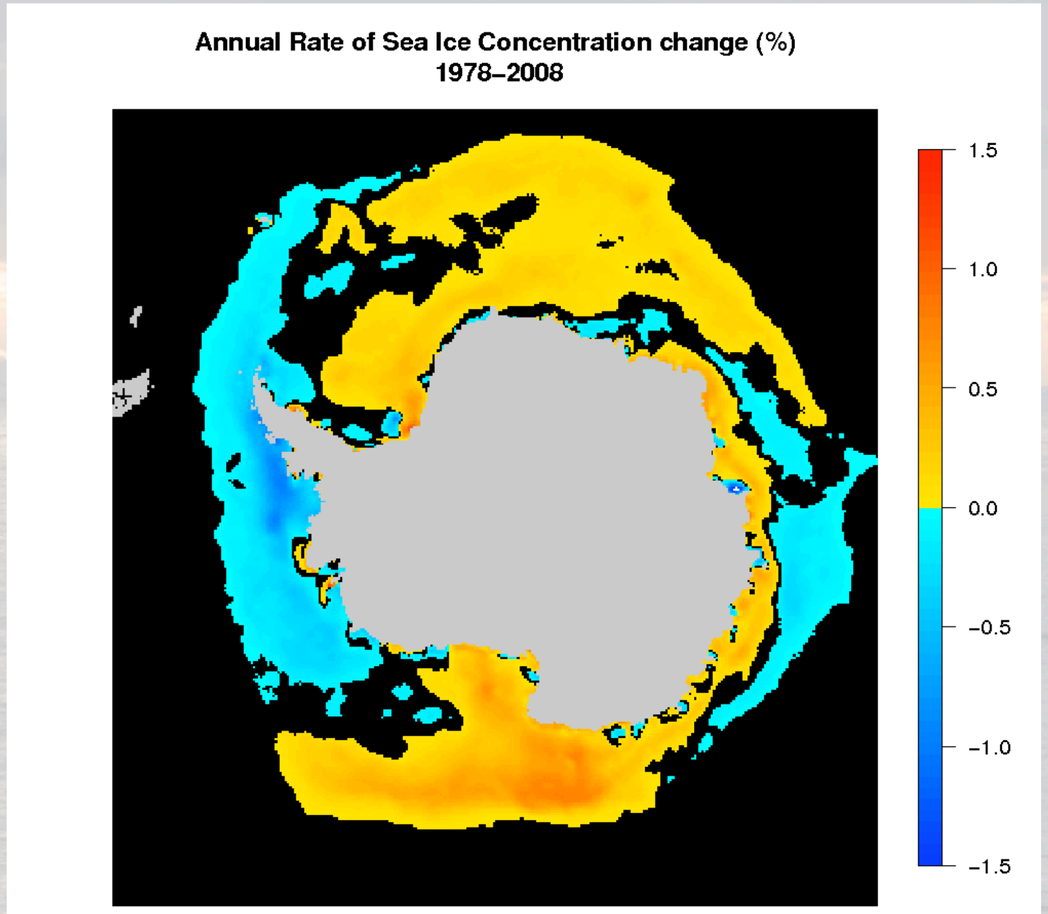
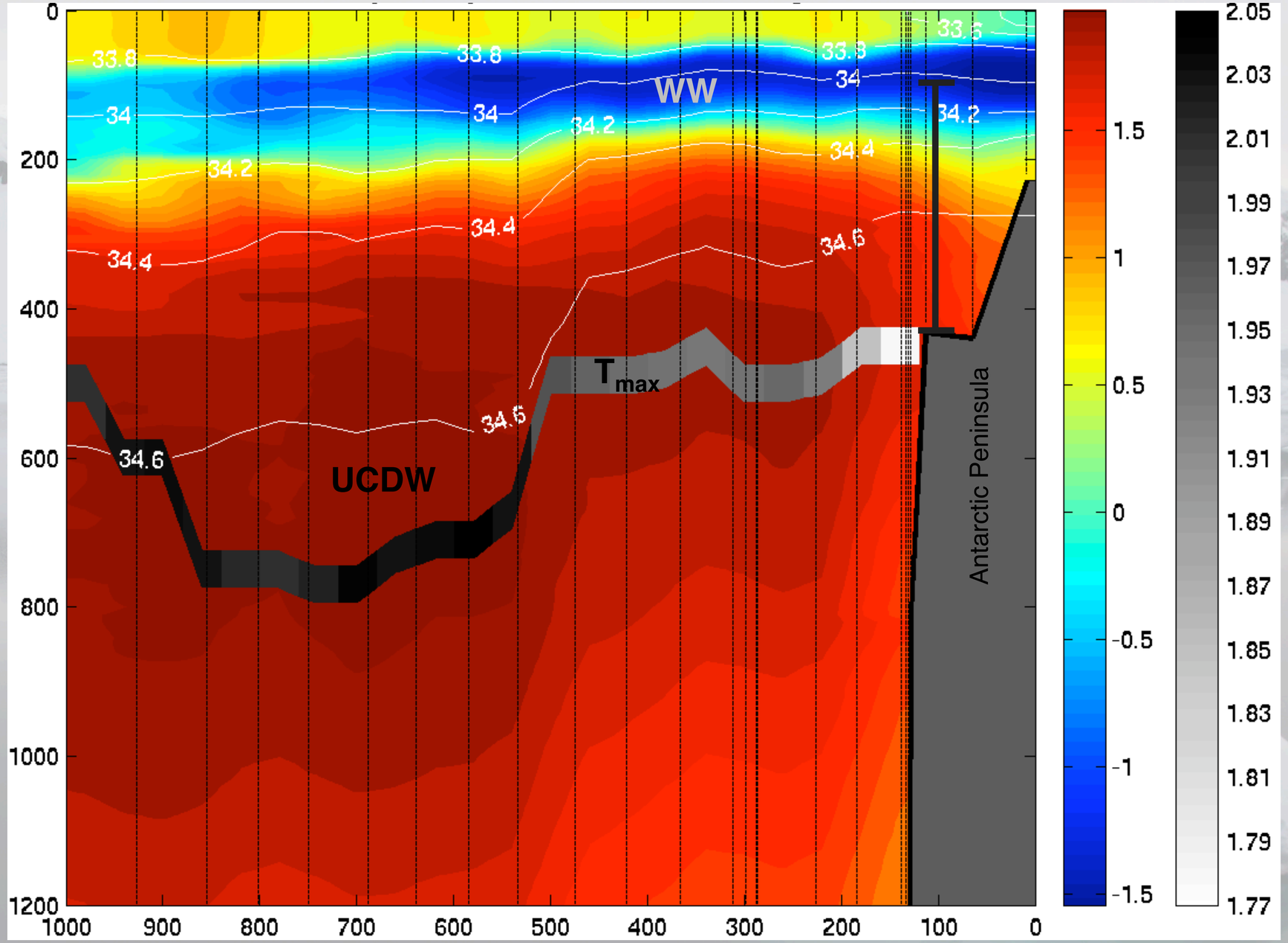


The WAP is the only location in the Antarctic where the ACC is adjacent to the shelf break. The ACC is Antarctica's warmest water

10 year analysis annual trends



ice decline



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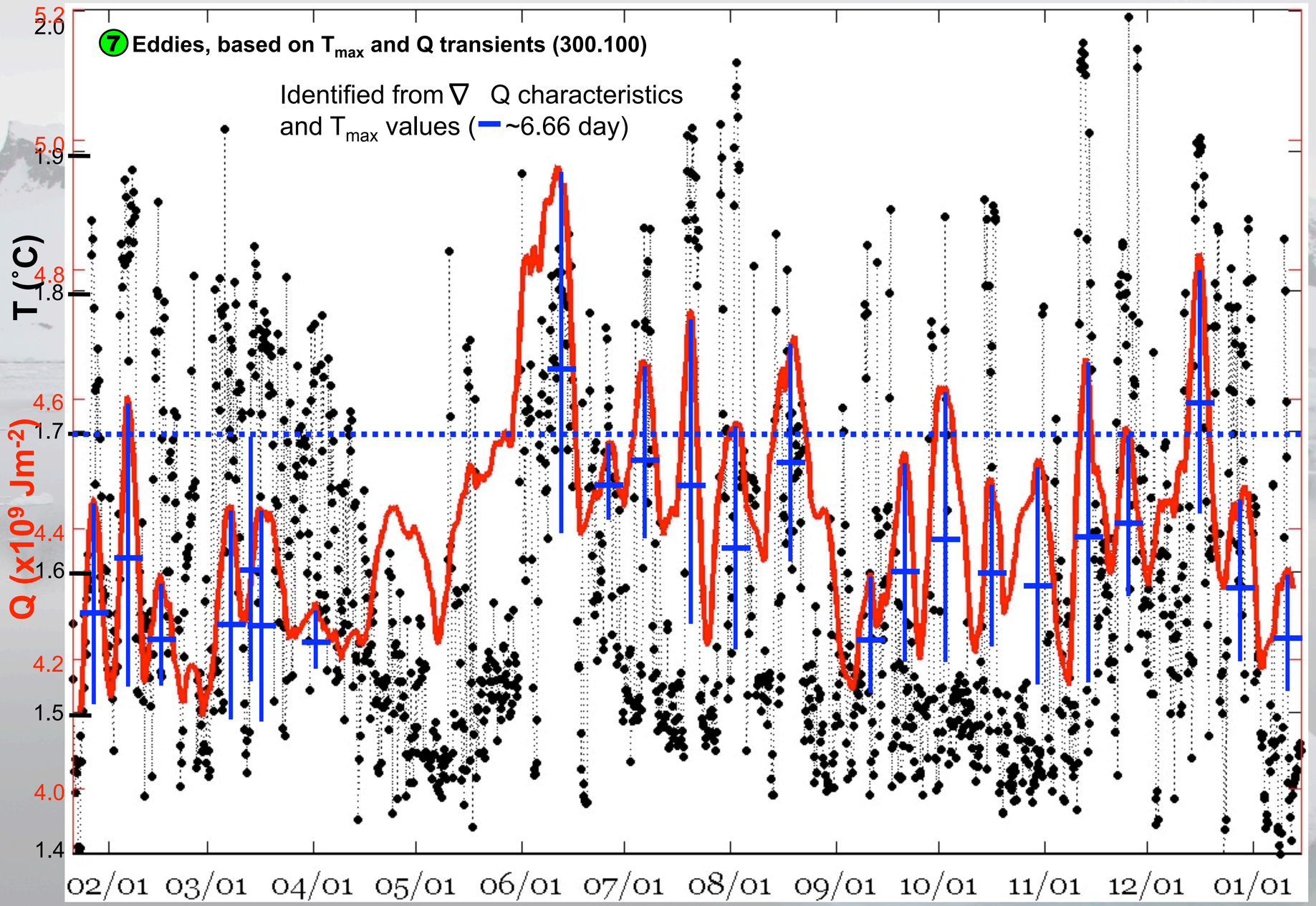

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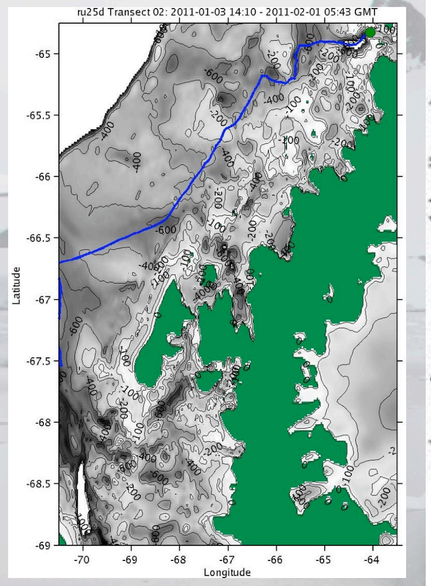
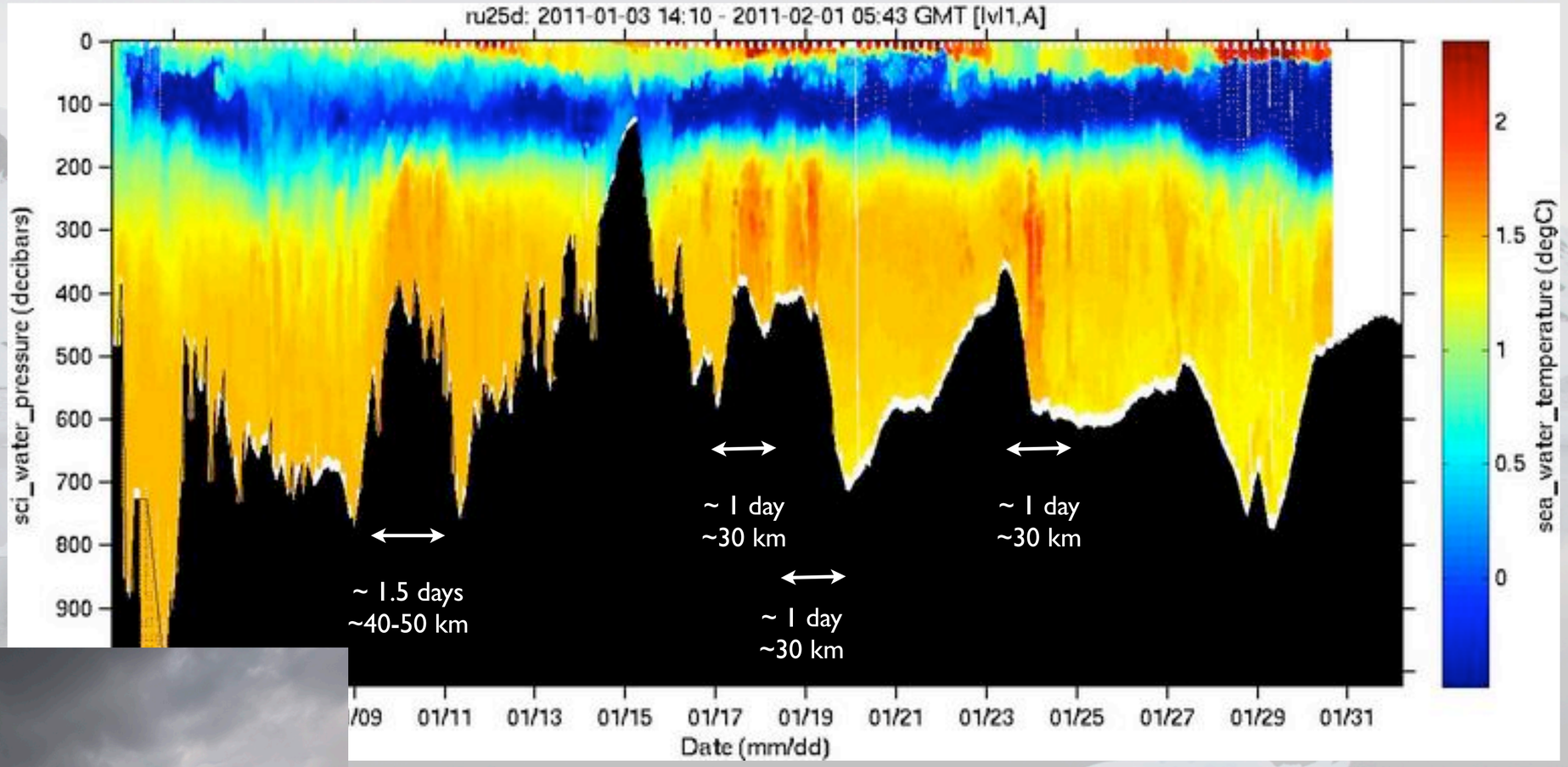
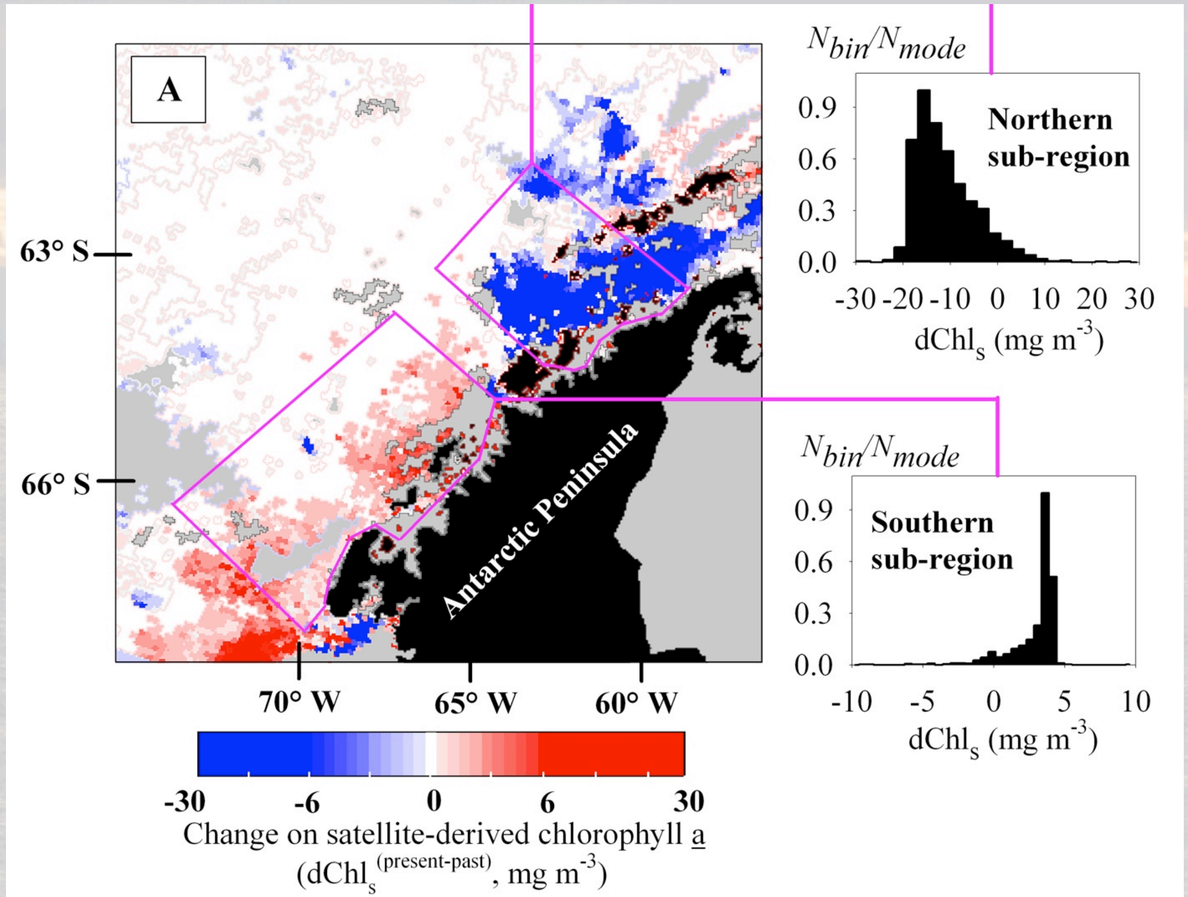


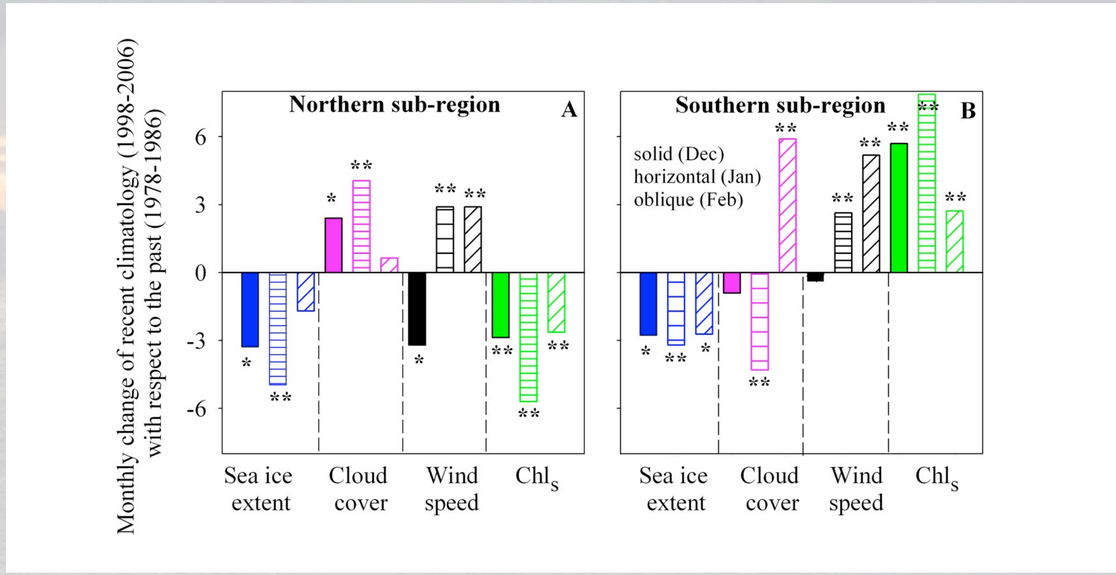


2011: Eddies moving across shelf?

The decadal changes have resulted changes in the phytoplankton

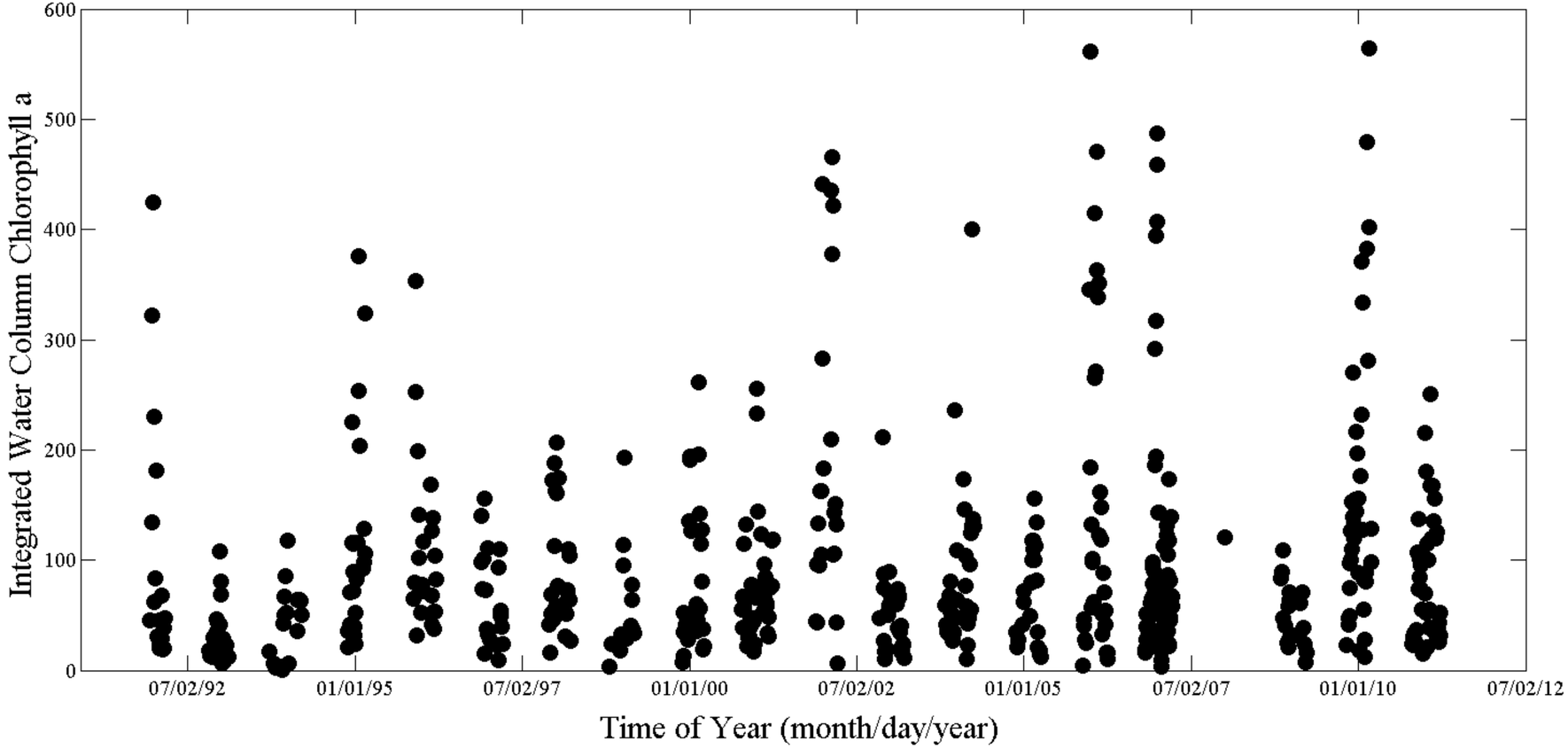


Montes Hugo et al. Science 2009

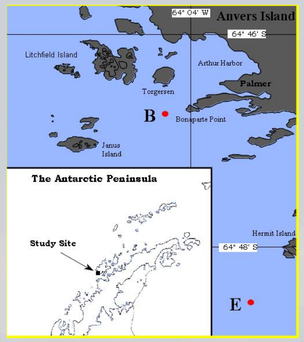


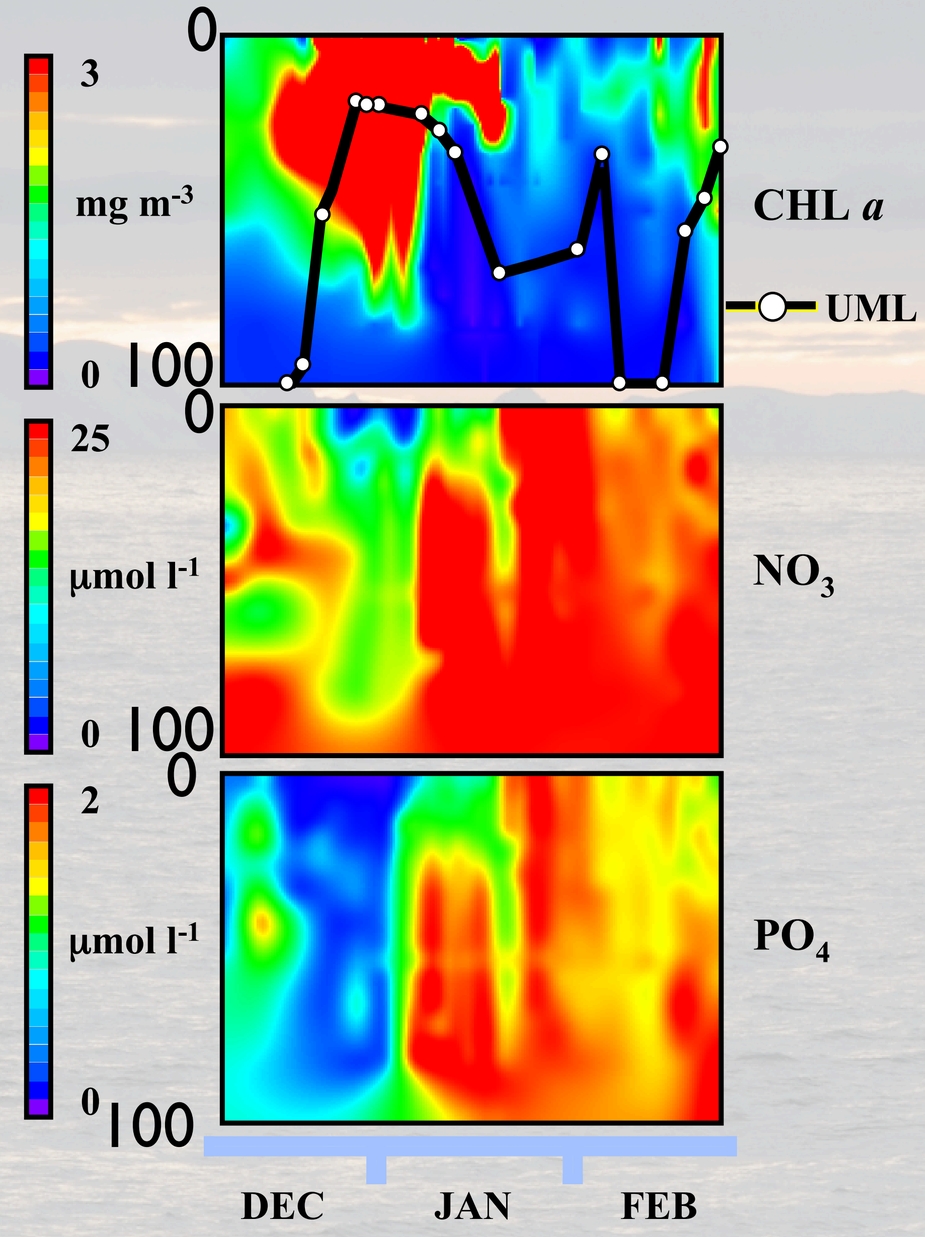
The changes driven by a decline in sea ice, wind and sun

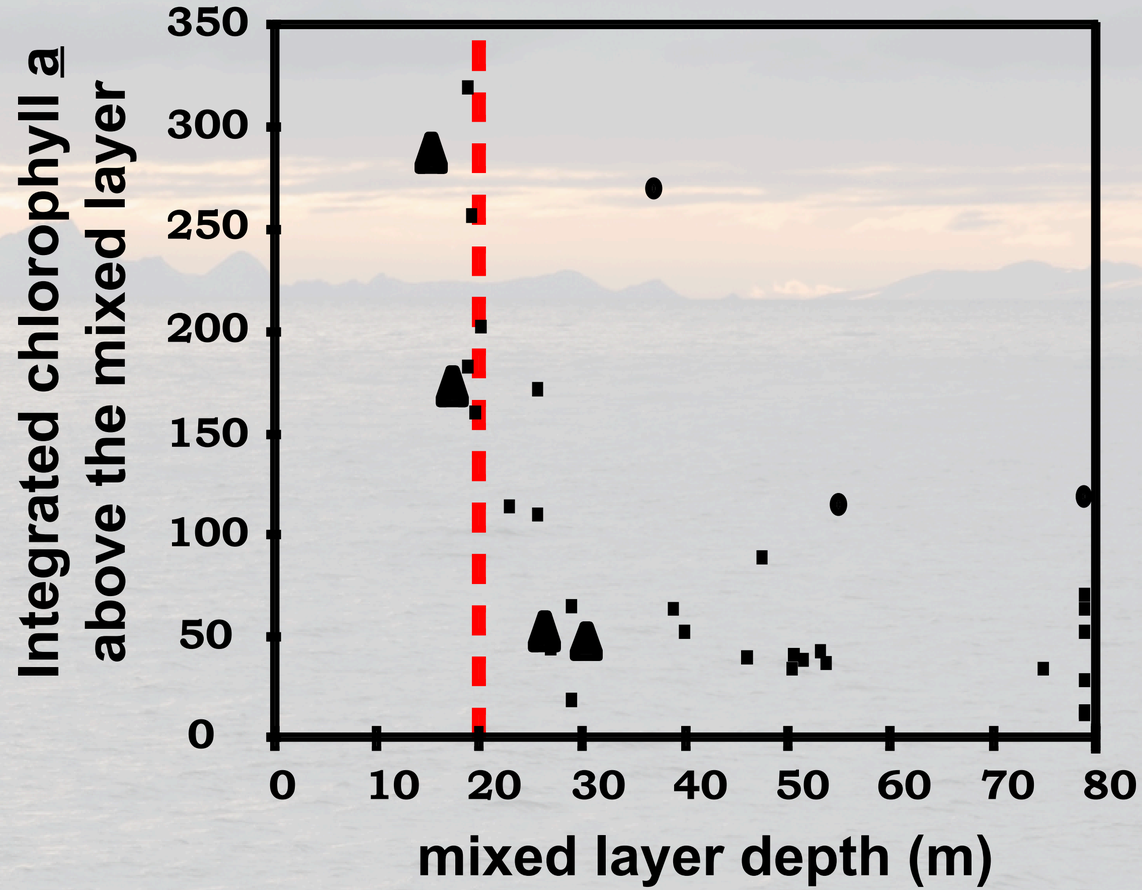
Time series at Palmer Station



What regulates phytoplankton blooms in this region?

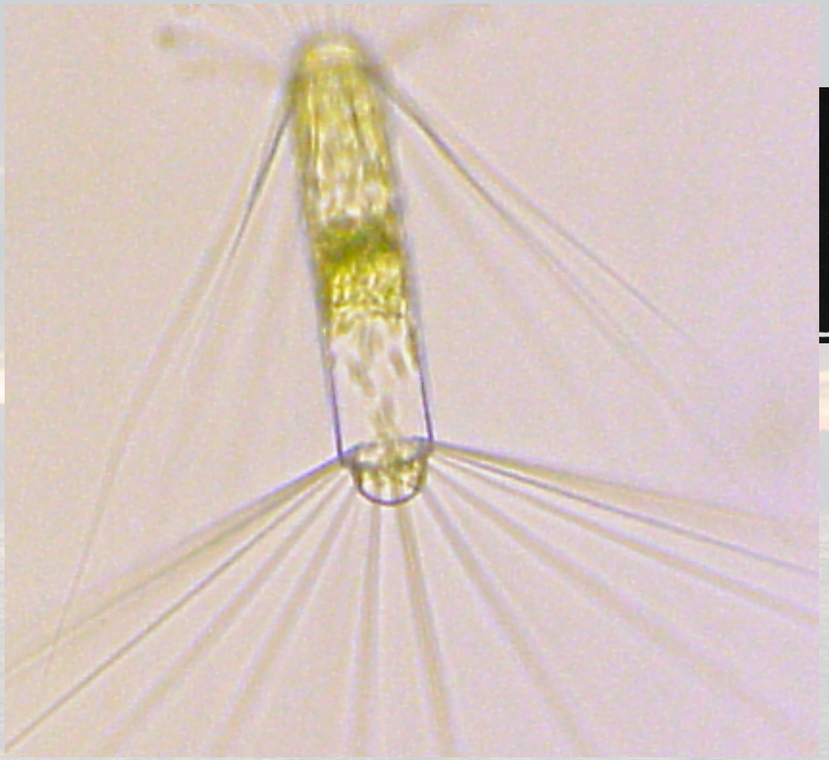




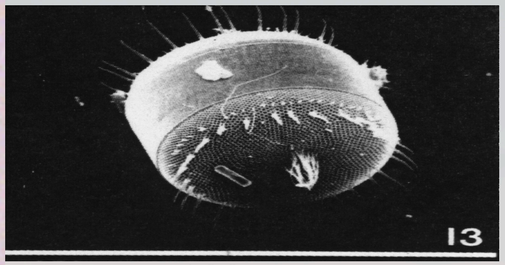


NEW WIRE
NSF

NSF
L

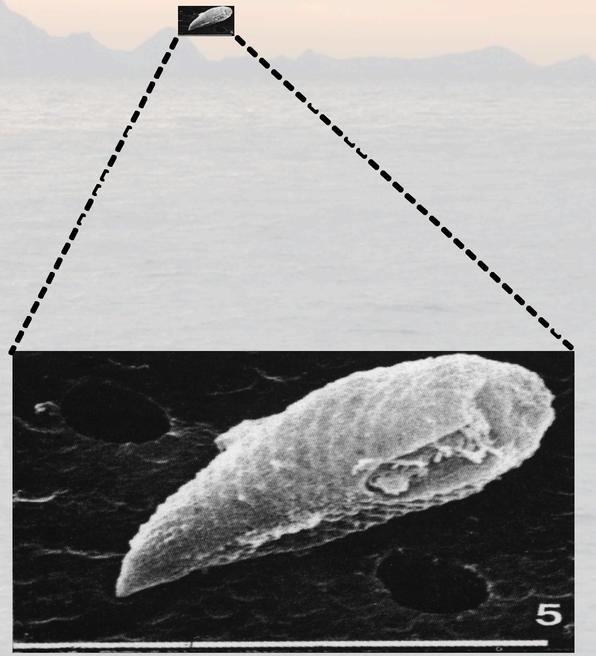


Corethron criophilum



100µm

Thalassiosira antarctica

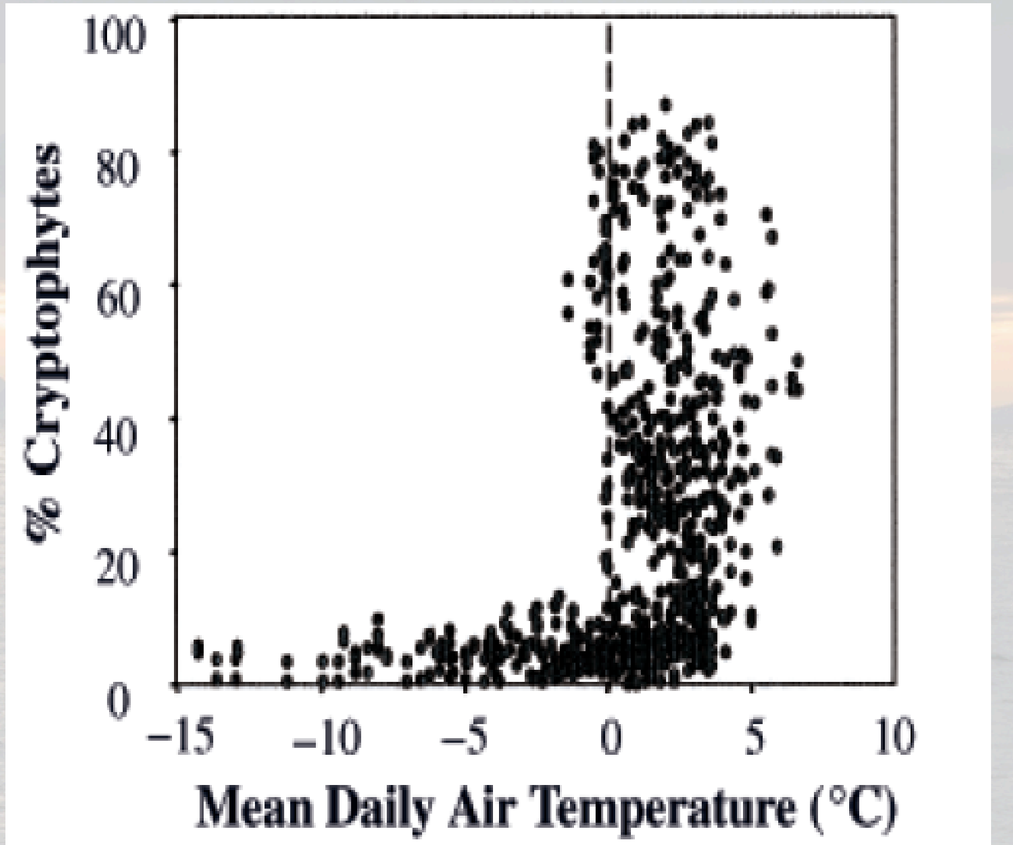


10µm

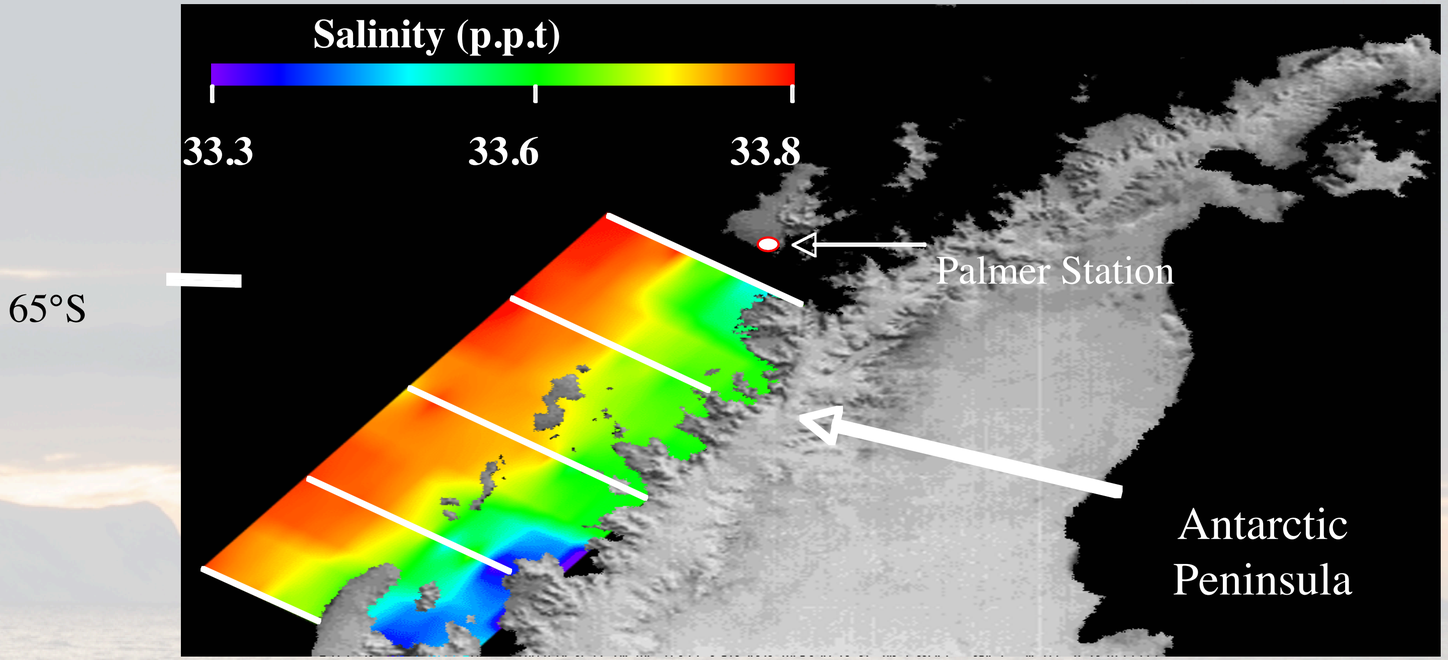
Cryptomonas cryophila

Palmer Cryptophytes --> 8 ± 2µm

SEM Micrographs from*McMinn and Hodgson* 1993

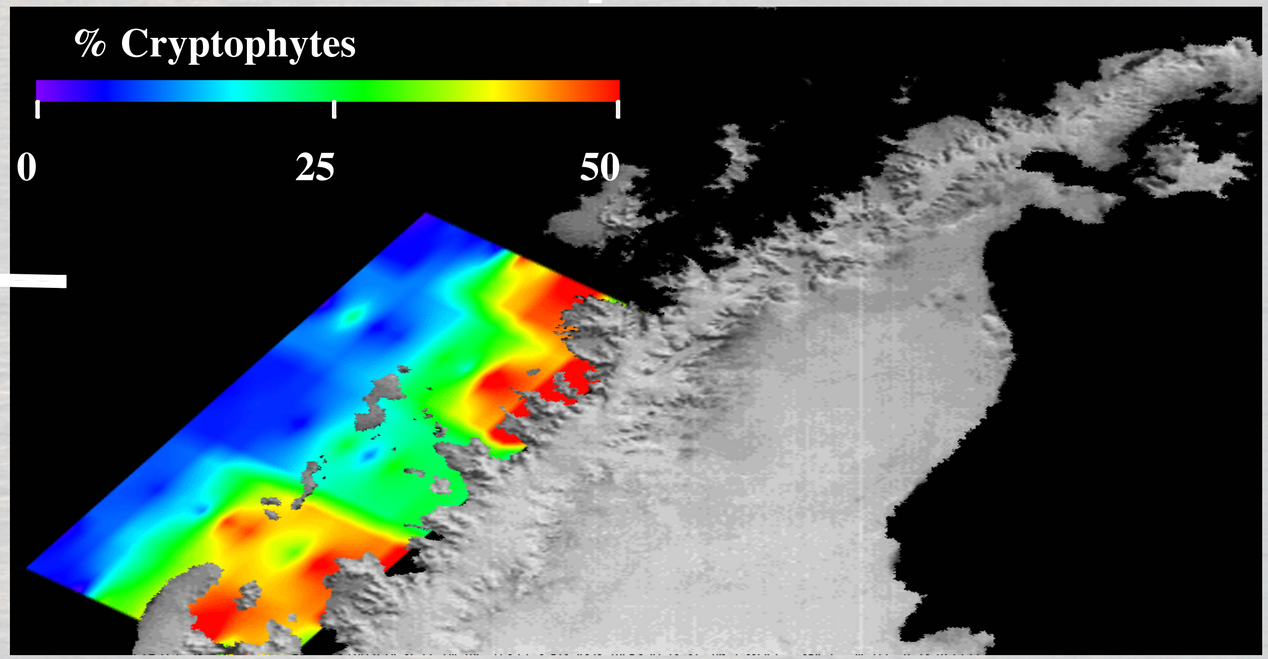


Moline et al.
GBC 2004



65°S

64°W



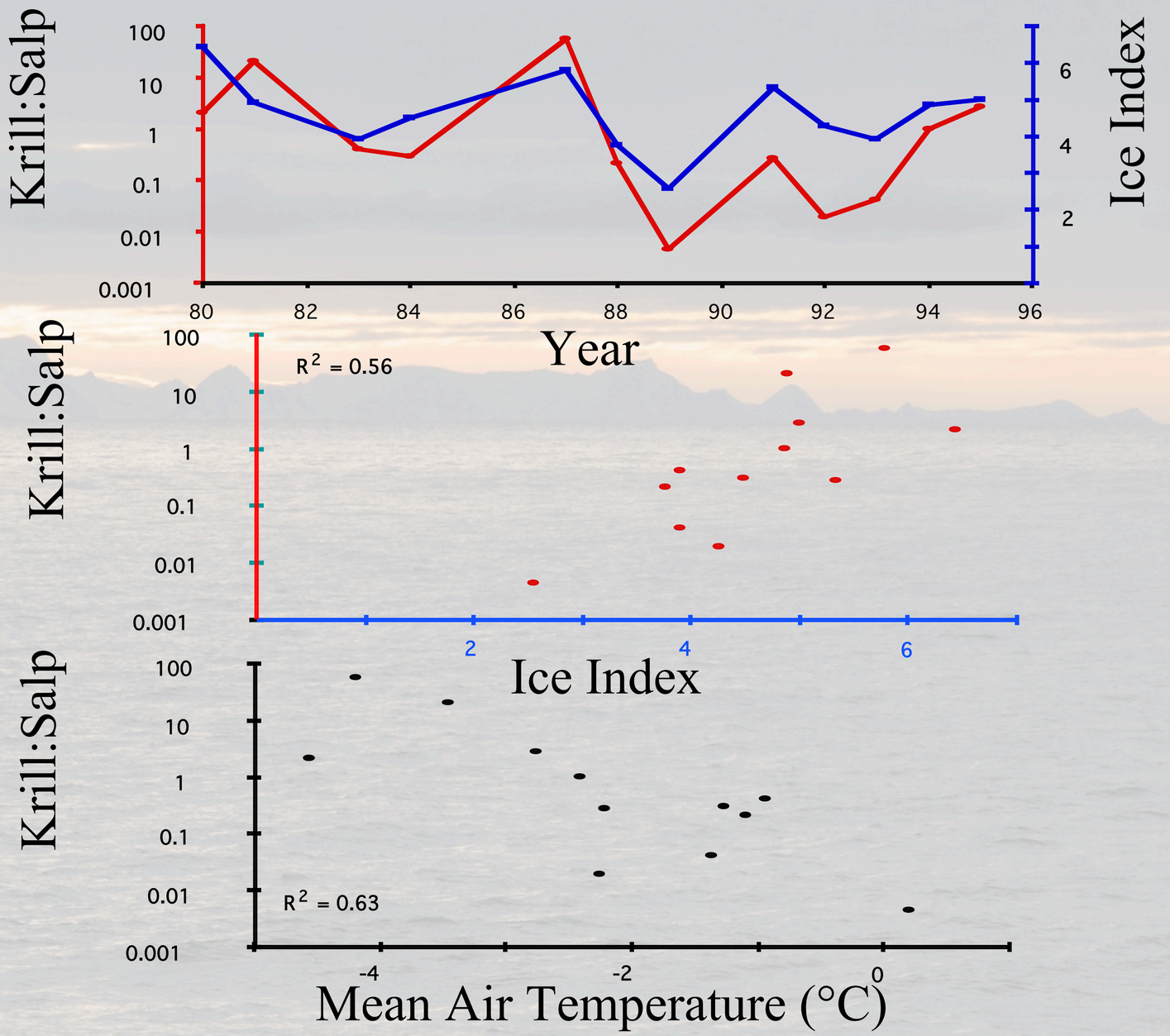
65°S

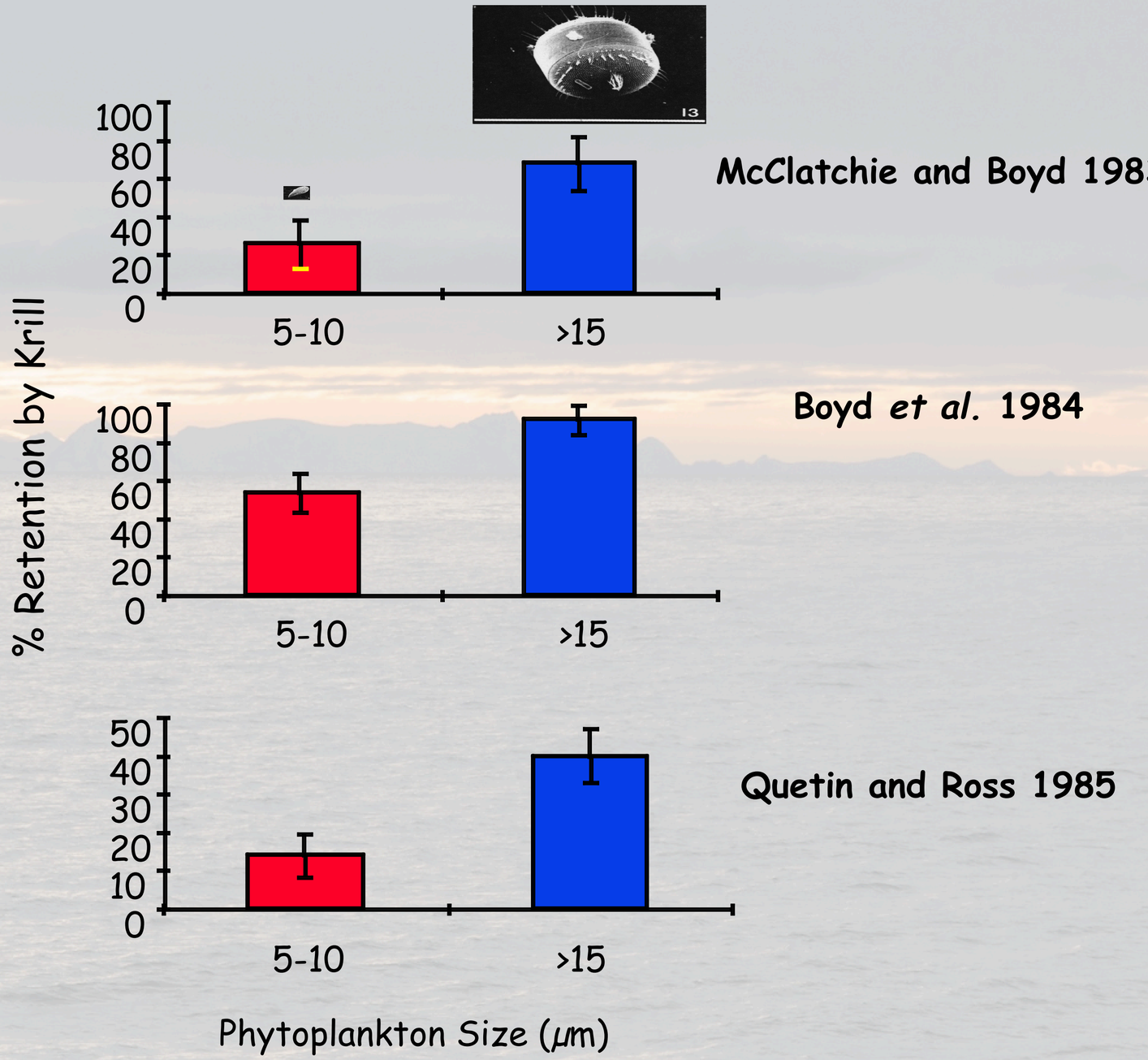
Moline et al.
GBC 2004

Zooplankton are dominated by krill or salps

Krill greatest biomass of any animal on earth

From *Loeb et al.*, 1997





McClatchie and Boyd 1983

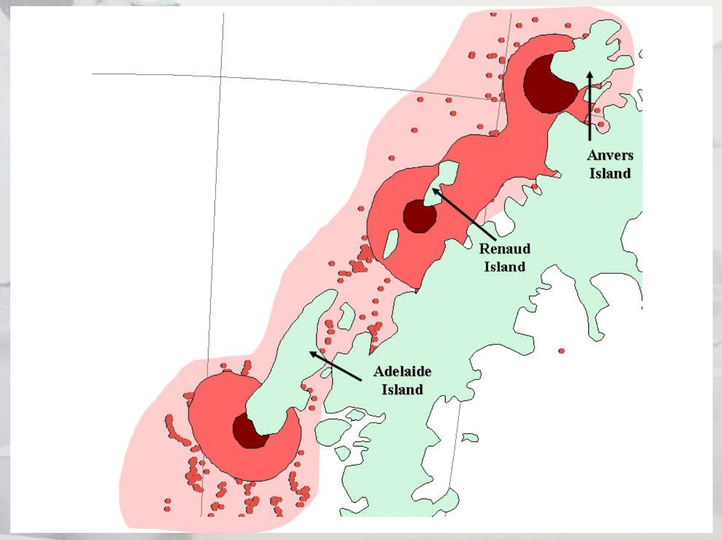
Boyd *et al.* 1984

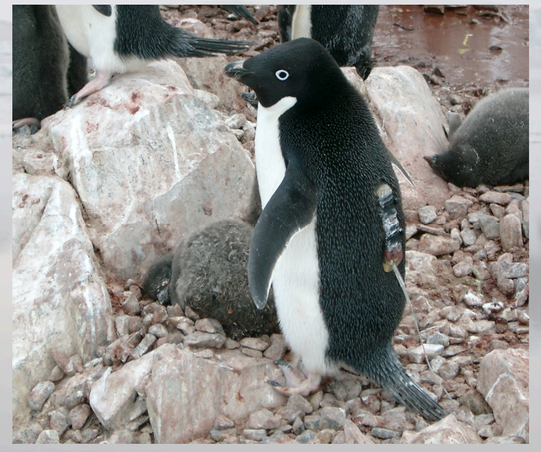
Quetin and Ross 1985

Is there an impact on higher trophic levels?

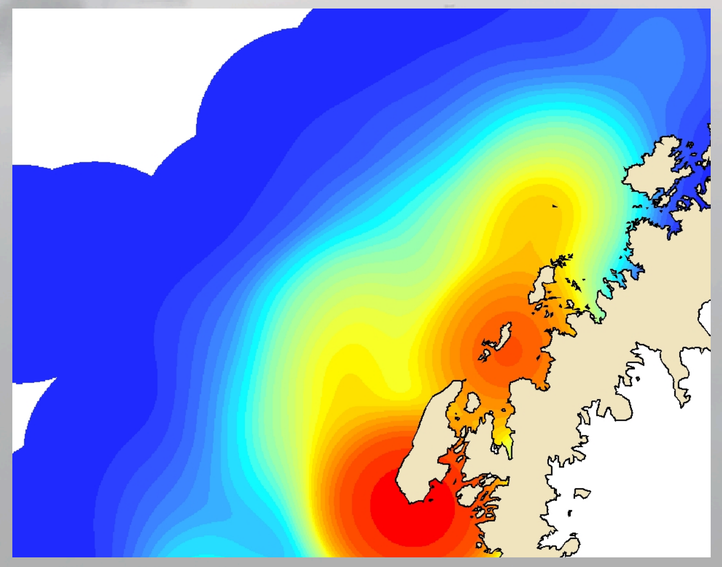
One focus idea of the LTER is testing, is that system is undergoing climate migration. We have structured sampling around the major Adelie penguin breeding areas along the peninsula.

Summer foraging areas for Adelie penguins



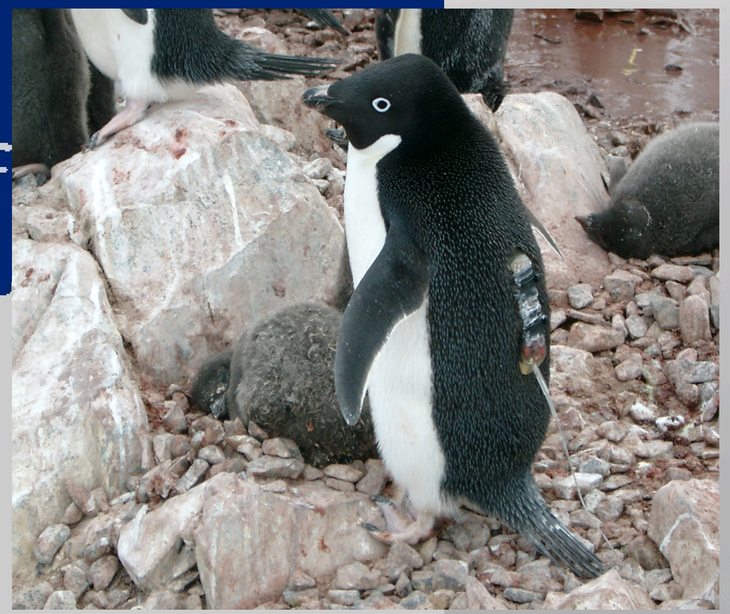


Winter foraging areas for Adelie penguins

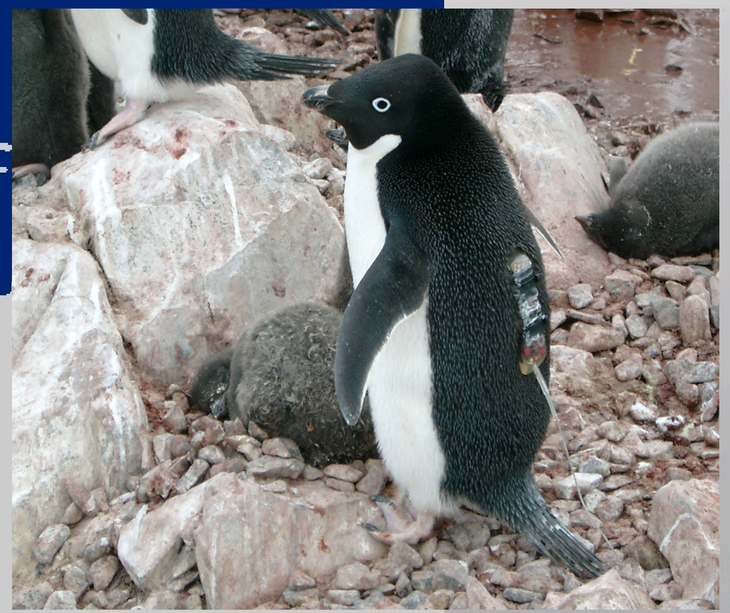


To be expanded by NASA grant awarded in Dec.

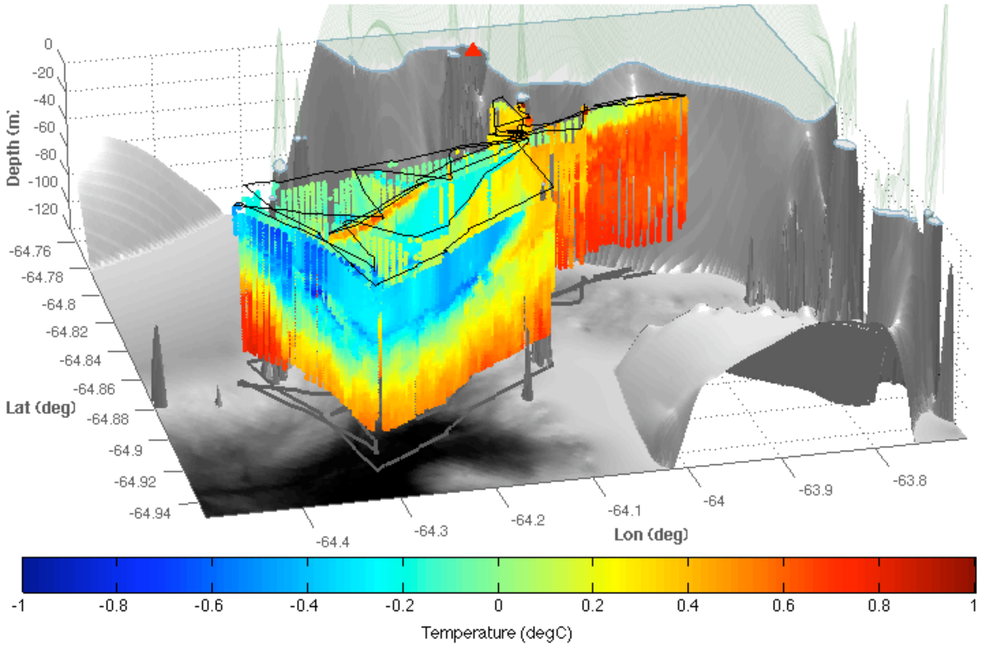
Anvers Island

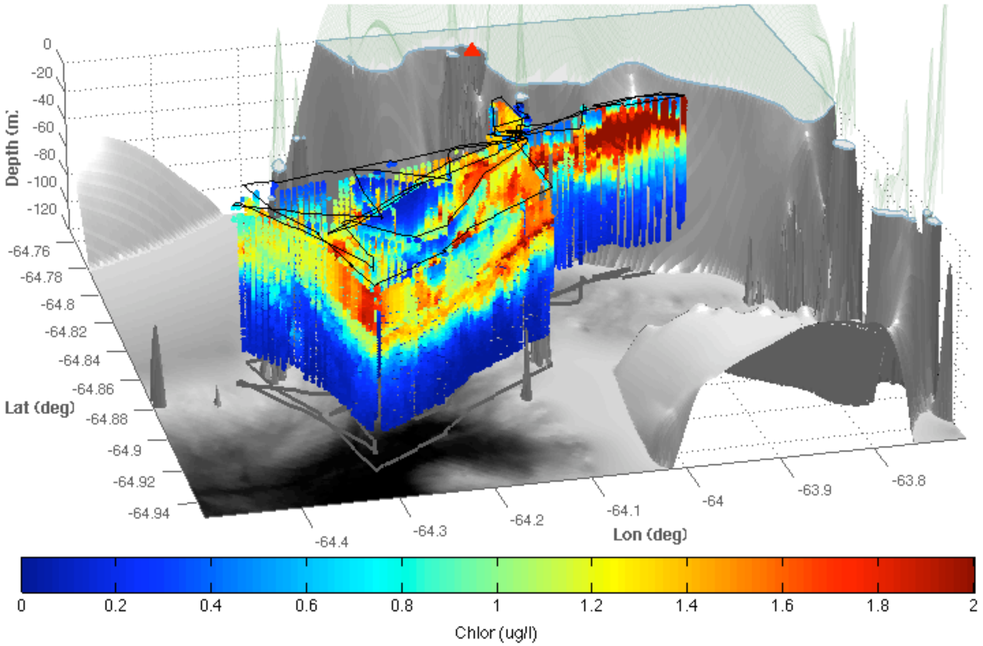


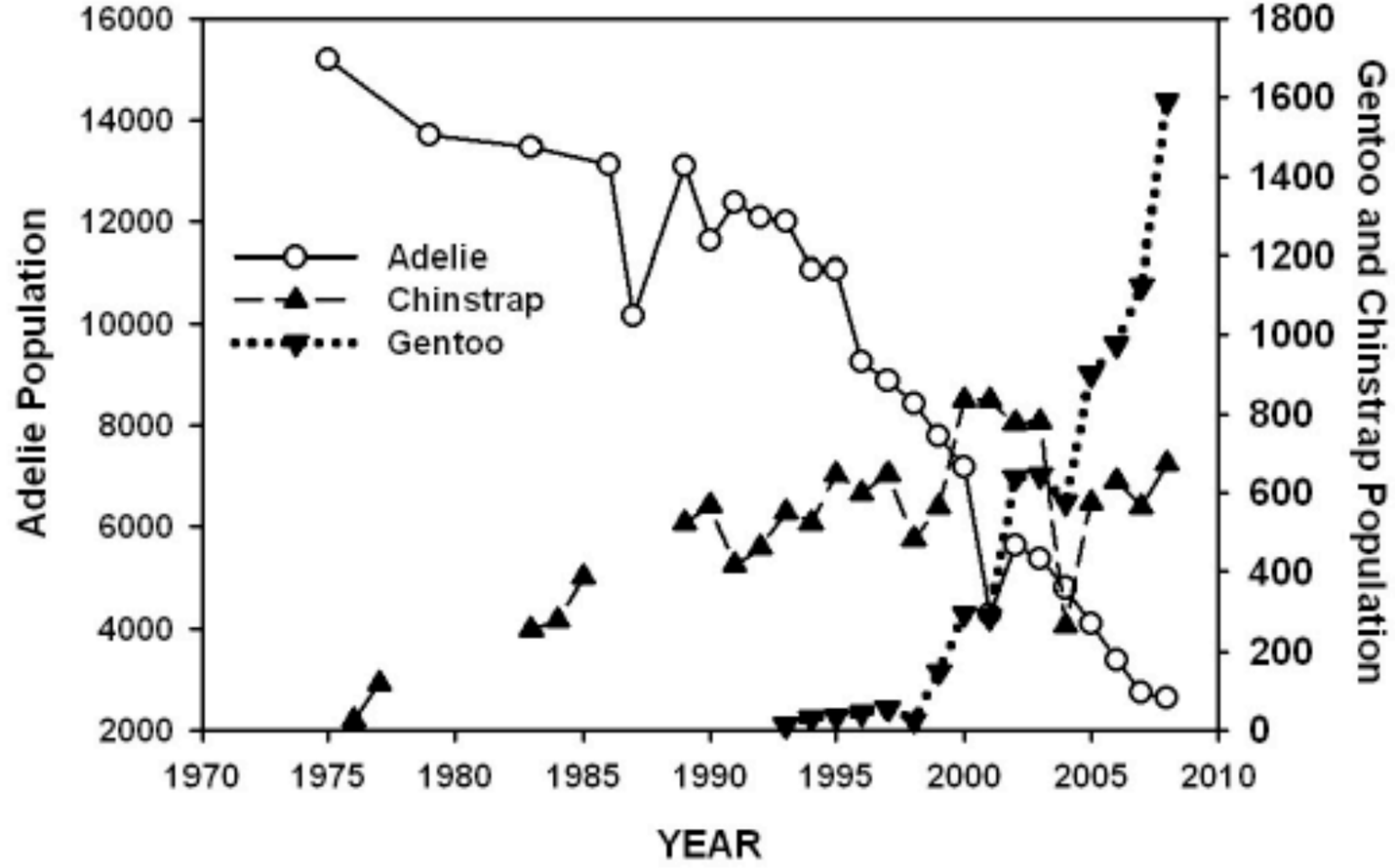
Anvers Island



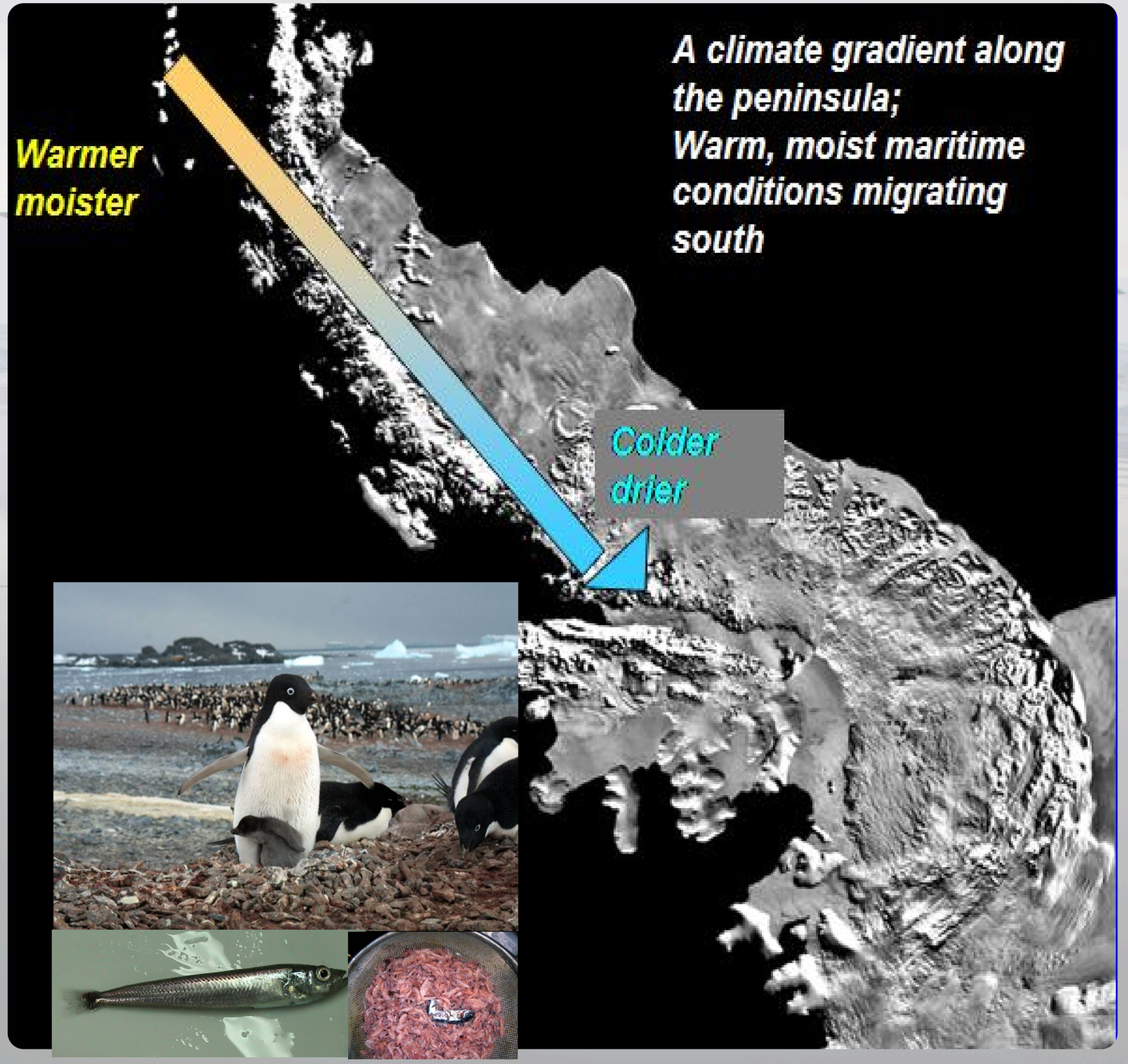
Enhanced productivity is associated with the warm upwelled water





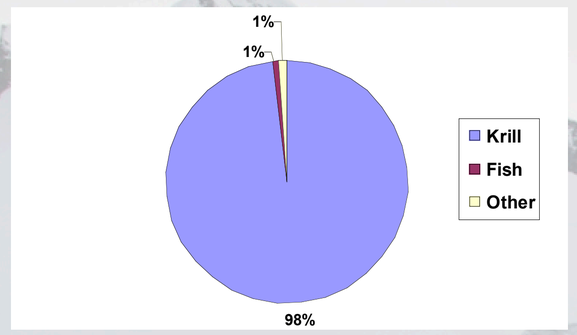

16000
14000
12000
10000
8000
6000
4000
2000
Adelie Population
1800
1600
1400
1200
1000
800
600
400
200
0
Gentoo and Chinstrap Population
Adelie
Chinstrap
Gentoo
1970
1975
1980
1985
1990
1995
2000
2005
2010
YEAR

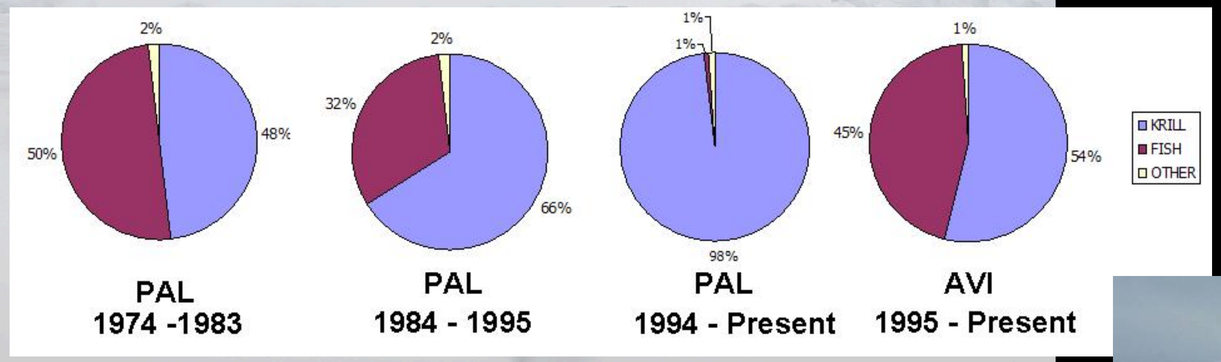
Changing diets for the Adelie penguins

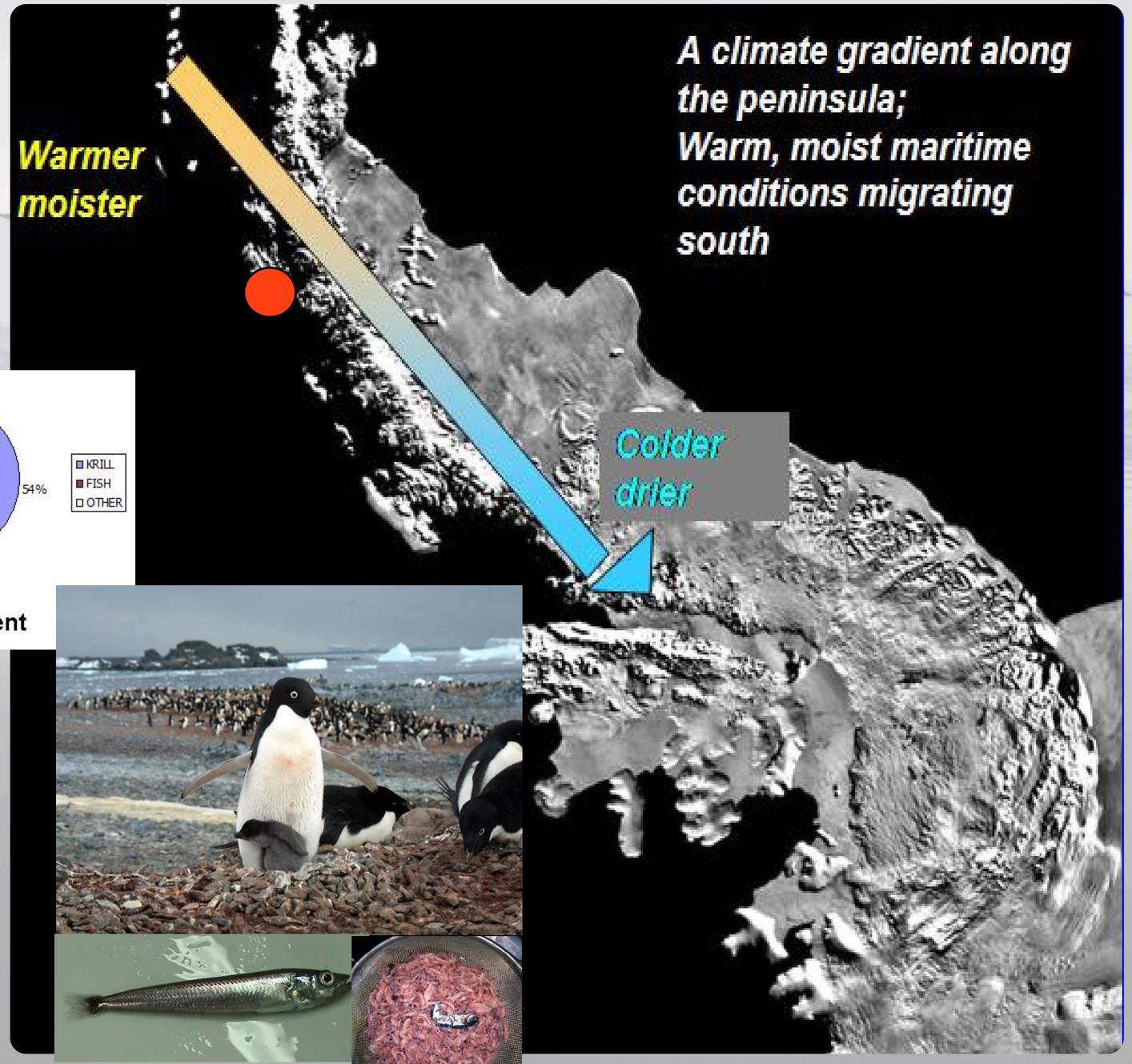


Changing diets for the Adelie penguins

1994-present

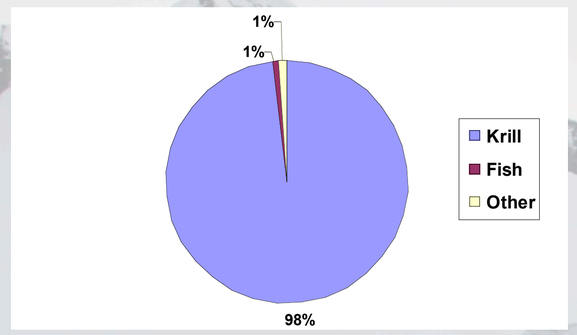


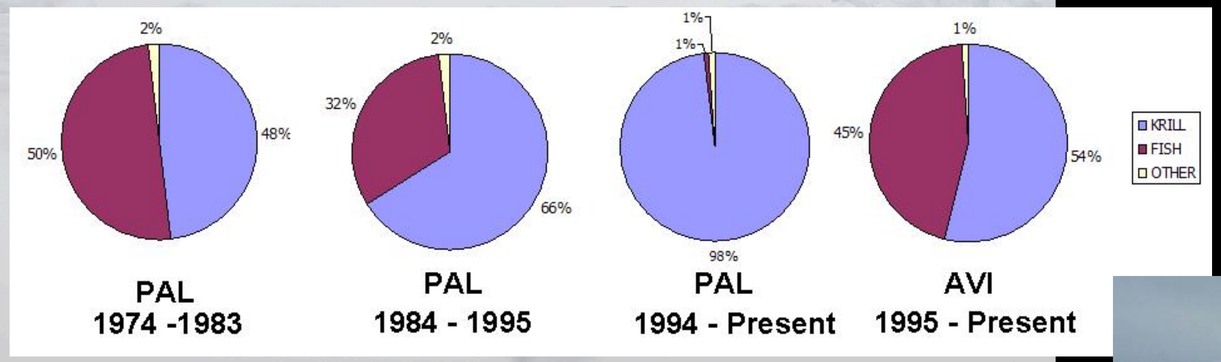




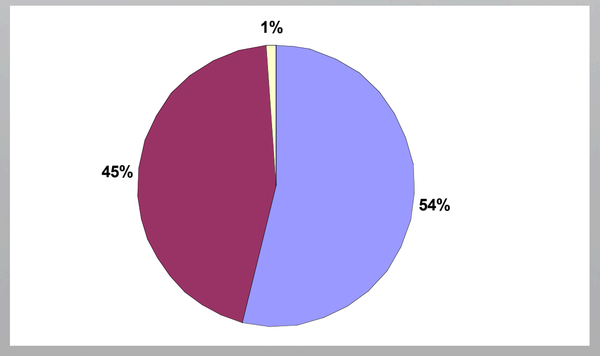
Changing diets for the Adelie penguins

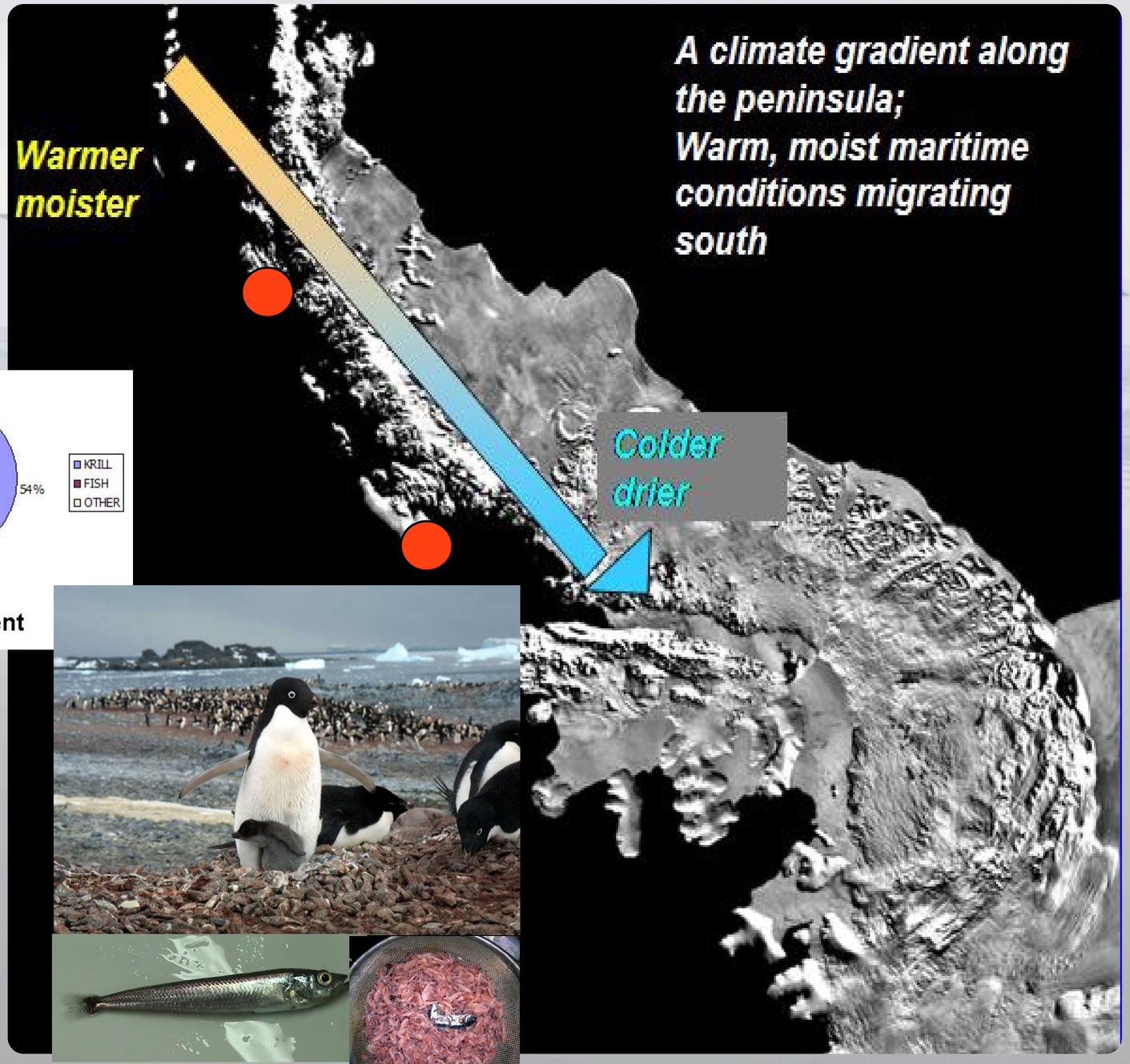
1994-present

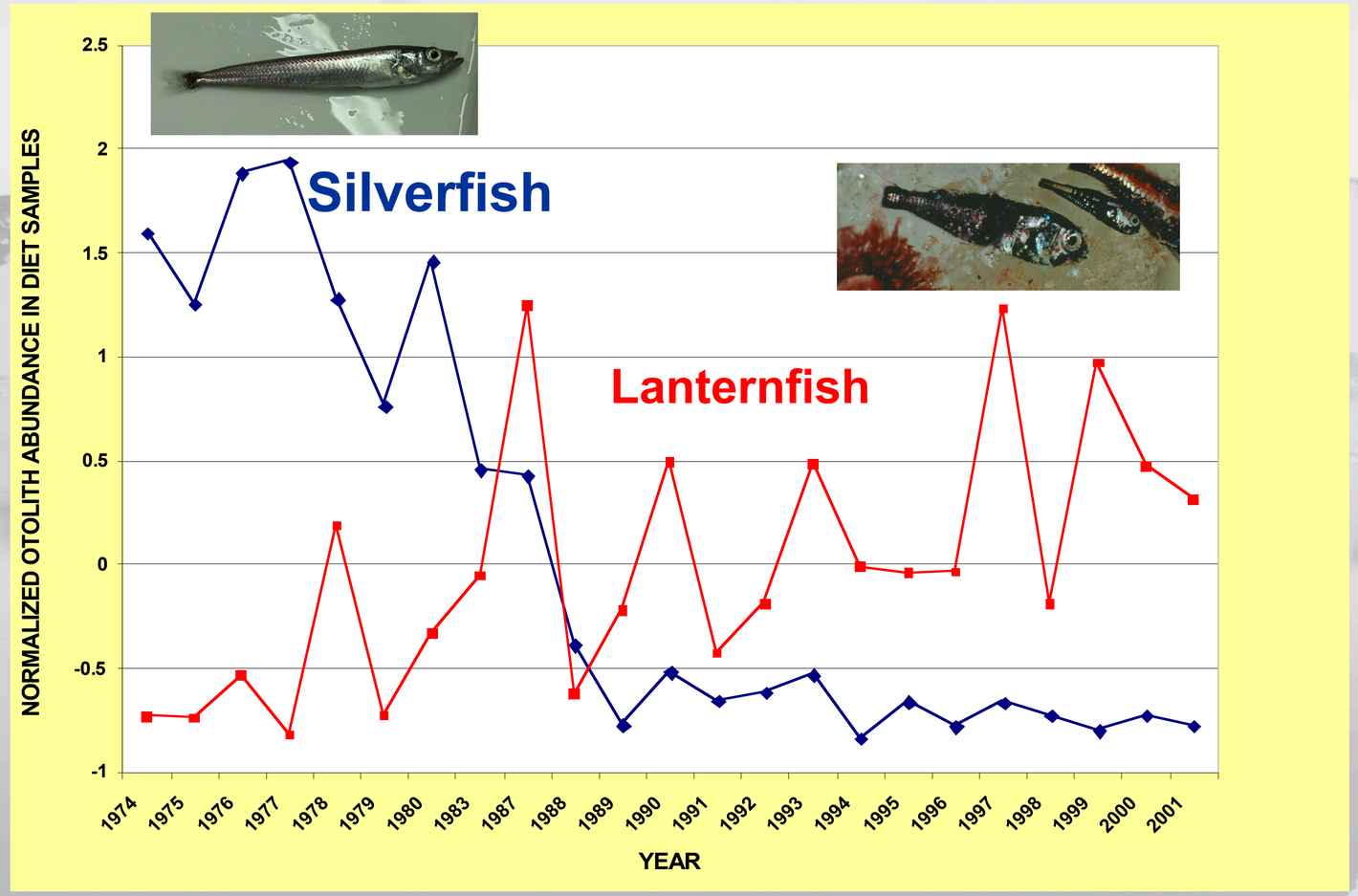


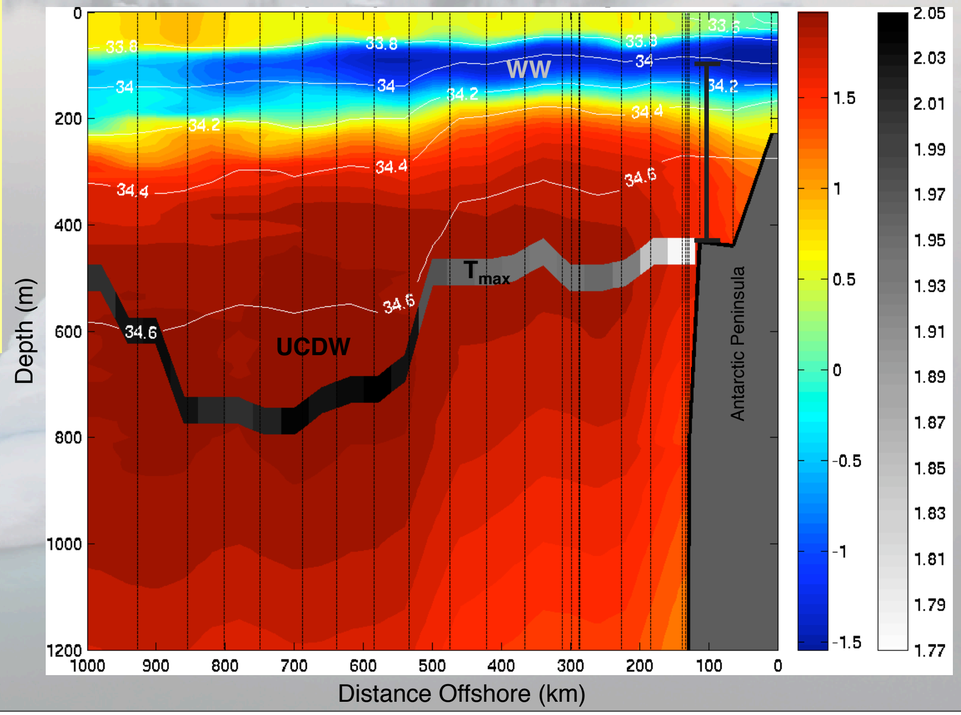


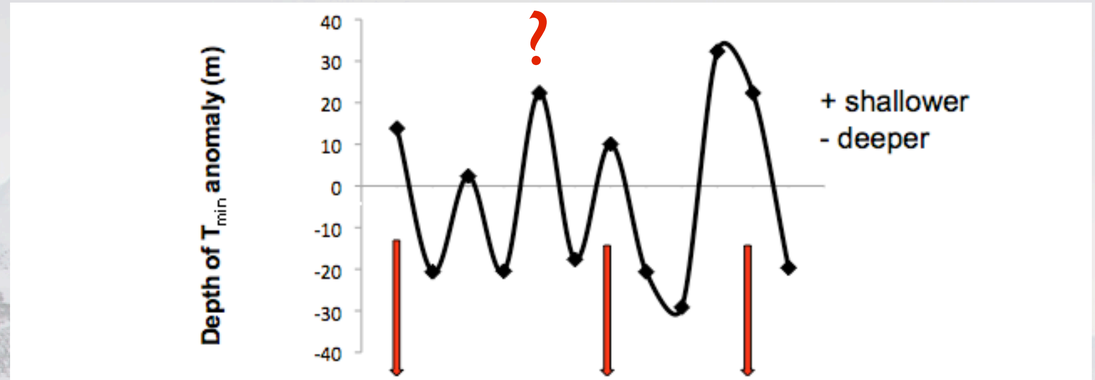
1995-present

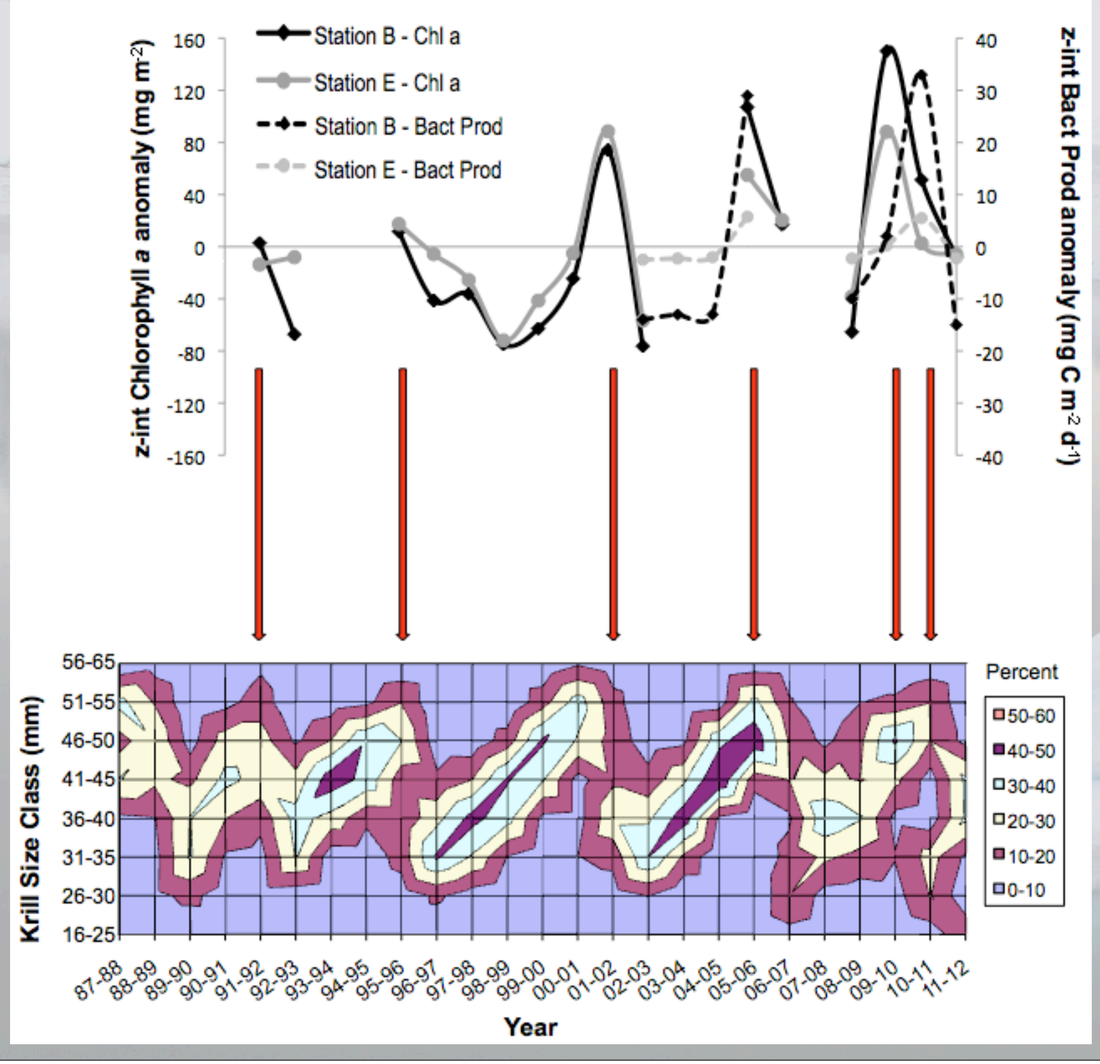





Silverfish
Lanternfish
NORMALIZED OTOLITH ABUNDANCE IN DIET SAMPLES
2.5
2
1.5
1
0.5
0
-0.5
-1
1974
1975
1976
1977
1978
1979
1980
1983
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
YEAR


WW
UCDW
T_{max}
33.8
34
34.2
34.4
34.6
Antarctic Peninsula
Depth (m)
0
200
400
600
800
1000
1200
1000
900
800
700
600
500
400
300
200
100
0
Distance Offshore (km)
1.5
1
0.5
0
-0.5
-1
-1.5
2.05
2.03
2.01
1.99
1.97
1.95
1.93
1.91
1.89
1.87
1.85
1.83
1.81
1.79
1.77



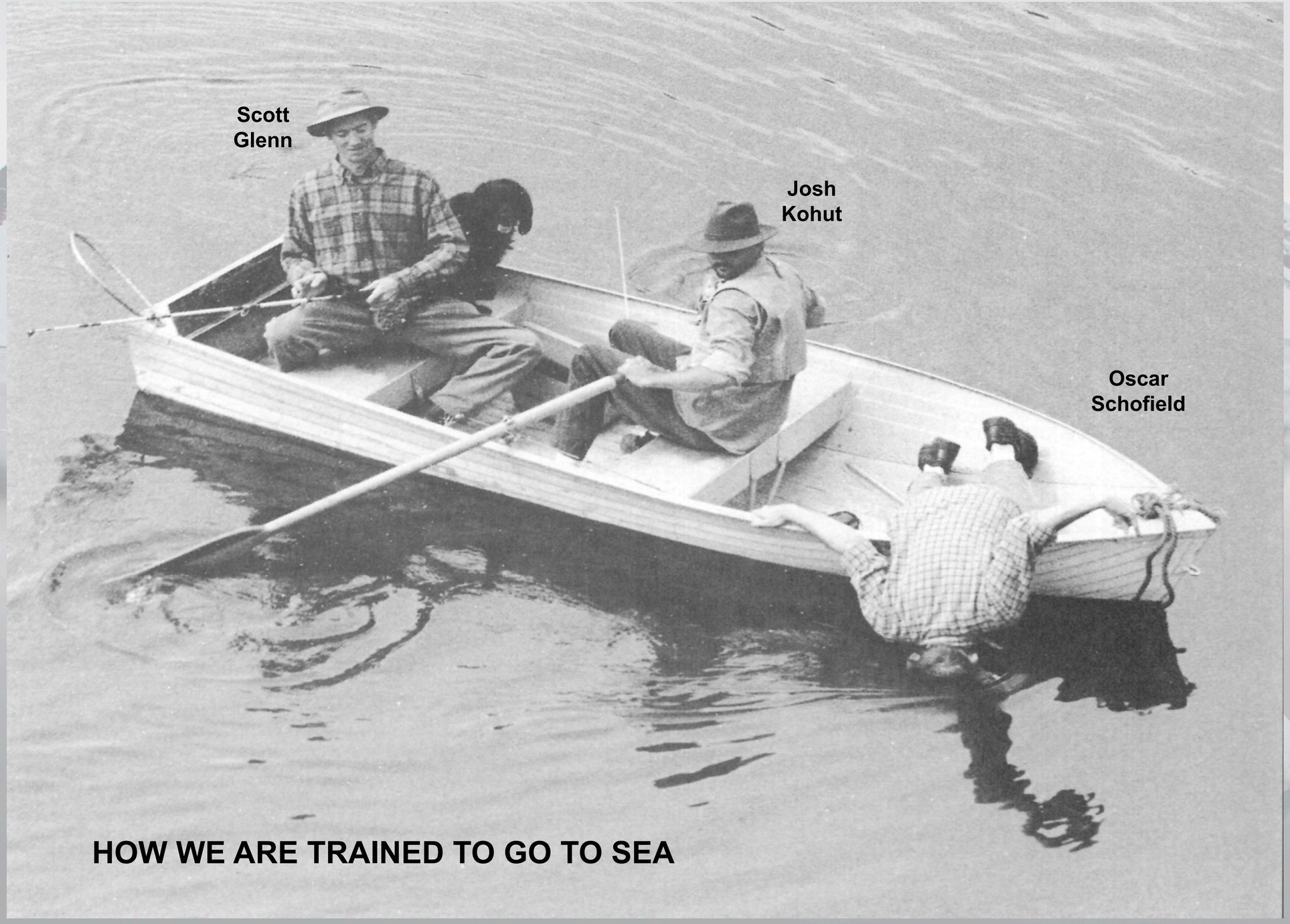


PHYSICAL SYSTEM

PLANKTONIC SYSTEM

HIGHER TROPHIC LEVELS

If that was not enough, warmer temps leads to more moisture and more snow. Breeding failure.....



HOW WE ARE TRAINED TO GO TO SEA

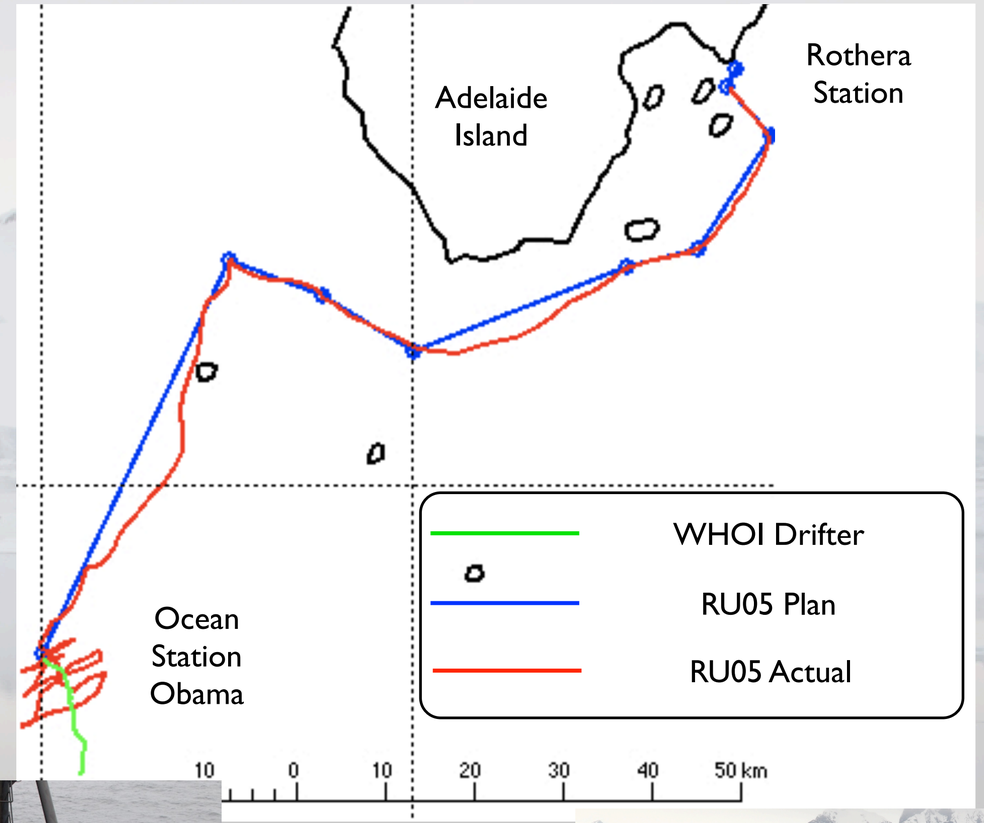
Ocean is hard to sample

Bring in the Robots

Old Day Communication

HAM Operator Coms Palmer Station 1988

Brave New Day



RV Gould

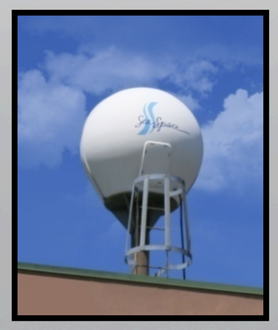
Rothera Base

Real time comms

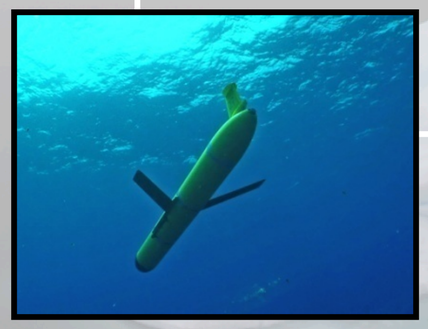
Rutgers COOLroom

Rutgers University - Coastal Ocean Observation Lab

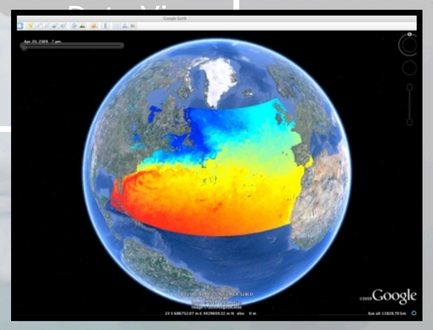
CODAR Network



L-Band & X-Band Satellite Receivers

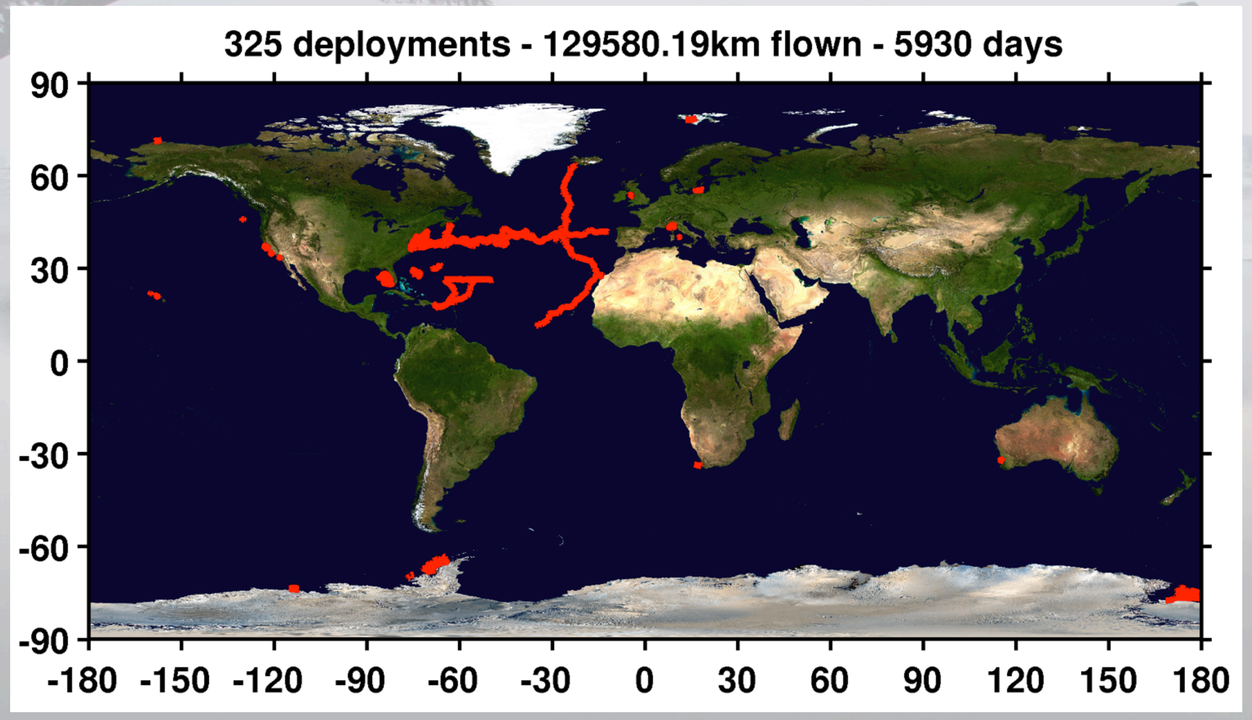


Glider Fleet



3-D Nowcasts & Forecasts

Your Labs will be everywhere all the time

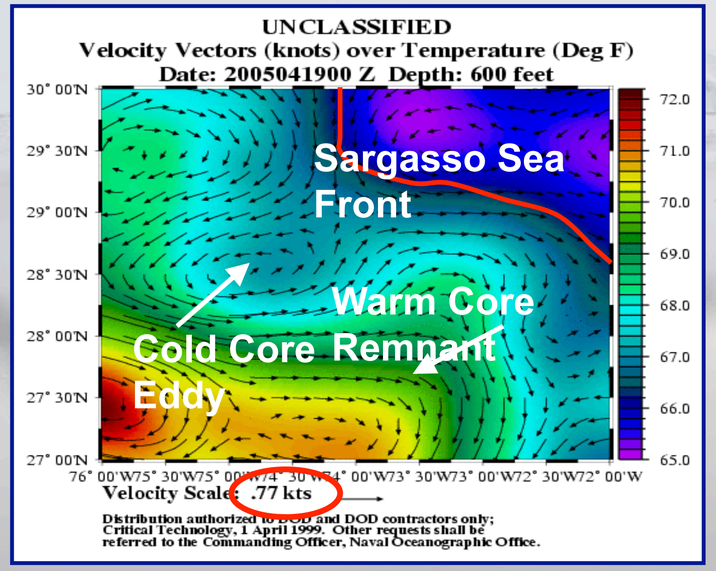


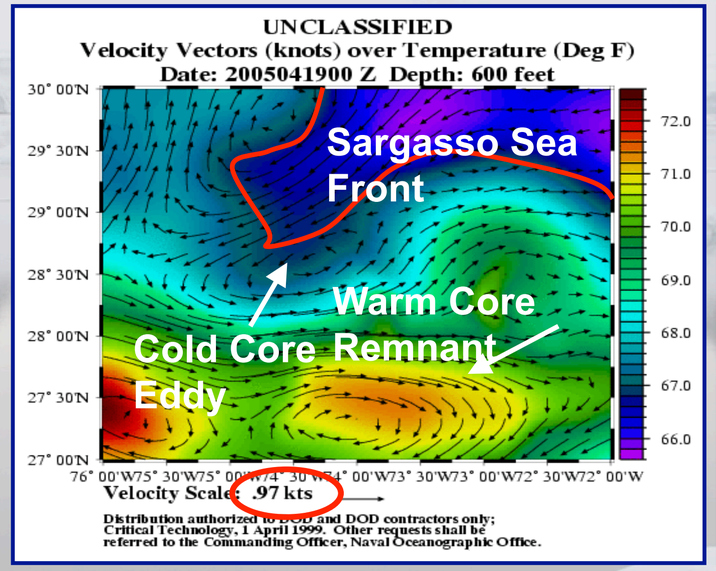
RU-COOL Deployments by Year

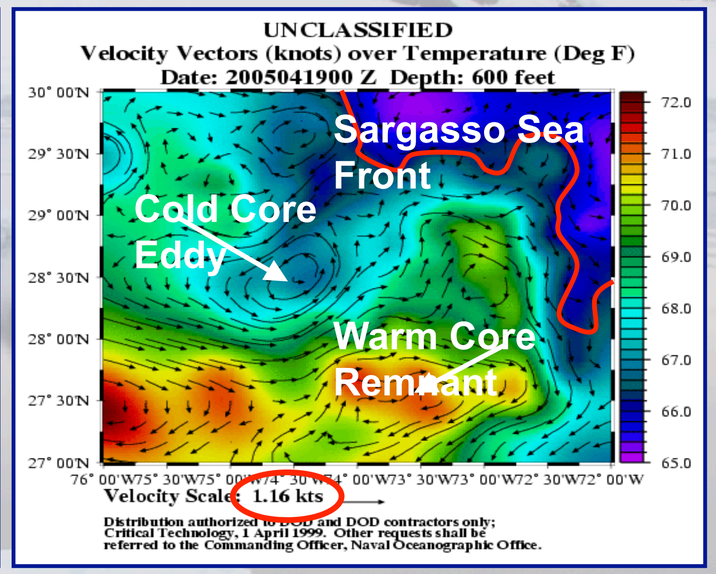
Year	Number	Distance (km)	Days
2012	19	5054.31	290.3
2011	37	11975.53	624
2010	46	17003.36	876.6
2009	30	18114.34	761.1
2008	28	16642.28	604.7
2007	27	10277.99	462.9
2006	38	9745.88	538
2005	16	4113.87	207.1
Totals	**241**	**92927.56**	**4364.8**

Includes all Global deployments

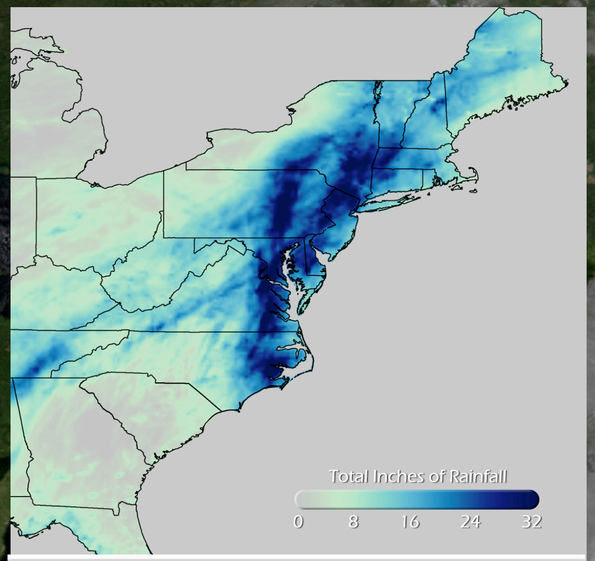
Models improved with in situ data via data assimilation

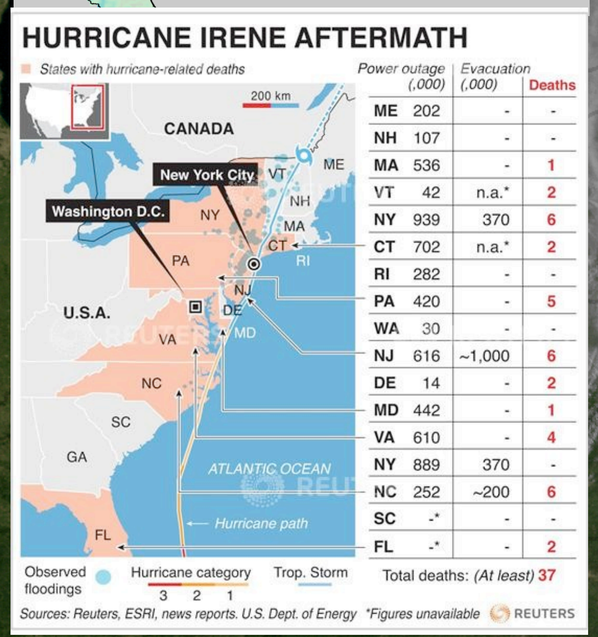






Hurricane Irene





- First tropical storm to threaten NYC since Hurricane Gloria in 1985
- Flooding records broken in 26 rivers
- Caused at least 56 deaths
- Damage nearly $8 billion

The Miami Herald > Weather >

Hurricanes

Sunday, 02.19.12 Welcome Guest •

HOME | NEWS | SPORTS | ENTE

Miami-Dade | Broward | Keys |

Posted on Friday, 09.02.11

HURRICANE SEASON

Intensity remain

Like 1

The National Hurricane Ce
it wasn't the first time — bu
the increasing standards of

BY CURTIS MORGAN
MORGAN@MIAMIHERALD.COM

The New York Times

U.S.

WORLD | U.S. | N.Y. / REGION | BUSINESS | TECHNOLOGY | SCIENCE | HEALTH | SPORTS | OPINION

POLITICS | EDUCATION | BAY AREA | CHICAGO | TEXAS

THE GREAT COURSES
NOW ENJOY BRILLIANT COLLEGE COURSES IN YOUR HOME OR
Origins of Ancient Civil
My Favorit Universe
Understan Complexit
The History of the Making of the Testament Canon
A History of Empire, 2nd Edi
What Are the Ch Probability Mad
Museum Masterpieces: The Louvre

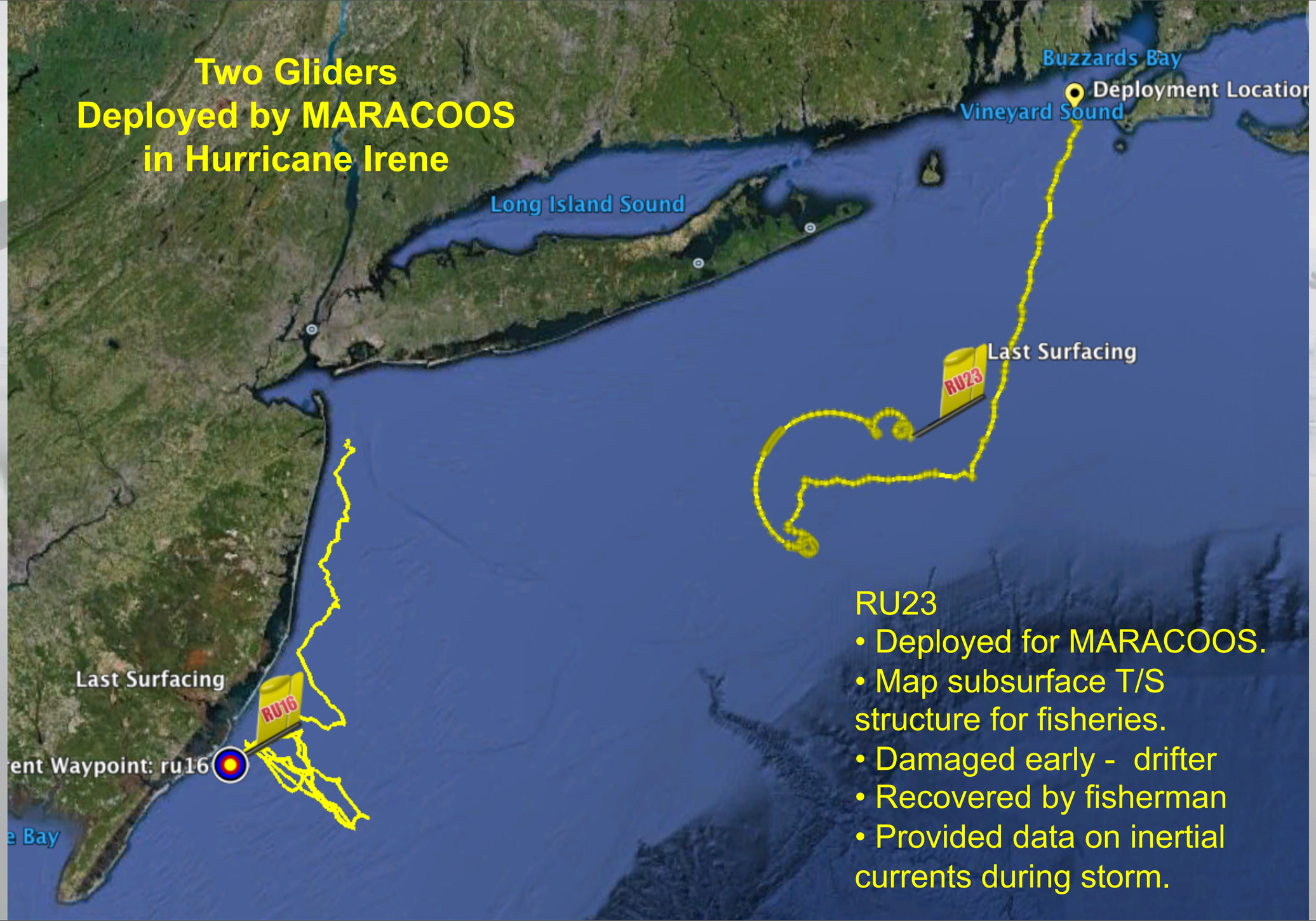
Challenges in Predicting the Intensity of Storms

Andy Newman/Associated Press

Scientists say that it is much easier to accurately predict what path a hurricane will take.

By HENRY FOUNTAIN
Published: August 27, 2011

Two Gliders Deployed by MARACOOS in Hurricane Irene

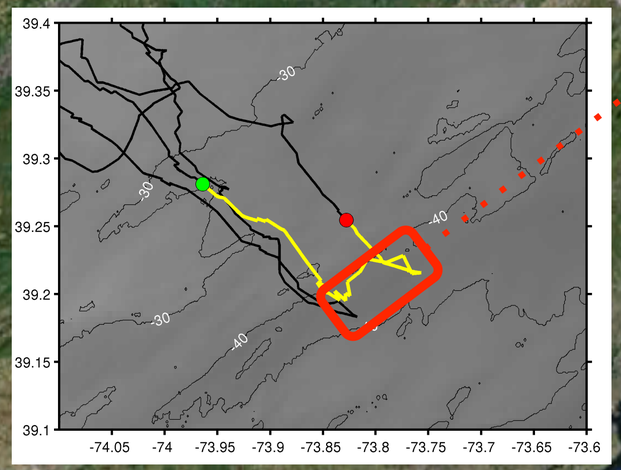


RU23
- Deployed for MARACOOS.
- Map subsurface T/S structure for fisheries.
- Damaged early - drifter
- Recovered by fisherman
- Provided data on inertial currents during storm.

Buzzards Bay

Hurricane Irene

Long Island Sound

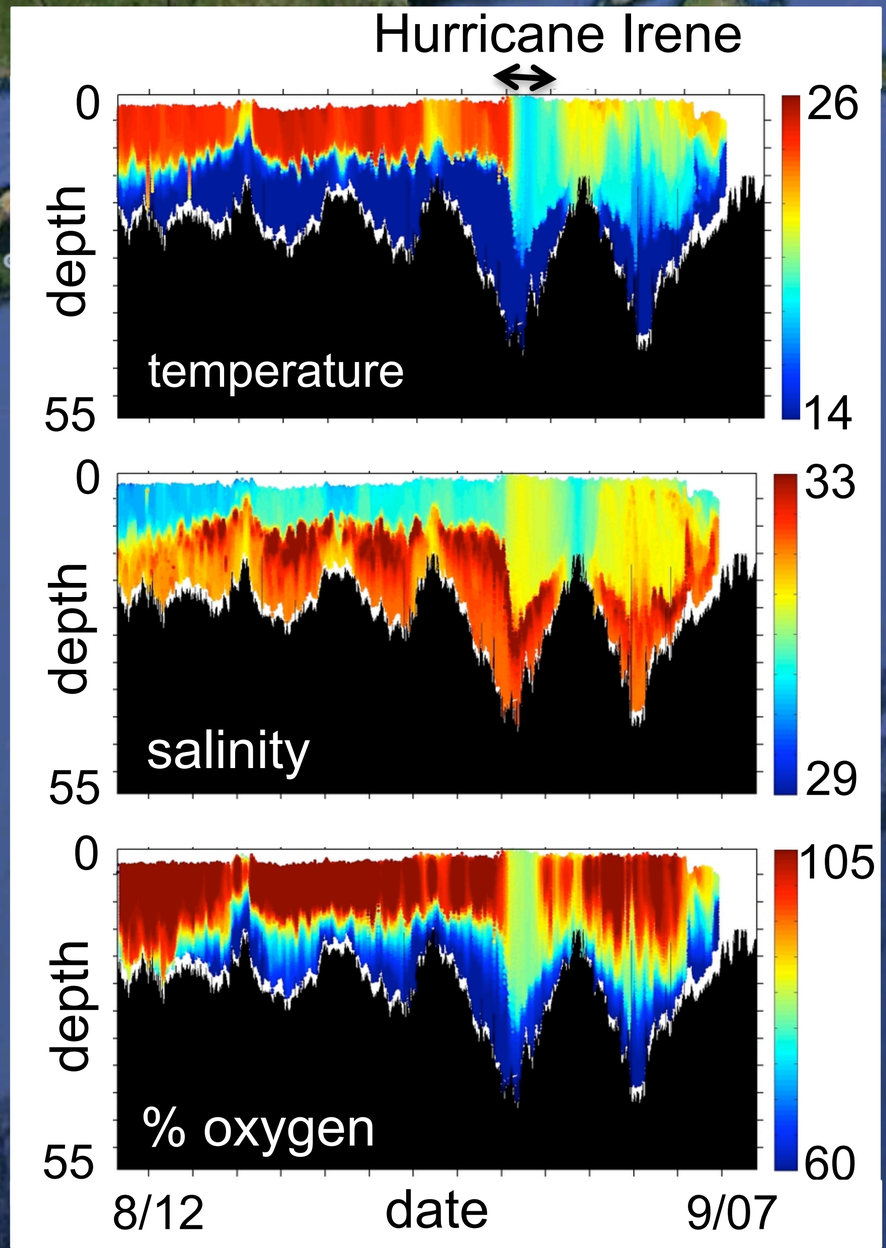


Last Surfacing

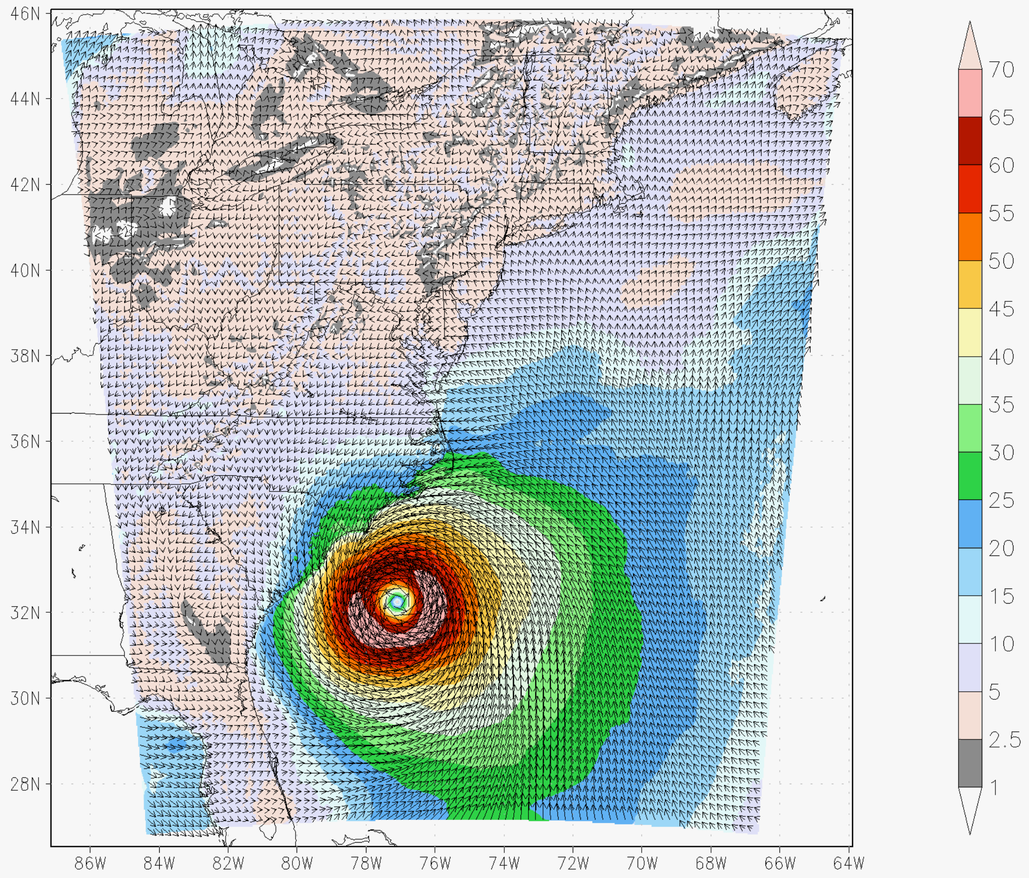
RU16

Current Waypoint: ru16

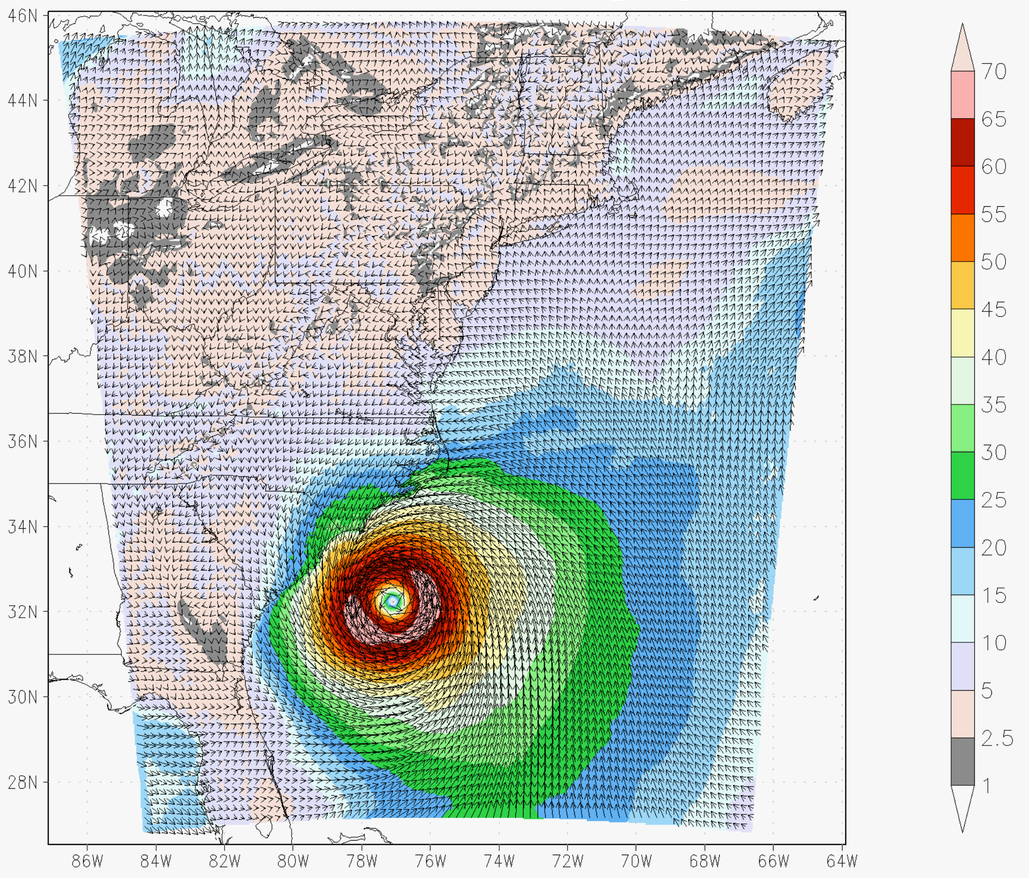
Delaware Bay

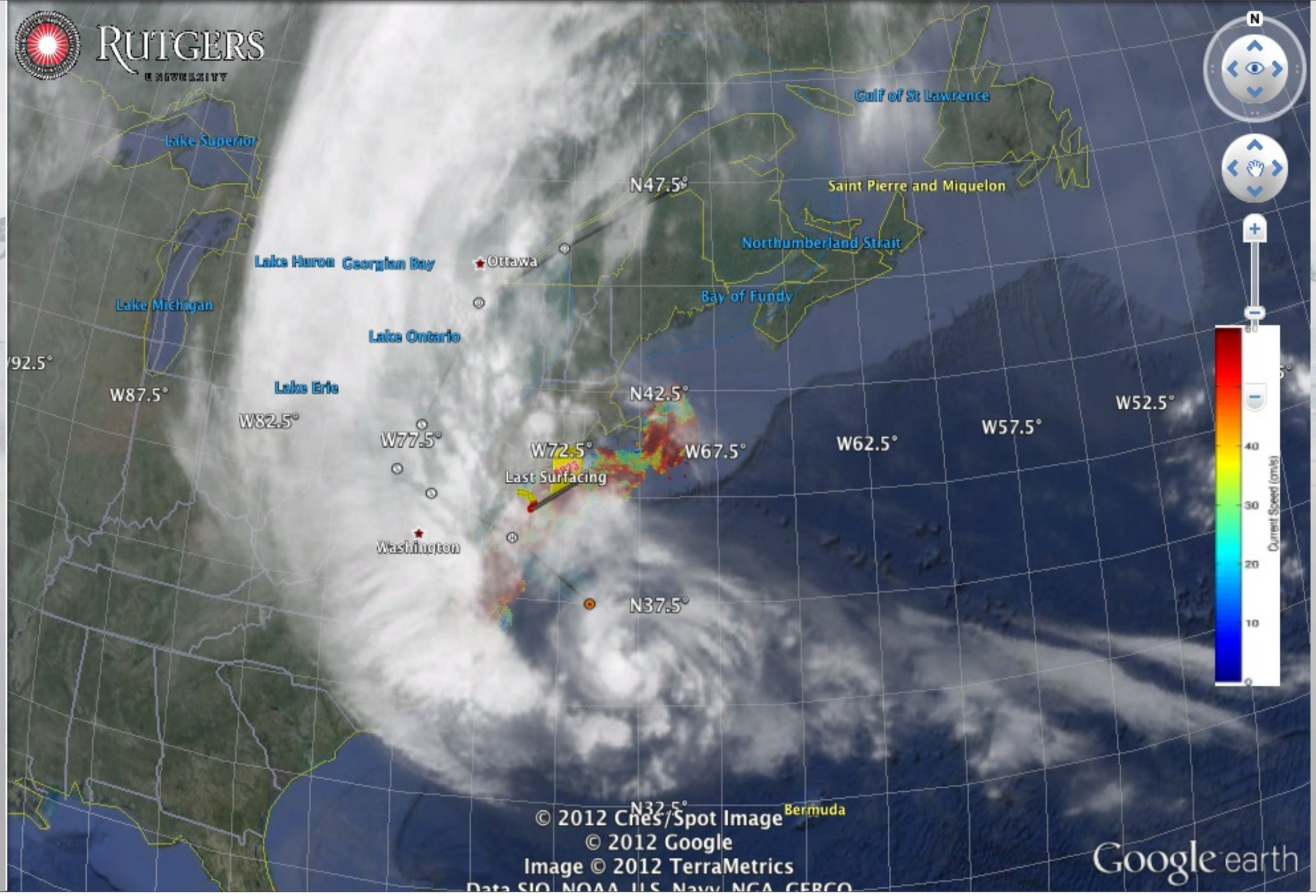


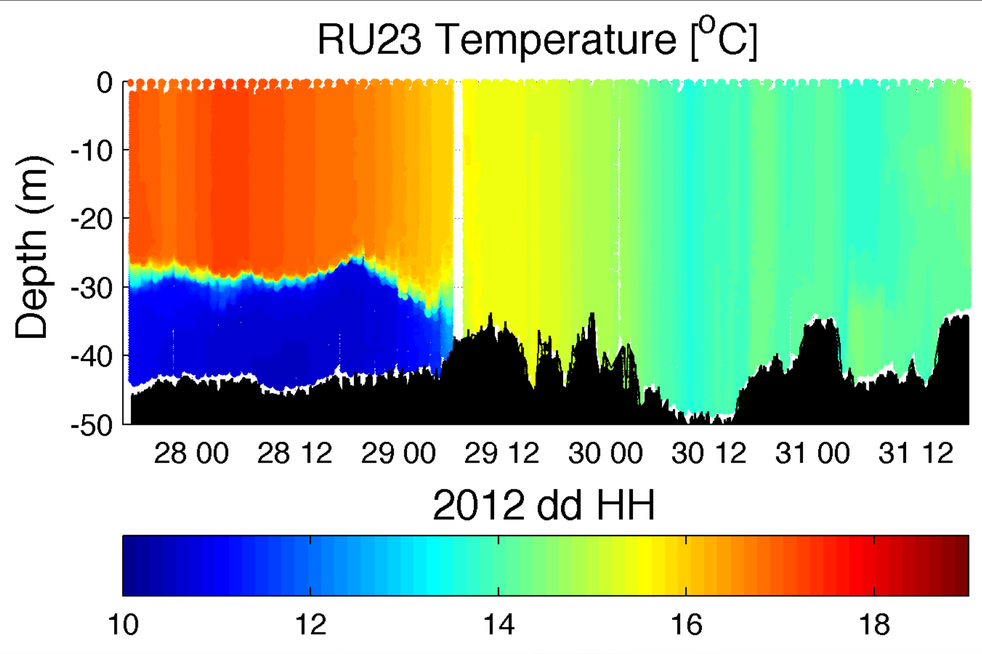
Warm water (standard)

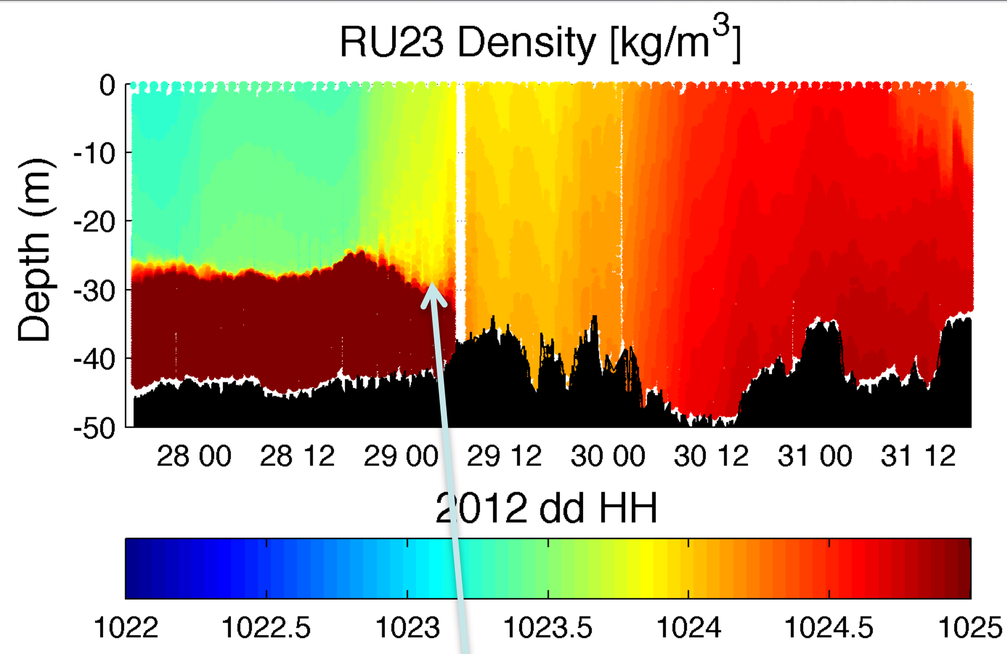


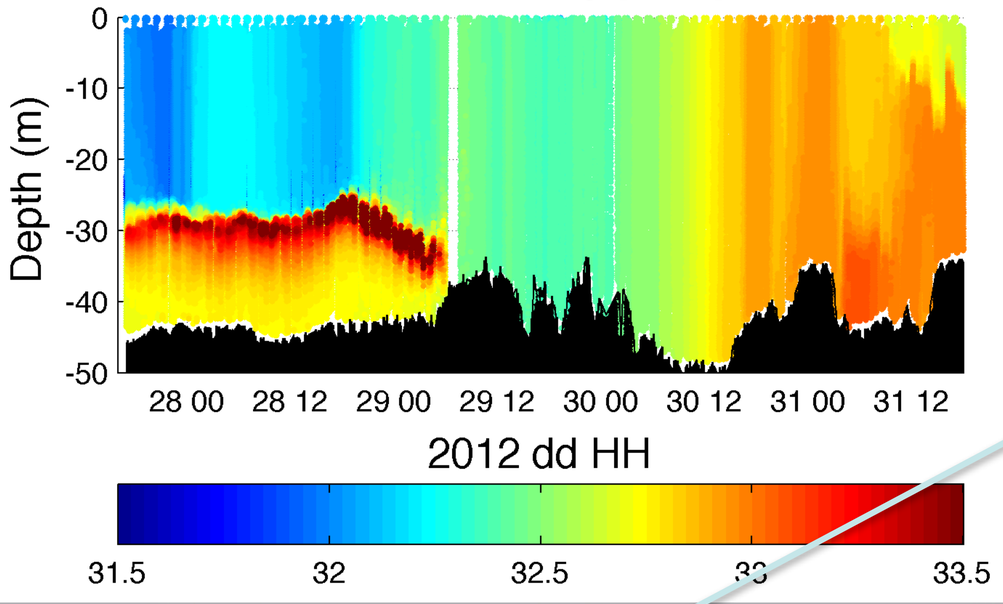
Cold water (glider)

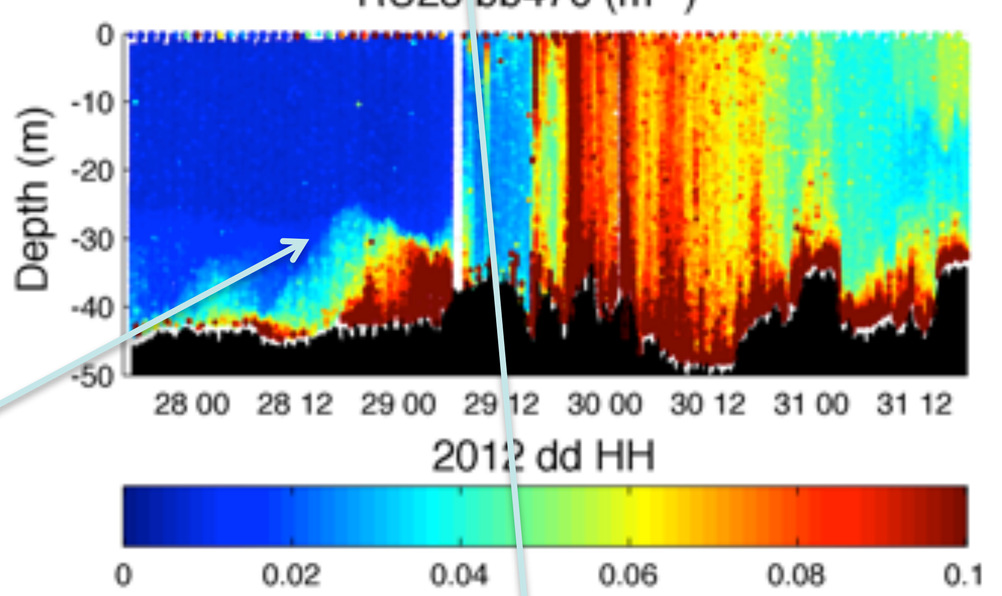



RUTGERS
UNIVERSITY
Gulf of St Lawrence
Lake Superior
Saint Pierre and Miquelon
N47.5°
Northumberland Strait
Lake Huron
Georgian Bay
Ottawa
Bay of Fundy
Lake Michigan
Lake Ontario
92.5°
W87.5°
Lake Erie
N42.5°
W52.5°
W82.5°
W77.5°
W72.5°
W67.5°
W62.5°
W57.5°
Last Surfacing
Washington
N37.5°
N32.5°
Bermuda
© 2012 Cnes/Spot Image
© 2012 Google
Image © 2012 TerraMetrics
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google earth
N
Current Speed (cm/s)
40
30
20
10
0









WBL grows and mixes from the bottom up

Winds mix from the top down

Enter a location
Share
Map
Satellite
Simple
3 days after Sandy
20 m
50 ft
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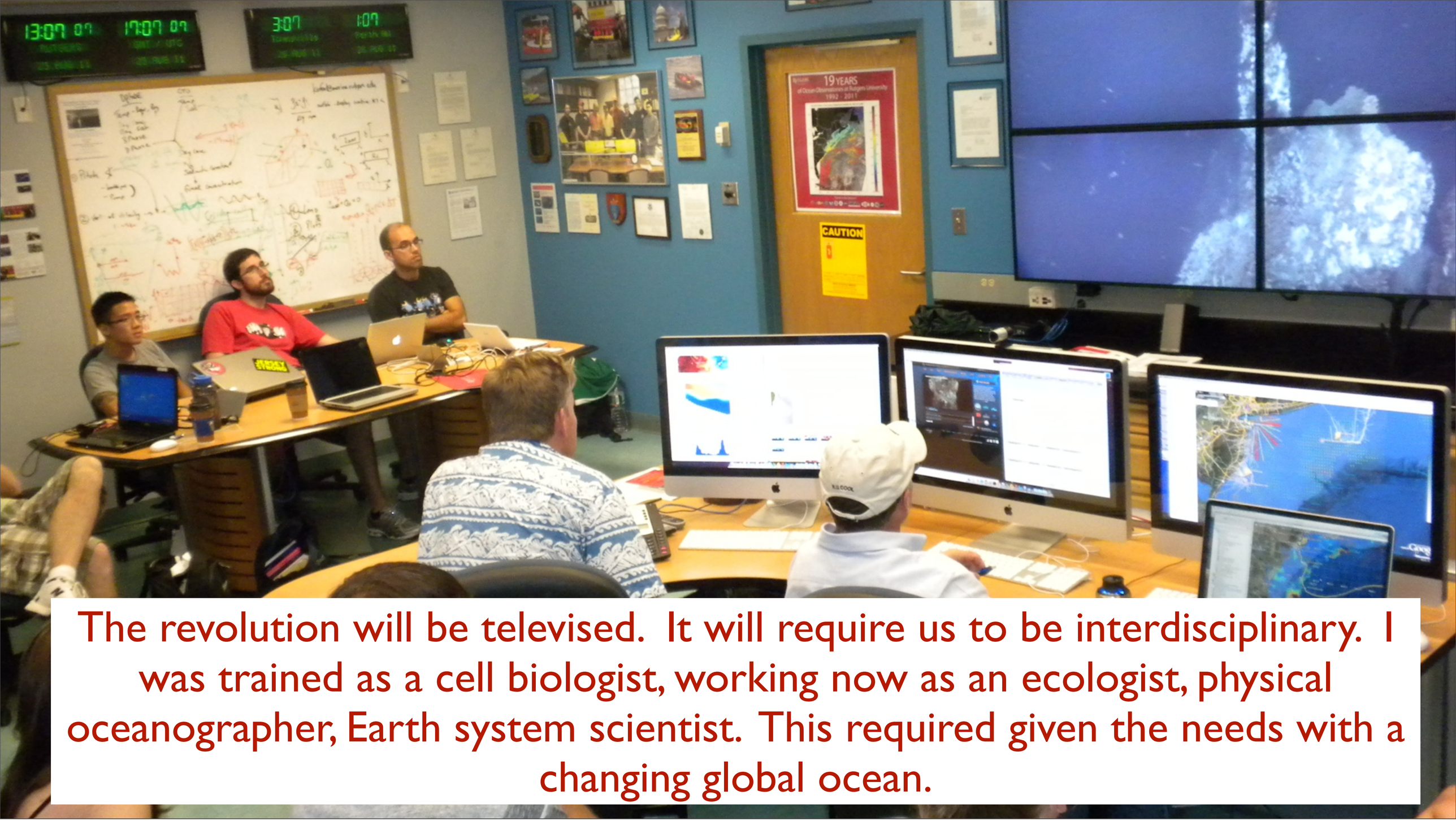


The revolution will be televised. It will require us to be interdisciplinary. I was trained as a cell biologist, working now as an ecologist, physical oceanographer, Earth system scientist. This required given the needs with a changing global ocean.

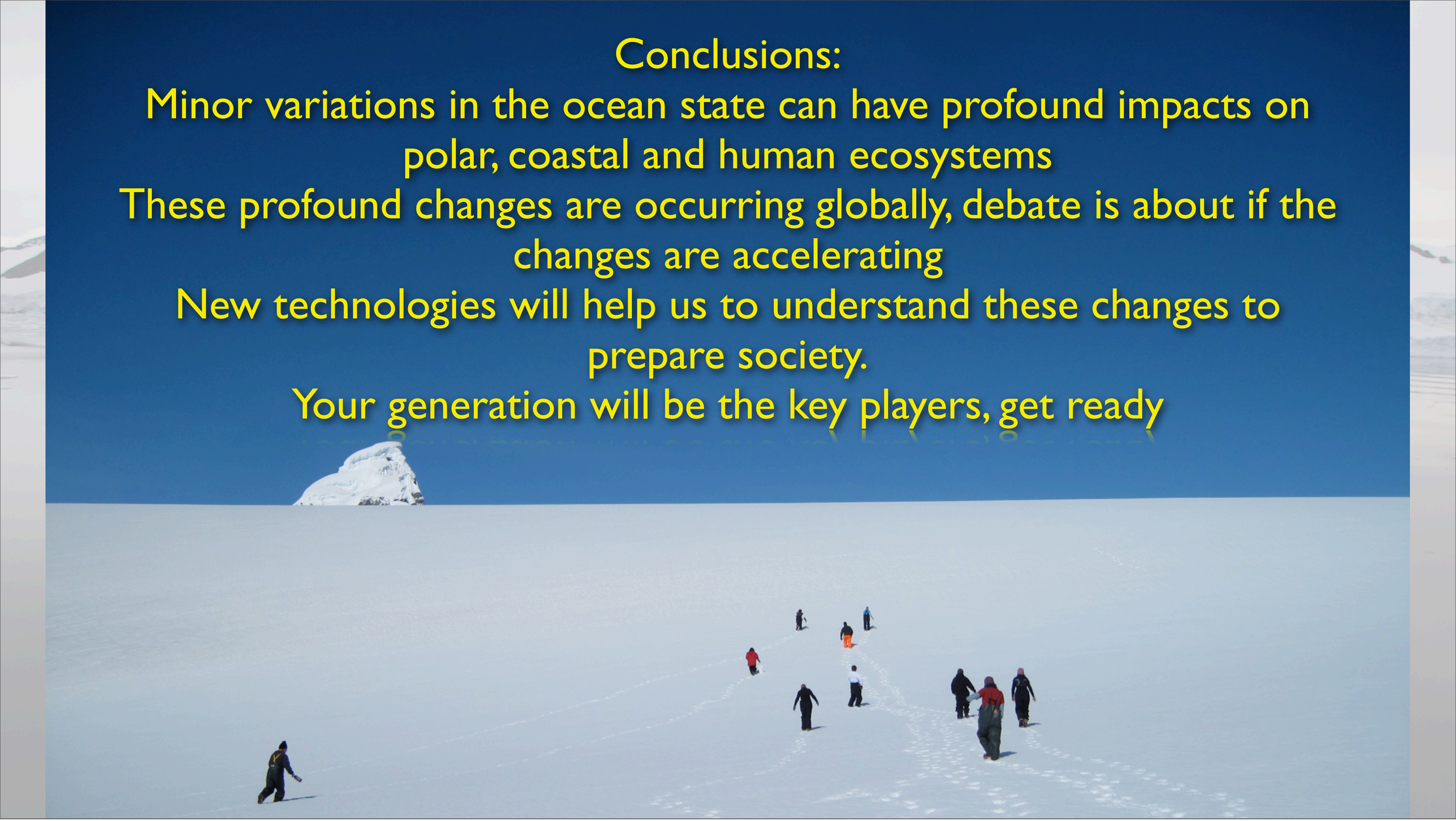
Conclusions:

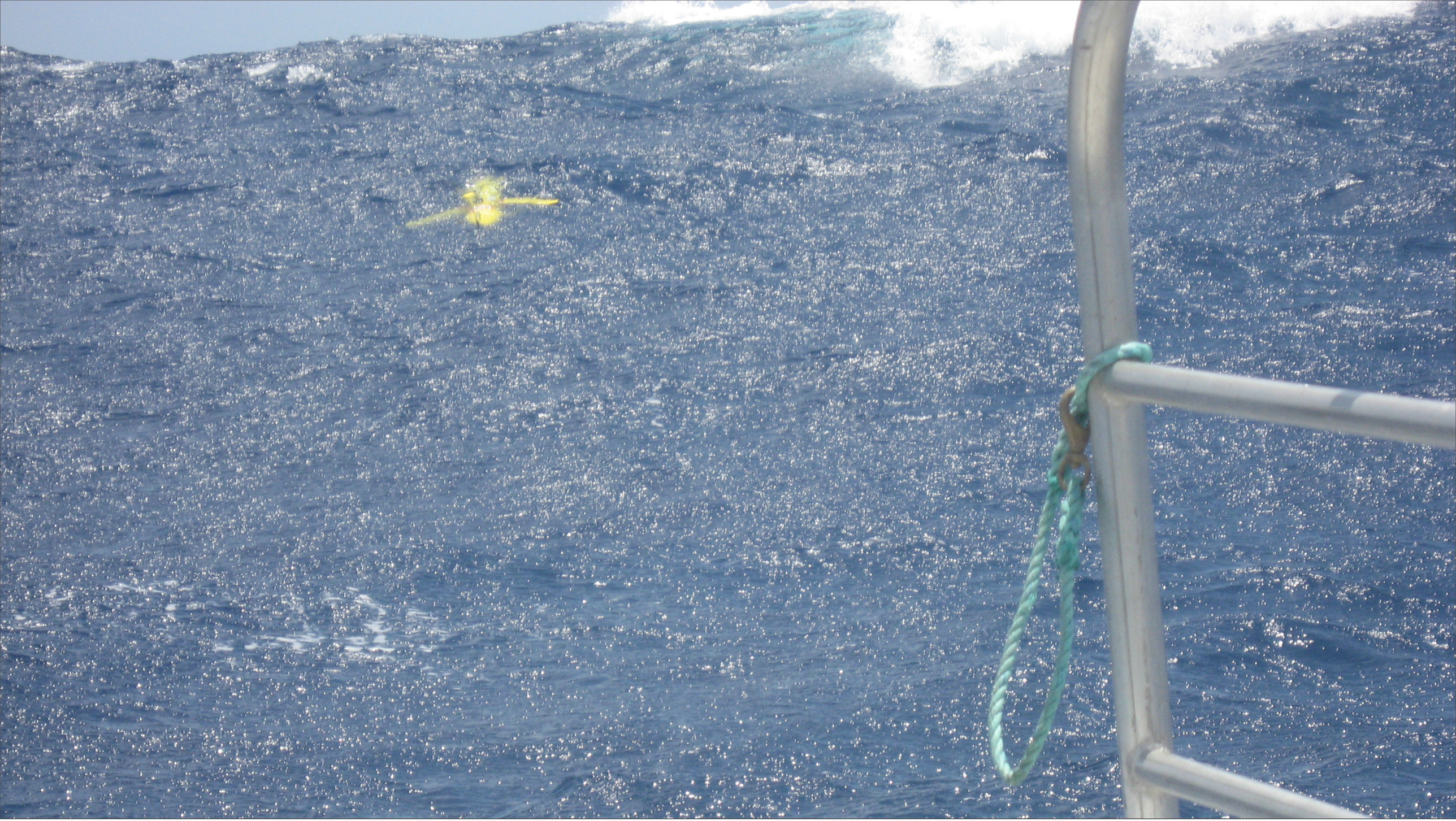
Minor variations in the ocean state can have profound impacts on polar, coastal and human ecosystems

These profound changes are occurring globally, debate is about if the changes are accelerating

New technologies will help us to understand these changes to prepare society.

Your generation will be the key players, get ready





Thursday, August 1, 13