

Antarctic Sea Ice

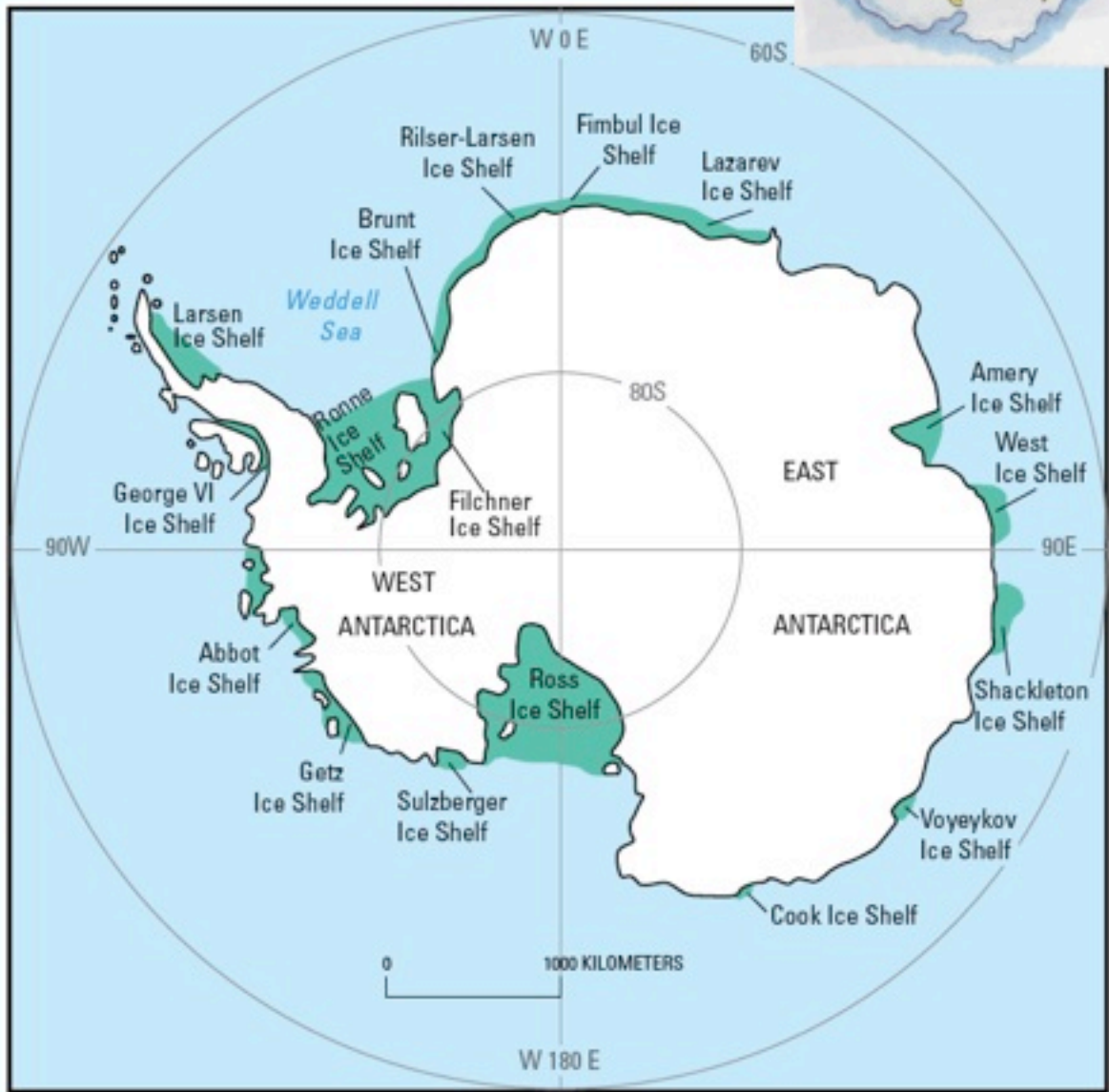
Dr. Patricia Yager
University of Georgia
School of Marine Programs

Jakob Wegelius

Continent: 5.4 million sq miles (2x the size of US)

Southern Ocean:
8 million sq miles

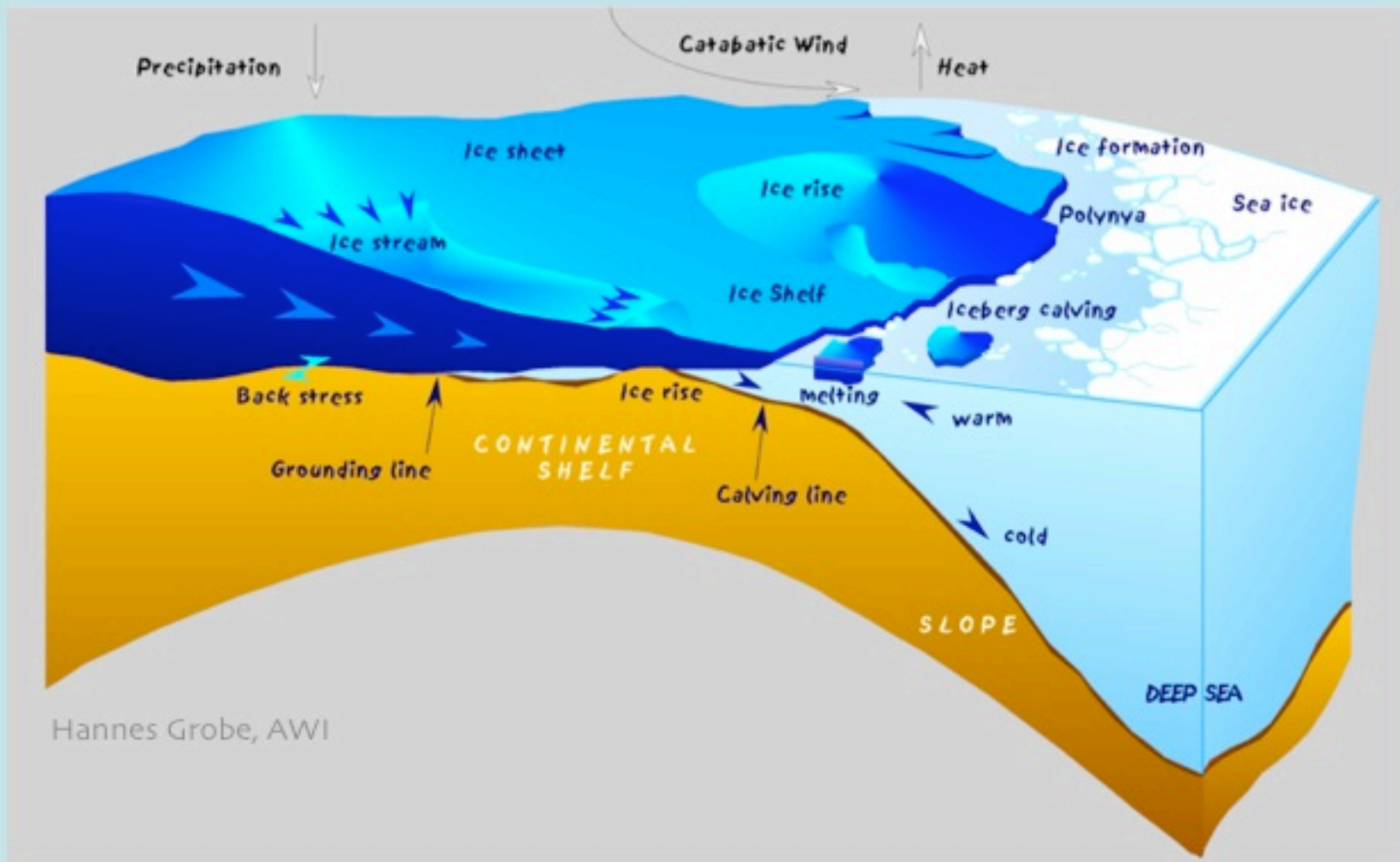
Coastline:
11,000 miles



Coastal types around Antarctica (Drewry, 1983)

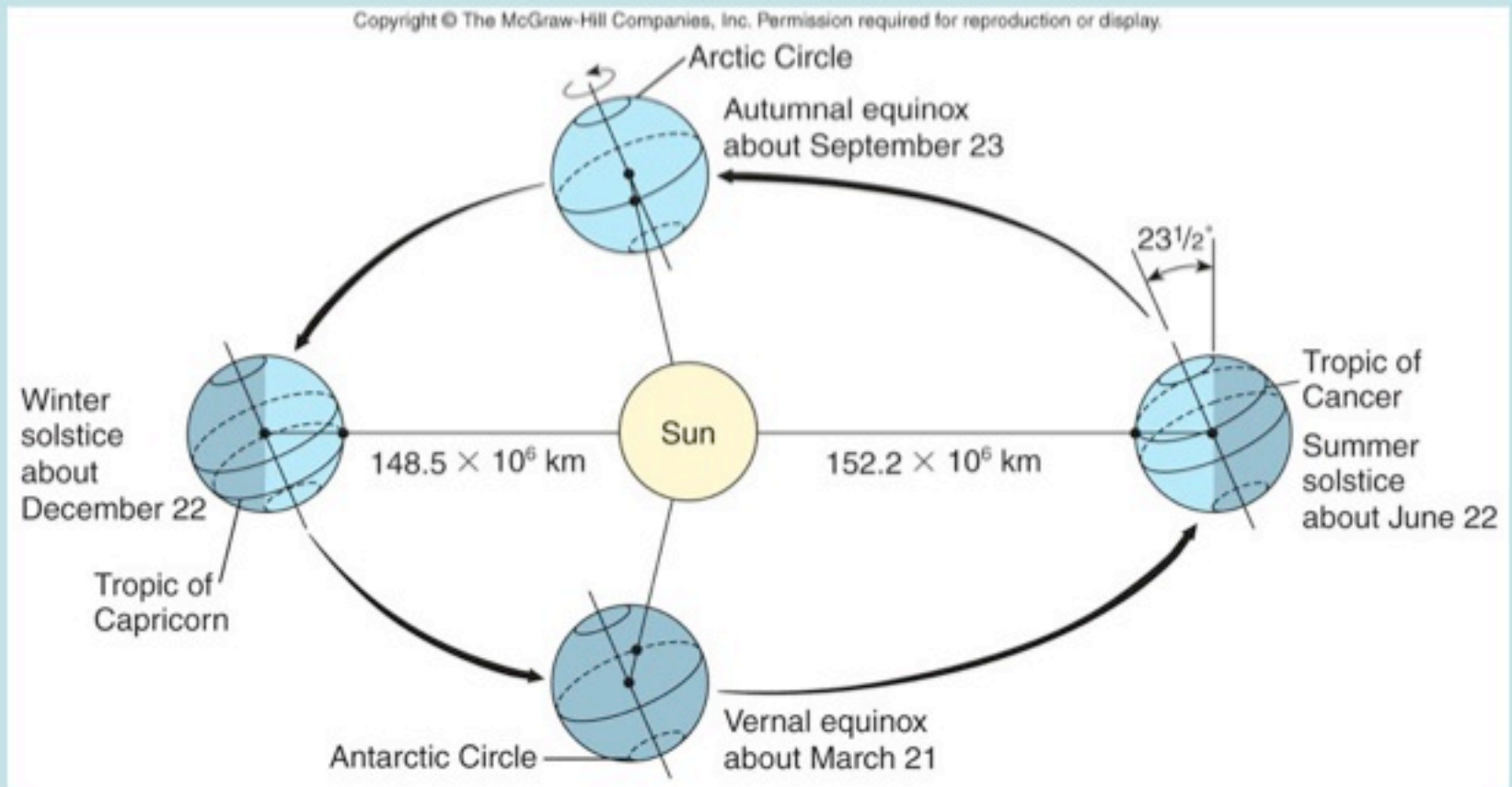
Type	Frequency
Ice shelf (floating ice front)	44%
Ice walls (resting on ground)	38%
Ice stream/outlet glacier (ice front or ice wall)	13%
Rock	4%
Total	100%

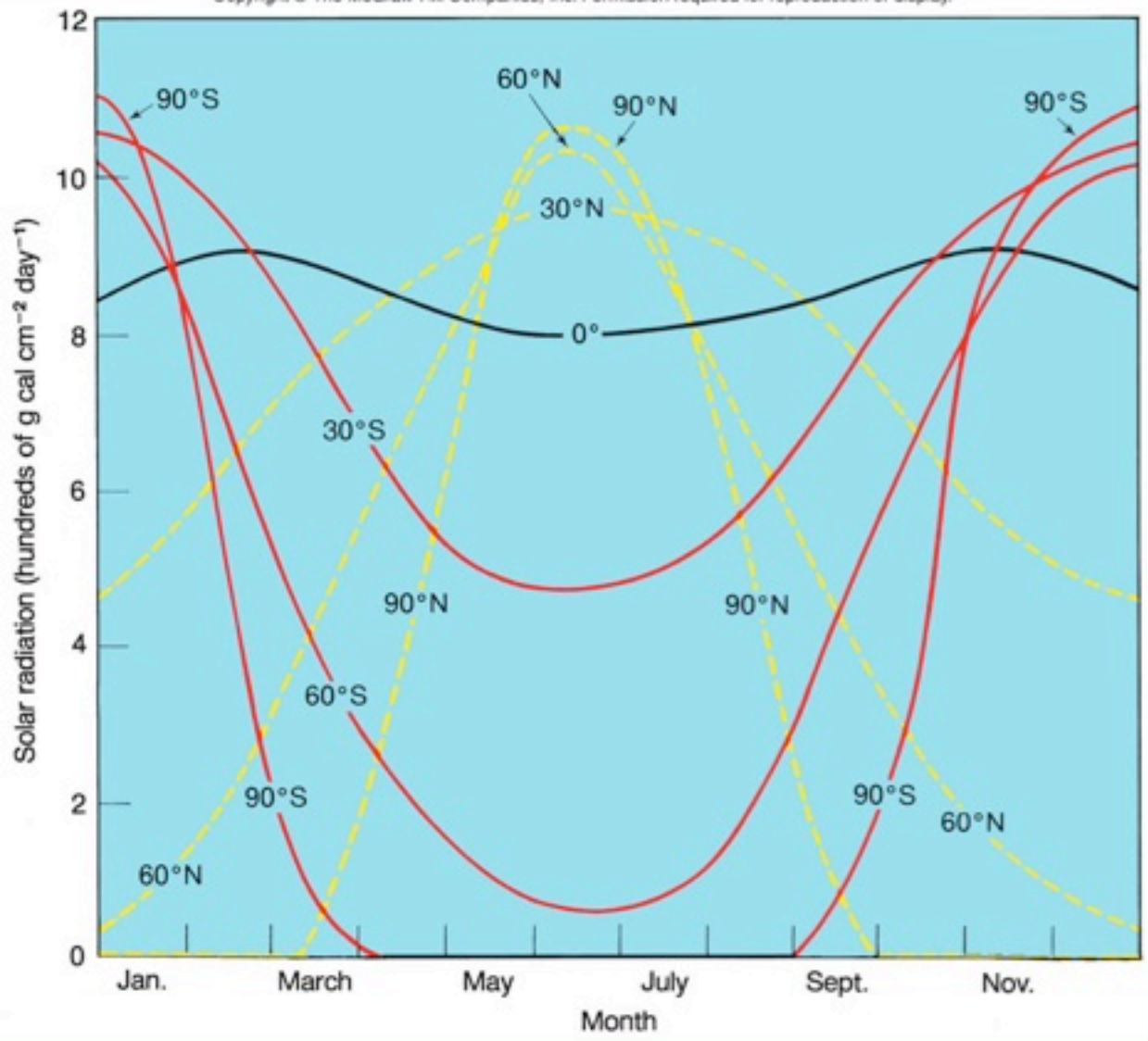
Glaciers, Ice sheets, Ice shelves



Light in the Antarctic

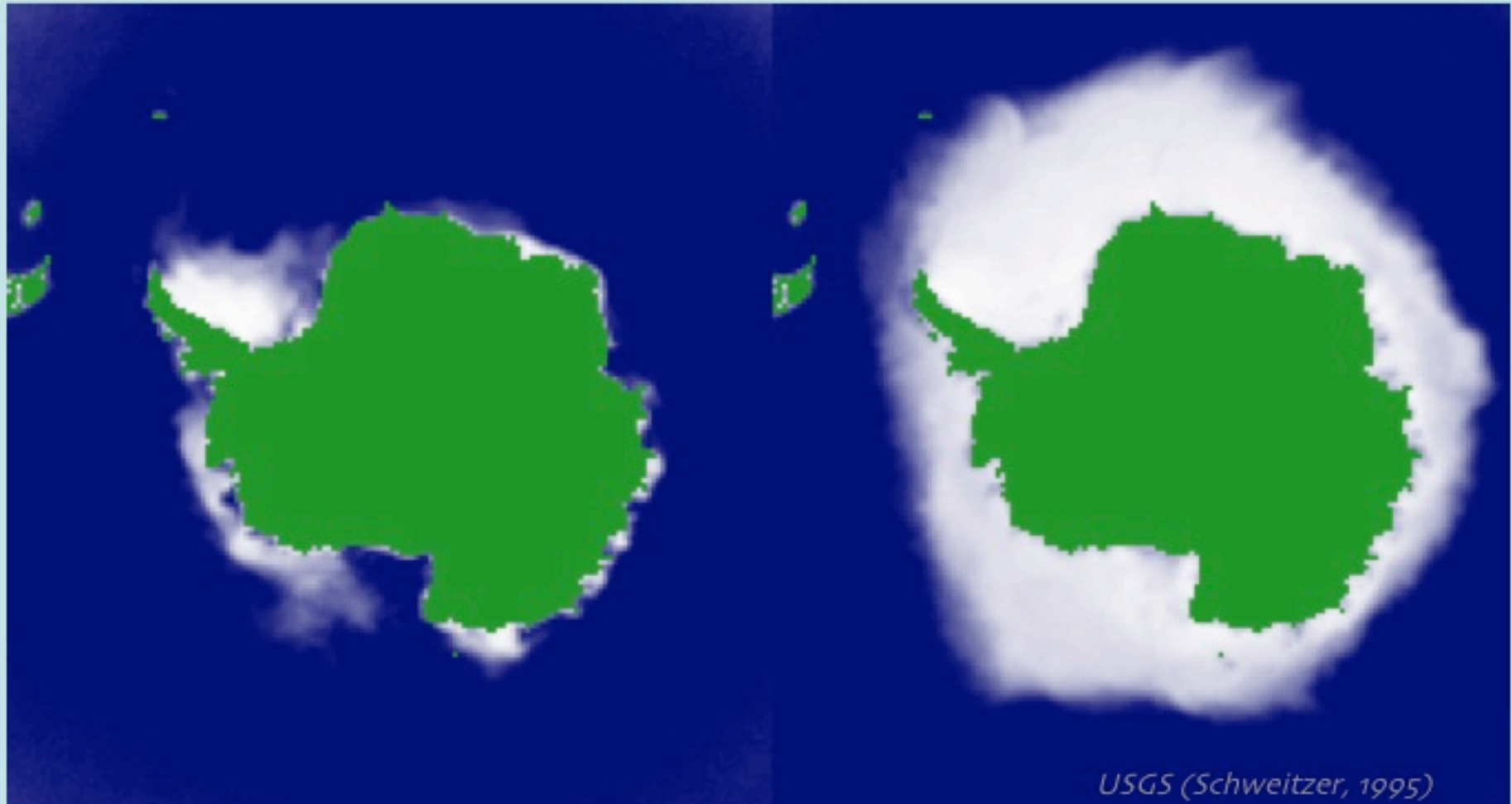
Strong seasonality due to earth's tilt





- 24 hr sunlight in summer
- 24 hr darkness in winter
- Rapid changeover

Seasonal sea ice is a dominant feature of the Southern Ocean



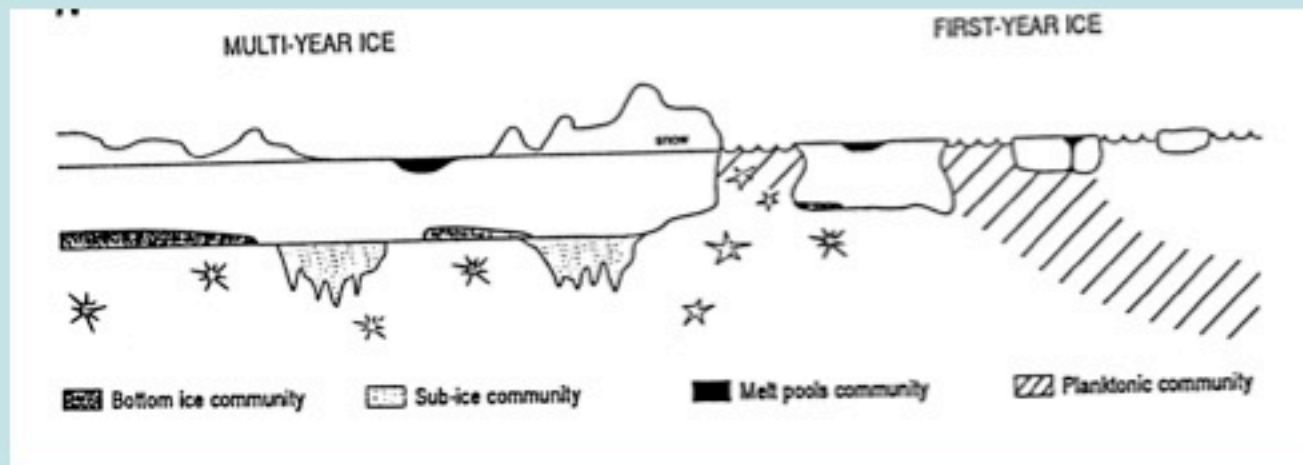
USGS (Schweitzer, 1995)

FEB

AUG

Monthly Average Polar Sea-Ice Concentration
(1987-91; SSMR,SSM/I)

Multiple habitats for primary producers





Sea-ice algal productivity

40-70 million metric tons (Tg) C yr⁻¹

5% of total productivity of Southern Ocean

Food source for higher trophics

Mediators of chemical transformations



Sea Ice Changes:

Amundsens/Bellinshausen

-7% per decade

Ross Sea sector:

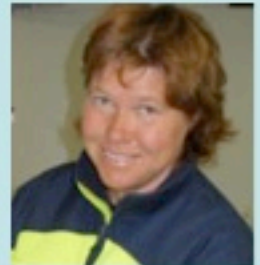
+5% per decade

Consequences?

- Ice biota
- Climate active gases
- Feedbacks

OSO 2008-09:

*Controls on climate-active gases
by Amundsen Sea ice biota*



Patricia Yager
Walker Smith
Mark Dennett
Jeff Peneston

Katarina Abrahamsson
Melissa Chierici
Agneta Fransson




Climate active gases:

*CO₂, CH₄, DMS,
tropospheric ozone,
Organohalogenes*

Source/sinks:

Autotrophy/Heterotrophy
Gas solubility = $f(\text{brine})$



Organohalogens

Compound name	Chemical formula
Iodomethane	CH_3I
Trichloromethane	CHCl_3
Tetrachloromethane	CCl_4
1,1,1-trichloroethane	CH_3CCl_3
Trichloroethene	$\text{CHCl}=\text{CCl}_2$
Dibromomethane	CH_2Br_2
Bromodichloromethane	CHCl_2Br
Chloriodomethane	CH_2ClI
2-Iodobuthane	$\text{CH}_3\text{CHICH}_2\text{CH}_3$
Tetrachloroethene	$\text{CCl}_2=\text{CCl}_2$
Dibromochloromethane	CHClBr_2
1-Iodobuthane	$\text{CH}_2\text{ICH}_2\text{CH}_2\text{CH}_3$
2-Iodopropane	$\text{CH}_3\text{CHICH}_3$
Tribrommethane	CHBr_3

Abrahamsson et al., 2004



Project Objective:

Determine quantitative relationships among sea-ice properties, organohalogen production/degradation, CO₂ fixation/respiration, sea-ice microbiota composition, physiology, and activities.



Major science questions under this overarching goal include:

1. How does sea ice biology control gas concentrations in the ice?
2. What is the role of community composition and physiology?
5. How are community structure and gas flux related to the physical environment of the sea ice?

Our working hypotheses are:

- A) Composition and activities of sea-ice biota linked to the physical environment of the ice
- B) Organohalogen and DOC production positively correlated to algal biomass
- C) Organohalogen production a function of the *composition* of autotrophs present
- D) Physiological state, stoichiometric composition, and the photosynthetic capacity of the algae controls the biogenic production of organohalogens and the drawdown of CO_2
- E) Heterotrophic halocarbon degradation driven by co-metabolism with other dissolved organic compounds
- F) Balance of autotrophy versus heterotrophy determines net production and destruction of trace gases. Sea ice fluxes of CO_2 and halocarbons will be inversely related.





Montevideo, Uruguay



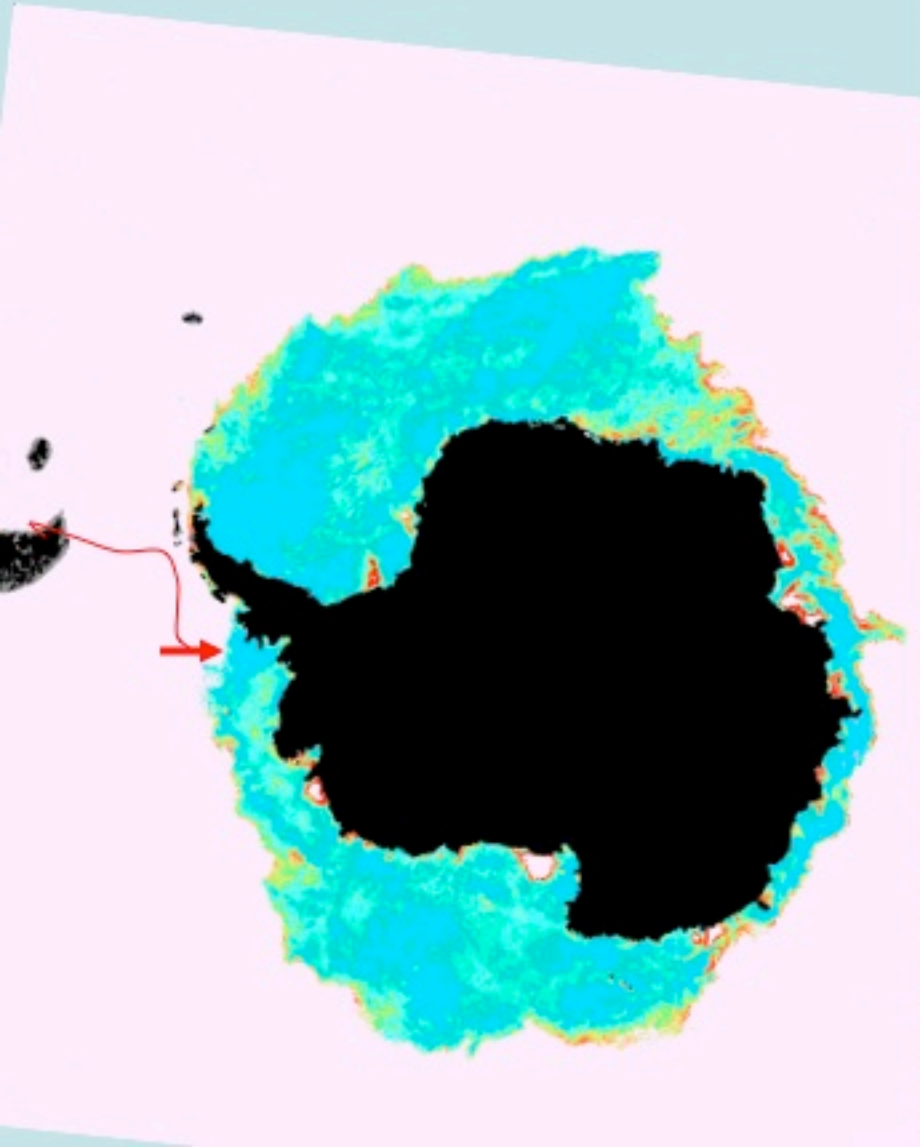
Drake's Passage



SOURCE: NASA World Wind

Jakob Wegelius

Into the ice



Åke Wallin





A powerful icebreaker - shaped like the belly of a whale

Sea Ice is about 3ft thick





Sampling ice from Oden



We will use a Kovacs Ice Drill
to collect 14-cm diameter
ice cores



<http://www.kovacsicedrillingequipment.com/photogallery.html>



**KOVACS
ENTERPRISES**
ICE DRILLING AND CORING EQUIPMENT

If the ice is very thin, we may need to sample from the basket...



<http://www2.fsg.ulaval.ca/giroq/now/Gallery/WorkatC.html>



**KOVACS
ENTERPRISES**
ICE DRILLING AND CORING EQUIPMENT



tea.armadaproject.org



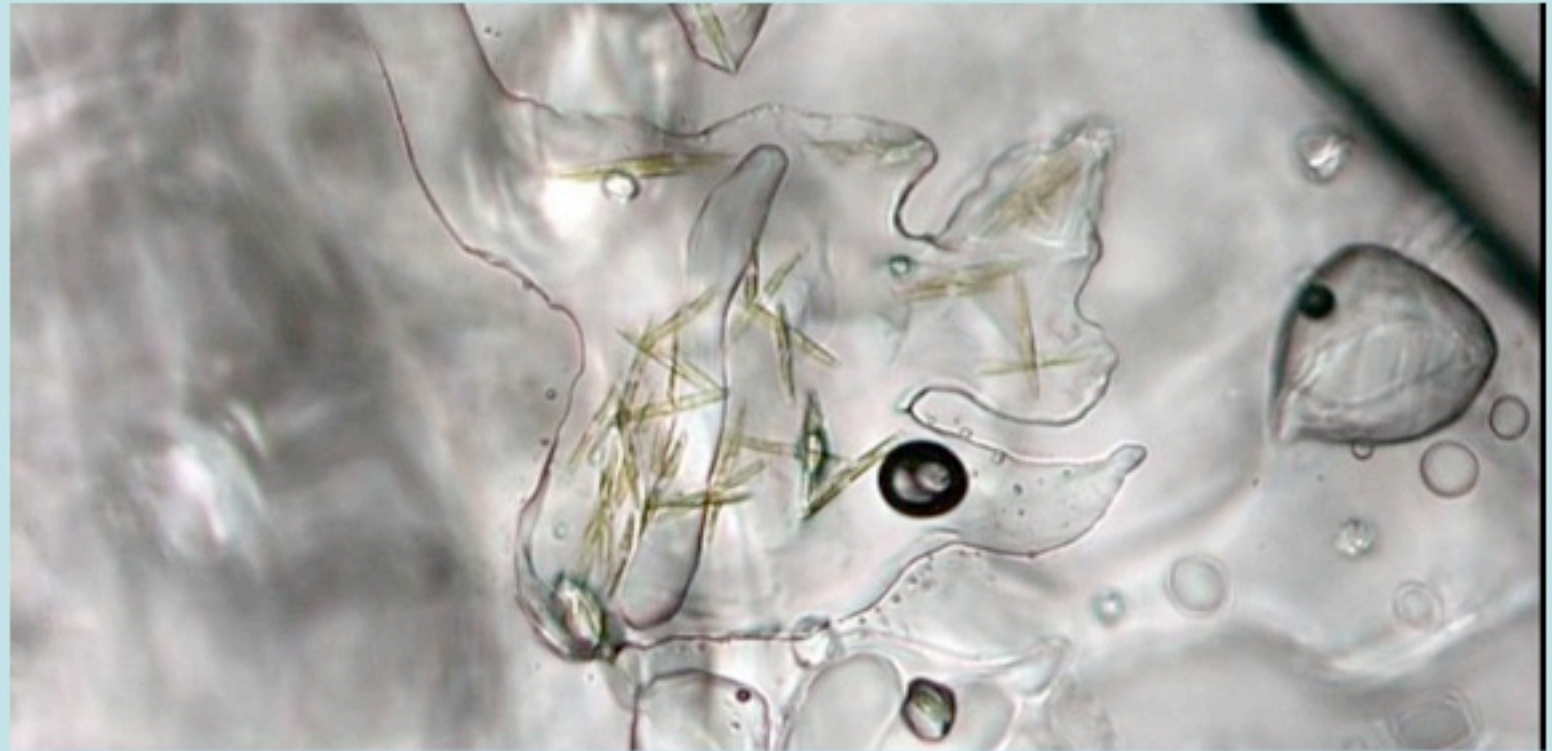
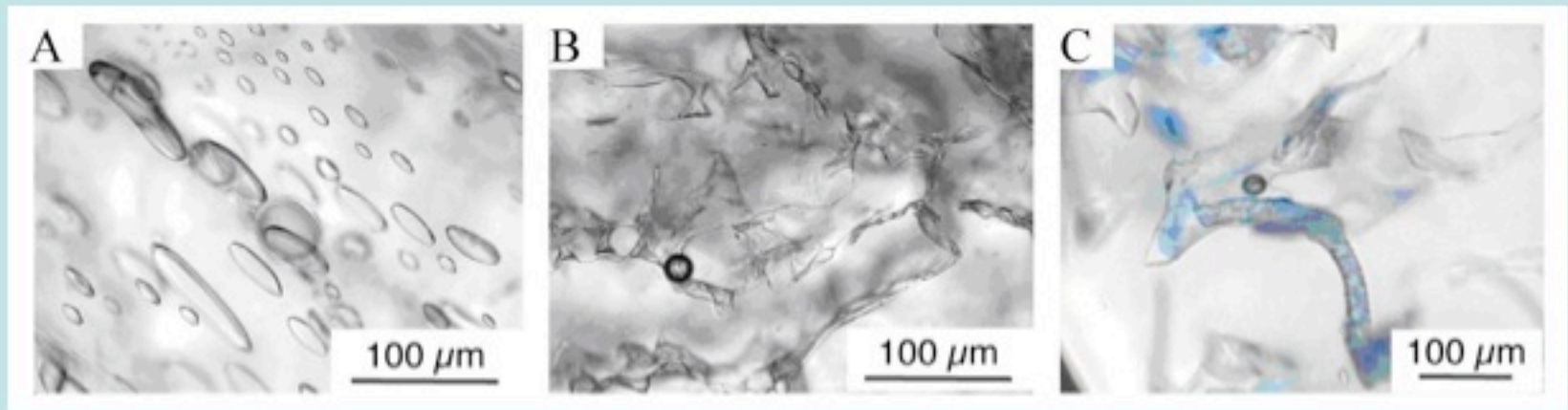
We will photograph and describe the core,
and then take its temperature



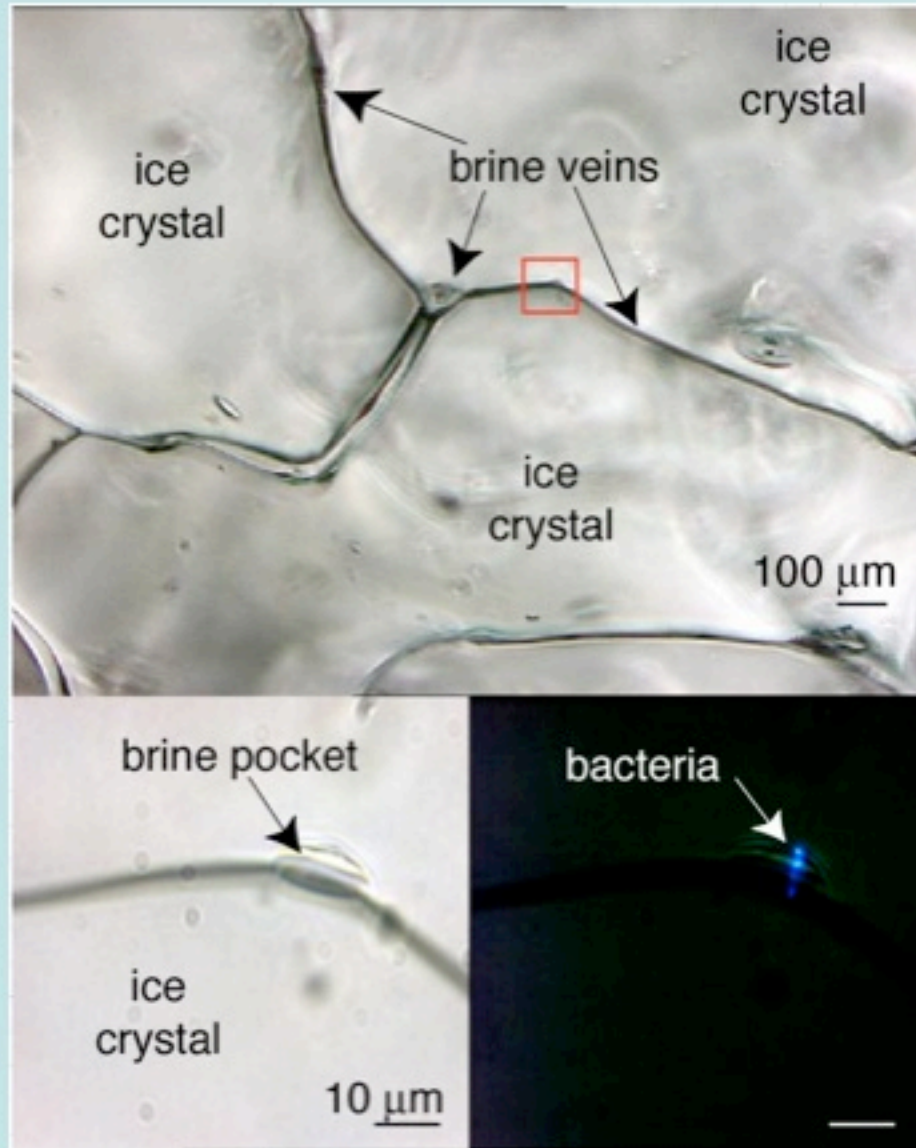
Once we remove the core, we will measure the thickness of the ice



http://www.arctic.noaa.gov/essay_kremsdeming.html



http://www.arctic.noaa.gov/essay_kremsdeming.html



Junge et al., 2001, *Annals of Glaciology*

http://oceanexplorer.noaa.gov/explorations/05arctic/logs/july21/media/seaice_work.html



Cores will be sliced with a wire saw and then sealed into gas-tight sampling (Tedlar) bags



We will also use a Jiffy Ice Auger to drill a hole through the ice, big enough to send down our light meter and some sampling bottles





BRINE INVENTORIES

Carbonate system (MC, AF, PY)

Organohalogens (KA)

Dissolved organic carbon/nitrogen (PY)

Nutrients (?)

MELTED ICE CORE INVENTORIES

Chlorophyll a (WS)

Pigments (WS)

Particulate carbon/nitrogen/ phosphorus (WS)

EPS (PY)

Biogenic silica (WS)

Community composition (autotrophs and protists; MD)

Bacterial Abundance (PY, MD)

Bacterial community structure (PY)

MELTED ICE (INTO FSW) RATES / ACTIVITIES

Photosynthesis / Irradiance (^{14}C -bicarb; WS)

Photosynthetic capacity (PAM-FRRF; WS)

Bacterial Production (^{14}C -LEU), Respiration,

Organohalogen degradation (PY)

**Same as above for underway surface seawater
or Niskin water from 1 m**



Kevin Bakker is a graduate student at UGA working on his Master Degree





Lollie Garay

Here's Tish all suited up in the "Rad Van"



Lots of little bottles

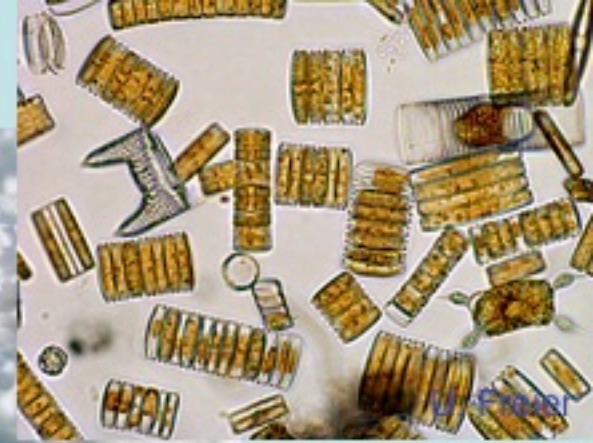


Lollie Garay



Lollie Garay

A three-week experiment to measure effects of climate change



Sea ice algae is at the base of the food chain here

Antarctic Krill

<http://www.answers.com/topic/antarctic-krill>



Rob Sherrell

Life in an icy world



Can you see the Snow Petrel in this picture?

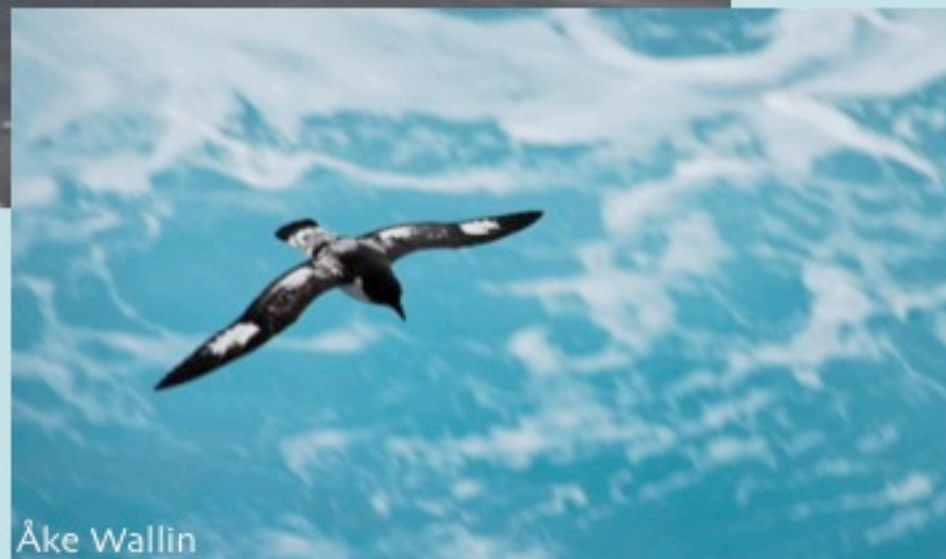
Life in an icy world



Can you see the Snow Petrel?



A Cape petrel





Who makes these tracks?



Adelie Penguins



Daniel Barrdahl



Adelie Penguins





Lollie Garay



Who says penguins can't fly?



Jakob Wegelius



Jakob Wegelius



Lollie Garay

Emperor penguins



Daniel Barrdahl

Crabeater seals

Jakob Wegelius



Jakob Wegelius



Weddell seals



We think this was a Leopard seal



Daniel Barrdahl

Minke whale



Orca whales



A. Burd

We also saw a lot of icebergs





The ice shelf - about 150 ft above the water line, 600 ft below





Life onboard Oden was
a lot like living in
Sweden





The best thing about my room was the view out the window





We had "coffee time" twice a day - in addition to three meals

Santa Lucia Day Celebration

December 13



Lollie Garay



Lollie Garay



Lollie Garay

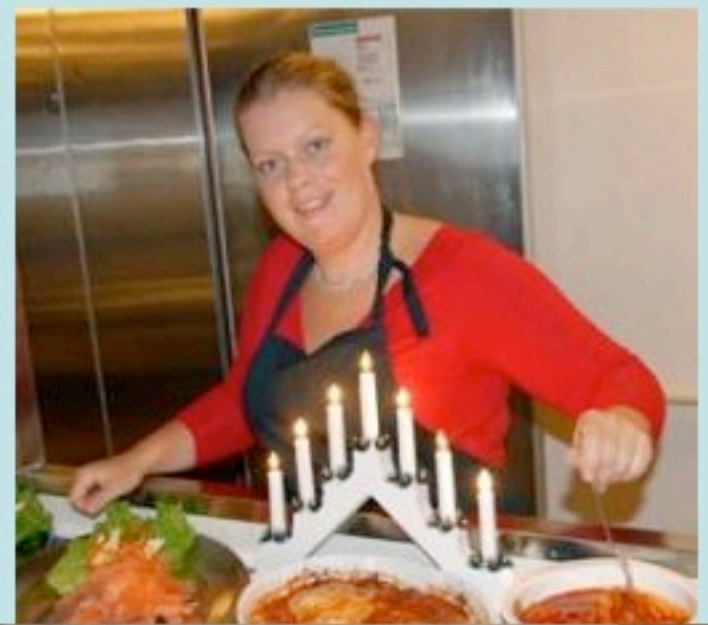
SWEDARP 2007/08 - Oden Southern Ocean

Time change

On December 20 we will advance our clocks 16 hours.

At 04:00 (4 AM) in the morning the time will become 20:00 (8 PM) in the evening. Brunch will then be served at 23:30 (11.30 PM).

Next meal will be breakfast December 21 at 07:30 (7:30 AM).



Christmas Eve dinner
was very special

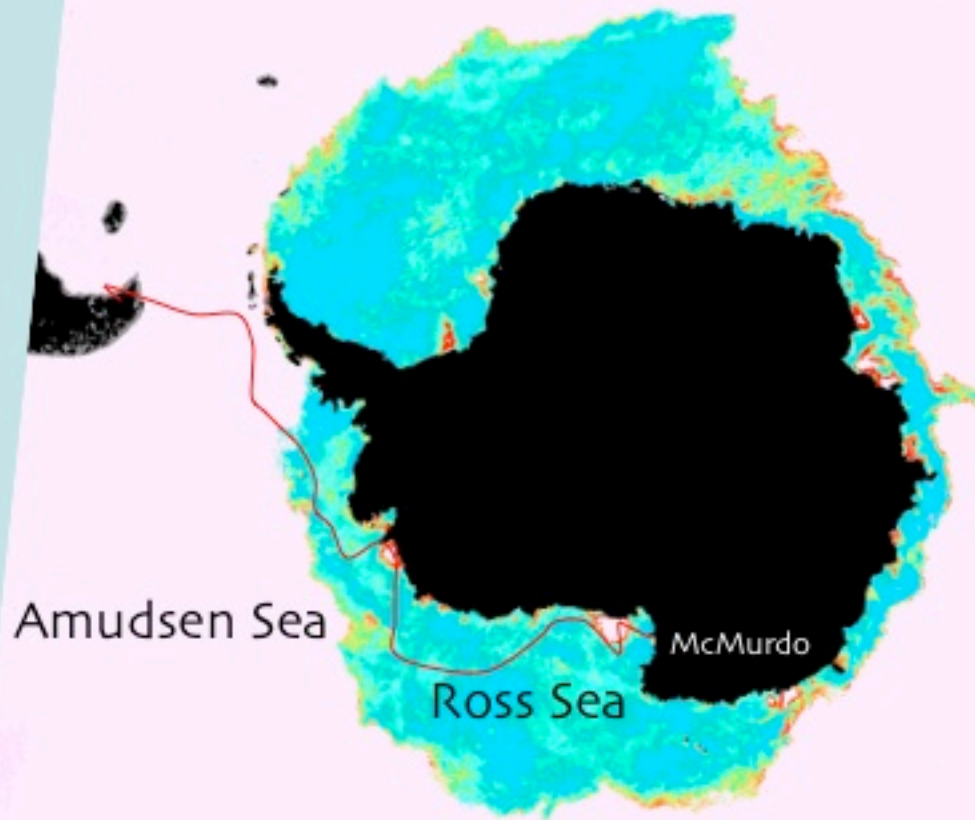


Mount Erebus - an active volcano near *McMurdo*

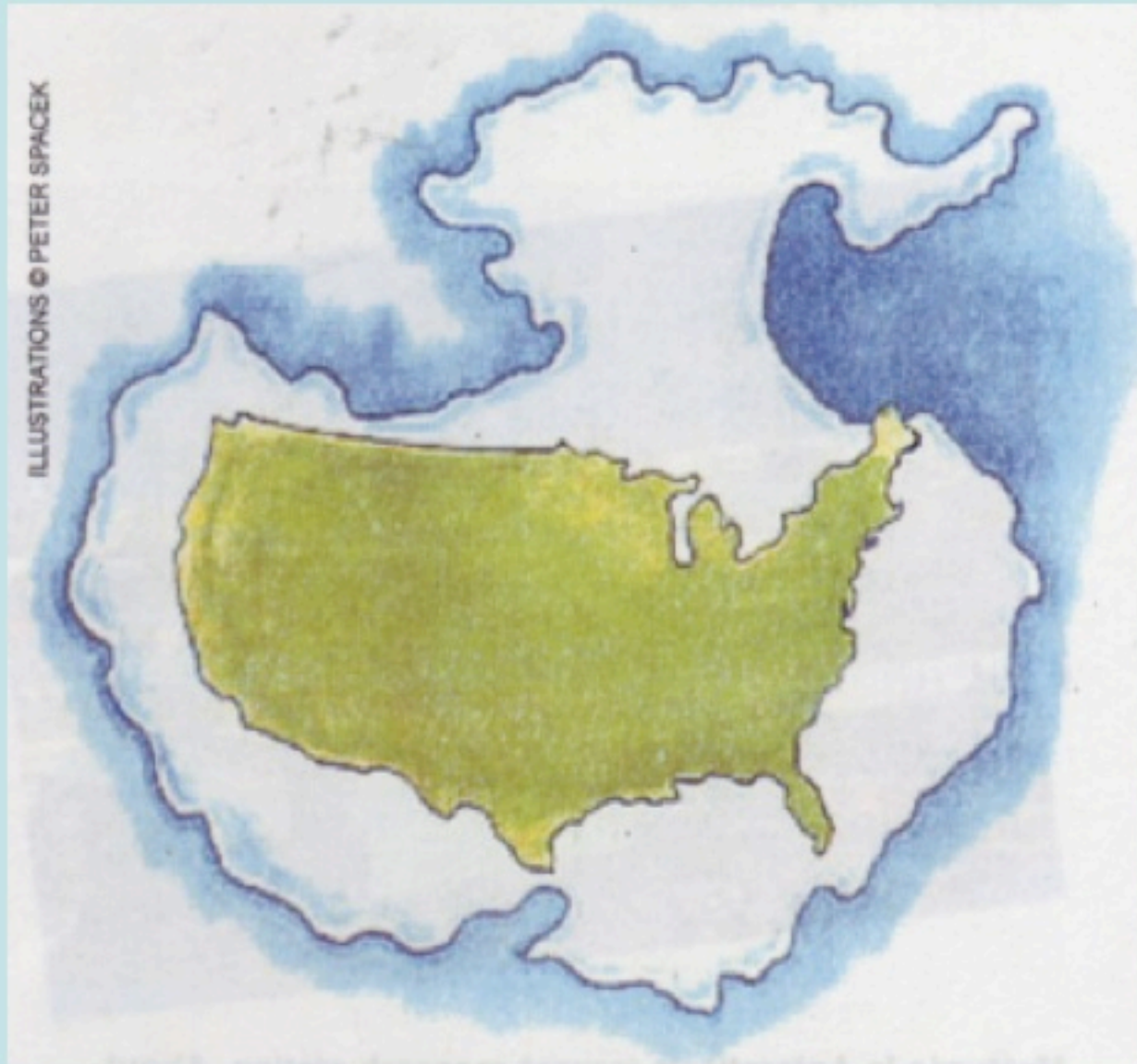
Amundsen Sea... Ross Sea... and then on to McMurdo Station

Punta Arenas:
 $53^{\circ}\text{S}, 71^{\circ}\text{W}$

McMurdo Station:
 $78^{\circ}\text{S}, 168^{\circ}\text{E}$



We traveled more than
3000 miles!



“like driving
across the US at
12 miles per hour”

We were flown from the ship to *McMurdo* by helicopter





McMurdo Station - Scott's hut in the foreground



McMurdo supports about 1400 people during the summer months, and has a hospital and fire station



Our "shuttle"
to the "airport"



An airforce C17 flew us to
New Zealand...



...where we saw
our first
darkness in over
six weeks





CURRENT EXPEDITION

Antarctic Undersea ROV '08
 Teacher: *Cameo Slaybaugh*
 Starts: **November 4** | [Read More](#)

[Join PolarTREC](#)[Virtual Base Camp](#)[CARE Network](#)[Learning Resources](#)

Live From IPY!



Virtual Base Camp

2009 Expeditions

- ▶ Geologic Climate Research in Siberia

2008 Expeditions

- ▶ Current Expeditions
 - ▶ Lake Ecosystems in Antarctica
 - ▶ Antarctic Undersea ROV '08
 - ▶ Ancient Buried Ice in Antarctica

Upcoming Expeditions

Oden Antarctic Expedition '08

Overview

- [Mr. Peneston's Journal](#)
- [Ask the Team](#)
- [Photo Gallery](#)
- [Resources](#)

- ▶ Erebus Volcano Antarctica

Completed Expeditions

- ▶ 2007 Expeditions
 - ▶ Oden Antarctic Expedition '06

2008 Expeditions » Upcoming Expeditions

Oden Antarctic Expedition '08

[Overview](#) [Mr. Peneston's Journal](#) [Ask the Team](#) [Photo Gallery](#) [Resources](#)

International Expedition to Antarctica aboard the Icebreaker Oden '08

November 25, 2008 - January 12, 2009 | Southern Oceans, Antarctica



Researcher
Tish Yager
 University of Georgia
 Athens, GA



Teacher
Jeff Peneston
 Liverpool High School
 Liverpool, NY

Join PolarTREC teacher, Jeff Peneston, aboard the Oden and check out all the class flags that he will be taking with him. To view all the flags that classrooms around the country have sent him to carry to Antarctica, [click here](#).

Who is on the expedition?

Jeff Peneston can walk or snowshoe out his back door into the forest and lakes of Camp Talooi, a children's camp that he has helped his wife direct for 24 years. Each school day he leaves his forested home to teach Earth Science at Liverpool High School, just North of Syracuse, New York. Mr. Peneston has been teaching for 22 years and his passion has been to find ways to bring his students out into the natural world where they can learn to solve authentic problems. In 2000

