

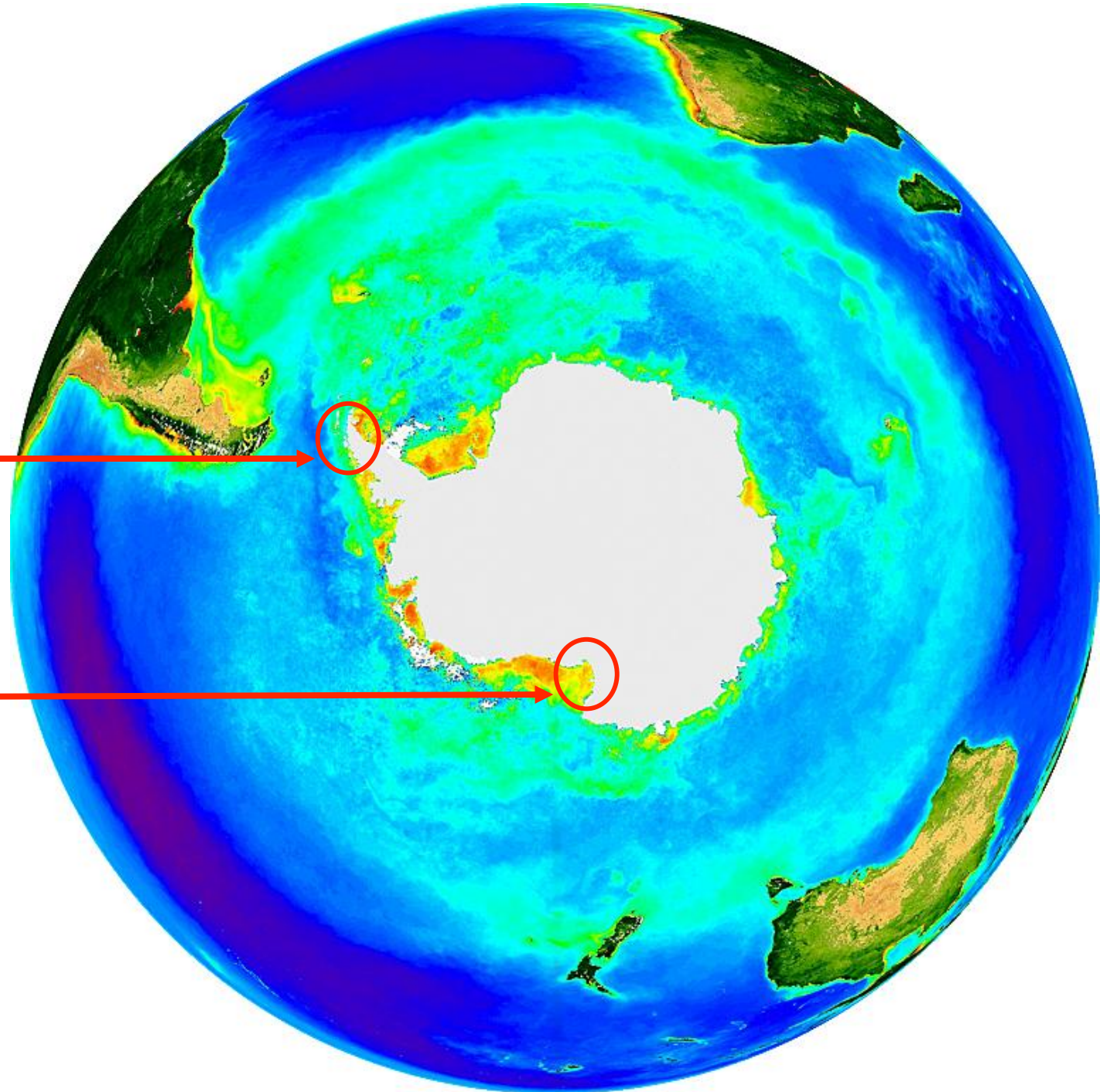


**Palmer Antarctica LTER  
Long-Term Ecological Research Project  
1991 – 2006**



Palmer,  
Antarctica  
LTER site on  
West  
Antarctic  
Peninsula,  
64.7S, 64.1W

MCM Site  
77S, 163E

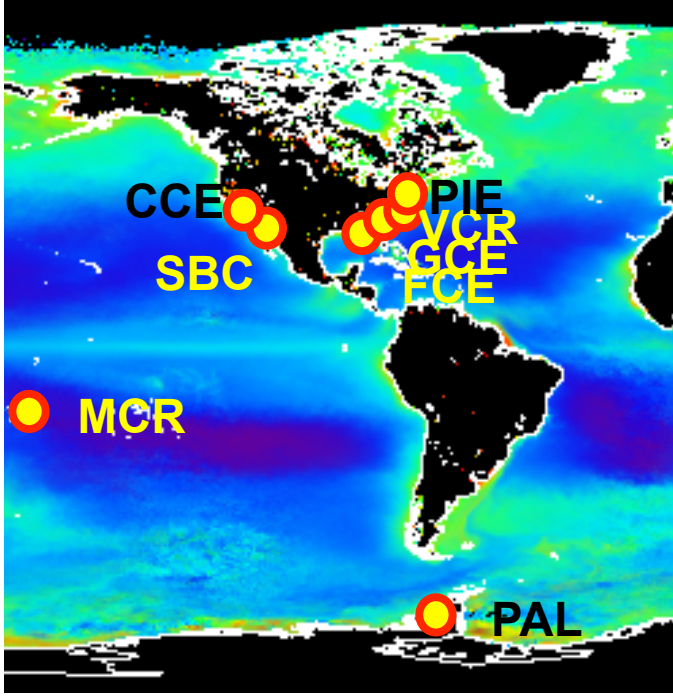
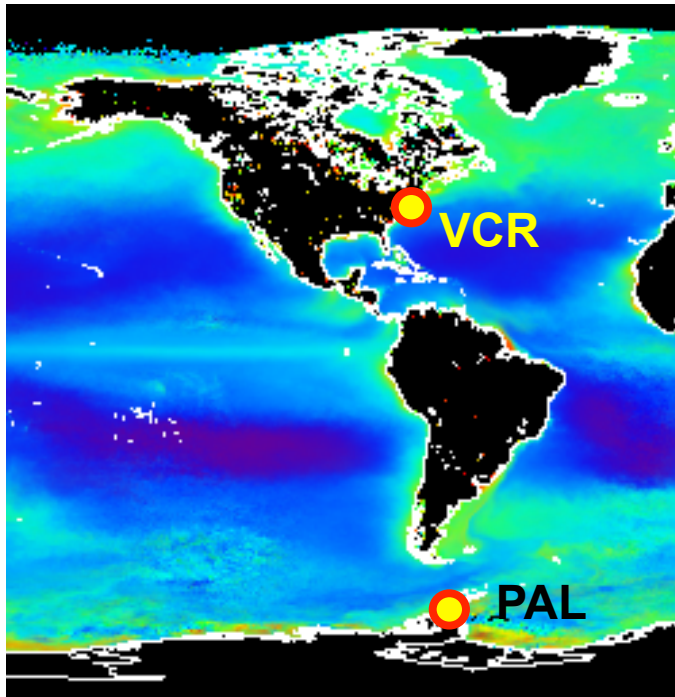


NASA SeaWiFS  
Austral summer, 2003



**Palmer LTER**  
Started 1990  
18<sup>th</sup> LTER Site added to LTER Network  
First marine pelagic site (and only one until CCE)

1990 2 LTER Marine Sites 8 2005



NASA Ocean Color November Composite, 1990-2005



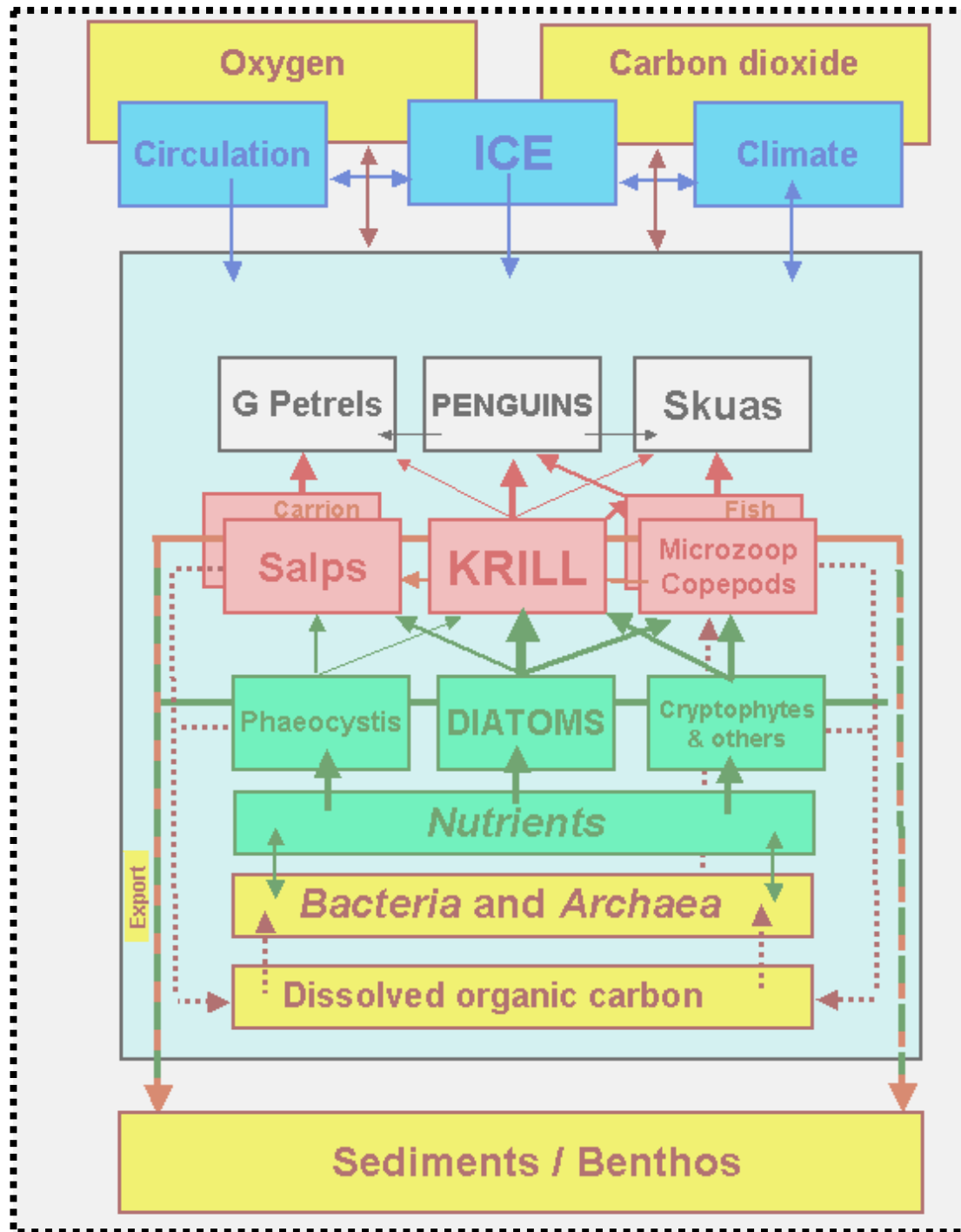
## Current Hypothesis: Climate Change and Ecosystem Response

*The central tenet of PAL is that the annual advance and retreat of sea ice is a major physical determinant of spatial and temporal changes in the structure and function of the Antarctic marine ecosystem... We now recognize the west Antarctic Peninsula (WAP) as a premier example of a climate-sensitive region experiencing major changes in species abundance and composition due to changes in range and distribution that are occurring in response to regional climate change manifested here primarily as a southern migration of principal climate characteristics (climate migration). In effect, the maritime system of the northern WAP is replacing the continental, polar system of the southern WAP along the peninsular climate gradient. This change is driven by regional warming, which is modulated by regional hydrography, sea ice processes and global teleconnections to lower latitude atmospheric variability...we seek to understand the full ecological implications of climate migration in the WAP, and uncover the mechanisms linking them through teleconnections to global climate variability.*



## **Palmer LTER Scientific Components**

<b>Hugh Ducklow</b>	<b>College of Wm &amp; Mary, VA</b>	<b>Lead PI</b> <b>Microbial ecology</b> <b>Biogeochemistry</b>
<b>Doug Martinson</b>	<b>Lamont-Doherty</b>	<b>Physical Oceanography</b>
<b>Ray Smith</b>	<b>Santa Barbara</b>	<b>Remote sensing</b>
<b>Martin Montes</b>	<b>Scripps</b>	<b>Optics &amp; plankton ecology</b>
<b>Maria Vernet</b>	<b>Scripps</b>	<b>Phytoplankton ecology</b>
<b>Robin Ross</b> <b>Langdon Quetin</b>	<b>Santa Barbara</b>	<b>Krill &amp; other zooplankton</b>
<b>Bill Fraser</b>	<b>Polar Oceans Group</b>	<b>Penguins &amp; other seabirds</b>
<b>Karen Baker</b>	<b>Scripps</b>	<b>Information management</b>

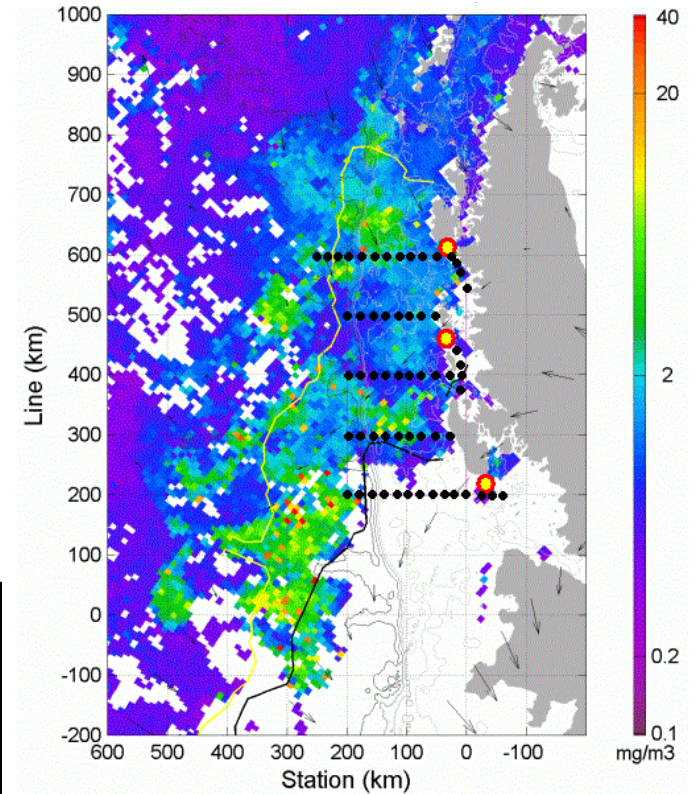




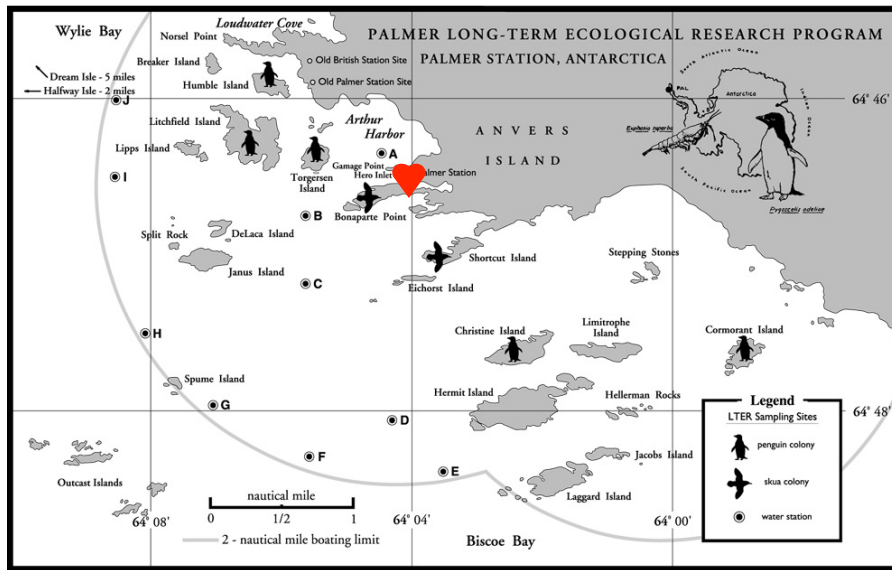
# Palmer LTER: Scientific emphasis

Interannual variability at the regional scale

November 2004



Processes & mechanisms at the local scale





# Annual regional survey cruise (January 1993 – 2006)



## Interannual variability at the regional scale

Grid stations •

Penguin rookeries ●

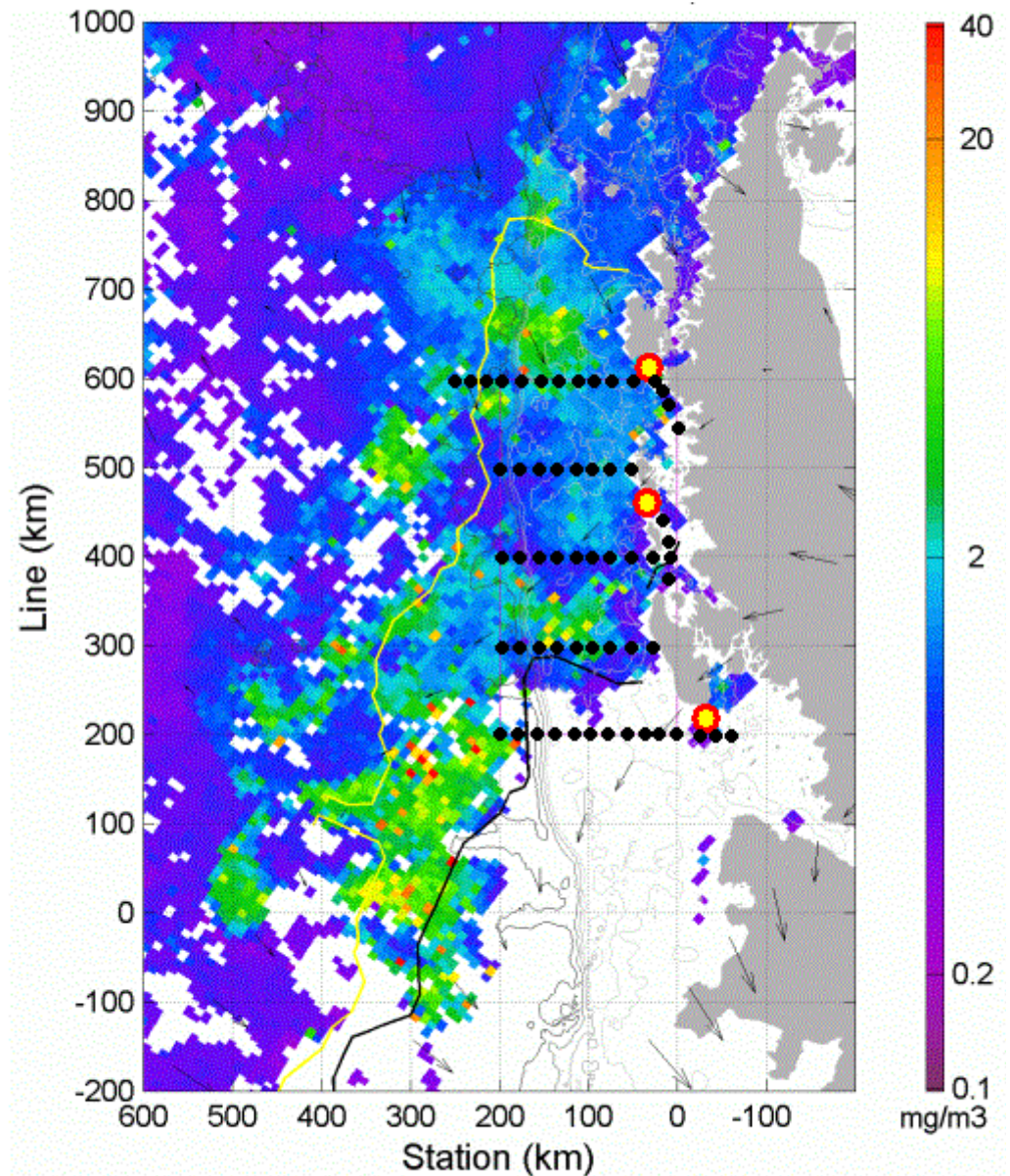
White = sea ice

Yellow line: beginning ice edge

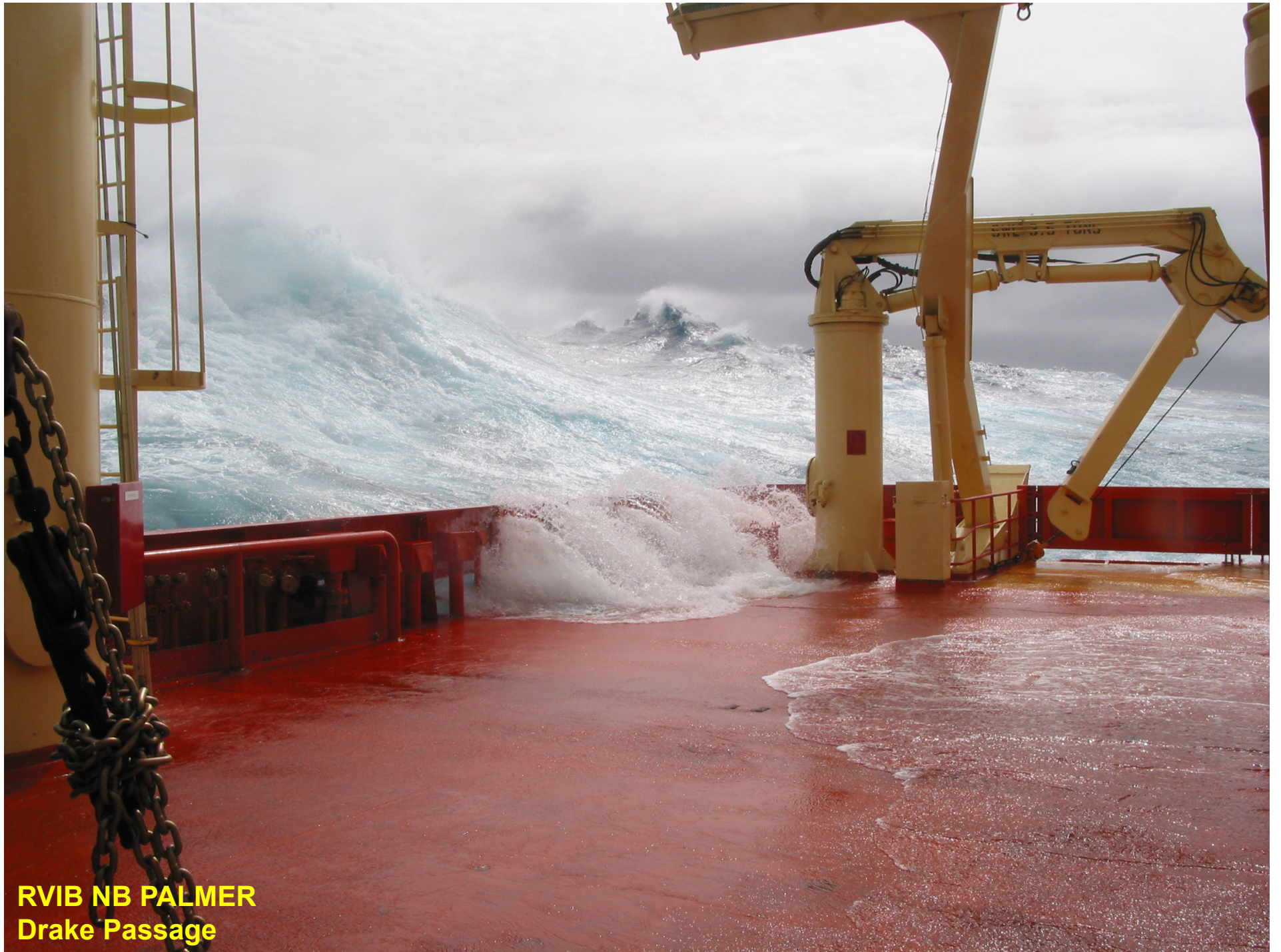
Black line: ending ice edge

Arrows: wind vectors

Color = SeaWiFS Chlorophyll







**RVIB NB PALMER**  
**Drake Passage**



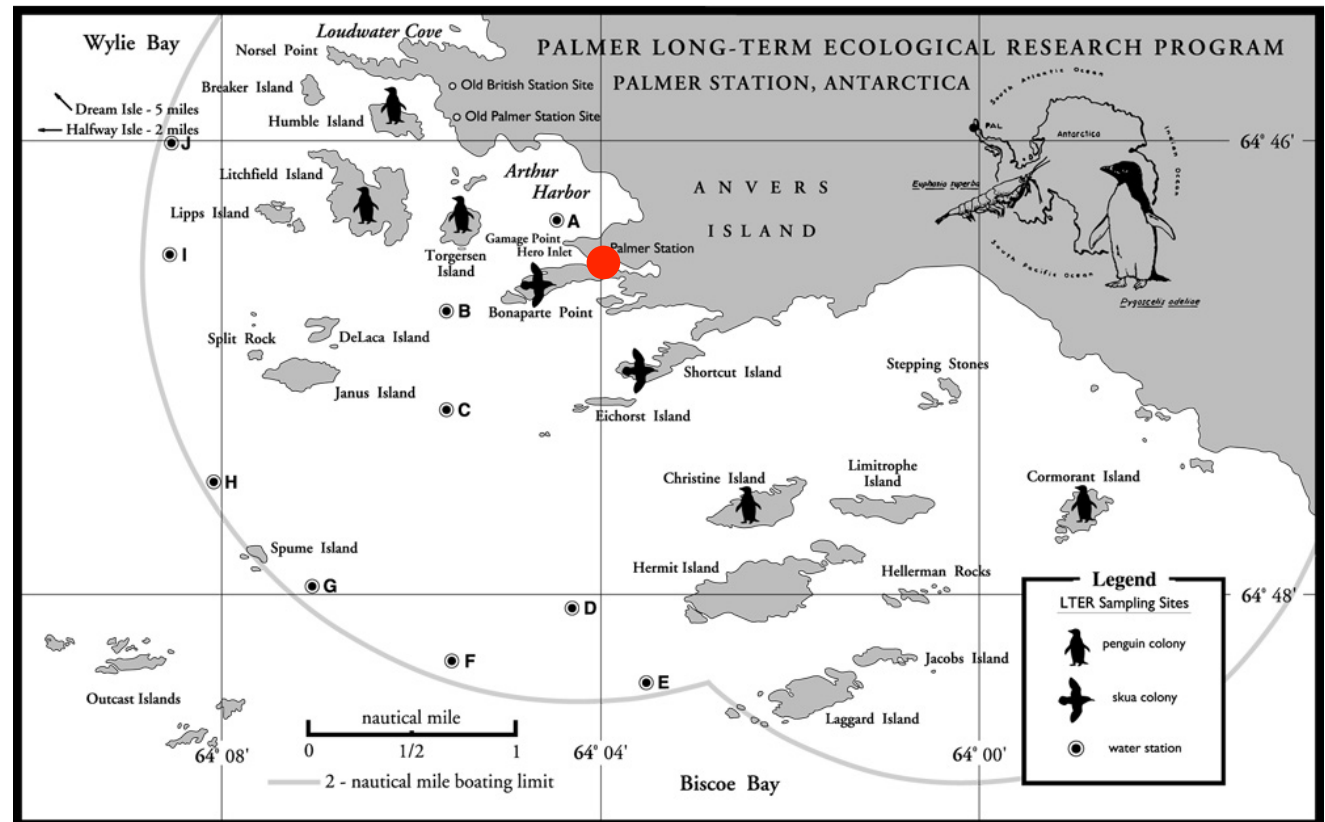
# Seasonal cycles at Palmer Station

## Processes & mechanisms at the local scale

### Palmer Station

### Bird demography & dynamics

### Stations B, E hydrography & ecology/biogeochemistry



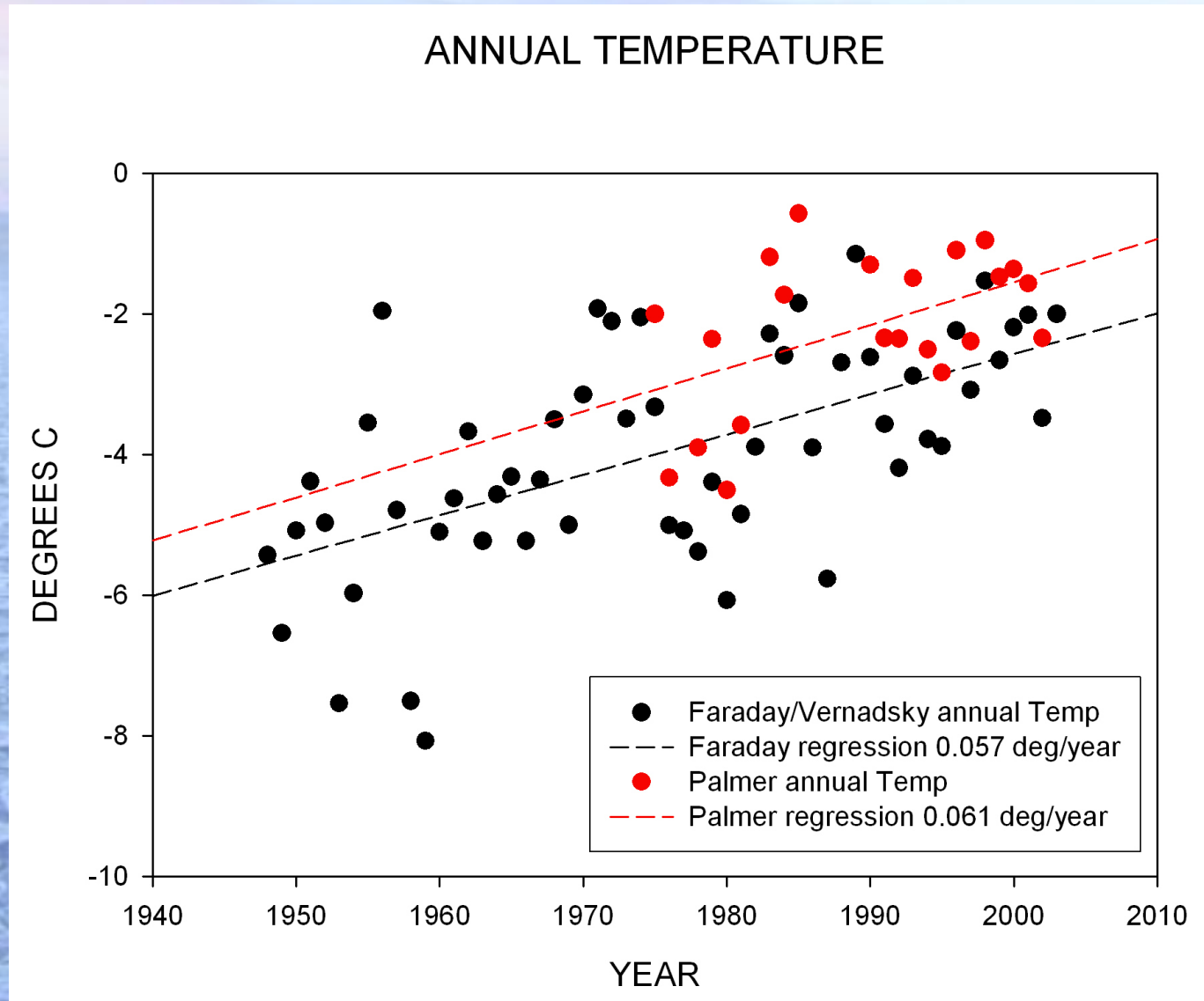




**Aerial photo of Anvers Island and Gerlache Strait courtesy Chilean Navy**



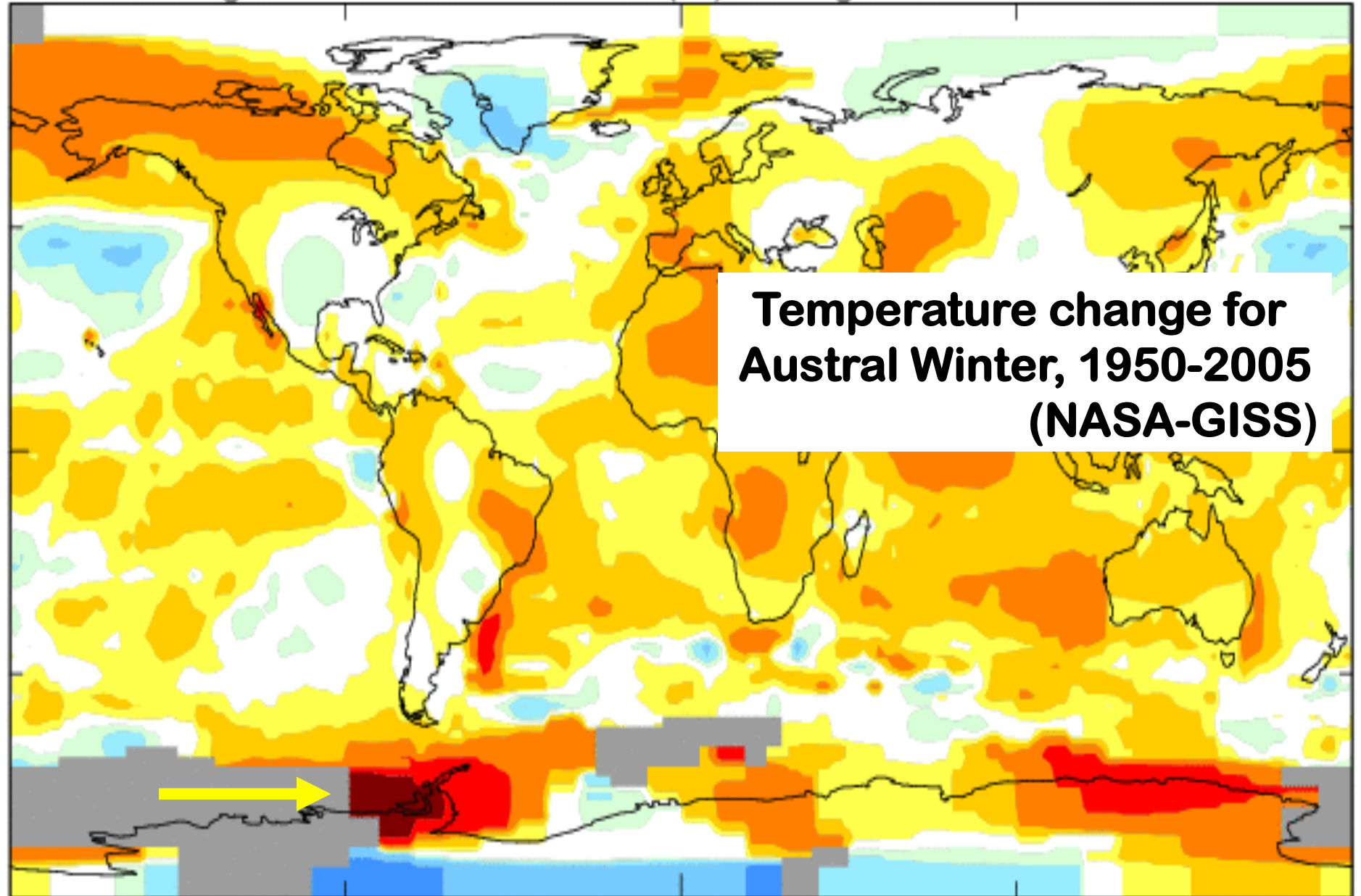
# CLIMATE and SEA ICE



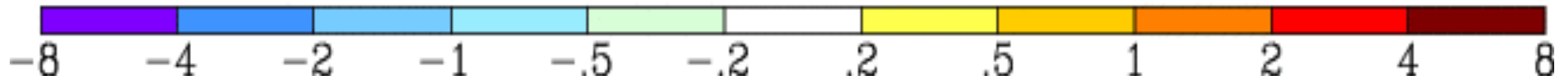
Jun-Jul-Aug

L-OTI(°C) Change 1950-2005

.47



**Temperature change for  
Austral Winter, 1950-2005  
(NASA-GISS)**



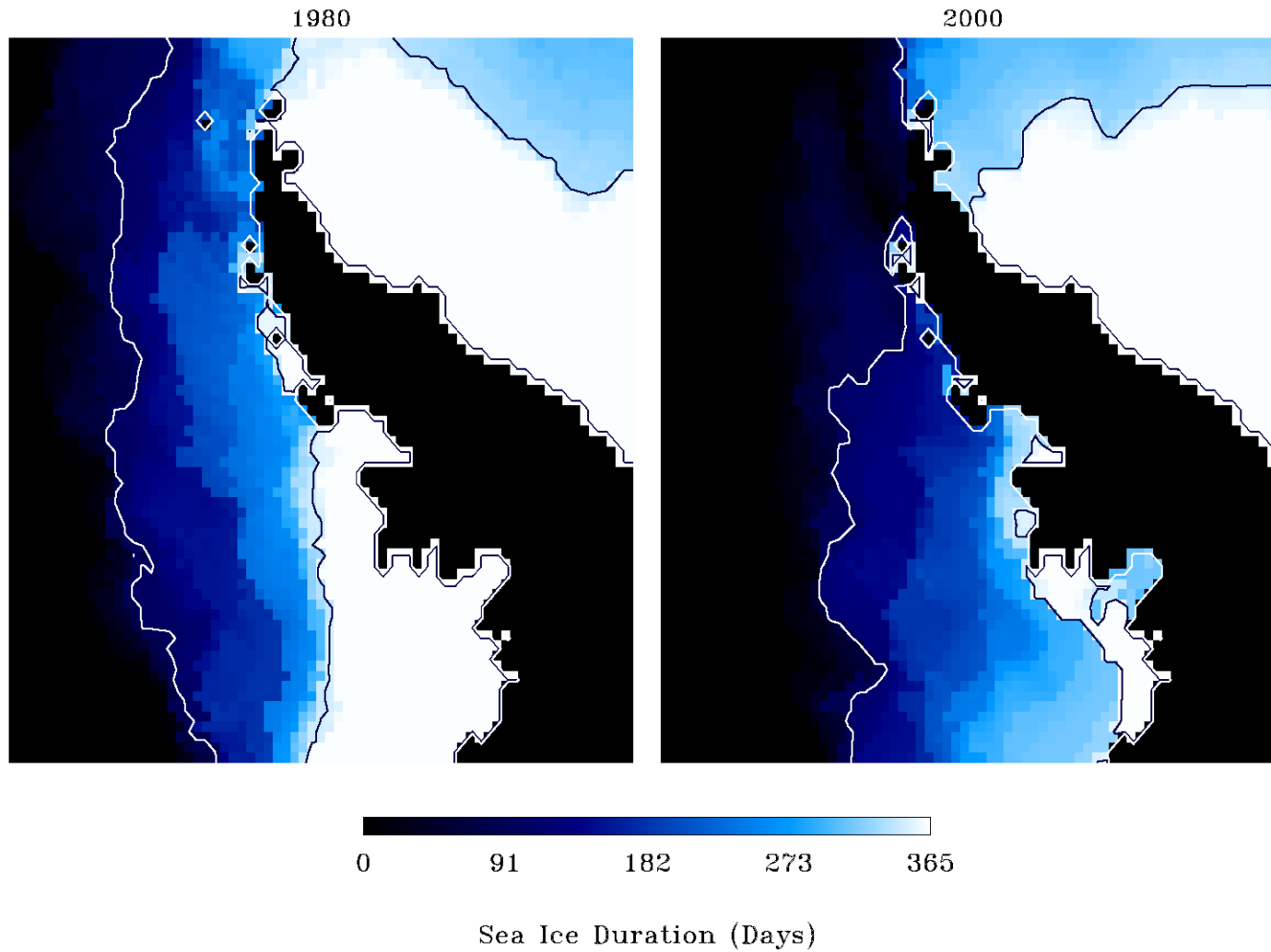


# Climate change: glacial retreat and vegetation expansion





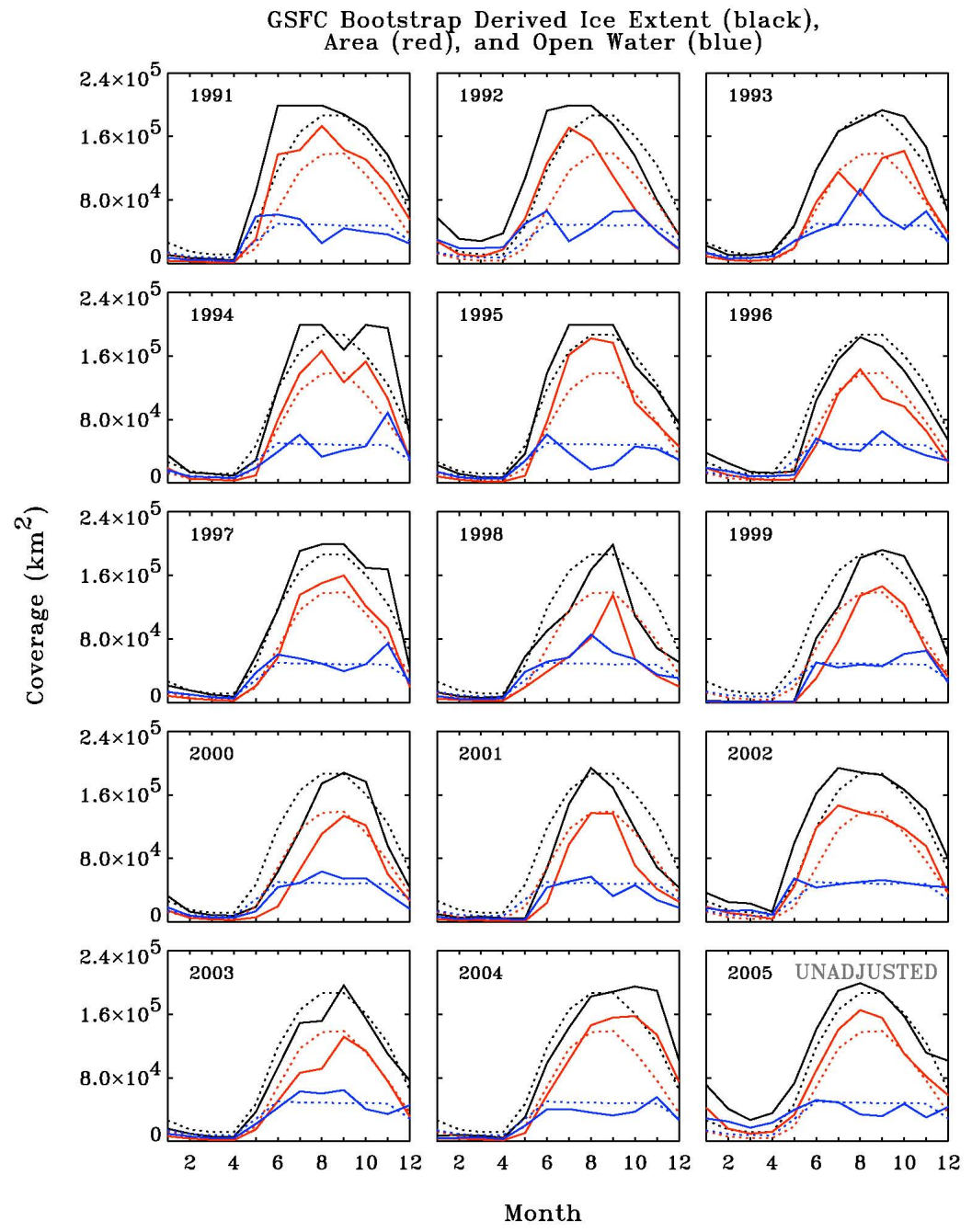
# CLIMATE and SEA ICE



# SEA ICE: Interannual variability

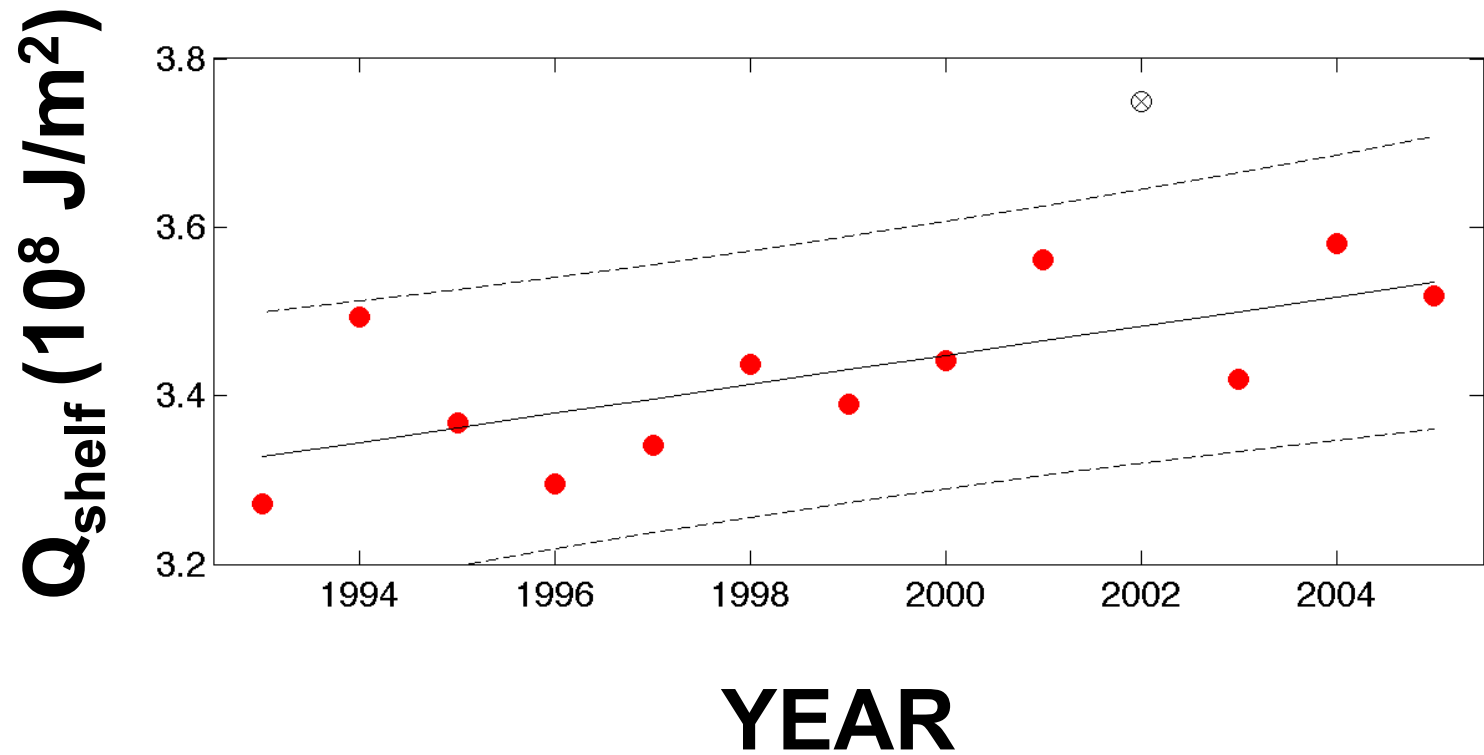


**Black:** sea ice extent in region  
**Solid lines:** individual year  
**Dotted lines:** average 1978-2004

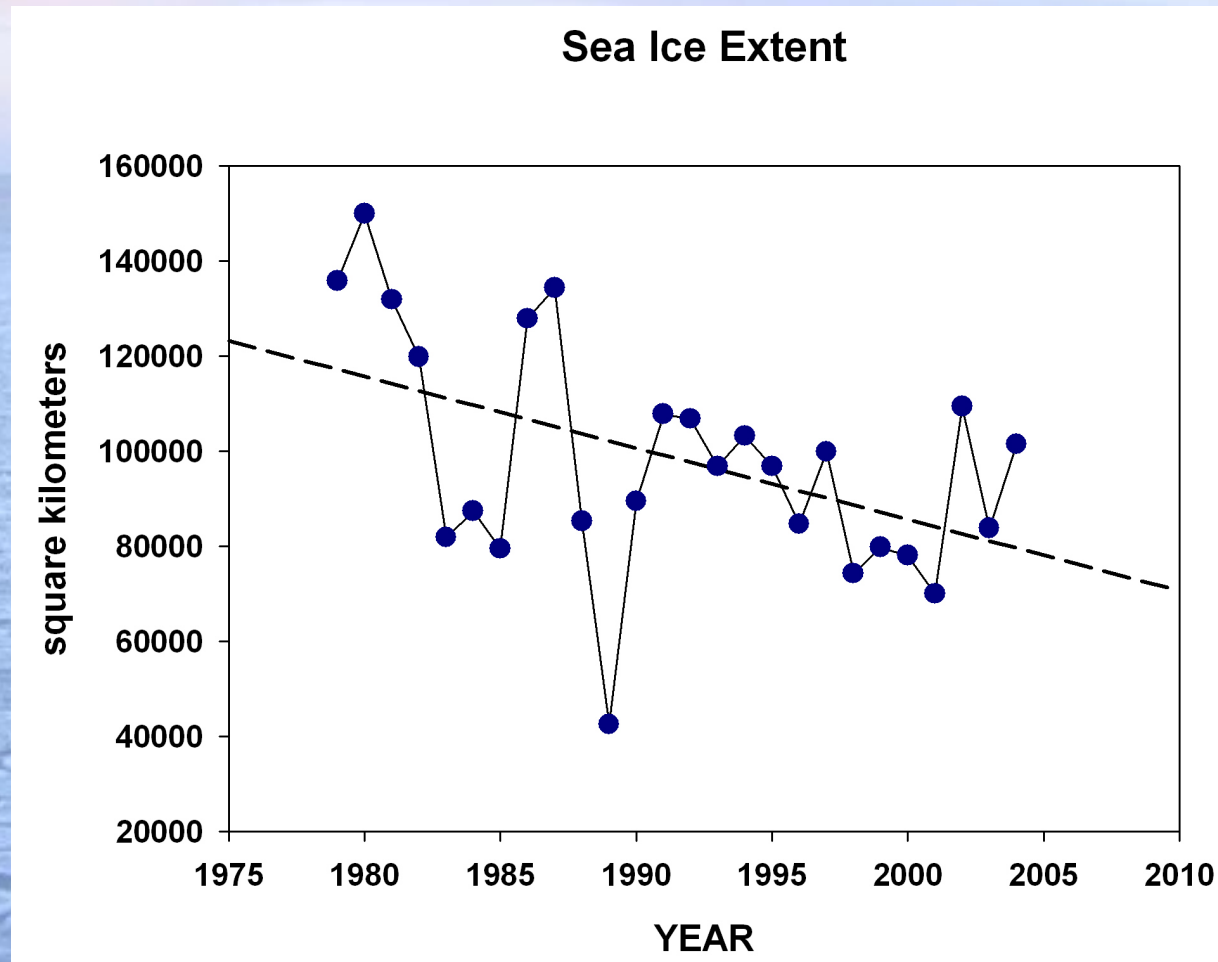




*Increasing heat delivery to continental shelf*

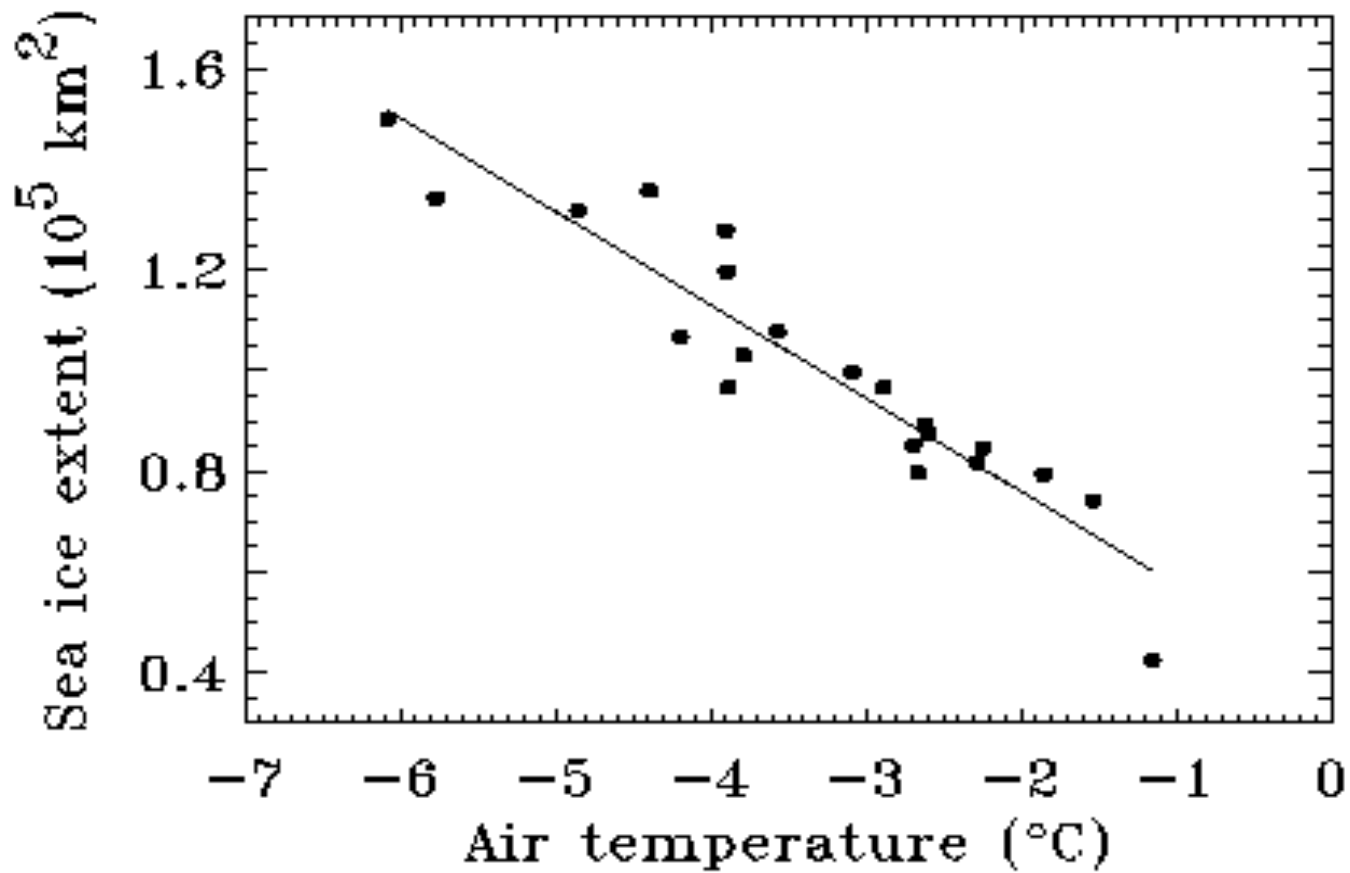


# CLIMATE and SEA ICE

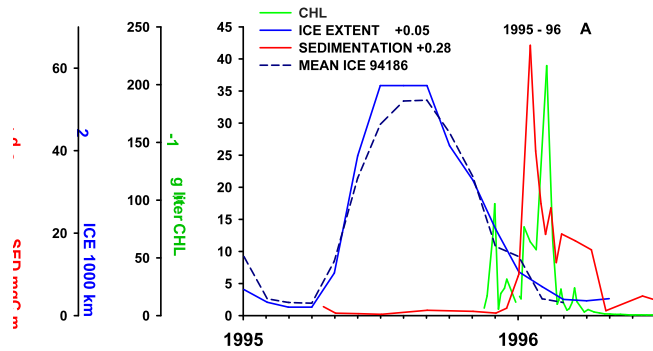




***A direct link between warming and declining sea ice seems likely:***



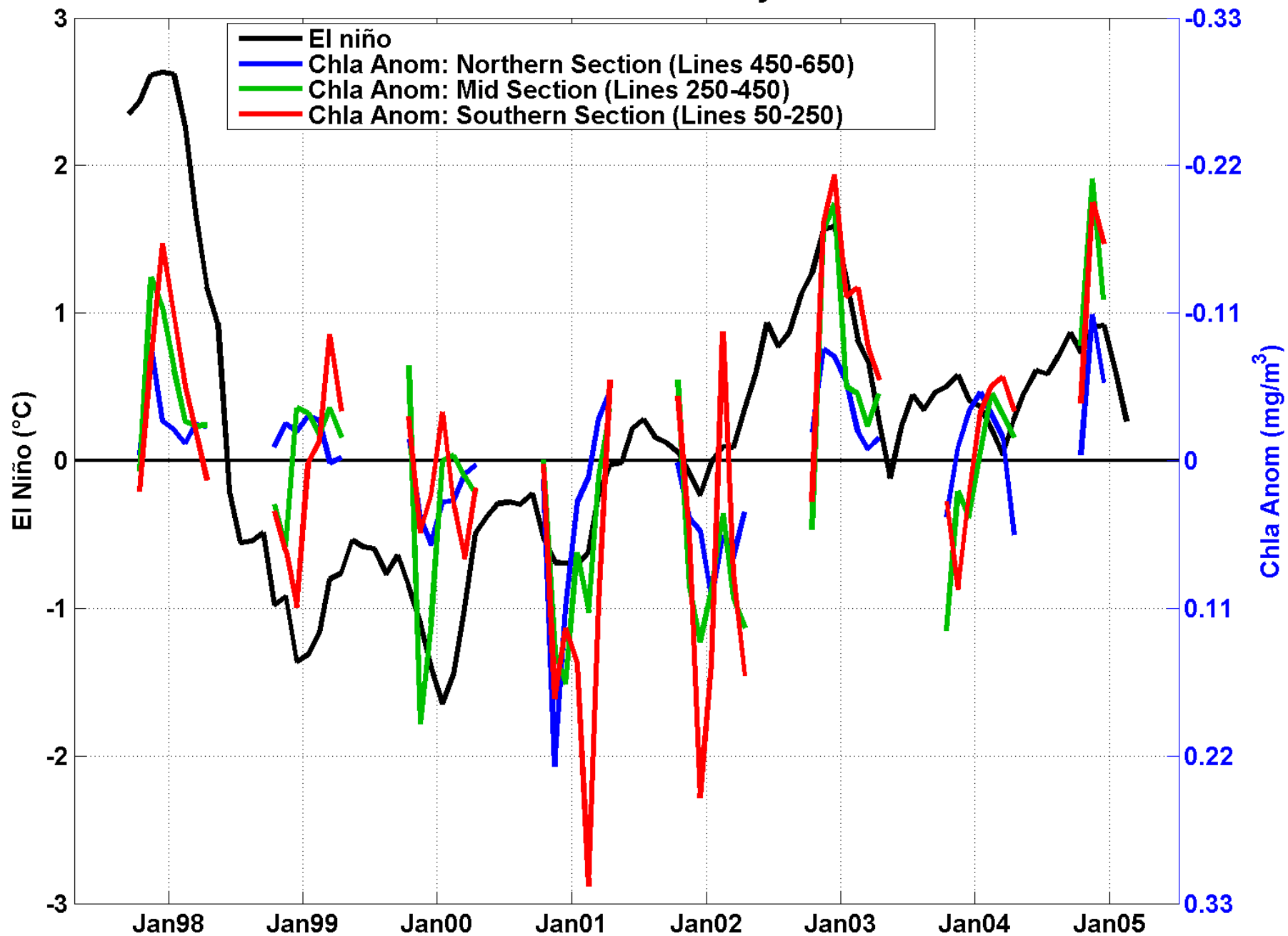
# Ice, primary production and sedimentation, 1995-96



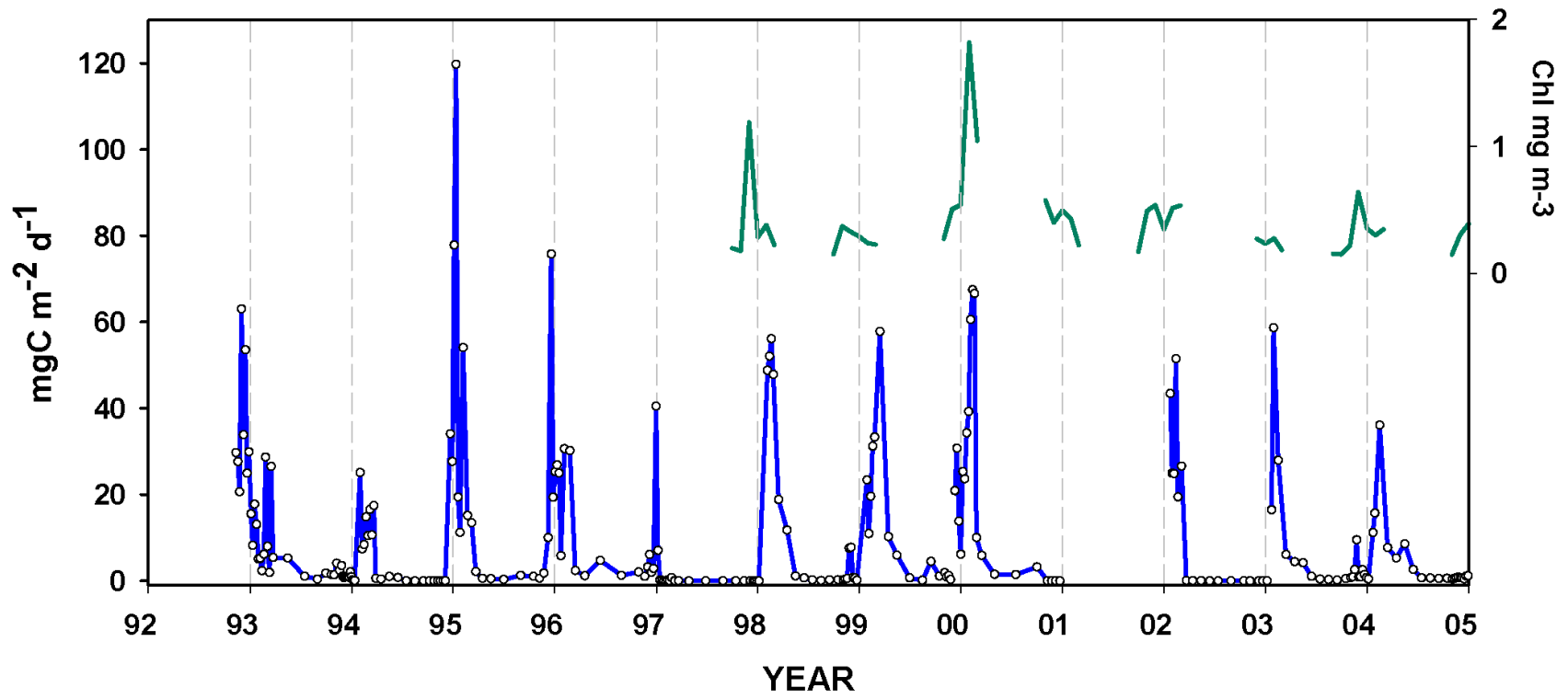
**ICE RETREAT: +25 DAYS**

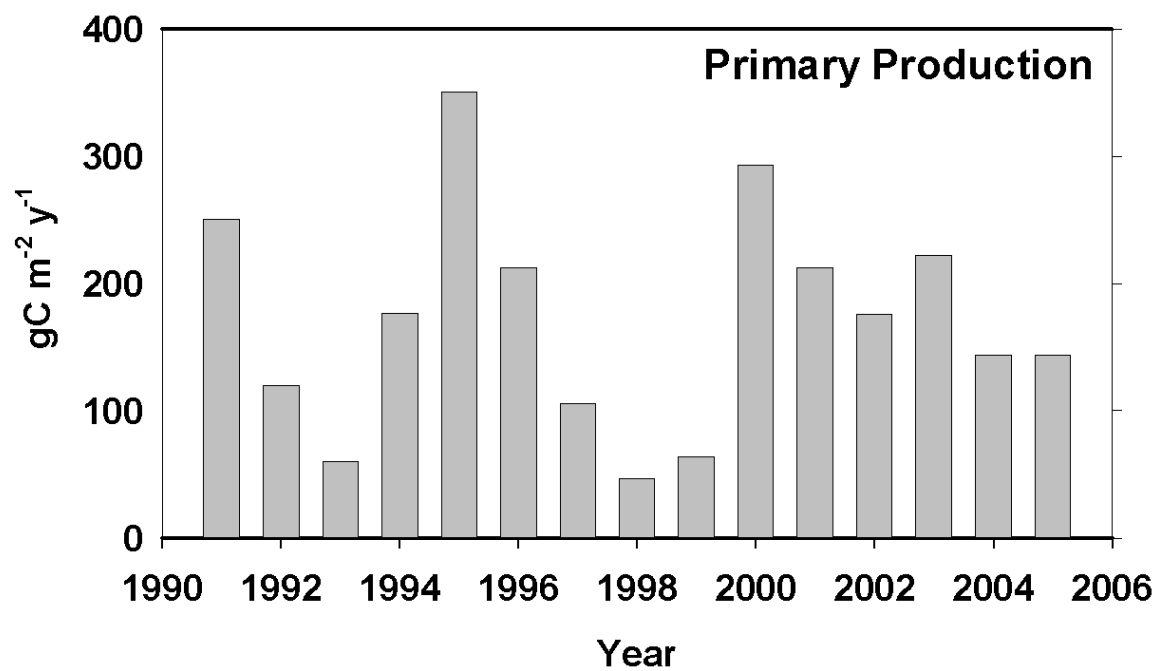
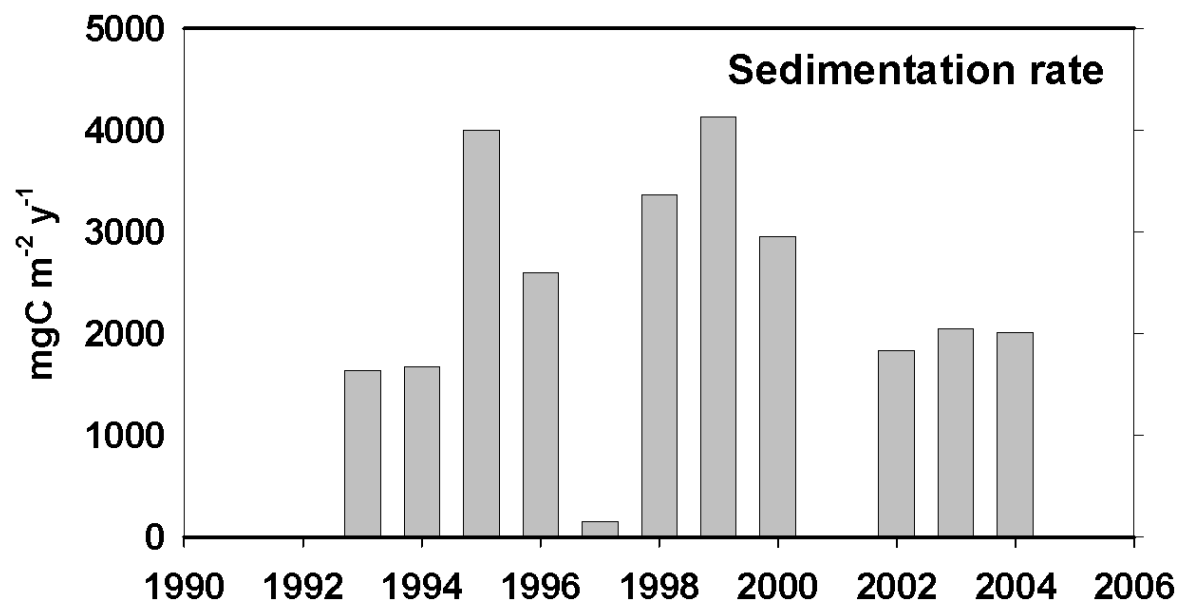


# El Niño vs. Chla Deviations by Sections



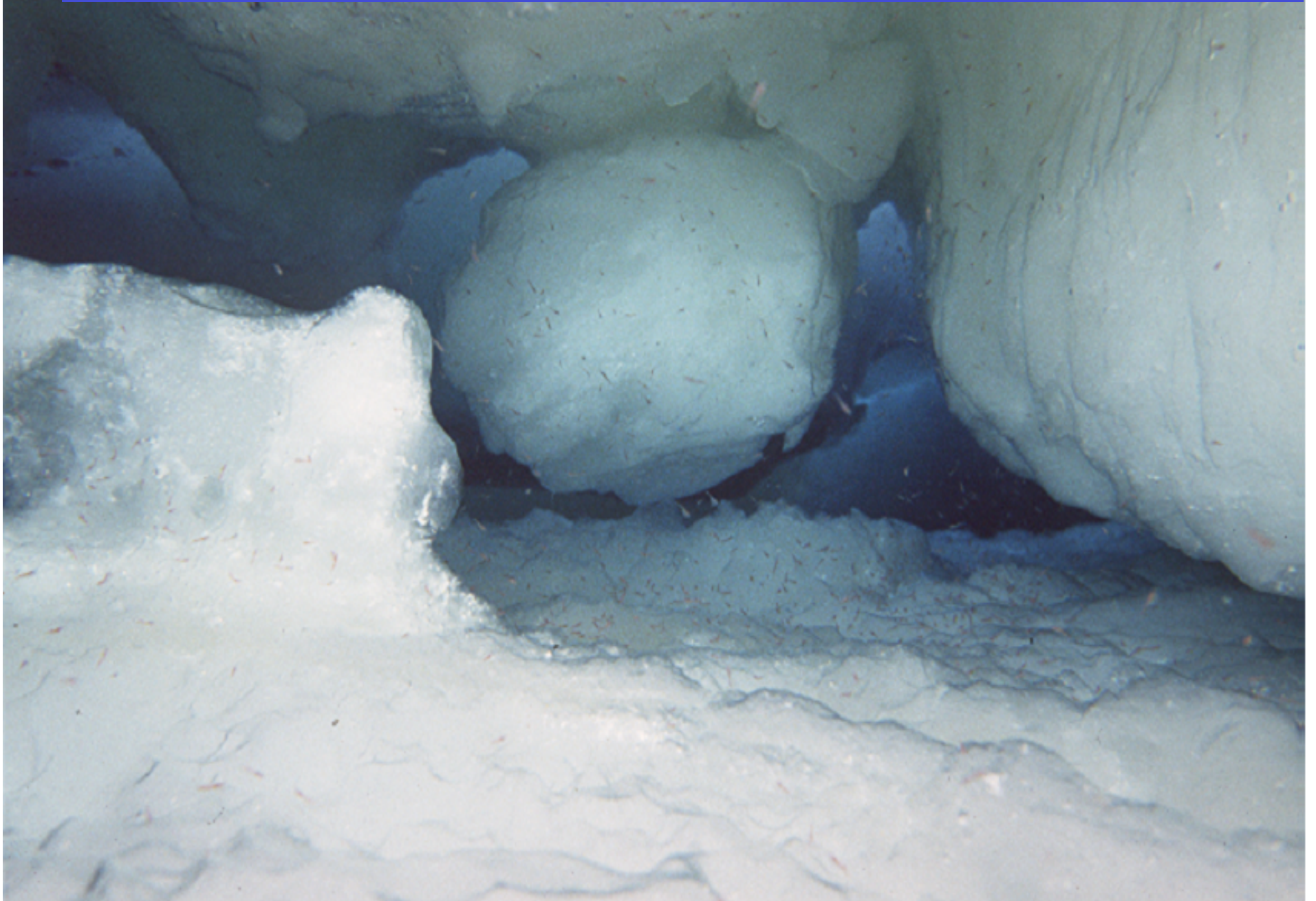
### Carbon sedimentation and surface chlorophyll

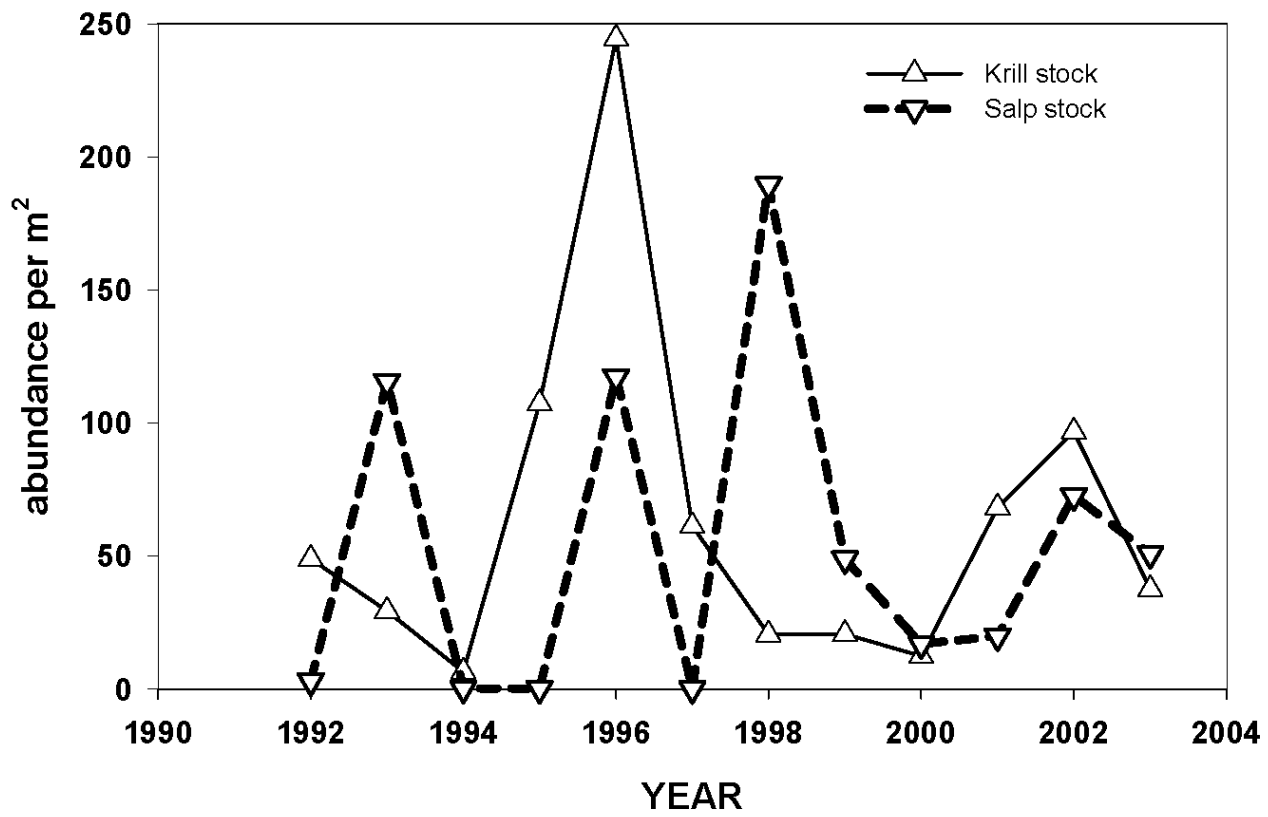




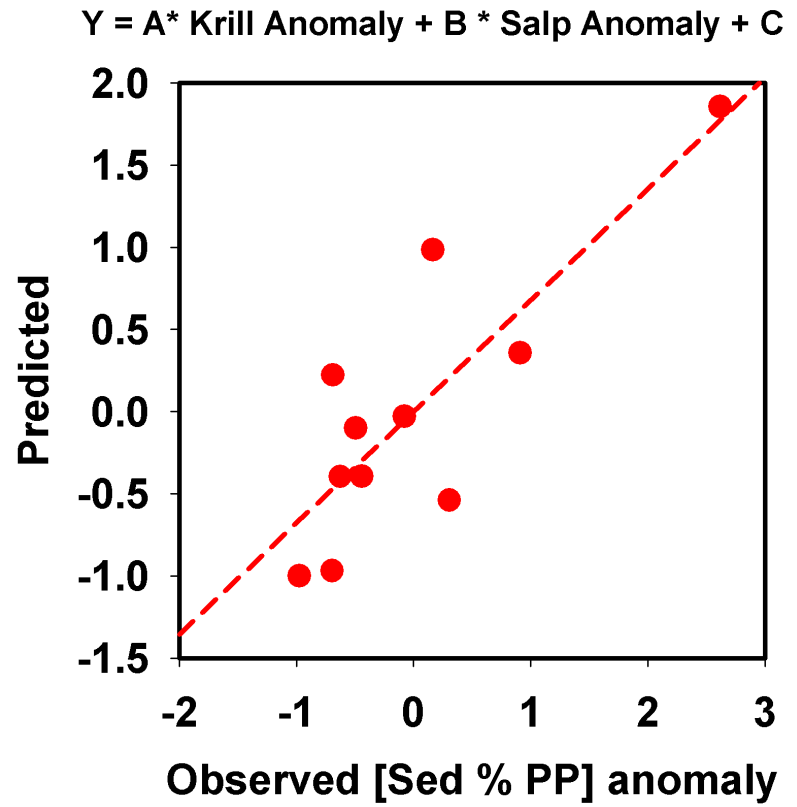
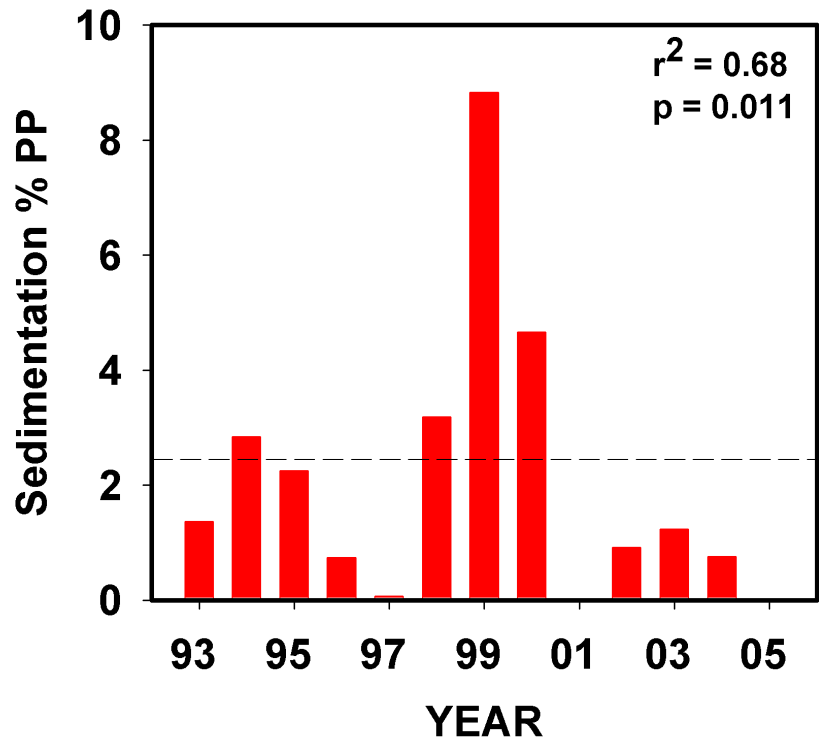


## Juvenile krill and sea ice habitat

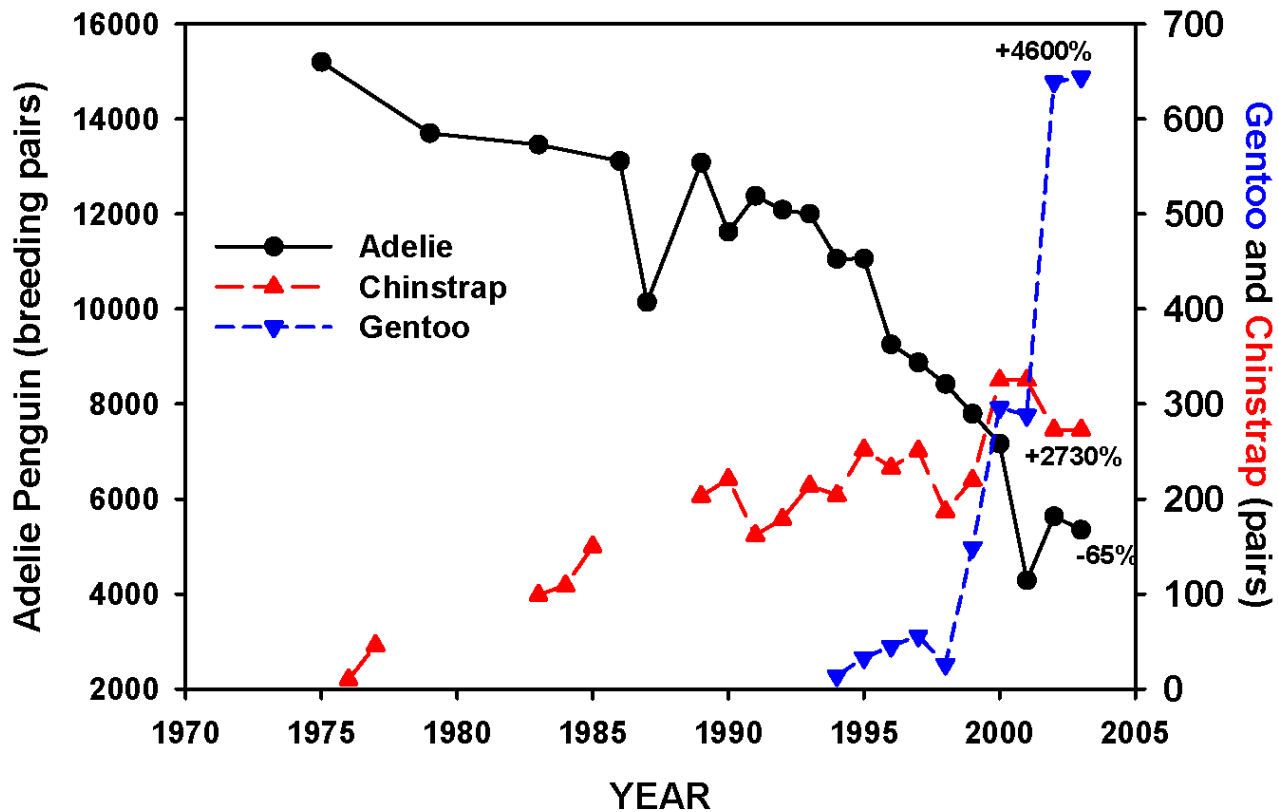








# Declining sea ice and warming affect penguins



Torgerson Island <3000 pairs



## South region: penguins increasing

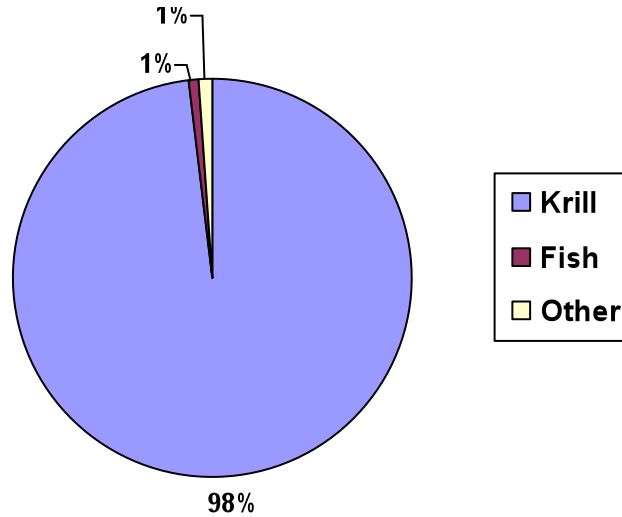


**Avian Island >50,000 pairs, increasing since ~1990**

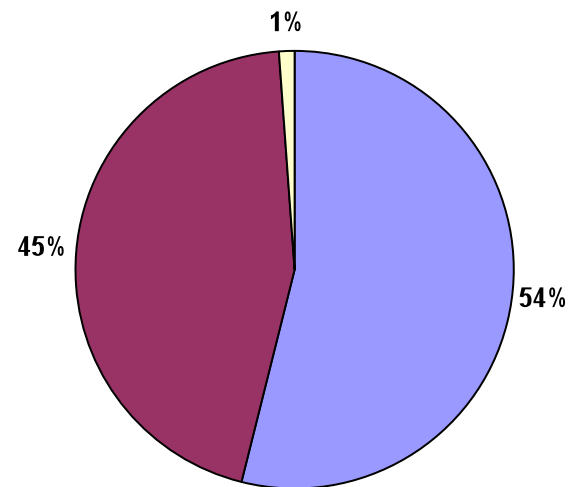


# Changes in penguin diet composition

## North region (was like south <1990)



## South region



Arctowski Point, Antarctic Peninsula, Oct 2004



## 3 Penguin rookeries (“hotspots”) in study region

**What oceanographic conditions favor rookery location?**

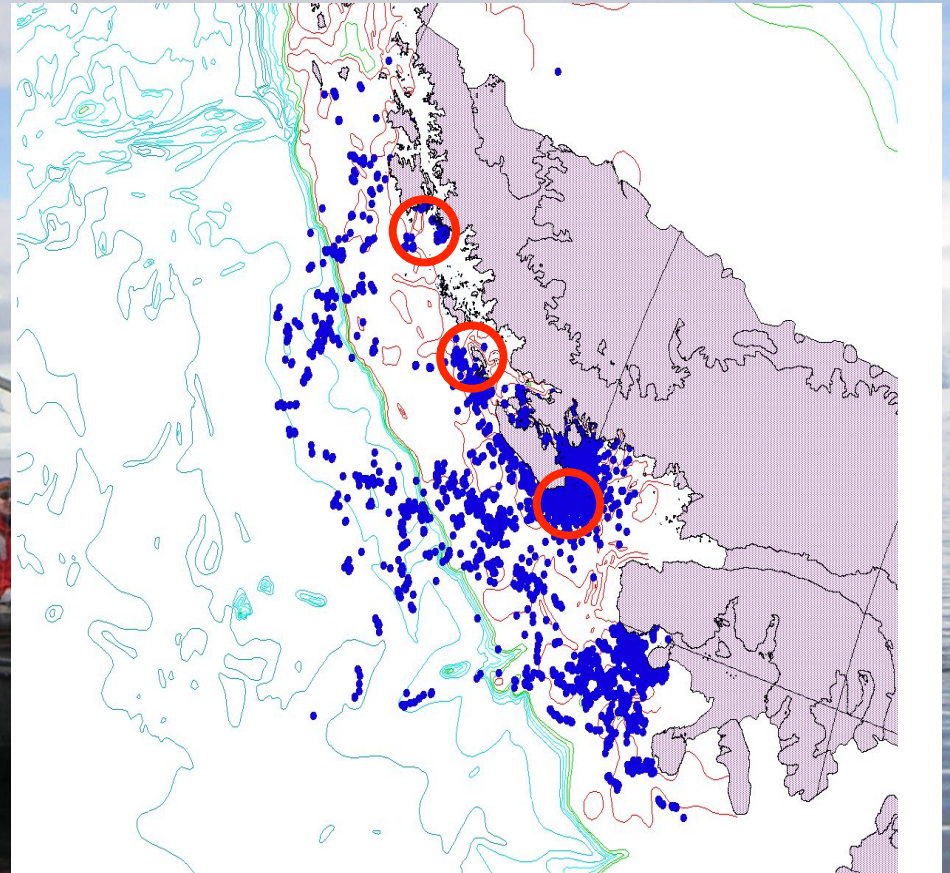
Predictable prey availability

Access to prey

Polynya occurrence

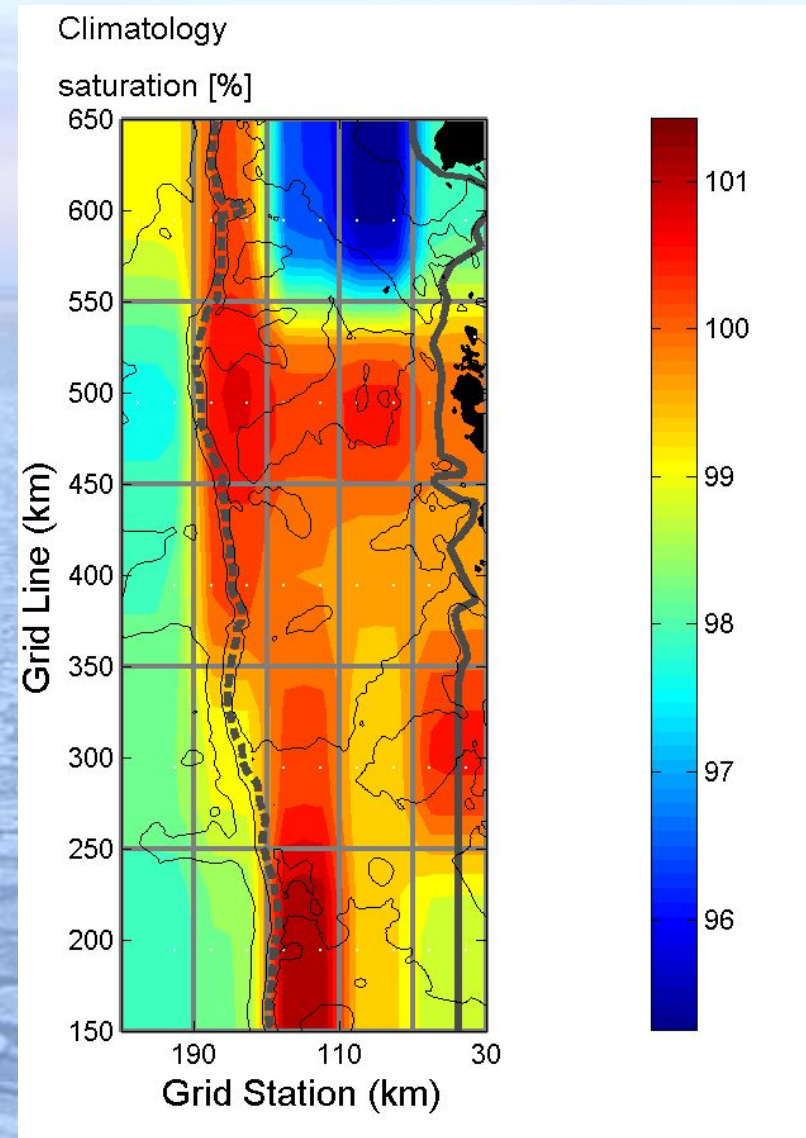
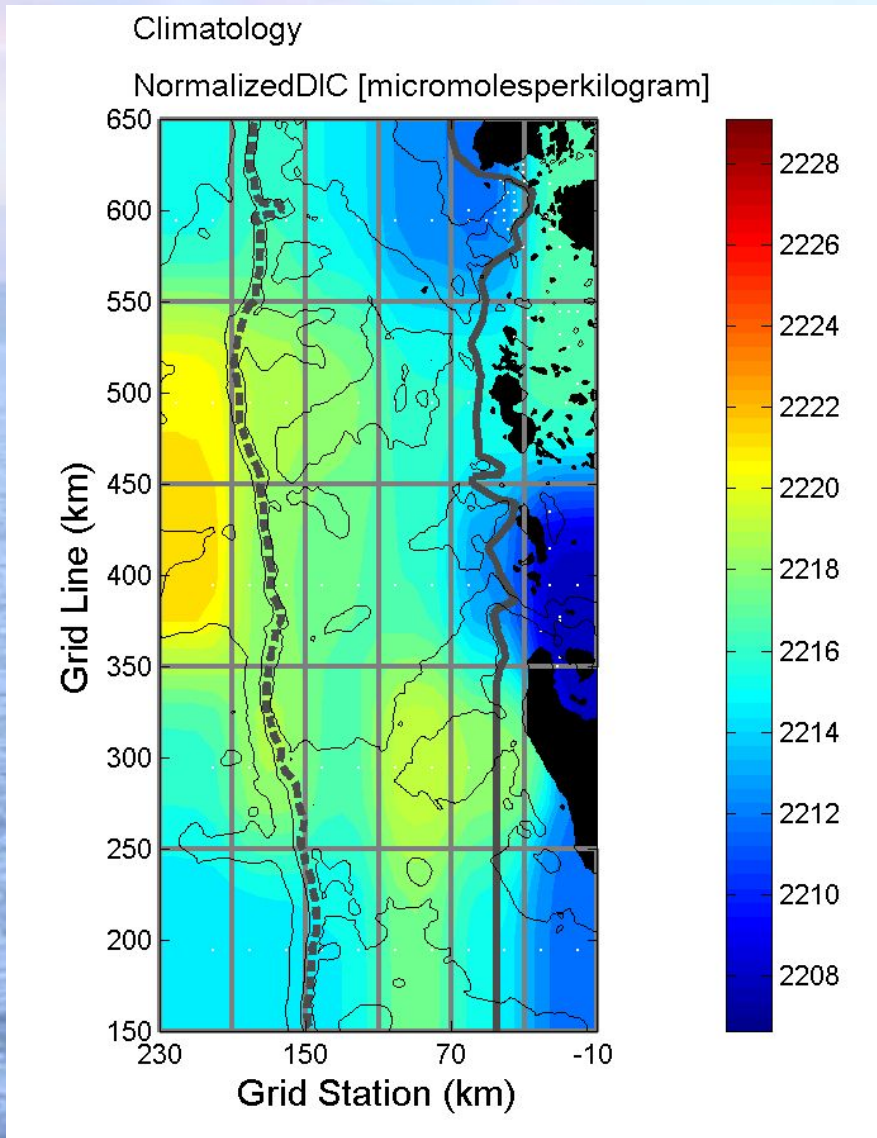
Nutrient transport up canyons

Enhanced primary production



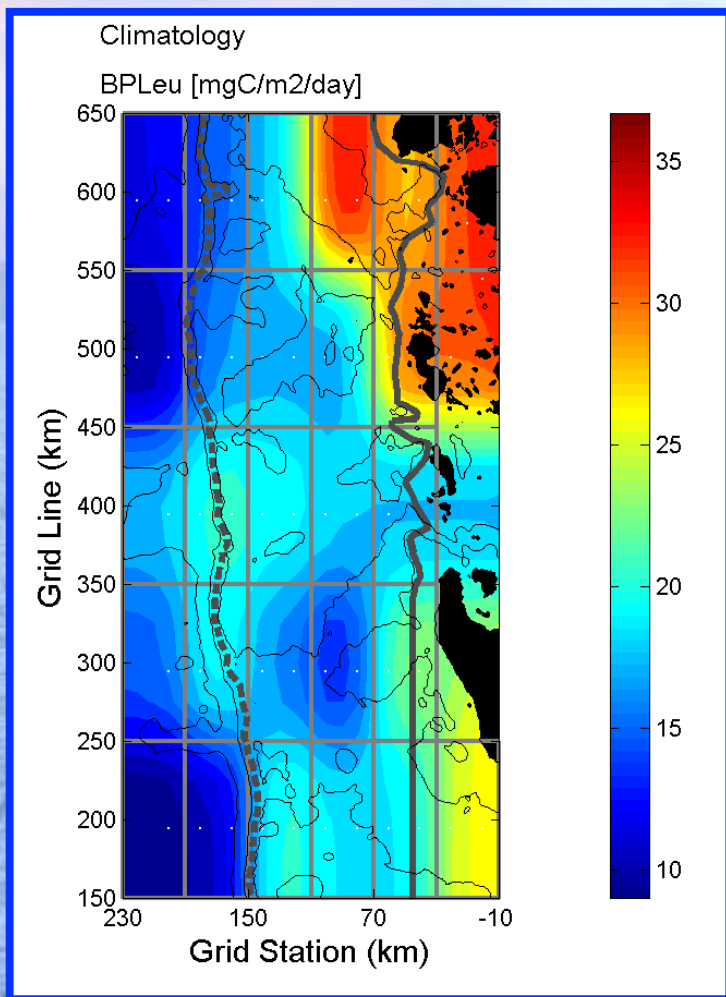
# Dissolved inorganic carbon (Salt-normalized)

# Oxygen saturation





# Bacterial production



<u>Year</u>	<u>BP</u>	<u>PP</u>	<u>%</u>	<u>n</u>
2003	7	504	1.4	52
2004	23	456	5.0	54
2005	26	864	3.0	50
2006	33	1954	1.6	51



Thanks for your interest !

