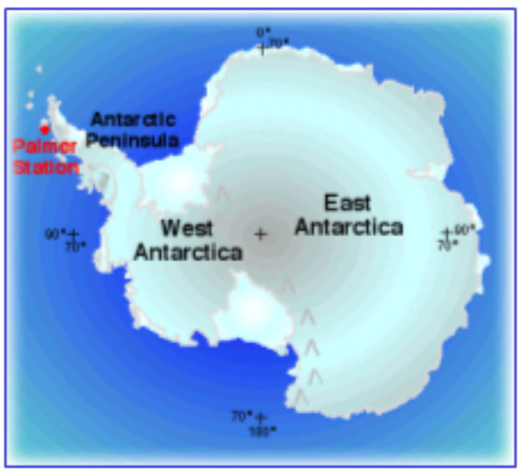
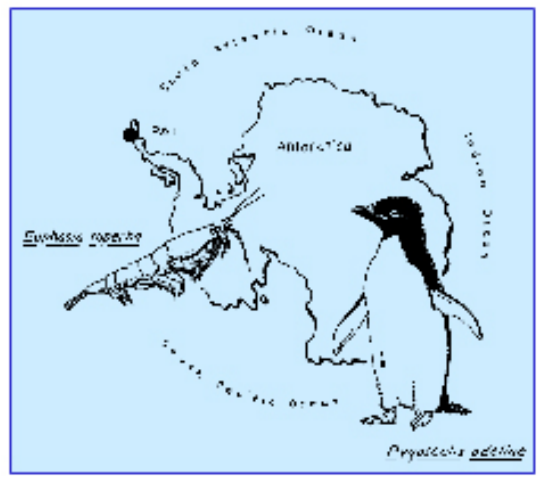
Palmer LTER

Palmer Station, Antarctica
Long-Term Ecological Research Program

<u>Palmer LTER Ecosystem Components</u>:
Birds-Bill Fraser (MSU)
Microbial Loop-Hugh Duckow (W&M), Dave Karl (UHM)
Modeling-Doug Martinson (LDEO)
Zooplankton-Langdon Quetin, Robin Ross (UCSB)
BioOptics/Remote Sensing-Raymond Smith (UCSB)
Phytoplankton-Maria Vernet (UCSD)
Information Management-Karen Baker (UCSD)



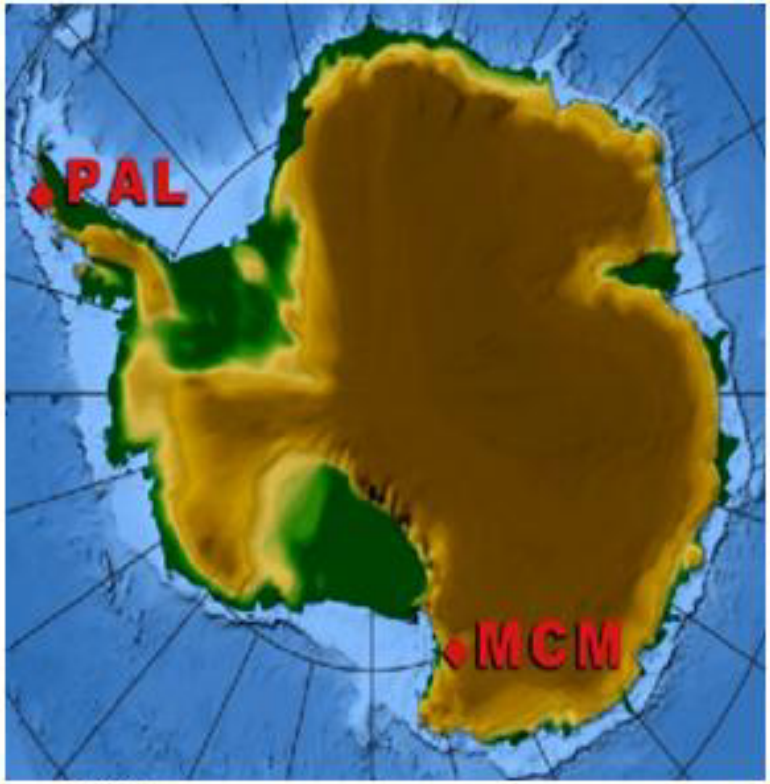


Palmer LTER:
Long Term Ecological Research
Focusing on the Antarctic Marine Ecosystem

The National Science Foundation, in 1990, designated Palmer as a polar biome LTER site in the Southern Hemisphere. Palmer studies are funded by the Office of Polar Programs with logistics support by Raytheon Polar Services.

The LTER Network:

a group of research sites focused on the study of diverse ecosystems

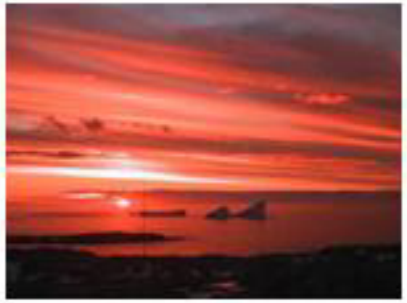


PALMER

LTER

Balloon image of Palmer Station, Anvers Island, Antarctica by Earth Space Research Group, UCSB. The tether coming up to the right holds the balloon to approximately 500m height. Arthur Harbor is south of the tether..

Research in a Large-Scale, Natural Laboratory:



The Antarctic Marine Ecosystem encompasses the plants, animals, ocean and sea ice bounded by Antarctica to the south and an oceanic polar front to the north. Within this ecosystem, Palmer Station provides ideal access to a natural laboratory site that experiences strong climate gradient feedback processes, varying sea-ice coverage and possible amplification of environmental change.

PALMER

LTER

Research focuses on the Antarctic coastal and open-ocean marine ecosystem, terrestrial sea-bird nesting sites and regional oceanography along the Western Antarctic Peninsula. A primary research objective is to understand this marine ecosystem's natural variability in order to discover and define long- and short-period natural cycles as well as the changes brought about by human activities. Testable hypotheses link sea ice timing and magnitude to seasonal primary production; carbon and oxygen dynamics; krill abundance, distribution and recruitment; breeding success and survival of apex predators; and large-scale interactions of the atmosphere and ocean.

A. Winter B. Summer

The research site centers on a 180,000 sq km region surrounding Palmer Station. Elevation ranges from 10 m on land to 2000 m below sea surface. An oceanic sampling grid , which is 200 km on/offshore, stretches 900 km along shore roughly parallel to the Peninsula. Characteristics of the landscape-seascape of seawater, ice, snow and rock vary with altering temperatures as the 24-hour darkness in June changes to 24-hour daylight in December.

Investigations at LTER Palmer site include:

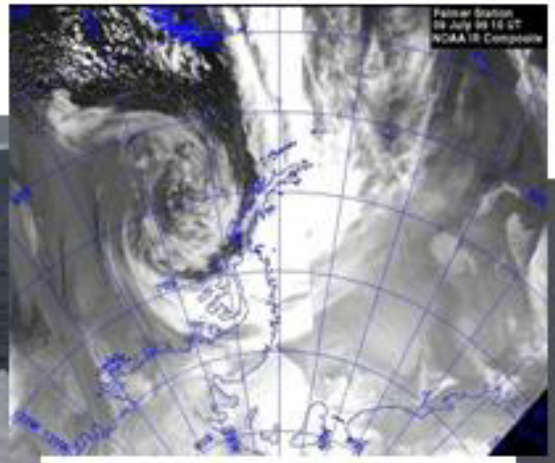
- Physical forcing (solar radiation, atmospheric, oceanic and sea ice with emphasis on ecological consequences of annual and inter-annual variation)

- Life-history parameters of secondary producers (krill) and apex predators (penguins)

- Biological processes with emphasis on community structure and carbon fluxes, including air-sea exchange

- Physical/chemical/biological modeling that links ecosystems processes to environmental variables

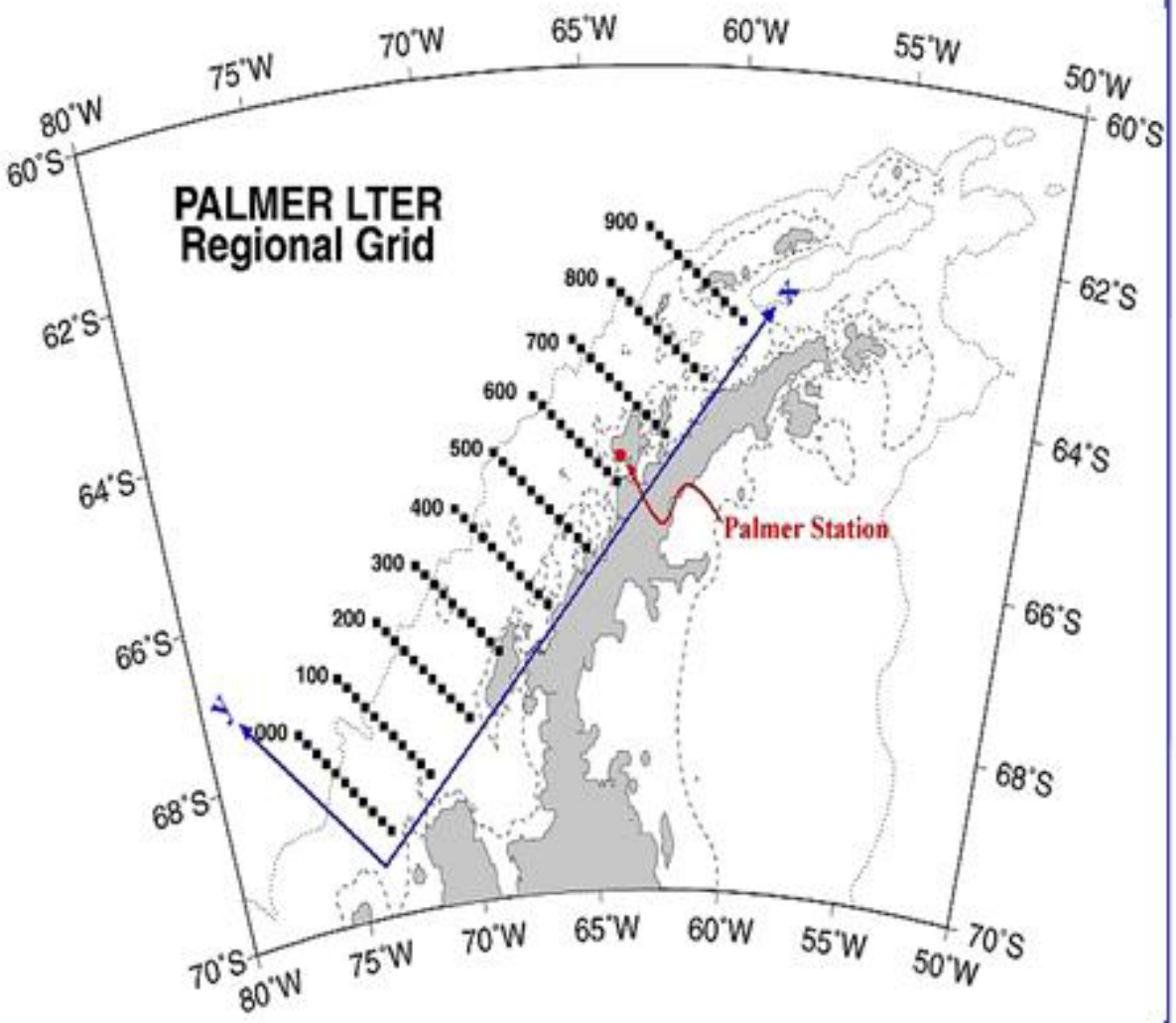
A central tenet of the Palmer LTER is that the annual advance and retreat of sea ice is a major physical determinant of spatial and temporal changes in the structure and function of the Antarctic marine ecosystem, from total annual primary production to breeding success



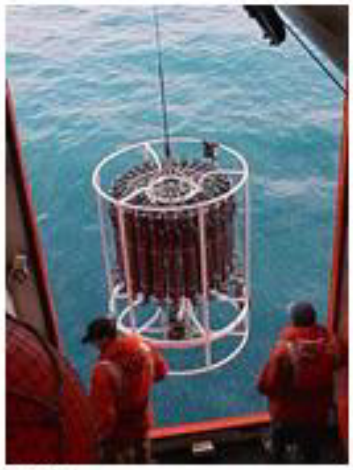
Factors strongly influencing the flora and fauna of this site include: low temperatures; a short growing season; high winds affecting the depth of the ocean's mixed layer; input of micronutrients from nearby land; and varying snow and sea-ice coverage. This so-called high-nutrient, low-biomass marine environment, sustains a few hundred grams C/m2/yr of primary production. Ecosystem populations include various microbes, phytoplankton, krill and apex consumers such as penguins and seals.

Paticipating scientists conduct field studies at Palmer Station from research vessels, zodiacs, laboratories and remote-sensing platforms such as satellites, weather stations and moorings. Further analysis and experiments are based at their home institutions which include the University of California, Santa Barbara; University of California, San Diego; University of Hawaii; Montana State University and Lamont-Doherty Earth Observatory.

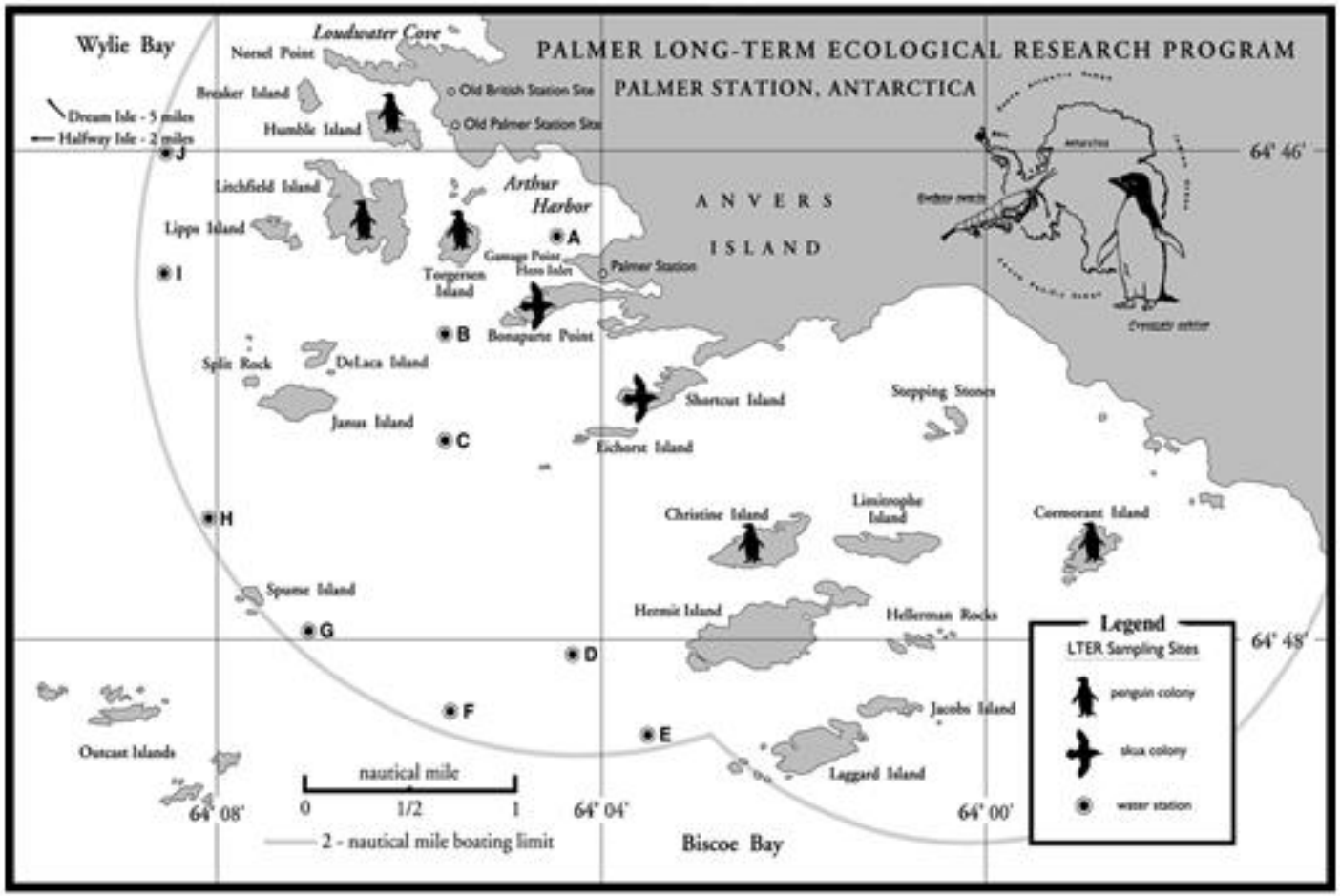
Data collection: Standard measurements are taken at established stations within a series of embedded grids. The largest grid reflects the regional scale of atmospheric, oceanic, and sea-ice interactions with populations in the marine ecosystem. Smaller embedded sampling grids address local hydrography, near-shore primary and secondary production, and the foraging range of nesting seabirds.



Ice sampling from a zodiac and from the ice;
ship-board analysis of krill, ice, and water samples.



Shipboard sampling with profiling instruments provides measures of water column characteristics such as temperature, conductivity, fluorescence and irradiance. Sample bottles attached to the instruments permit capture of water to be brought on deck and into the laboratory.



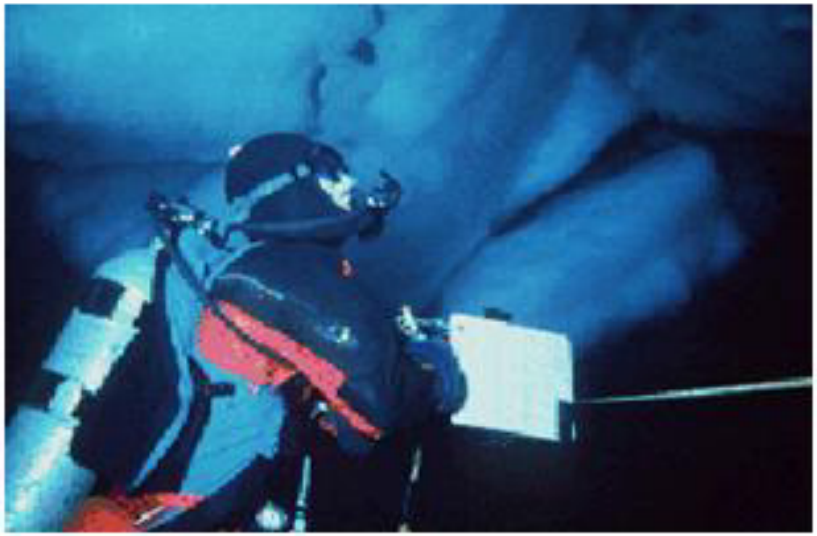
Smaller embedded sampling grids address local hydrography, near-shore primary and secondary production, and the foraging range of nesting seabirds.

PALMER

LTER

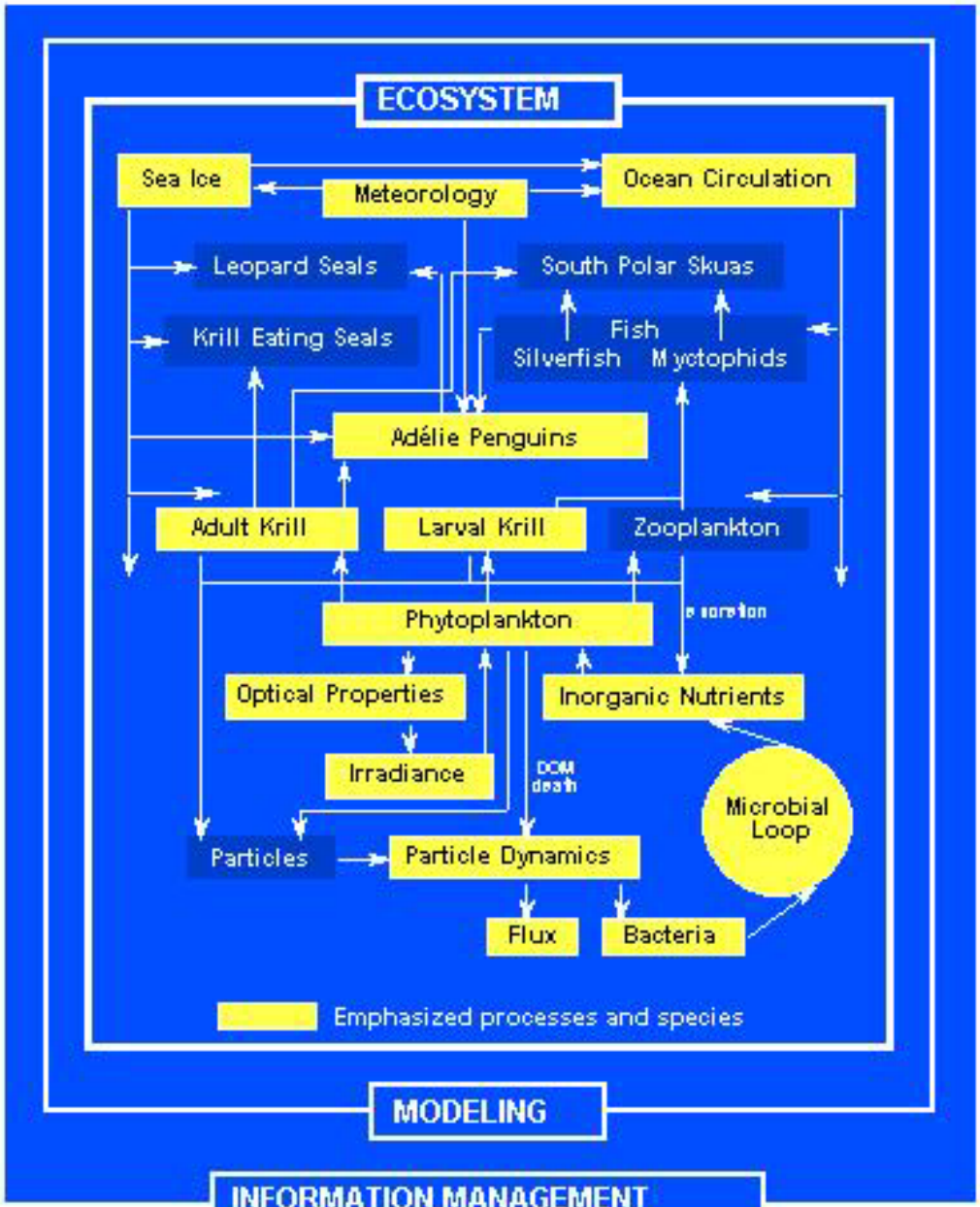
Data collection: Scientists and technicians cruise on a research vessel each January to take samples of the larger grid and the penguin foraging area. From October through March, smaller inflatable zodiac watercrafts based at Palmer Station sample hydrography, as well as near-shore abundance and distributions. These near-shore data help scientists place data gathered during the January cruise into a sesaonal context of interannual variability. Data from satellite-borne instruments combined with in situ measurements provide significant and reliable long-term data.

This krill was taken for a diet sample from a penguin. Penguins are good indicators of krill populations



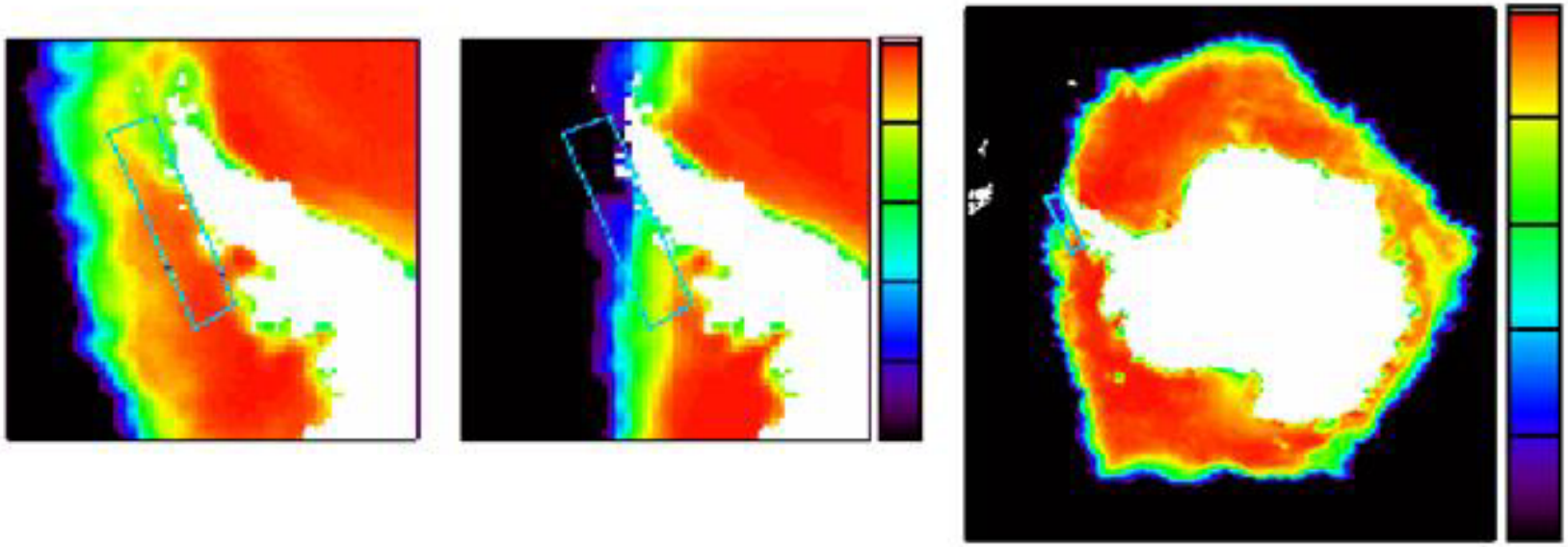
A diver examines the under-side of the ice, which provides a unique habitat for krill in chilly Antarctic waters.

The Antarctic food web represented (from the left) by a bacteria, a diatom, a krill and an Adelie penguin.


ECOSYSTEM
Sea Ice
Meteorology
Ocean Circulation
Leopard Seals
South Polar Skuas
Krill Eating Seals
Fish
Silverfish
Myctophids
Adélie Penguins
Adult Krill
Larval Krill
Zooplankton
Phytoplankton
Optical Properties
Inorganic Nutrients
Irradiance
DOM
death
Microbial
Loop
Particles
Particle Dynamics
Flux
Bacteria
Emphasized processes and species
MODELING
INFORMATION MANAGEMENT

Palmer LTER centers on a unifying research question:

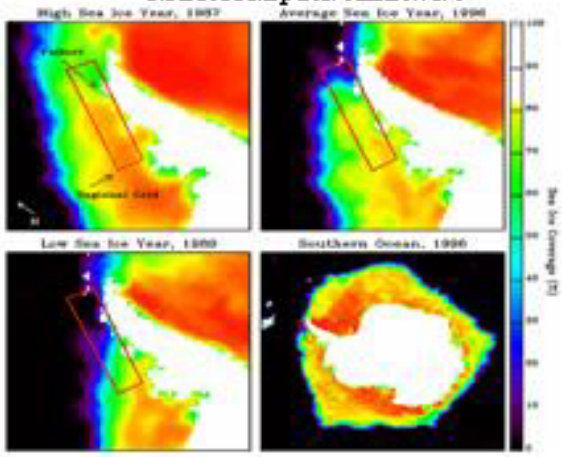
How does changing sea ice cover affect the structure and function of the Antarctic Marine Ecosystem?



The Southern Ocean and its Antarctic Marine Ecosystem undergoes the largest seasonal surface change on earth (right: Sept 1996 average sea ice) as ice coverage waxes and wanes. Passive microwave satellite imagery (Stammerjohn 1997) shows high ice years (above left; Jul 1987) and low ice years (above right, Sept 1989) differ significantly. The Palmer sampling grid (shown as a rectangle) typifies this range of ice cover.

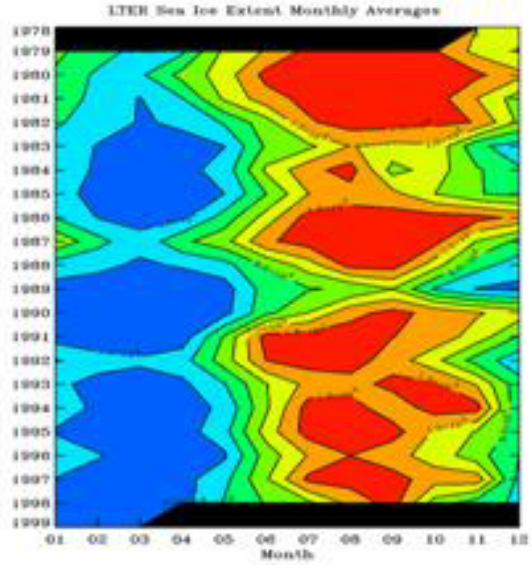
Sea Ice Coverage

NASA SSMI passive microwave



Marine Ecosystem Sensitivity to Climate Change: Western Antarctic Peninsula

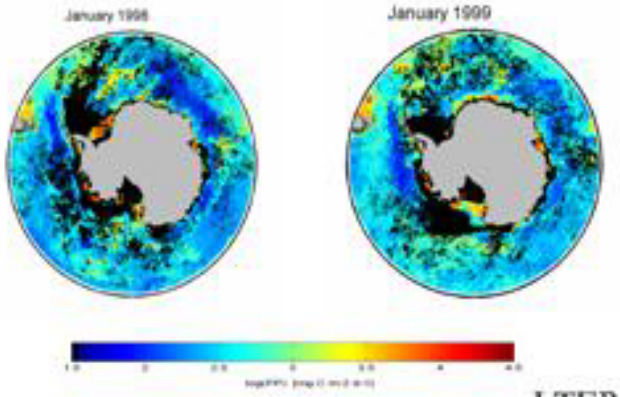
Ray Smith (UCSB), Eugene Domack (Hamilton College), Steve Emslie (Western State College), Bill Fraser (Montana State U.), David Ainley (T.H. Harvey & Assoc), Karen Baker (UCSD/SIO), Jim Kennett (UCSB), Amy Leventer (Colgate College), Ellen Mosley-Thompson (Ohio State U.), Sharon Stammerjohn (UCSB), Maria Vernet (UCSD/SIO)



There is evidence of major change in the marine Ecosystem of the Western Antarctic Peninsula in response to climate change during the past century. All records are consistent from instrument records, distribution of seabirds as well as marine sediments and ice cores. Further, the Western Antarctic Peninsula appears to be a location where slight changes in sea ice extent may amplify the biotic response in climate variability.

Southern Ocean Primary Productivity

from SeaWiFs Satellite



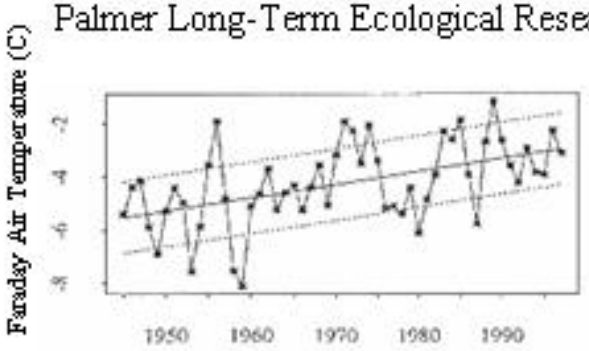
PALMER LTER

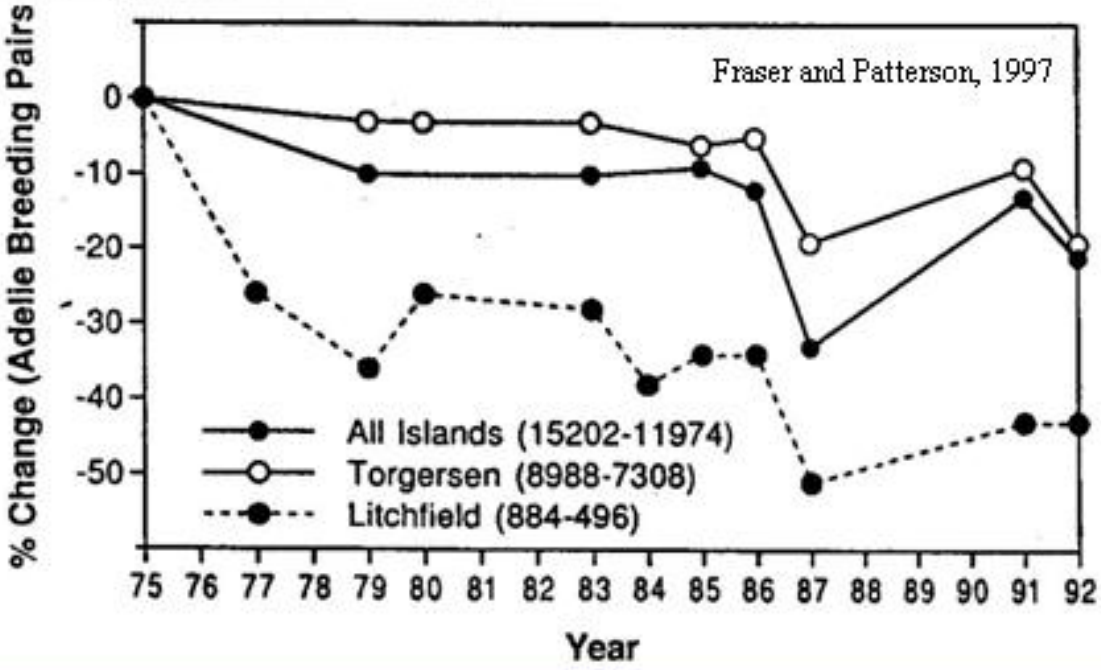
Palmer LTER

Penguin Breeding and Climate Variability

in the Western Antarctic Peninsula area

Palmer Long-Term Ecological Research Program

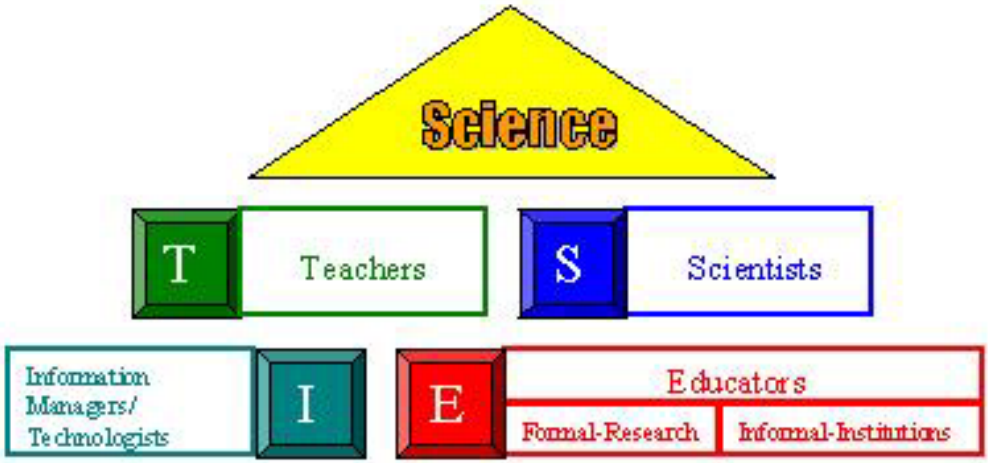




PALMER

LTER

Palmer LTER Education Outreach

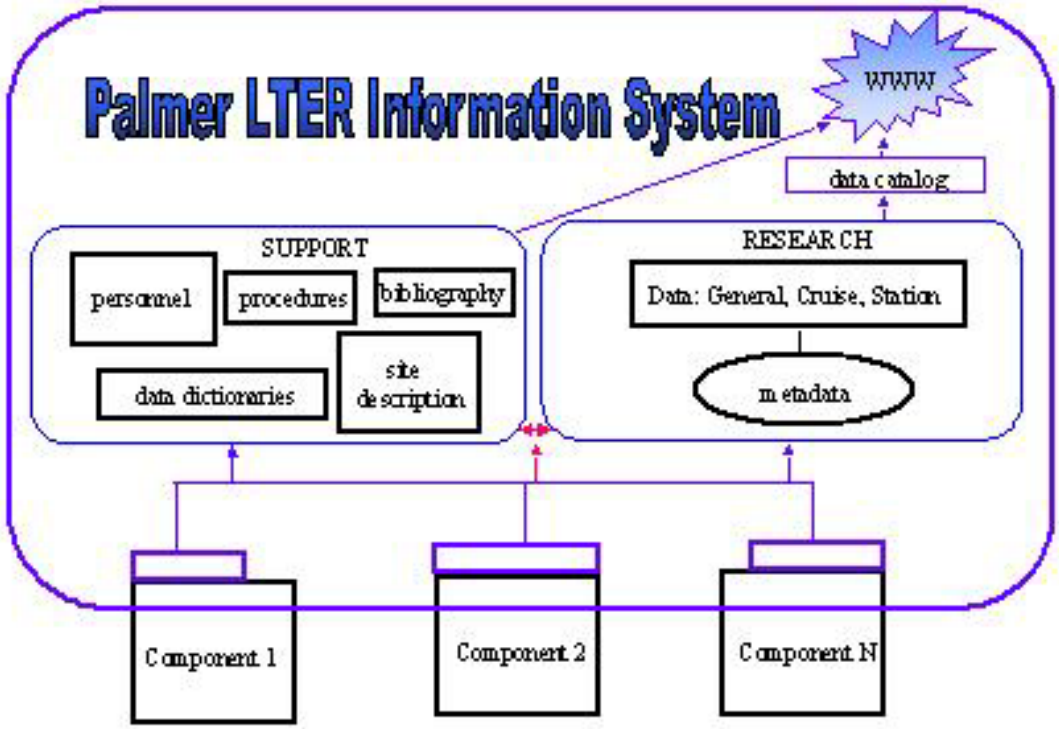


Palmer's outreach program fosters partnerships among classroom teachers, research scientists, information managers, educators by establishing ties with ongoing programs such as the Office of Polar Program's Teachers Experiencing the Antarctic and Arctic, Palmer participants can help teacher's experience inquiry based science and encourage students to explore research processes, base investigations upon scientific methods, and collect and then analyze long-term data.

Education Activities

Products include electronic journals, education forum report, cruise CD, and panoramic virtual tours.

Teachers Experiencing Antarctic (TEA) Program participants engaged in Antarctic field activities with Palmer LTER research team: high school teachers Besse Dawson (1998), Mimi Wallace (1999) and Bill Swanson (2000).



Palmer LTER's information management strategy builds upon existing network structures, develops connectivity, creates a dynamic central hub with distributed, autonomous centers and establishes an accepted data and metadata policy. An electronic hub at the Institute for Computational Earth System Science at the University of California, Santa Barbara provides immediate access and a long-term repository for Palmer LTER data and documentation.

PALMER

LTER

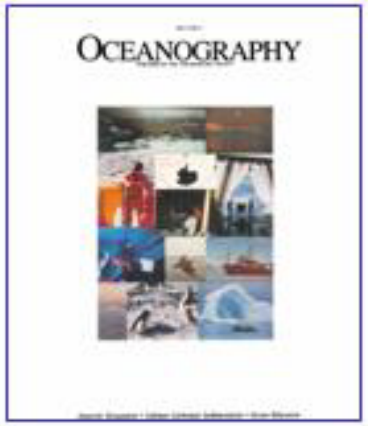
References

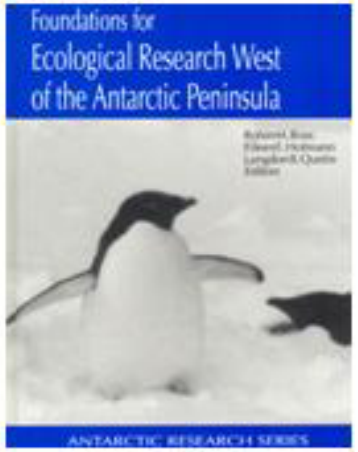
•*Smith et al., 1995. Palmer LTER,* Oceanography *8:77-86.*

•*Foundations for Ecological Research West of the Antarctic Peninsula,* AGU Antarctic Research Series *70, Ross et al. (eds), 1996.*

•*Stammerjohn and Smith, 1997, Opposing Southern Ocean Climate Patterns as revealed by trends in regional sea ice cover.* Climate Change *37, 617-639.*

•*Smith et al., 1998, Exploring sea ice indexes for polar ecosystem studies,* BioScience *48, 83-93.*





PALMER LTER

Ecosystem science research: it's a team effort.

PALMER

LTER