



# PALMER STATION ANTARTICA – LONG TERM ECOLOGICAL RESEARCH

## Global Intercomparability in a Changing Ocean: An International Time-Series Methods Workshop



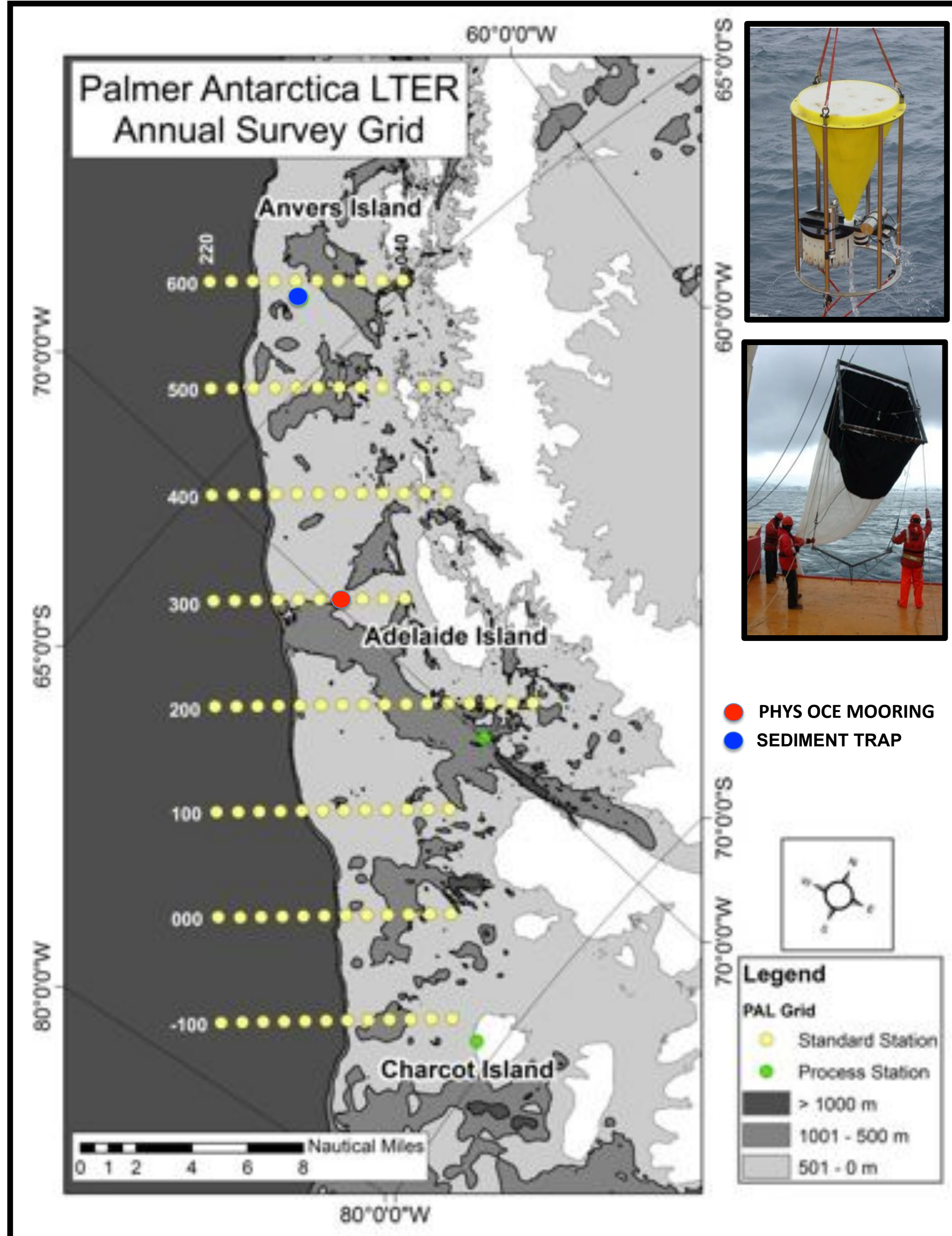
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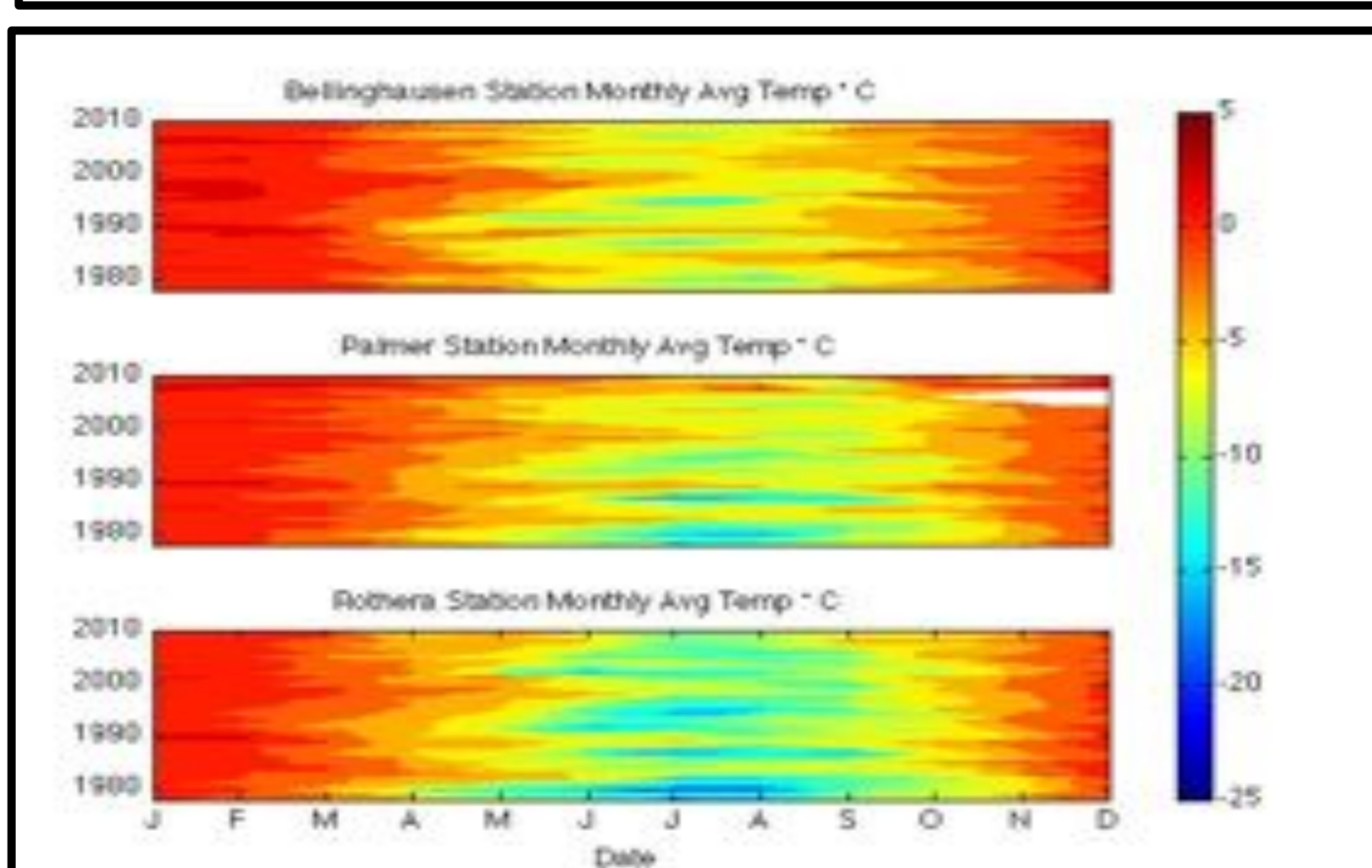


## PAL-LTER

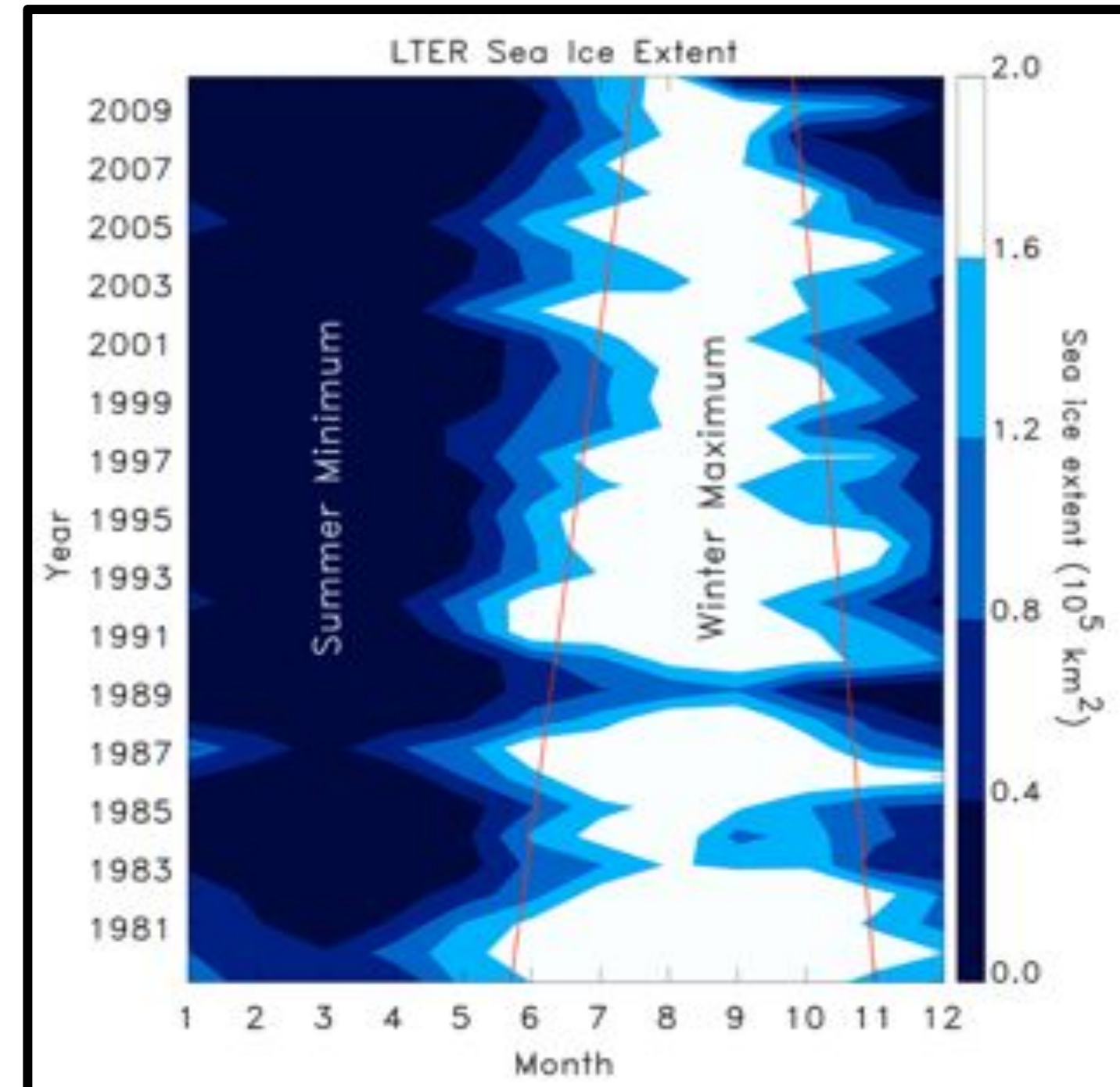
Our research emphasizes regular annual sampling of a grid of hydrographic stations along the west Antarctic Peninsula, oceanographic process studies, moored sediment traps, intensive seasonal studies in seabird colonies, moored and glider-based oceanographic sensors, remote sensing of ocean color, sea surface temperature and sea ice. Testable hypotheses link sea ice advance, retreat and extent to carbon and oxygen dynamics, seasonal primary production, zooplankton abundance, distribution and recruitment; foraging, breeding success and survival of apex predators such as Adélie penguins; and large-scale interactions of the atmosphere and ocean. The oceanic sampling grid (see below), which is 200km on/offshore, stretches 900km along shore roughly parallel to the Peninsula. This 180,000 sq km region surrounding Palmer Station reflects the regional scale of atmospheric, oceanic, and sea-ice interactions with populations in the marine ecosystem. Smaller embedded grids address local hydrography, near-shore primary and secondary production, and the foraging range of nesting seabirds. Elevation ranges from 10m on land to 3000m below sea surface.



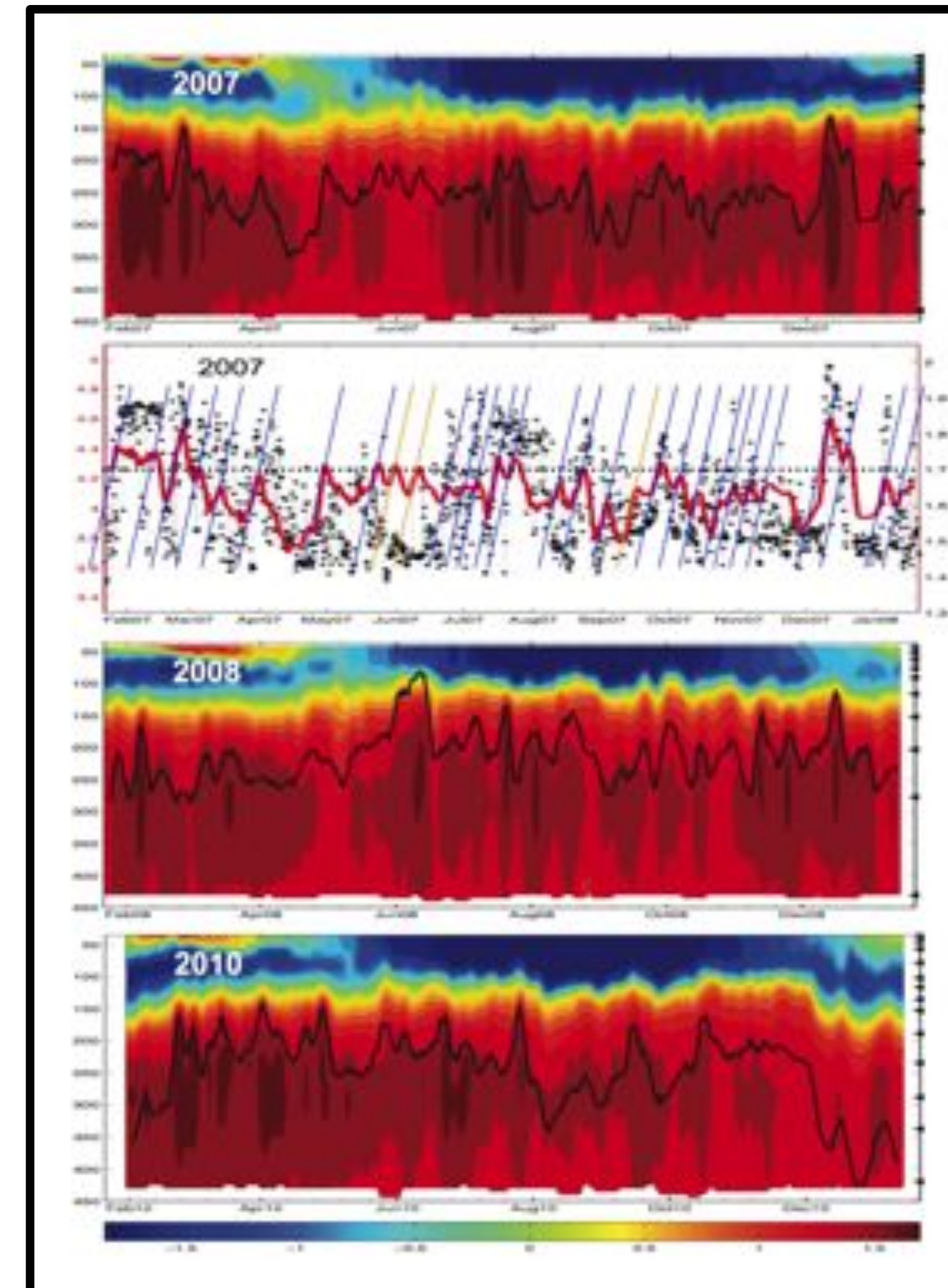
AR/SV Laurence M. Gould docked at Palmer Station, Antarctica (above left) cruise dates 1998 to 2012. R/V Polar Duke (above right) cruise dates 1993 to 1997.



## PHYSICAL

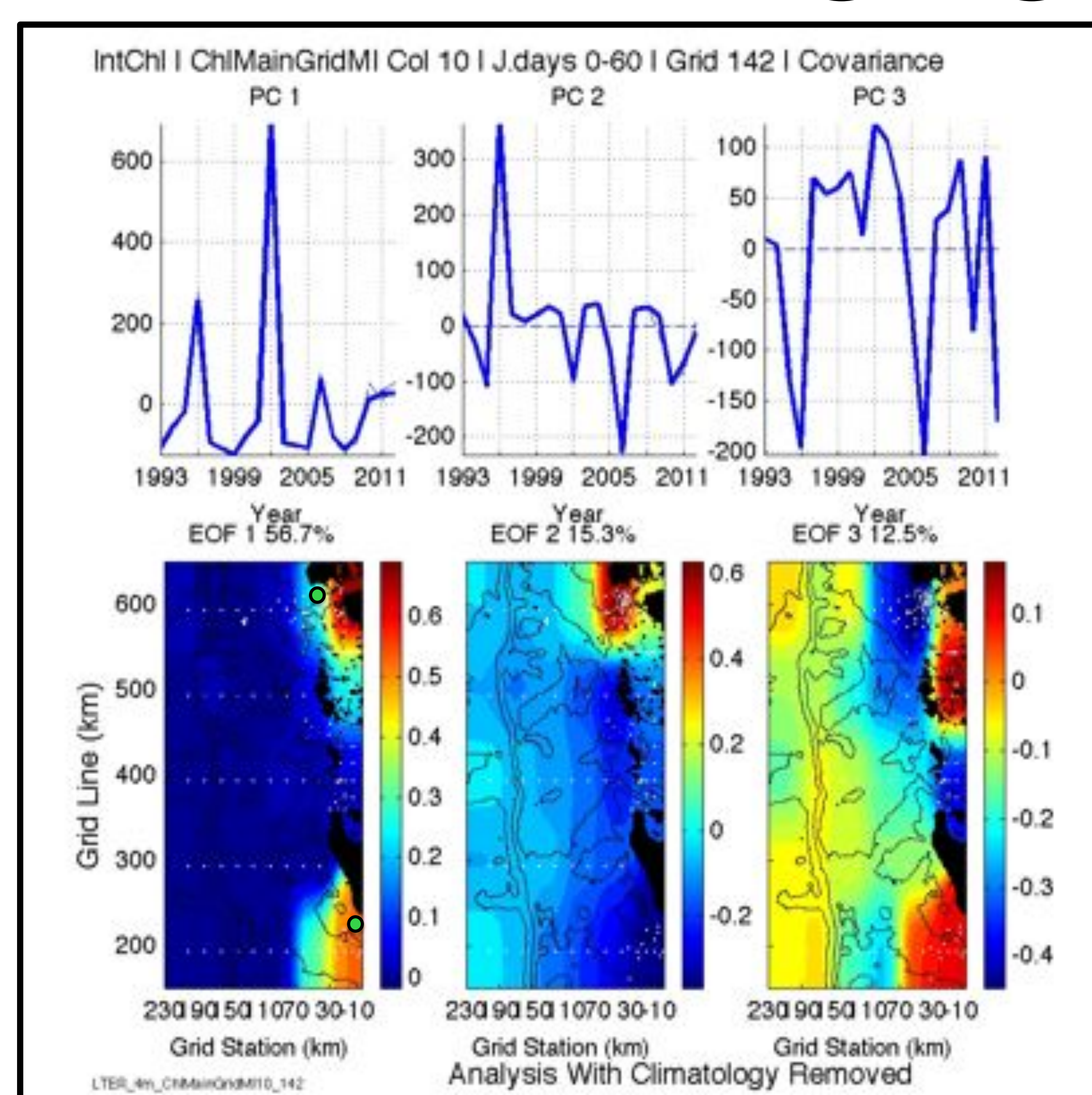


Since the 1970s satellites have allowed Palmer LTER scientists to track sea ice changes from space in great detail. The sea ice season has shortened by almost three months and it is likely that this melting will continue regardless of the rate of global warming. Palmer LTER scientists are studying the mechanisms delivering heat to the region to evaluate its present state and predict its future course

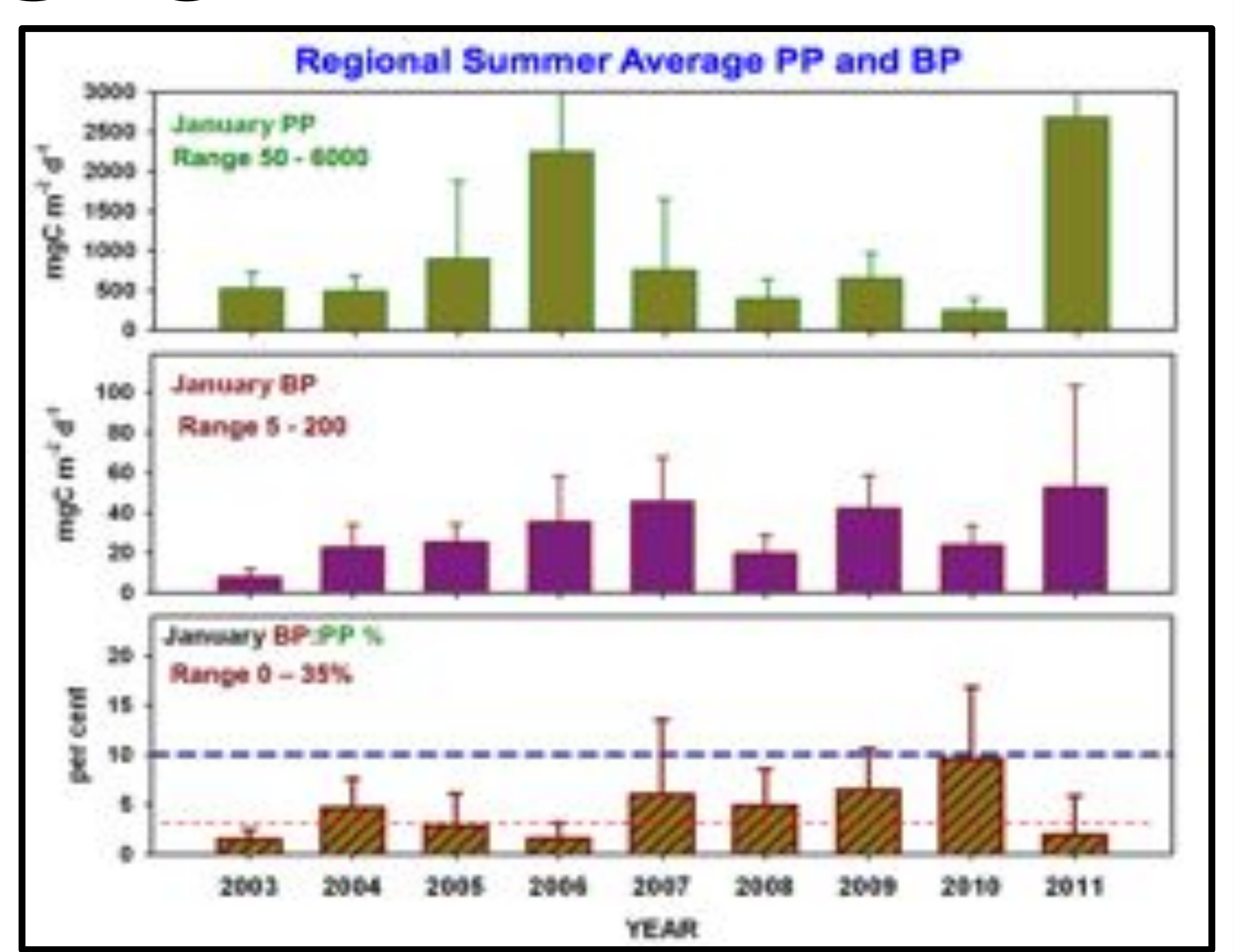
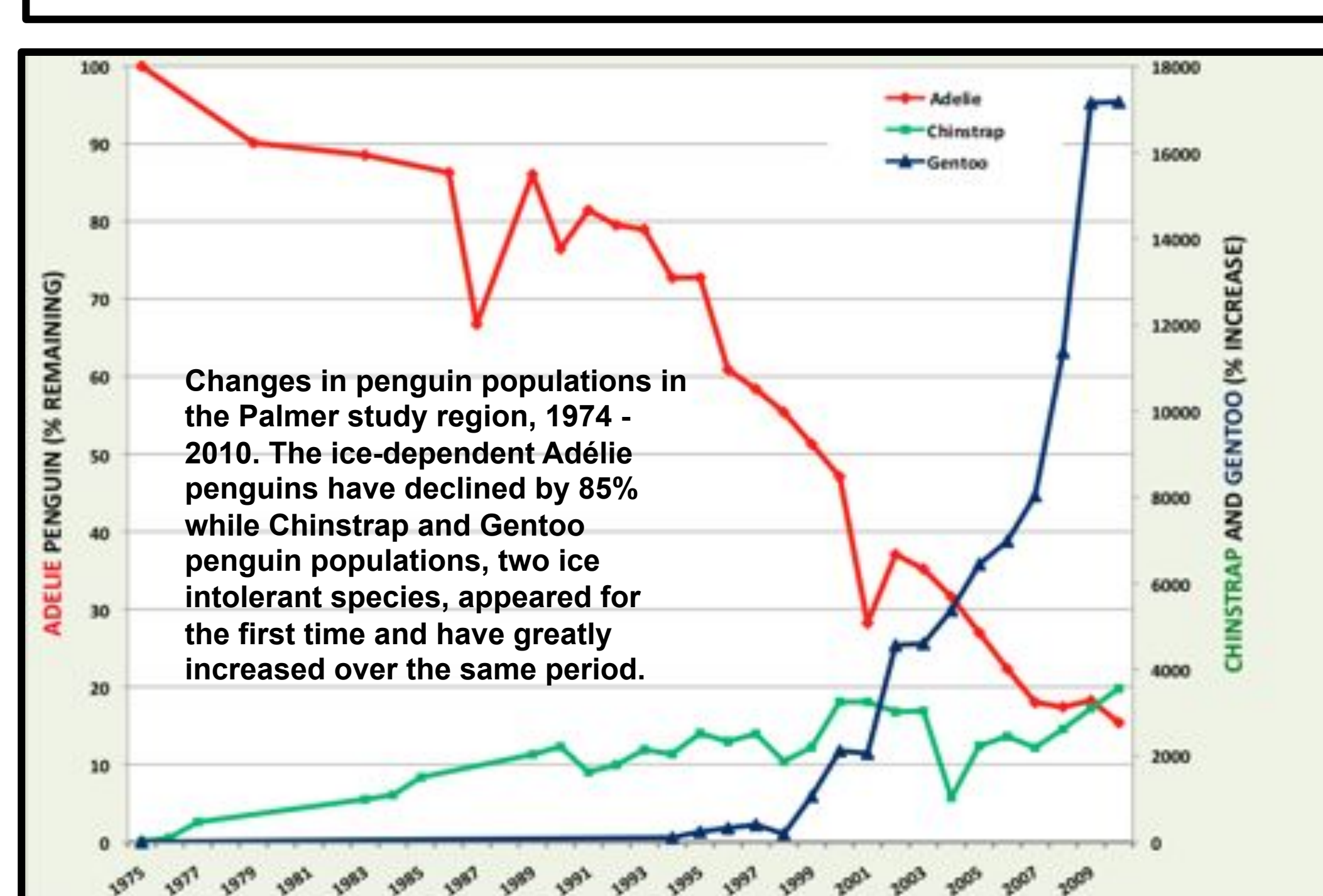


From physical oceanography thermistor mooring array. 3 Colored panels: are temperature sections for mooring located at station 300.100, for years 2007, 2008 and 2010 (mooring was lost in year 2009). Solid black line on sections shows smoothed ocean heat content (Q, relative to the freezing point) from the mixed layer down 415 m (essentially to the bottom of the array). Temperature color bar located at bottom of figure. Left ordinate shows depth scale in dbars. Arrows on right ordinate show position of thermistors (note that depths and numbers of sensors change each year with addition of new sensors or repositioning in some cases). Second panel shows (for 2007): red line is Q, left ordinate in units of 109 J/m<sup>2</sup>; black dots show temperature of T<sub>max</sub> water (right ordinate, units of °C), waters warmer than 1.7 °C (indicated by horizontal dotted line) only are found in the Upper Circumpolar Deep Water (UCDW) as delivered to the continental shelf via the Antarctic Circumpolar Current (ACC); sloped lines (blue and gold) show that the change in heat content with time is the same for every warm event that passes mooring. Gold sloped lines are for the only warm events in which the T<sub>max</sub> water does not exceed 1.7 °C. Together, results reveal that UCDW is delivered to continental shelf via UCDW (warm)-core eddies, generated at shelf slope break (thus eddies all of similar size) and tracking bathymetry to mooring site. UCDW delivers heat and nutrients to shelf. For details, see Martinson and McKee, Ocean Science, 2012.

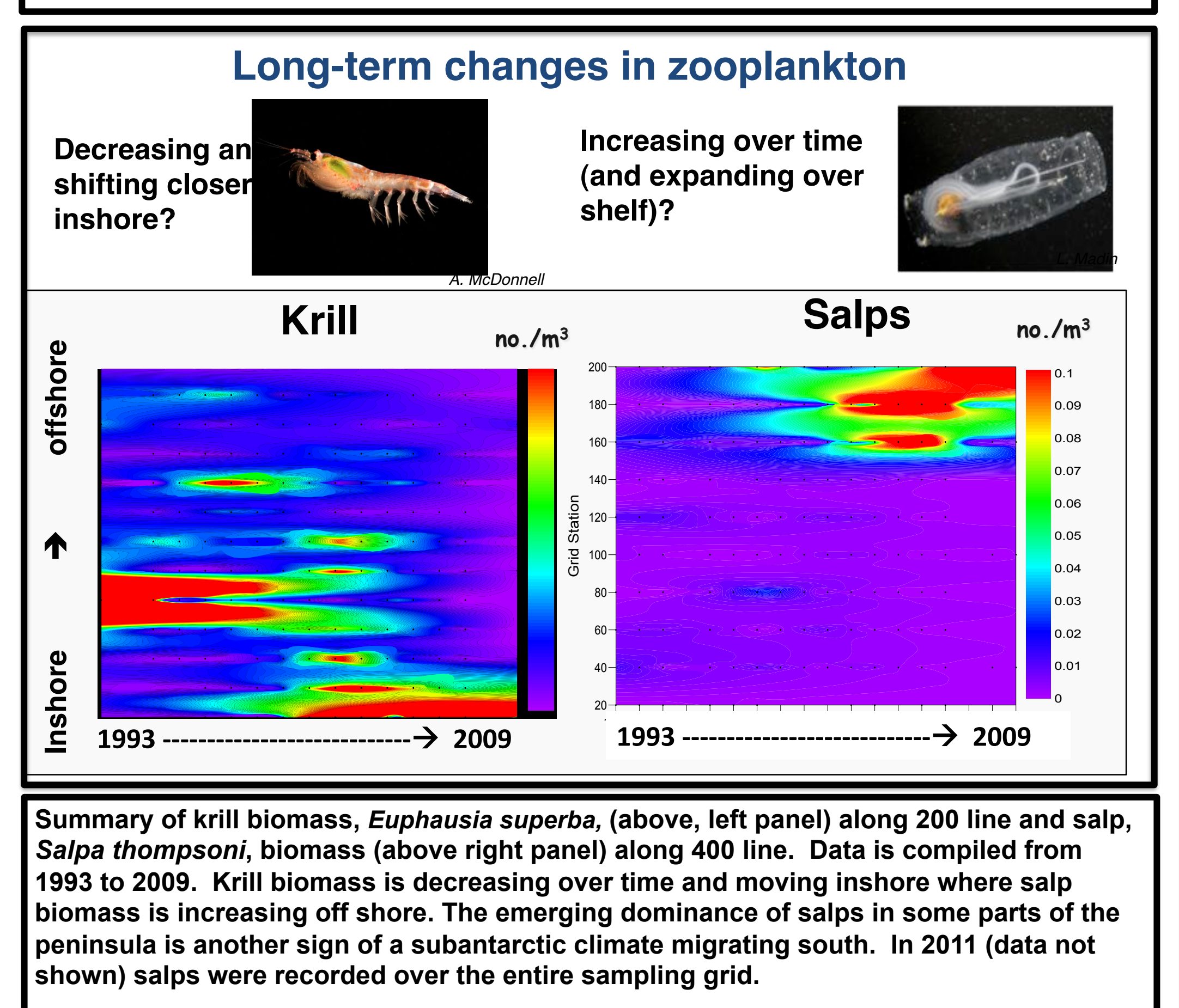
## BIOLOGICAL



Spatial-temporal patterns in depth-integrated chlorophyll (1993–2012) via classical principal component analysis (PCA). First mode describes the greatest % of data variance. First mode in depth-integrated Chl shows that the most common pattern of variability in the time series was located in-shore both in the north and south. Higher years of '96, '02, '06 and '11 and lower years of '93, '99, '05 and '08). Do these patterns of variability in the data direct attention to location of the large submarine canyons and their role in supporting greater production via ACC exchange?

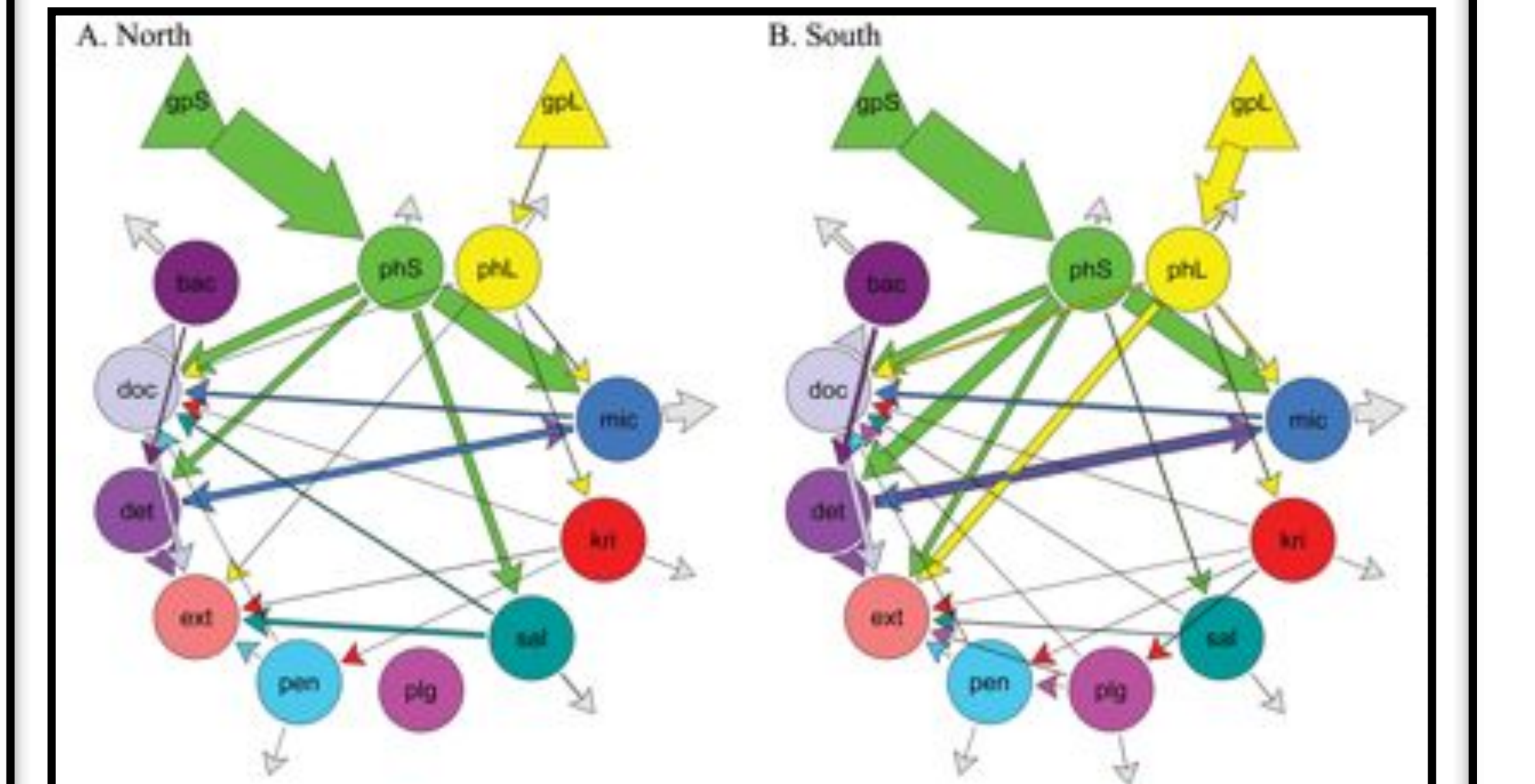
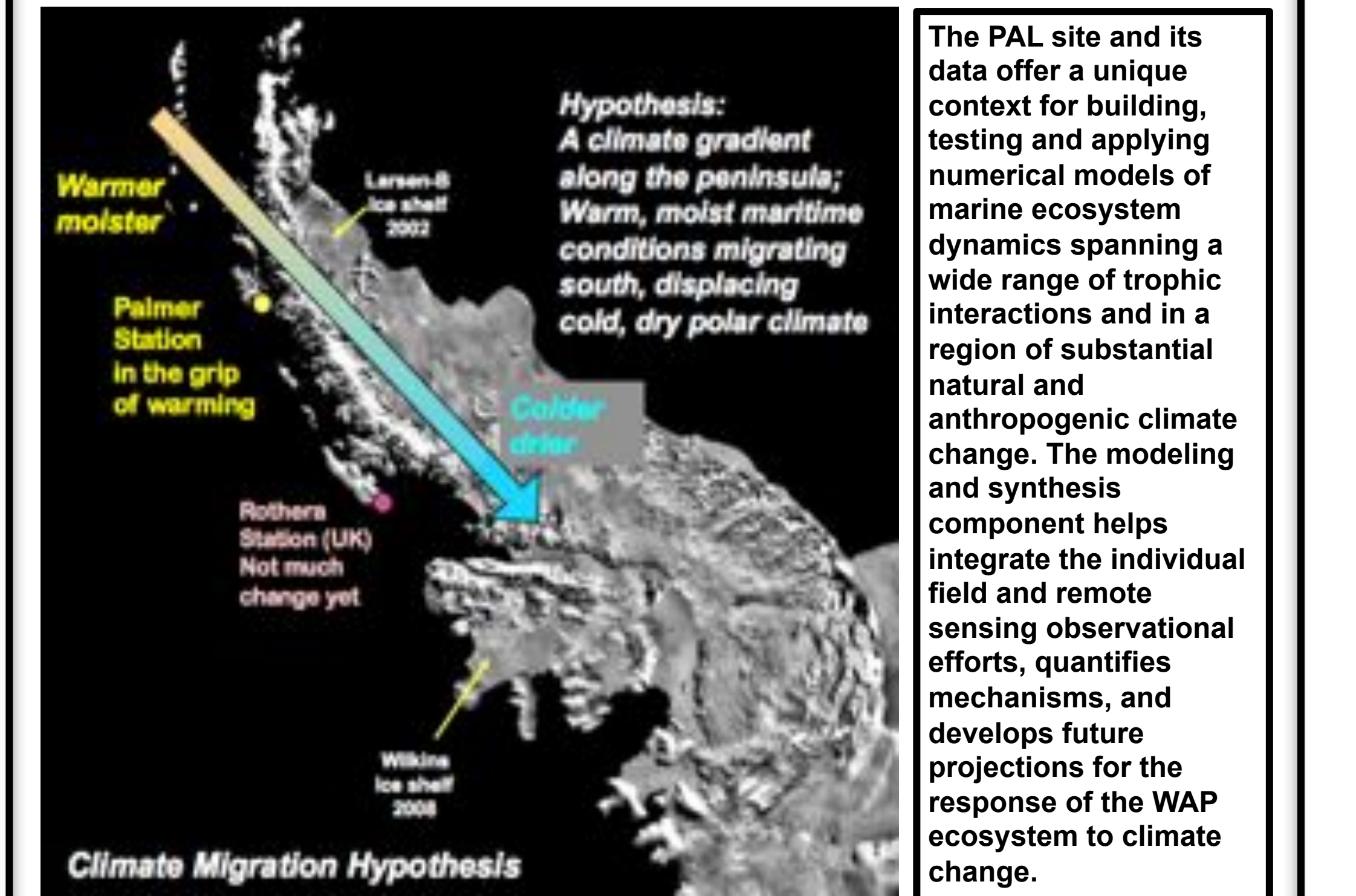


Summary of average midsummer (January) primary production (PP, top panel), euphotic zone integrals and bacterial production (BP, middle panel, upper 50 meters) rates for the Palmer LTER continental shelf region of the western Antarctic Peninsula, 2003-11. The lower panel is the average ratio of BP to PP for each year. Bars show standard error of the mean for each year. For each year there are 12-15 individual observations at LTER Grid stations in the Shelf region (map). The ranges are for individual stations over all years.

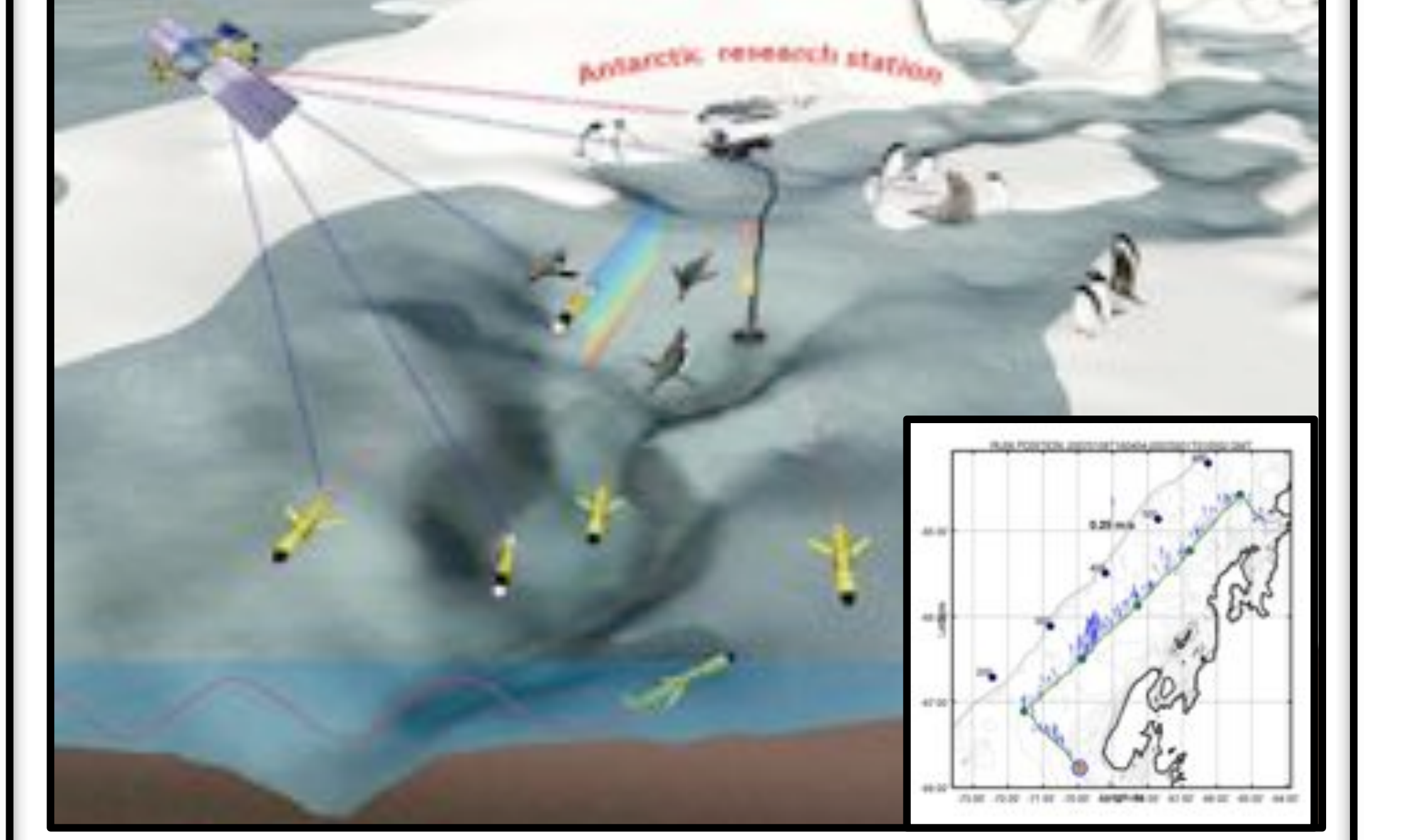


Summary of krill biomass, *Euphausia superba*, (above, left panel) along 200 line and salp, *Salpa thompsoni*, biomass (above right panel) along 400 line. Data is compiled from 1993 to 2009. Krill biomass is decreasing over time and moving inshore where salp biomass is increasing off shore. The emerging dominance of salps in some parts of the peninsula is another sign of a subantarctic climate migrating south. In 2011 (data not shown) salps were recorded over the entire sampling grid.

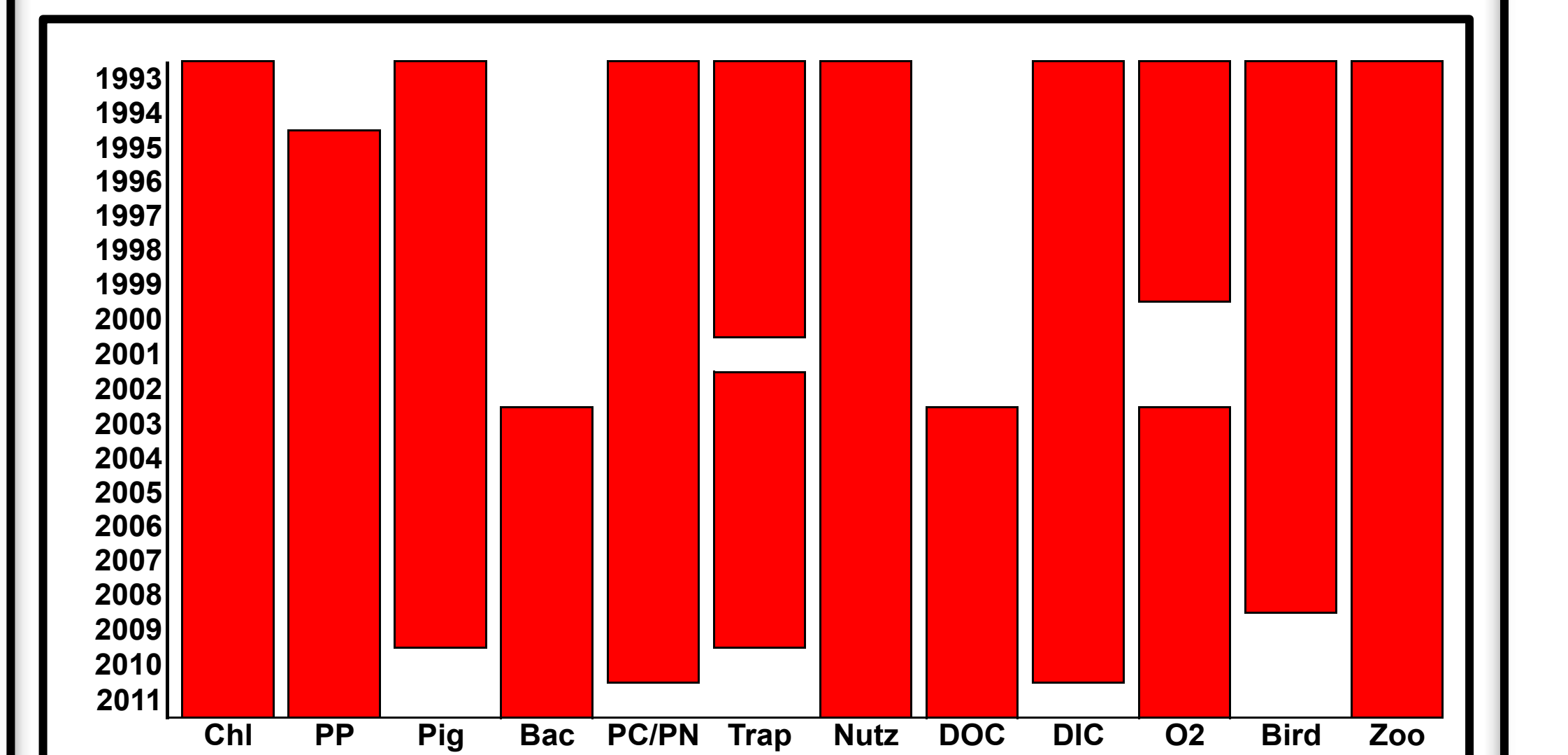
## FUTURE



Small phytoplankton Large phytoplankton Microzooplankton Krill Salps Small fish Penguins Export Detritus DOC Bacteria  
INVERSE MODELING OF FOODWEB FLOW STRUCTURE 1995-2008 NORTH vs. SOUTH What are the relative magnitudes of measured/unmeasured flows in solved system?



Autonomous gliders, instrumented penguins and satellites survey the canyons near Palmer Station. Inset: a glider mission from Palmer Station to the British Antarctic Survey base at Rothera. Arrows in the inset show current direction/speed along the glider track.



Current data sets for primary and derived measurements from annual cruises. Note some data sets have missing years due to instrument malfunction (Trap), delayed upload (Pig) or addition of measurement to project (Bac and DOC). Data sets are available at Ocean Informatics DataZoo.  
[oceaninformatics.ucsd.edu/datazoo/data/palmer/datasets](http://oceaninformatics.ucsd.edu/datazoo/data/palmer/datasets)