Some things about the CRYOSPHERE
Fig. 1 The great ice sheets: Greenland (*left image*) in the Northern Hemisphere and Antarctica (*right image*) in the Southern Hemisphere. Images obtained from Google Earth 2009 (Data SIO, NOAA, U.S. Navy, NGA, GEBCO)
Fig. 6 History of deep ocean and global surface temperature (a and b on same arithmetic scale) and paleo CO₂ estimates (c on a log scale) over the last 65 m.y. See italicised section in the text.
Fig. 2  Map of Antarctica, showing major ice shelves (light blue shading), Vostok and EPICA Dome C Ice Core records (yellow circles), and ANDRILL and Cape Roberts marine sediment cores (red stars)
Figure 1.4 Bed elevation illustrating major regions (in blue and green) below sea level, the major subglacial continent underneath East Antarctica, and the mountain ranges separating East and West Antarctica and along the Antarctic Peninsula. Note the topography shown here has not been corrected for isostatic rebound. Taken from Lythe, Vaughan and BEDMAP Consortium, 2001.
Figure 1.3 Surface elevation illuminated from directly overhead shows the general shape of the continent as well as the smaller scale roughness. Topographic divides between major catchments are bright (white) sinuous ridges. Fringing ice shelves are extremely flat (shown as pale grey matt). Smaller scale roughness is often associated with subglacial relief. The smoother surface surrounding the South Pole is the result of sparser and less accurate elevation data south of 80°S. (from Bamber et al., 2008).

Figure 1.5. Ice thickness (difference between surface and bed elevations) in metres, showing the much thicker East Antarctic ice sheet, gradual thinning from the interior to the coast and the many deep outlet glaciers. Seawards of the continental outline, the dark blue areas are the permanent ice shelves that represent floating extensions of the continental ice sheet. From Lythe, Vaughan and BEDMAP Consortium, 2001.
Fig. 3  Map of Greenland, showing locations of major towns (red circles) and ice core records (yellow circles)
Fig. 11  Sea level variation from ice-volume change over the last five glacial cycles (from Rohling et al., 2009). The data are from carbonate $^{18}O$ measurements on central Red Sea cores. The green symbols are coral and speleothem-based high sea-level markers.
West Antarctica warming: +0.17 ± 0.06°C
East Antarctica warming: +0.10 ± 0.07°C

Fig. 17  Warming over Antarctica since 1957 AD  (Source: Steig et al., 2009)
Winter warming in West Antarctica caused by central tropical Pacific warming

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The Pacific sector of Antarctica, including both the Antarctic Peninsula and continental West Antarctica, has experienced substantial warming in the past 30 years. An increase in the circumpolar westerlies, owing in part to the decline in stratospheric ozone concentrations since the late 1970s, may account for warming trends in the peninsula region in austral summer and autumn. The more widespread warming in continental West Antarctica (Ellsworth Land and Marie Byrd Land) occurs primarily in austral winter and spring, and remains unexplained. Here we use observations of Antarctic surface temperature and global sea surface temperature, and atmospheric circulation data to show that recent warming in continental West Antarctica is linked to sea surface temperature changes in the tropical Pacific. Over the past 30 years, anomalous sea surface temperatures in the central tropical Pacific have generated an atmospheric Rossby wave response that influences atmospheric circulation over the Amundsen Sea, causing increased advection of warm air to the Antarctic continent. General circulation model experiments show that the central tropical Pacific is a critical region for producing the observed high latitude response. We conclude that, by affecting the atmospheric circulation at high southern latitudes, increasing tropical sea surface temperatures may account for West Antarctic warming through most of the twentieth century.
West Antarctic Ice Shelf Melting

January 9, 1995

February 27, 1995
Larsen B ice shelf, 17th Feb 2002

Larsen B ice shelf, 5th March 2002 (16 days later)
Fig. 18  Spatial pattern of changes in the ACC. The *dots* show the distribution of the 52,447 Argo profiles used in this study. The *colour* indicates the deviations of Argo potential temperatures averaged over the neutral-density layer 26.9–27.7 from the climatological mean (Rönine et al. 2008).
Fig. 22  Extent of melt on the Greenland ice sheet during 1992 (light red) and 2006 (dark red). Graphic by Konrad Steffen and Russell Huff of the Cooperative Institute for Research in Environmental Sciences (CIRES) at the University of Colorado at Boulder.
Source: HUcires.colorado.edu/steffen/greenland/melt2005/U
Shepard et al., 2007
Fig. 21 Mass balance estimates for Greenland (top) and Antarctica (bottom). The coloured rectangles indicate the time span over which the measurements apply and the range, and follow Thomas et al. (2006). The range estimate is given as (mean + uncertainty) as reported in the original papers. See italicised section in the text.
Figure 2.5. Estimates of equivalent sea-level rise from (top) Greenland and (bottom) Antarctica polar ice loss over the last 30 years. Each box represents a range in equivalent sea level rise from a paper reporting satellite data (colors represent different approaches). Sources listed in Bertler, and Barrett (2010).
Mitrovica et al., 2009

WAIS melt - effect on SL:
Normalized to eustatic SL change of 5 m,

- Gravitational effect of ice sheet
- Effect on Earth’s rotation
- Rebound and expulsion of water from marine areas due to unloading

Gomez et al., 2010

Partial EAIS melt of marine-based sectors - effect on SL:
Normalized to eustatic SL change of 14.2 m