Senate Standing Committee on Environment and Communications
Legislation Committee
Answers to questions on notice
Environment portfolio

Question No: 119

Hearing: Supplementary Budget Estimates

Outcome: Agency

Programme: Bureau of Meteorology

Topic: Sea Ice Cover

Hansard Page: 45

Question Date: 18 November 2013

Question Type: Spoken

Senator Ruston asked:

Dr Vertessy: Yes, I was just going to go on to say, though, that it is a little less clear as to whether there is also an increase in the thickness. As I understand it, there is evidence to show that the sea ice thickness is in fact decreasing. I would need to confirm that. If you would like me to look into that further, I could. In terms of why this is happening, this is an area of active research. There are a few key theories around at the moment. The first of these is that the circulation pattern, the wind patterns around Antarctica, are changing. Generally we are getting stronger westerly flow around Antarctica, and that is tending to push the sea ice further north, which would be one reason why it would increase in extent. The second thing is that we are seeing a bit more rainfall over that territory, and that would favour the accumulation of more sea ice, partly because it is freshening the ocean and that then makes it easier for freezing to be attained. They are some theories, but these are active areas of research at the moment. Senator RUSTON: I would be interested if you could provide additional information when you get it, only because I can remember the climate change commissioner standing up and saying the dams in Australia would never refill, and they seem to have done that over the last couple of years. So I would be interested in any further research or information you have; that would be great. Thank you, Chair.

Answer:

Observations show rapid and significant reductions in sea ice extent (areal coverage) in the Arctic, currently exceeding climate change projections.

When discussing sea ice, scientists refer to sea ice concentration, extent, thickness and volume. Concentration is the ratio of the area of sea ice relative to the total area at a given point in the ocean. Extent means areal coverage. In Antarctica this varies seasonally between 3 and 19 million km^2 through the year. Thickness is self-explanatory and is usually not more than two metres, but can occasionally reach several metres. Volume is the extent multiplied by the thickness multiplied by the concentration of sea ice. In Antarctica, the overall volume of sea ice typically ranges seasonally between 2 and 14 000 km^3.

There is a weak increasing trend in Southern Hemisphere sea ice extent. However, the net areal increase is not spatially uniform around the Antarctic continent. Some regions have recorded markedly reduced sea ice coverage, while other regions have shown an increase in coverage. While the net increase in sea ice extent is possibly within the bounds of natural climate variability, the likely drivers of the regional trends are consistent with changes in

atmospheric and oceanic circulation (which has allowed greater northward drift of sea ice). These, in turn, are likely to be related to global warming and stratospheric ozone reduction (Turner et al., 2009; Li et al., 2014), along with changes in freshwater fluxes (precipitation, basal melting of ice shelves (Bintanja et al., 2013; Reid et al., submitted) and outflow of continental sub-ice sheet lake water (Flament et al., 2013; McMillan et al., 2013).

In 2013, the trend of increased Antarctic sea ice extent continued. A new record of annual daily maximum was reached on 1 October 2013 at 19.57 million square kilometres, which is just over five per cent above the 1981–2010 mean.

A major limitation in estimating sea ice thickness around Antarctica is the current inability for sea ice thickness to be measured by satellite. Observations of sea ice thickness in the Arctic are better than those for the Antarctic, since they are based upon regular, undersea observations from submarine cruises.

Sea ice thickness in the Arctic showed substantial decline in the latter half of the 20th century. There are no observations currently available to robustly detect changes in sea ice thickness in the Antarctic. Some recent studies, using short and spatially-limited observational records, have suggested a very weak decline in Antarctic sea ice thickness. Without observations of broad-scale sea ice thickness the total volume of sea ice is unknown. However, recent model simulations (Massonnet et al., 2013) suggest that total Antarctic sea ice volume has increased over recent decades.

A significant development in respect of measuring and monitoring Antarctic sea ice thickness was the launch of the European Space Agency's CryoSat II satellite in 2010. This is dedicated to Earth ice and snow measurements, including monitoring of sea ice thickness. The Australian Antarctic Program is playing a crucial role in providing ground-truth data for calibration and validation of the satellite data. The Bureau provides a role in supporting research missions.

The state of sea ice in both the Antarctic and Arctic is discussed in the IPCC's Working Group I contribution to the 5th Assessment Report *Climate Change 2013: The Physical Science Basis* (Fifth Assessment Report). A copy is at:
http://www.climatechange2013.org/images/uploads/WGIAR5_WGI-12Doc2b_FinalDraft_Chapter04.pdf.

Researchers at the Bureau of Meteorology monitor Antarctic sea ice on a daily basis, but not Arctic. Daily data on sea ice extent, updated daily, are available on the web here:
http://www.cawcr.gov.au/staff/preid/seaice/sea_ice_table_extent.html.

ATTACHMENTS

A: List of the references.

B: A brief comparison of Arctic and Antarctic sea ice extent, with data provided from the US National Snow and Ice Data Center (NSIDC).

Attachment A

LIST OF REFERENCES:

Bintanja R, van Oldenborgh GJ, Drijfhout SS, Wouters B and Katsman CA (2013) Important role for ocean warming and increased ice-shelf melt in Antarctic sea-ice expansion. *Nature Geosci*. **6**, 376-79

Flament T, Berthier E and Rémy F (2013) Cascading water underneath Wilkes Land, East Antarctic Ice Sheet, observed using altimetry and digital elevation models. *The Cryosph. Discuss*., **7**, 841-871, doi:10.5194/tcd-7-841-2013

Li X, Holland DM, Gerber EP and Yoo C (2014) Impacts of the north and tropical Atlantic Ocean on the Antarctic Peninsula and sea ice. *Nature*, **505**, 538-542

Massonnet F, Mathiot P, Fichefet T, Goosse H, Beatty CK, Vancoppenolle M, Lavergne T (2013) A model reconstruction of the Antarctic sea ice thickness and volume changes over 1980–2008 using data assimilation. *Ocean Modelling*, **64**, 67-75

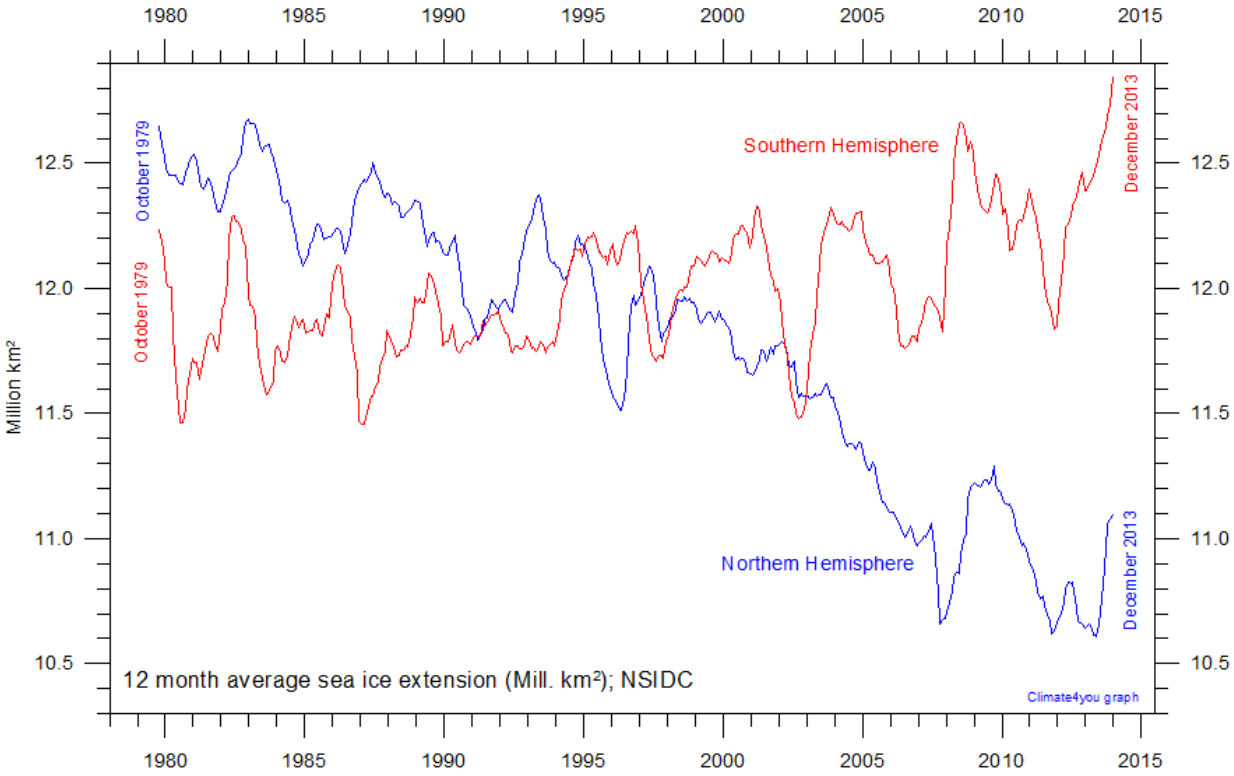
McMillan M, Corr H, Shepherd A, Ridout A, Laxon S and Cullen R (2013) Three-dimensional mapping by CryoSat-2 of subglacial lake volume changes. *Geophys. Res. Lett*., **40**, 4321–4327, doi:10.1002/grl.50689

Reid PA, Stammerjohn A, Massom R, Scambos T, and Leiser J (accepted) The record 2013 Southern Hemisphere sea ice extent maximum. *Annals of Glaciology*

Turner J, Comiso JC, Marshall GJ, Lachlan-Cope TA, Bracegirdle T, Maksym T, Meredith MP, Wang Z and Orr A (2009). Non-annular atmospheric circulation change induced by stratospheric ozone depletion and its role in the recent increase of Antarctic sea ice extent *Geophys. Res. Lett*., **36**, L08502

Attachment B

Figure 1. 12 month running average sea ice extent in both hemispheres since 1979, the satellite-era.



- Data source: National Snow and Ice Data Center (NSIDC) which is part of the University of Colorado and is sponsored by United States National Science Foundation (NSF), National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA).

http://nsidc.org/data/seaice_index/index.html. Latest figure update: 7 January 2014.

Figure 2. Decadal trends (%) of ice extent anomalies (i.e. after removal of the seasonal cycle), in the Arctic (top) and Antarctic (bottom) from 1979 to 2012.

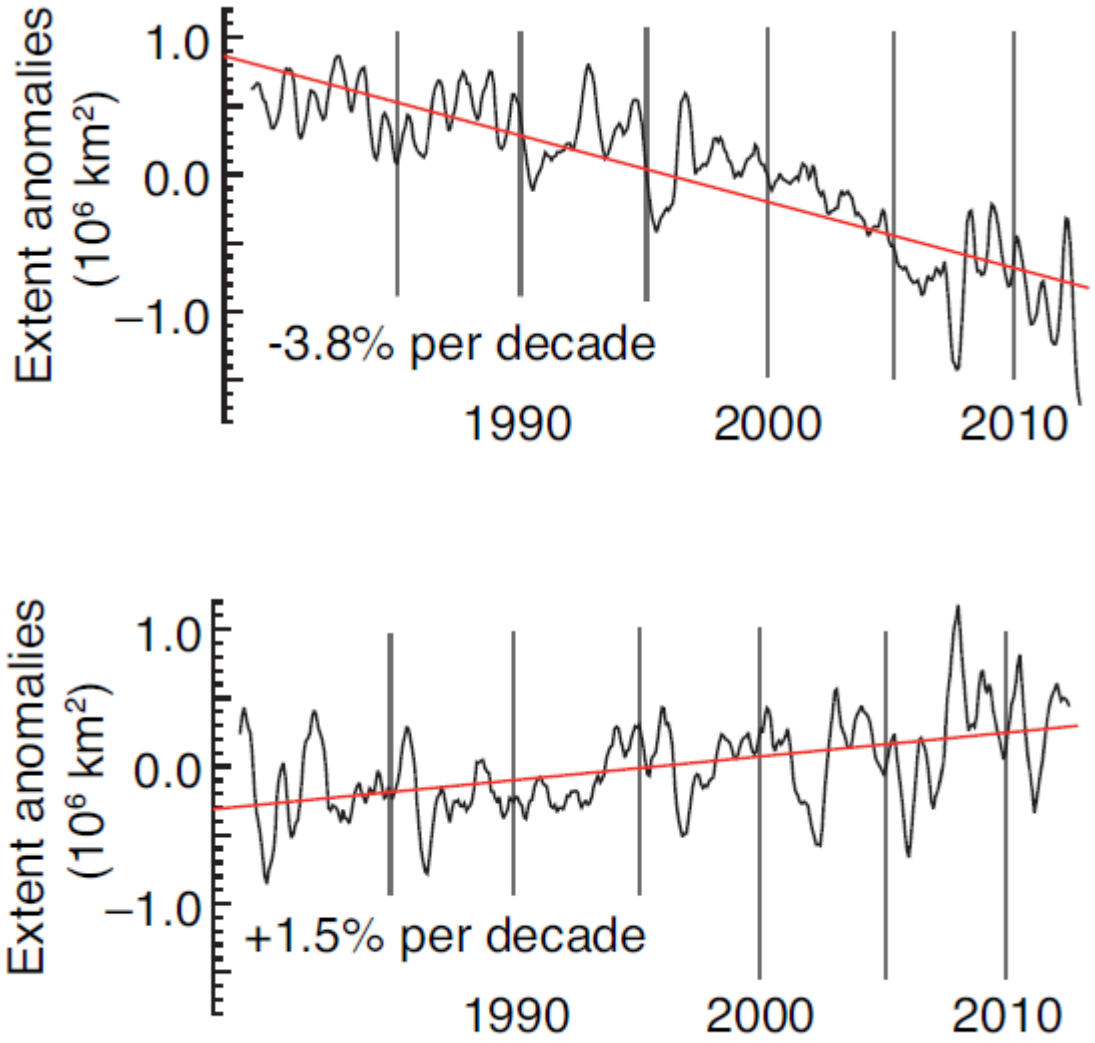


Figure 2. Decadal trends (%) in anomalies of ice extent (i.e. after removal of the seasonal cycle), in the Arctic (top) and Antarctic (bottom) from 1979 to 2012. The values are anomalies (or departures from the means) in millions of square kilometres. Arctic sea ice varies from around 7 million km^2 during the (northern) summer to about 15 million km^2 in winter while Antarctic sea ice varies from a (southern) summer of near 3 million km^2 to about 19 million km^2 in winter.

Source: 'FAQ 4.2 Figure 1' of Chapter 4 of the IPCC's Working Group 1 report

http://www.climatechange2013.org/images/uploads/WGIAR5_WGI-12Doc2b_FinalDraft_Chapter04.pdf