NOTUS

The AGCS Newsletter

Issue 2 July 2007

Inside ...

Editor's Introduction

Welcome to the second edition of Notus, the newsletter of the SCAR Antarctica and the Global Climate System programme. If you are unfamiliar with AGCS, well, you should have read the first edition (and you still can - check http://www.antarctica.ac.uk/met/SCAR_ssg_ps/agcs_newsletter_issue1.pdf).

In addition to the science presented in this session, a great deal of other AGCS research is now coming to fruition. We take the opportunity here to showcase some of the highlights of recent and ongoing science from across the spectrum of AGCS activity.

It is now important that we maintain the momentum that has been built up in the AGCS community. To this end, you are encouraged to participate as fully as you are able. Contacts for AGCS are listed on the back page, and fuller details of the programme and its aims are outlined at http://www.antarctica.ac.uk/met/SCAR_ssg_ps/AGCS.htm. Please feel free to contact any of the committee or national representatives, who would be delighted to engage with you concerning how your science might fit into the programme, and what AGCS can do for you.

This has been a busy period for the AGCS community, with much of the planned science getting into full swing, and many important new results being generated. This was especially apparent during the AGCS Special Session at the European Geosciences Union meeting in Vienna, which was well-supported and featured some excellent talks. In this issue of Notus, we include an overview of the session by Alberto Naveira Garabato (who convened the session on behalf of the AGCS committee), and also include summaries of the talks given by a number of the invited speakers.

- Mike Meredith, Ed.

AGCS at the European Geosciences Union

The EGU IV General Assembly, held in Vienna (Austria) between 15-20 April 2007, hosted a special session on 'Antarctic and the Global Climate System'. The session, convened by Alberto Naveira Garabato and John Turner on behalf of the AGCS committee, was lively and well attended. The six talks and fifteen posters presented within the session illustrated many of the exciting lines of cross-disciplinary research currently being pursued by the AGCS community. Four of the talks were solicited by the convenors in account of each of the four major research themes of AGCS.

Neil Wells delivers his invited talk during the AGCS special session at EGU. See Page 3 for full details.

The oral programme was opened by John Fyfe, who argued that the rapid warming experienced by the Southern Ocean in recent decades is of anthropogenic origin. John proposed that the warming has to date been attenuated by an unusual abundance of volcanic dust in the atmosphere, and predicted that Southern Ocean temperatures will rise faster in coming decades. In the following talk, Neil Wells presented recent evidence of the existence of surprisingly rapid oceanic teleconnections between the high-latitude Southern Ocean and equatorial regions, and examined the physical mechanisms behind the teleconnections.

A subsequent presentation by Nathan Gillett initiated the discussion of the major large-scale modes of Southern Hemisphere climate variability. Nathan identified substantial impacts of the Southern Annular Mode (SAM) on the climate of the Southern Hemisphere mid latitudes, and considered the implications that this link may have for seasonal forecasting and future climate change in those regions. The complex interaction between the SAM and El Niño – Southern Oscillation (ENSO, the other major large-scale mode of Southern Hemisphere climate variability) was discussed by Nancy Bertler, who argued that significant shifts in the phase relationship between these two modes have been instrumental in shaping Southern Hemisphere climate in recent decades. The relationship between Antarctic and mid-latitude climate was revisited by Tas van Ommen in a later talk. Tas highlighted that although such a relationship is prominent in the Australian sector, it appears to be strongly driven by regional processes rather than directly related to the SAM.

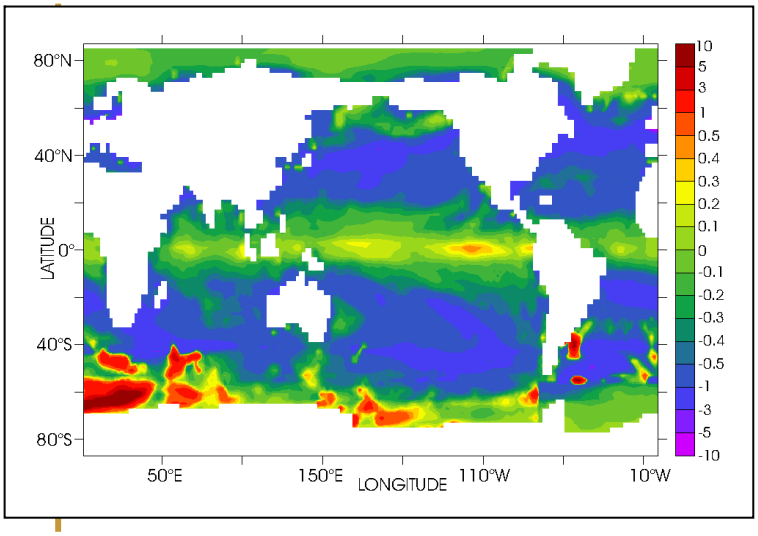
The concluding oral presentation was delivered by John Turner, who discussed the evolution of Antarctic climate over the next 100 years as predicted by 20 models used in the 4th IPCC Assessment Report. Most startling amongst the model predictions are a further strengthening of the near-surface winds over the Southern Ocean, a large warming in the sea ice zone and on the Antarctic plateau, and an increase in precipitation over Antarctica.

Further details on the science presented by the invited speakers are found in this issue of Notus. Our thanks to them, and to all who contributed to making this an excellent interdisciplinary science session.

- Alberto Naveira Garabato

Quick response of anomalies from the Antarctic Ocean to the Equatorial Regions

Recently, we have been addressing a very curious phenomenon that has arisen from experiments with ocean models. Vladimir Ivchenko used the OCCAM model to consider the impact of a large Antarctic sea-ice anomaly on the global ocean and discovered that a positive sea surface temperature signal appeared in the equatorial Pacific after 2 years. A similar experiment run by the University of East Anglia, using the Hadley Centre climate model (HADCM3) found a similar signal in the equatorial Pacific. At the National Oceanography Centre, Southampton, we have been using a simpler coupled climate model (FORTE), to investigate the sensitivity of the equatorial ocean to Antarctic salinity anomalies, caused by sea-ice or by melting of ice shelves. Much work has been done on atmospheric teleconnections between the equator and the Antarctica, but ocean teleconnections are not well explored. (A teleconnection is a very remote response to an anomaly, normally by a planetary wave mechanism in the ocean or atmosphere.)



The sea surface temperature anomaly squared, following the introduction of a salinity anomaly in the Weddell Sea sector of the Southern Ocean, from the FORTE model. There is a large response along the equator, especially the Eastern Pacific Ocean, but very small signals in the middle latitudes, and large signals in many areas of the Southern Ocean (40° S to Antarctica). With kind permission of Blaker et. al., *Geophys. Res. Letts.*, 2006.

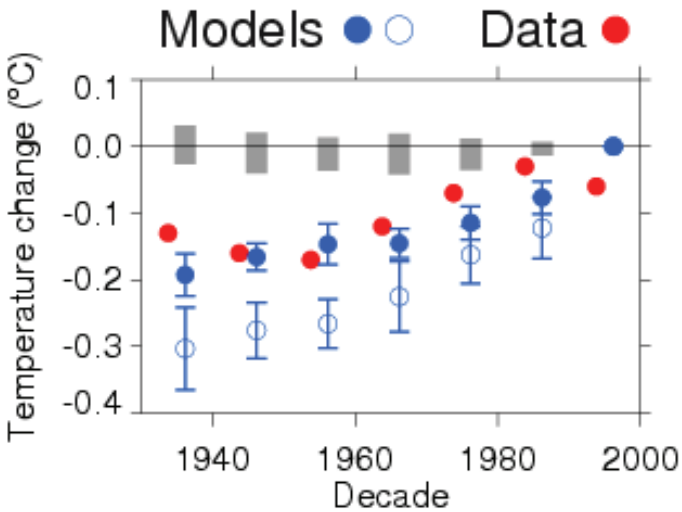
In these experiments we have found that the teleconnection is rather complex and involves a series of fast barotropic planetary waves, which travel from the anomaly in the Antarctic Ocean to the equator on a time scale of days. These waves interact with ocean bottom topography, at the continental shelf and ocean ridges, to produce a series of waves on the thermocline (baroclinic waves), which travel along the shelf or ridges to the equator. The wave on the thermocline amplifies close to the equator, and travels eastward across the equatorial ocean as a Kelvin wave, which can then trigger other equatorial waves (see Figure). The fascinating part of this story is that the tropical atmosphere is very sensitive to sea surface temperature, and these waves can trigger an air-sea interaction event, which amplifies the sea surface temperature signal. In some of our experiments the sea surface temperature rises by 1-2 °C in the eastern Pacific Ocean, a few months after the sea-ice anomaly is imposed. These sea surface temperature anomalies are similar to those associated with well known air-sea interaction phenomena such as the Madden-Julian Oscillations (periods of 60 – 90 days) and El Niño. Our present work is aimed at how we might observe this physical mechanism in the ocean with our remote sensing colleagues, as well as understanding the precise physical mechanisms using the new NEMO ocean model. The QUICK project, supported by U.K. Natural Environment Research Council, is being led by National Oceanography Centre, Southampton, and features collaborations with Chris Hughes at the Proudman Oceanography Laboratory, and Mike Meredith and colleagues at the British Antarctic Survey.

— Neil Wells

The Human Cause and Global Consequence of Southern Ocean Warming

At a special AGCS session of the EGU General Assembly in Vienna, Austria (15-20 April 2007) I presented an invited talk on Southern Ocean warming. To summarize:

1. I showed that the latest series of climate models reproduce the observed mid-depth Southern Ocean warming since the 1950s if they include time-varying changes in anthropogenic greenhouse gases, sulphate aerosols and volcanic aerosols in the Earth's atmosphere (see Figure). The remarkable agreement between observations and state-of-the-art climate models suggests significant human influence on Southern Ocean temperatures. I also showed that climate models that do not include volcanic aerosols produce mid-depth Southern Ocean warming that is nearly double that produced by climate models that do include volcanic aerosols. (See: Fyfe, 2006: Southern Ocean Warming Due to Human Influence, Geophysical Research Letters, 33, L19701).



Mid-depth decadal-mean temperature changes averaged over the latitude range of 35°S to 65° S. Changes are relative to the 1990s. The data, shown with solid red dots, are based on ALACE float and shipboard measurements. Model results involving anthropogenic greenhouse gases, sulphate aerosols and volcanic aerosols are shown with solid blue dots. Model results not involving volcanic aerosols are shown with open blue dots. Model results involving no time-varying external forcings are shown with grey boxes. Adapted from Fyfe (2006).

2. I showed results from a climate model of intermediate complexity indicating that the direct radiative effect of CO_2 emissions and poleward intensified winds together set the overall magnitude of Southern Ocean warming, and that the poleward intensified winds are key in terms of determining its latitudinal structure. The climate model also supports recent high-resolution ocean model experiments suggesting that enhanced mesoscale eddy activity associated with poleward intensified winds influences subsurface (and surface) warming. In particular, increased poleward heat transport associated with increased mesoscale eddy activity enhances the warming south of the Antarctic Circumpolar Current. I also reported on a mechanism involving offshore Ekman sea ice transport which acts to significantly limit the human-induced high-latitude Southern Hemisphere surface temperature response. (See: Fyfe, Saenko, Zickfeld, Eby and Weaver, 2007: The role of poleward intensifying winds on Southern Ocean warming, Journal of Climate, in press. - http://www.cccma.ec.gc.ca/papers/jfyfe/PDF/FyfeSaenkoZickfeldEbyWeaver2006.pdf)

3. I showed results from an Earth System Model used to explore the response of the oceanic and terrestrial carbon sinks to strengthening and poleward shifting of the extratropical Southern Hemisphere winds. Under time-varying CO_2 emissions poleward intensifying Southern Hemisphere winds act on average to slightly enhance the efficacy of both the oceanic and terrestrial carbon sinks, thus providing a small negative feedback on the atmospheric CO_2 concentration. Regionally, the effects of the changing winds on oceanic and terrestrial carbon uptake are more pronounced and partly of opposite sign. I further showed that the magnitude and sign of global oceanic CO_2 uptake is partially controlled by changes in mesoscale eddy activity. (See: Zickfeld, Fyfe, Saenko, Eby and Weaver, 2007: Response of the global carbon cycle to human-induced changes in the Southern Hemisphere winds, Geophysical Research Letters, in press. - http://www.cccma.ec.gc.ca/papers/jfyfe/PDF/ZickfeldFyfeSaenkoEbyWeaver2007.pdf)

- John Fyfe

Links explored between Antarctic precipitation and mid-latitude climate

Research in progress on the Law Dome record of snowfall accumulation is revealing links with large-scale mid-latitude meteorology in the Australian sector of the Southern Ocean. Law Dome itself is located directly south of the west coast

of Western Australia and is the most northerly continental point in East Antarctica: indeed only the tip of the Antarctic Peninsula reaches further north. This location gives Law Dome a strong maritime climate and very high snow accumulation rate (equivalent to around 64cm of water per year). This allows for accurate determination of past snow accumulation which can be compared to meteorological data, and extended back to investigate past natural variability.

At the recent EGU congress in Vienna, Tas van Ommen and Vin Morgan (Antarctic Climate & Ecosystems CRC and Australian Antarctic Division) presented preliminary data extending back over 700 years and showed that through the recent overlap with meteorological data, there is a significant correlation with sea-level pressure at mid-latitudes. This correlation, on multi-year timescales extends across southern Australia, and early results suggest that this could help in understanding the uniqueness of the present drought conditions, especially in south-west Western Australia.

Further work is in progress to explore the connections at a seasonal level and to characterize the underlying mechanisms.

- Tas Van Ommen

The SCAR-IASC Open Science Conference

SCAR XXX and the Third SCAR Open Science Conference (OSC) will be held in St Petersburg, Russia over 8-11 July 2008. The last OSC in Hobart was deemed a great success, but a number of attendees felt that an extra day devoted to the scientific presentations would be beneficial, hence the extension to four days. This OSC is being held jointly with the International Arctic Science Council (IASC) and the theme will be 'Polar Research - Arctic and Antarctic Perspectives in the International Polar Year'. The scientific programme for the OSC is being developed at the moment and a call for papers will be issued shortly. The OSC will be preceded by a number of workshops and associated meetings, including the Steering Committee of AGCS, which plans to meet on the afternoon on Monday 5 July. The SCAR Delegates' meeting will take place in Moscow over 14-17 July 2008.

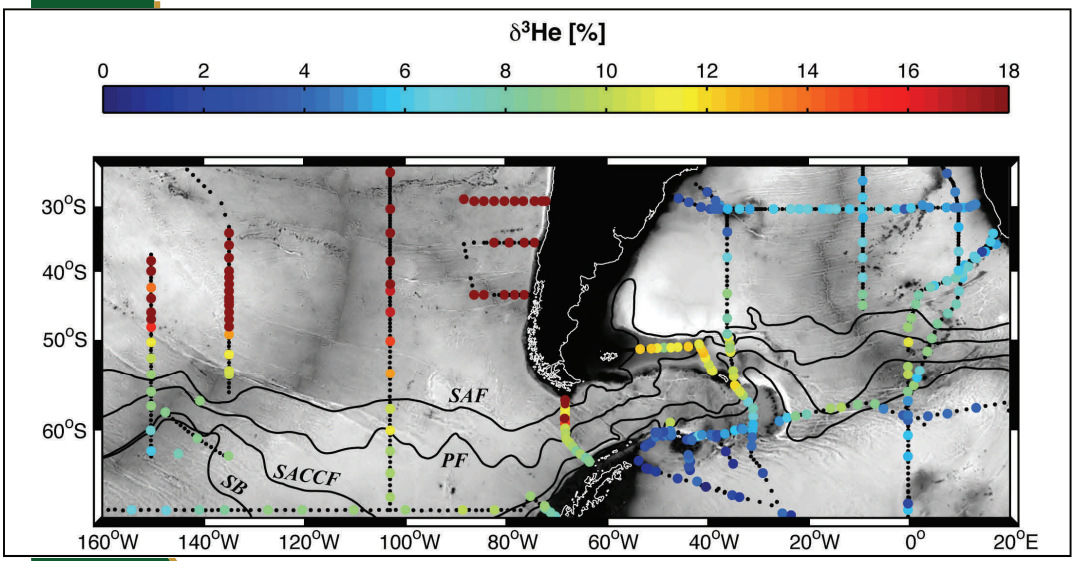
- John Turner

A 'short circuit' in the Southern Ocean limb of the overturning circulation

One of the most significant and hotly debated topics of physical oceanography concerns the processes that shape the stratification of the deep (below roughly 1 km) ocean and, in doing so, drive the climatically key oceanic overturning circulation. Cold, dense water masses sinking in certain areas of the North Atlantic and the high-latitude Southern Ocean as a result of extreme cooling fill much of the global ocean abyss and must become considerably warmer and lighter before they can upwell to the surface and fully overturn the ocean. In recent decades, oceanographers have proposed a range of conceptual models in which the oceanic overturning is primarily driven by either of two upwelling mechanisms: turbulent vertical mixing between the upwelling waters and shallower, lighter waters, associated with the breaking of internal gravity waves; and upward transport of deep water masses along the sloping density surfaces of the Southern Ocean, powered by the combined action of strong winds and the vigorous eddy field of the Antarctic Circumpolar Current (ACC).

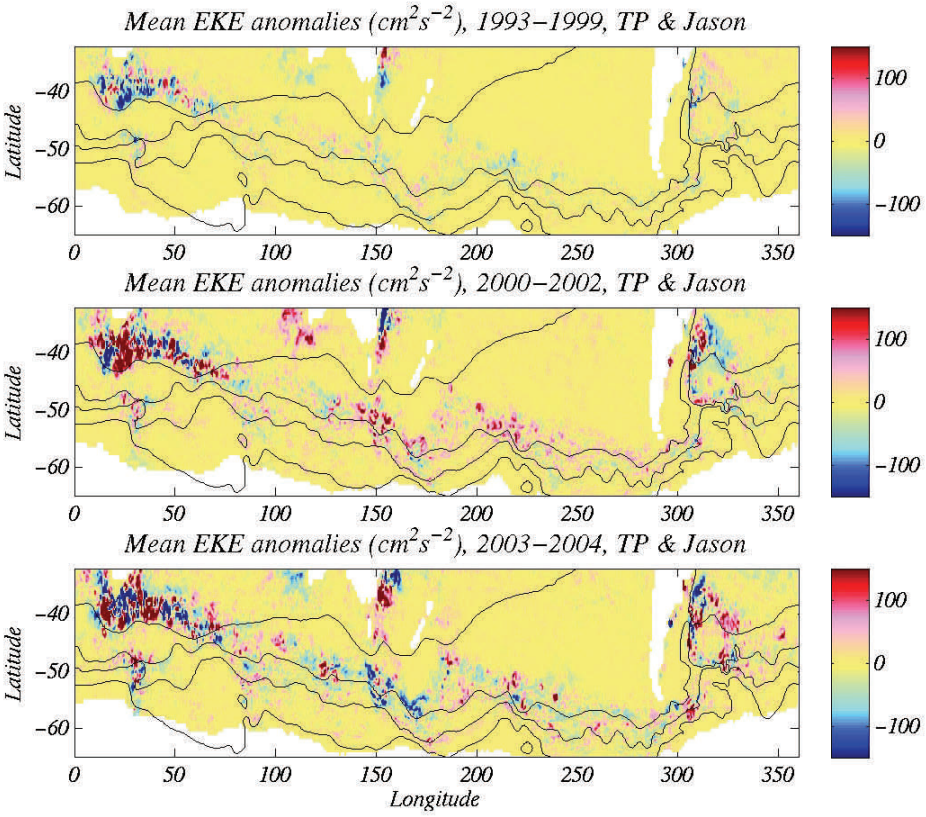
New observations of the spreading of a terrigenic helium plume in the South Atlantic (see Figure) reveal that these two seemingly unrelated mechanisms may be strongly coupled – both geographically and physically – in the Southern Ocean. The plume's evolution shows that the Scotia Sea region hosts rapid upwelling along density surfaces and intense vertical mixing at mid-depth, both occurring at rates that are an order of magnitude greater than implicit in present models of the zonal-average Southern Ocean overturning. The concurrent intensification of the two upwelling processes is consistent with a revised paradigm of the overturning circulation in which internal waves sustaining vertical mixing are generated by the interaction of the ACC and its eddy field with ocean-floor topography. The implication is that deep-water pathways along and across density surfaces are strongly intertwined in ACC regions of rough bathymetry, allowing Southern Ocean water masses to short-circuit their circulation (otherwise directed along density surfaces) through the deep ocean basins to the north. This is at odds with the predictions of present models of the Southern Ocean, which imply substantially longer transit paths and residence times in the deep ocean for the water masses participating in the overturning. Given its expected impact on the structure and rate of oceanic overturning, accounting for the above coupling between the two major upwelling mechanism in ocean models is likely to introduce important subtleties in the way in which the ocean responds to climatic changes in forcing. This work is described fully in Naveira Garabato et al. (Nature, 2007) and is a contribution to AGCS Theme 4.

- Alberto Naveira Garabato



Spatial distribution of the isotopic fraction of helium (δ^3He) on a mid-depth density surface in the Southeast Pacific and Southwest Atlantic. High values indicate the presence of terrigenic helium expelled by submarine volcanoes. The meandering black lines show the main jets of the ACC. Note the great abundance of terrigenic helium in the subtropical Pacific, which is associated with the intense tectonic activity in the region. The ACC in the central South Pacific is characterized by moderate concentrations, and receives the injection of a helium-rich lens from the north in the vicinity of Drake Passage. Tracing the downstream evolution of the helium plume has enabled us to measure the rates of mixing and upwelling in the deep waters of the Southwest Atlantic.

Response of circumpolar Southern Ocean eddy variability to changes in the zonal winds



Variations in intensity of eddy activity in the Southern Ocean during three time periods: 1993-1999 (top), 2000-2002 (middle) and 2003-2004 (bottom). Yellow shading denotes average eddy activity, pink and red denote strong eddy activity, and blue denotes weak eddy activity. Note the strong eddy activity (pink band) right around the Southern Ocean during 2000-2002. This was a couple of years after a peak in the strength of the westerly winds, and a corresponding peak in the transport of the Antarctic Circumpolar Current. See main text for full details.

The Southern Ocean is home to the Antarctic Circumpolar Current (ACC), the world's largest current system. It is now well-established that the transport of the ACC changes according to the intensity of the strong westerly winds that overlie it, certainly on timescales from days to years. More puzzling has been the observation that the changes in ACC transport on interannual timescales have been relatively small (order of 5% of the mean), despite much larger changes in the forcing from the winds.

One theory, based on model results, is that stronger winds accelerate the ACC initially, but much of the extra energy is then taken up by an intensification of the mesoscale eddy field in the Southern Ocean. These eddies play key roles in the dynamics of the ACC and the Southern Ocean overturning circulation, and are also known to be responsible for carrying heat southwards across the ACC.

To test this theory, we examined satellite altimeter data from the early 1990s up to recent times. These data permit direct calculation of the intensity of the eddy field, quantified as Eddy Kinetic Energy (EKE). The most obvious feature in the data was the strong intensification of the eddy activity during 2000-2002, about 2 years after a strong peak in the strength of the westerly winds and a corresponding peak in ACC transport (see Figure).

We investigated the dynamics behind the intensification of the eddy field, and the lag relative to the ACC transport, using an eddy-resolving numerical model. It was found that the lag is due to the time delay needed for the stronger winds to influence the deeper circulation of the ACC.

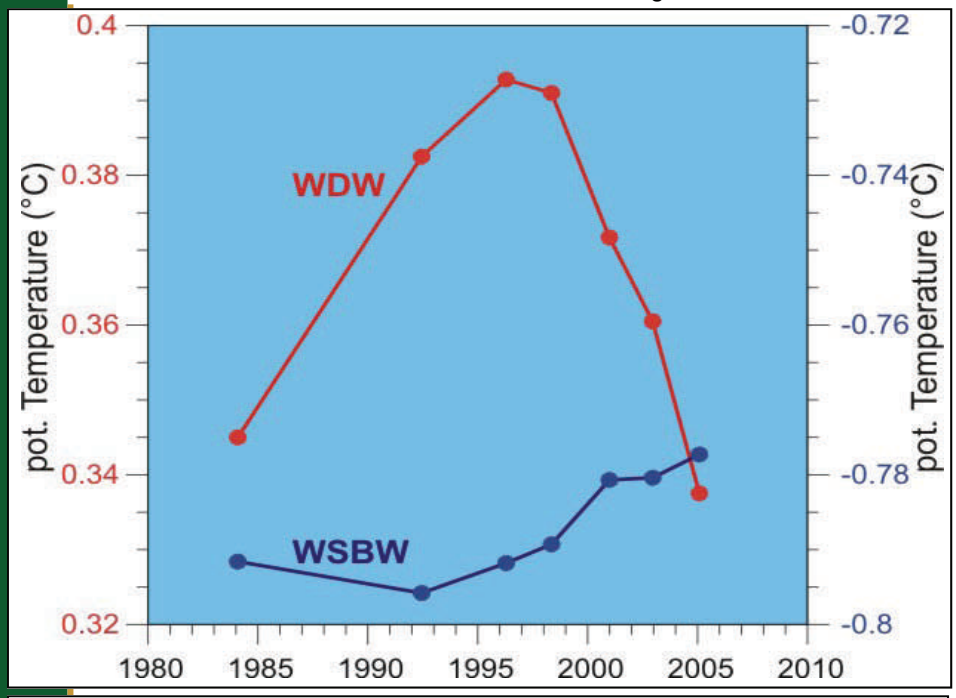
A logical implication of this work concerns warming of the Southern Ocean. Mesoscale eddies carry heat southward across the ACC, and it is known that the winds over the Southern Ocean have strengthened in recent decades. Could the warming of the Southern Ocean, such as observed by Gille (Science, 2002) be due to a climatological increase in mesoscale eddy intensity, and a corresponding increase in eddy heat flux? This is the subject of ongoing investigations, and whilst the satellite record is not long enough to permit observational insights, high-resolution modelling is key to resolving this.

For more details, see Meredith, M.P. and A.McC. Hogg, "Circumpolar response of Southern Ocean eddy activity to changes in the Southern Annular Mode". Geophysical Research Letters, 33(16), 2006.

- Mike Meredith (BAS) and
Andy Hogg (ANU)

Decadal scale variations of water mass properties in the Weddell Sea

The Weddell Sea is known to be the major source region from where freshly formed deep and bottom waters are fed into the Antarctic circumpolar water belt (Orsi et al., Prog. Oceanogr. 1999). From there the water masses of Antarctic origin spread as the deepest layer of the global thermohaline circulation into the basins of all three world oceans. By this process the Southern Oceans plays a significant role in global climate.



Time series of mean temperature of the Warm Deep Water (WDW) and the Weddell Sea Bottom Water (WSBW) from CTD sections at the Greenwich

Data from cruises with RV *Polarstern* between 1989 and 2005 reveal significant variations of the water mass properties in the Weddell gyre. Since 1999 vertically profiling floats were deployed in the Weddell Sea which complemented the CTD data in space and time. In particular, the floats provide data from the winter period, and also allow a reduction in the uncertainty resulting from aliasing of seasonal and other higher frequency fluctuations that arises from the temporally sparse repeat transects.

Significant temperature and salinity variations were observed in the Warm Deep Water and the Weddell Sea Bottom Water (see Figure). The water mass properties were averaged along the transects across the Weddell gyre in on the Greenwich Meridian and from Kapp Norvegia to the northern tip of the Antarctic Peninsula in order to reduce the effect of smaller scale regional variability. In the bottom water of the Weddell Sea proper a temperature increase by 0.12° C was observed over 16 years from 1989 to 2005. At the Greenwich Meridian warming occurred in the Warm Deep Water from 1984 to 1996 followed by cooling since then. The warming in the bottom water at the Greenwich Meridian started in 1992 and is still ongoing. The warming of Warm Deep and the Bottom Water is associated with a salinity increase.

The warming and salinity increase of the Weddell Sea Bottom Water is in contrast to observations in other bottom waters in the Antarctic. In the Australian Antarctic Basin, Aoki et al. (Geophys. Res. Letts., 2005) detected cooling and freshening and Yabuki (Ph.D. thesis, U. Tohoku, 2007) reported warming and freshening of the Ross Sea Bottom Water. The regional differences of the variations suggest regional processes to be the cause.

In the Weddell Sea Fahrbach et al (Ocean Dynamics, 2004) concluded that an intensified inflow from the Antarctic Circumpolar Current (ACC) until the mid nineties explained both the increasing temperature and salinity. However, despite the reversal of the temperature trend in the mid nineties, the salinity remained constant. This is consistent with a period of intensified injection of Circumpolar Deep Water. The advected warm water is partly upwelled in the Antarctic Divergence and mixed in the Winter Water where the heat is lost to the atmosphere whereas the salt remains in the water column. This effect, separating heat and salt variations, works since the temperature maximum in the Warm Deep Water is shallower than the salinity maximum due to the different origins of upper and lower Circumpolar Deep Water. In addition, the advected heat and salt gain leads to the increase of temperature and salinity of the bottom water, explaining the inverse trend as in the Australian-Antarctic Basin where the source water an the local bottom water are less directly linked.

The time lag of 5 to 10 years which occurs from the inflow of Circumpolar Deep Water, the water mass modifications in the Southern Weddell Sea and the flow of newly formed bottom water in the Weddell and Enderby basins explains why the bottom water is still warming and increasing in salinity, despite the fact that the Warm Deep Water has already significantly cooled. In the context of the IPY lead project Climate of Antarctica and the Southern Ocean - CASO, we will survey the water mass properties again in early 2008 to confirm this hypohesis.

- Eberhard Fahrbach, Olaf Boebel, Mario Hoppema, Olaf Klatt, Gerd Rohardt, Michael Schröder and Andreas Wisotzki (Alfred-Wegener-Institute, Bremerhaven).

Cryosphere Observing System Approved

At the 14th meeting of the Partners for an Integrated Global Observing Strategy (IGOS), at UNESCO's HQ in Paris on May 30, the plan for CryOS, an observing systems for the cryosphere, was approved as a theme document. The comments by the Partners were strongly positive, and they endorsed the comprehensive nature of the report is (even referring to it as the "bible" of cryospheric observations!). The latest version of the plan is available at http://stratus.ssec.wisc.edu/cryos/documents.html, which is the Documents page of the IGOS Cryosphere web site. Congratulations to Jeff Key, of NOAA NESDIS, for leading the process. The Cryosphere theme document is considered to be a product of the SCAR Standing Scientific Group for the Physical Sciences. It is also a key component of the IPY Cryosphere programme.

The observing system, CryOS, will be a major legacy of the IPY. It is relevant to the work of SCAR's glaciological groups including ISMASS, ASPecT, ITASE and AGCS.

- John Turner

SOPHOCLES - Southern Ocean Physical Oceanography and Cryospheric Linkages

This is a new project that will focus on model processes in Southern ocean–ice models ranging from those used on the time scales of climate change research through to those used for short term sea ice forecasting. The aim is broader than a model intercomparison, so the project will encompass how well the current models represent key Southern ocean processes, identify what processes are missing, and develop and test new parameterizations of these processes that can be used in future generation models. We wish to engage with the observational community to use their data to constrain our models, in particular to take advantage of new satellite data, and the fieldwork programmes that will occur during IPY and SOOS.

The aim is to consider all the components of the cryosphere that are in contact with the ocean, sea ice ice-shelves, circulation in ice shelf cavities, icebergs and freshwater fluxes from continental ice and glacier tongues.

This approach will hopefully include a broader number of people from our community with its range of interests with the focus on producing the best outcome in more realistic representation of cryosphere and Southern ocean in future models.

We are holding the inaugural meeting of SOPOCLES in Bergen on the 25th-26th August 2007 (see http://clic.npolar.no/theme/sophocles.php), the weekend before the Polar Dynamics meeting. There are a number of other small workshops like WGOMD, iAnZone and a numerical methods in ocean models workshop that are running alongside the main meeting, and it was chosen as it was a good location where both observationalists, processes modellers, regional and global modellers who have an interest in the Southern ocean might be attending.

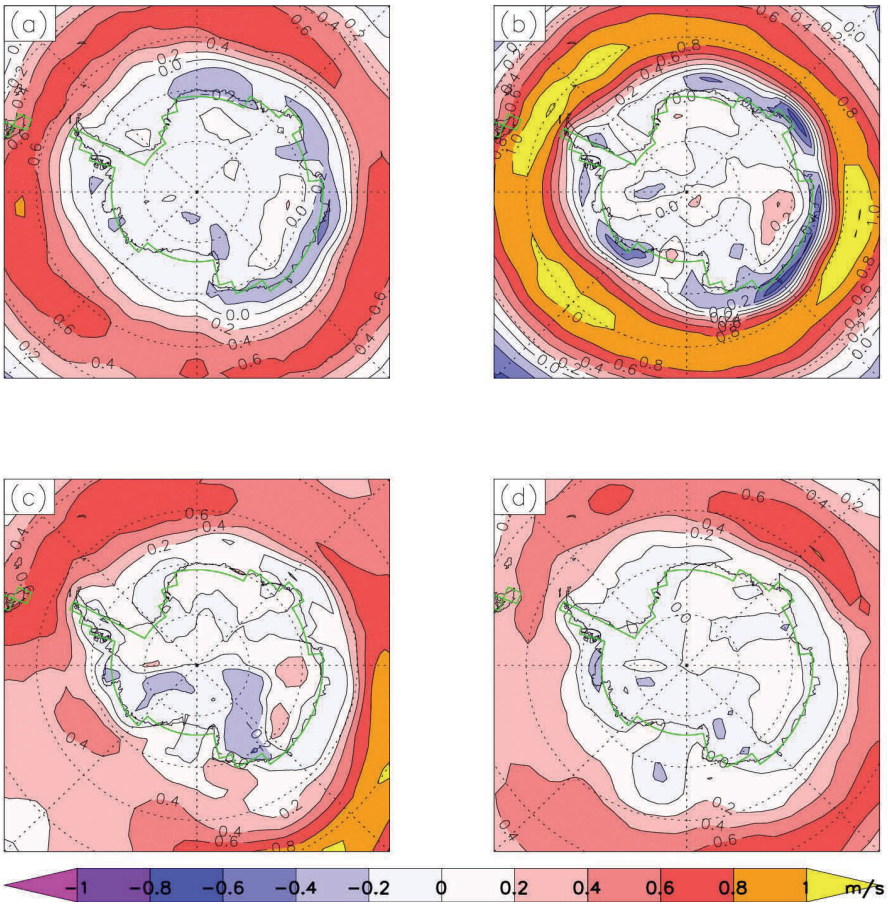
If you are interested in further details contact:-

Siobhan.OFarrell@csiro.au

Antarctic Climate Change over the 21st Century

A new assessment of Antarctic climate change over the 21st century has been conducted, based on data from the models that were developed as part of the Intergovernmental Panel on Climate Change (IPCC) 4th Assessment Report (AR4). To provide more reliable estimates of future change, a weighting scheme was applied to the model output, which depends on a measure of their ability to reproduce the mean climate of the late 20th century. When compared to current conditions, weighted projections of the annual mean circumpolar westerlies around Antarctica (60S) show an increase of 19% by the end of the 21st century (with an inter-model standard deviation of 9%). There is a large seasonal variation of these increases, with the largest increases of 30% in autumn. This seasonal variation was found to be consistent with projected changes in the semi-annual oscillation (SAO). In summer and autumn, the increases of the westerly wind component migrate sufficiently far south to be manifested as a reduction of the coastal easterlies. The surface warming averaged over the continent is projected to be 0.34 ± 0.10°C dec^{-1}. More rapid warming occurs during the winter over regions of sea ice retreat, e.g. 0.51 ± 0.26°C dec^{-1} around East Antarctica. Projections of total sea-ice area show a decrease of 2.6 ± 0.73 x 10^6 km^2 (33%). There is a projected increase of net precipitation averaged over the continent of 2.9 ± 1.2 mm yr^{-1} dec^{-1}, which will offset sea level rise by 1.04 ± 0.43 mm yr^{-1} by the year 2100. The weighting gives a larger increase of the autumn SAO peak, up to 30% larger for April. This is consistent with larger weighted autumn increases of circumpolar westerlies, more sea ice reduction and resulting larger skin temperature increases.

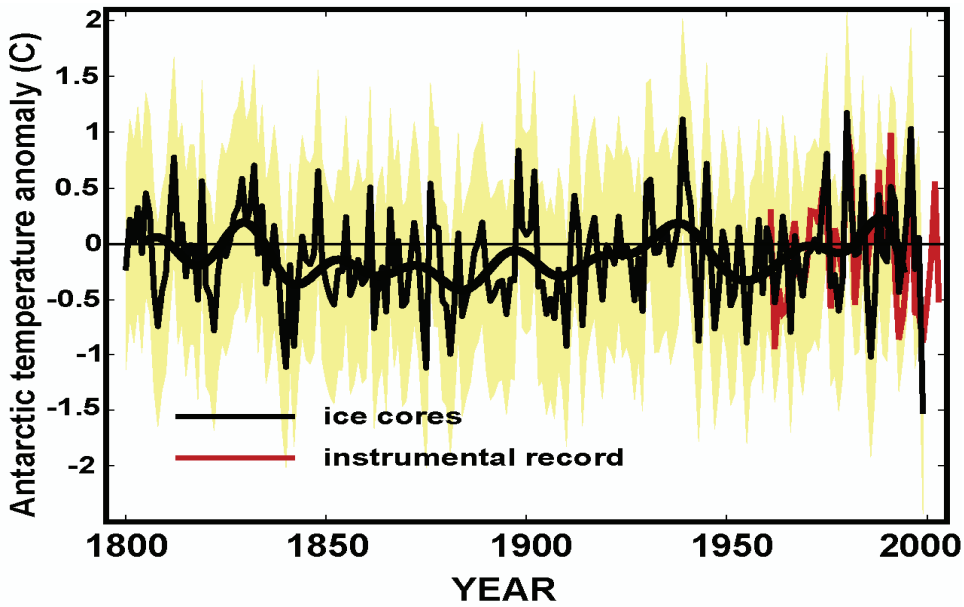
- Tom Bracegirdle, BAS



21st century change of near-surface (10m) monthly-mean wind vector magnitude for (a) DJF, (b) MAM, (c) JJA and (d) SON. Difference between 2080-2099 mean and 2004-2023 mean. From Bracegirdle et al., *Journal of Geophysical Research*, submitted, 2007.

Antarctic temperatures over the past two centuries from ice cores

A new Antarctic temperature reconstruction showed that over the continent as a whole (excluding the Peninsula), near-surface temperatures have warmed slightly since the mid-1800s (0.2°C), yet have remained largely within the range of variability in the context of the past 200 years. The reconstruction was based on water stable isotopes measurements ($\delta^{18}O$ and δD) from high-resolution, precisely-dated ice cores. The cores were from the SCAR ITASE program, the Australian Law Dome project, the German projects in Dronning Maud Land and an older Ohio State drilling at Siple Station.



Reconstructed mean annual temperature anomalies of the Antarctic continent

The temporal variability of Antarctic climate is not well known, as continuous meteorological observations in the Antarctic began only in the late 1950s. The new reconstruction is one of the first quantitative estimates of Antarctic temperatures to extend prior to the instrumental era. As such, it provides important context for trends that have recently been observed, such as cooling over the Antarctic continent and warming in the Antarctic Peninsula region. This behavior may not be entirely unusual, as both observed and reconstructed temperatures indicate large interannual to decadal-scale variability, with temperature anomalies on the continent out of phase with anomalies in the Antarctic Peninsula region.

Fluctuations in the strength of the southern polar vortex, as indicated by the Southern Annular Mode index, drive this large-scale pattern of temperature anomalies. However, on multidecadal to centennial timescales, temperatures on the Antarctic continent have paralleled changes in the Southern Hemisphere as a whole. This in-phase relationship suggests that given the projected increases in Southern Hemisphere mean temperatures over the coming century, Antarctic temperatures will also rise. The large interannual to decadal scale variability of Antarctic near-surface temperatures implies that the rate of change will be difficult to predict.

For more information, see Schneider D. P., E. J. Steig, T. D. van Ommen, D.A. Dixon, P. A. Mayewski, J. M. Jones, C. M. Bitz Antarctic temperatures over the past two centuries from ice cores, Geophys. Res. Lett., 33, 2006.

- David Schneider, NCAR

A note on Notus ...

Notus is the God of the South Wind, which brings with it fog and rain. He is the son of Eos and Astraeus (or of Aeolus, according to others), and brother to Zephyrus, Boreas and Eurus.

Being the wind of fog and mists, Notus was dangerous to shepherds on the mountain-tops or to mariners at sea, for he hindered visibility. For the same reason, the South Wind was a friend of thieves, enabling them to do their dastardly work unseen.

- contributed by Tony Worby

Your Contacts: the AGCS Committee

- Shigeru Aoki, Low Temperature Institute, Hokkaido University, Japan (shigeru@lowtem.hokudai.ac.jp)
- Nancy Bertler, Victoria University of Wellington, New Zealand (nancy.bertler@vuw.ac.nz)
- David Bromwich, Byrd Polar Research Center, Ohio State University, USA (Leader of Theme 1) (bromwich.1@osu.edu)
- Helen Campbell, British Antarctic Survey, UK (hcamp@bas.ac.uk) (JCADM representative)
- Gino Casassa, Centro de Estudios Cientificos, Chile (GC@cecs.cl)
- Paul Mayewski, Climate Change Institute, University of Maine, USA (Leader of Theme 2) (paul.mayewski@maine.edu)
- Mike Meredith, British Antarctic Survey, UK (Leader of Theme 4 and Editor of Newsletter) (M.Meredith@bas.ac.uk)
- Alberto Naveira Garabato, National Oceanography Centre, UK (acng@noc.soton.ac.uk)
- John Turner, British Antarctic Survey, UK (Chair of AGCS and Leader of Theme 3) (j.turner@bas.ac.uk)
- Tony Worby, University of Tasmania, Australia (a.worby@utas.edu.au) (ASPeCt representative)
- Cunde Xiao, Chinese Meteorological Administration, Beijing (cdxiao@cams.cma.gov.cn)

Dates for your diary

- Open Science Conference on Polar Dynamics - monitoring; understanding and prediction. 29 - 31 August 2007, Bergen, Norway. A meeting to commemorate the 90-year anniversaries of the Geophysical Institute, University of Bergen, Norway and the Norwegian Geophysical Society. For further details please go to http://web.gfi.uib.no/conference2007/
- 2nd Asia CliC Symposium, 22 - 26 October 2007, China. Further information is available at: http://www.casnw.net/clic/Asia_clic.html.
- 2008 Ocean Sciences Meeting, co-sponsored by AGU, ASLO and TOS. 2-7 March 2008, Orlando, Florida, USA. info@tos.org
- 5-7 July 2008, St Petersburg, Russia: XXX SCAR Science Week with business meetings and workshops of SCAR's Standing Scientific Groups.
- 8-11 July 2008, St Petersburg, Russia: Joint SCAR-IASC Open Science Conference (4-days). The theme is Polar Research - Arctic and Antarctic Perspectives in the International Polar Year.
- 2nd Symposium on the Ocean in a High CO_2 World. 6 - 8 October 2008, Monaco. Please contact m.hood@unesco.org for further details.