Antarctic Sciences GPRA Highlights, FY 2006

Understanding a Changing Ice Sheet a Joint US-UK Airborne Geophysical Survey

Nugget ID: 11354

During the 2004-2005 austral summer U.S. scientists from the University of Texas at Austin teamed up with researchers from the British Antarctic Survey and conducted an extensive survey of the Pine Island and Thwaites Glacier drainage basins as part of the Amundsen Sea Embayment Program in West Antarctica. Recent studies have shown that although this part of the ice sheet has one of the highest rates of snow accumulation in Antarctica, the ice in the embayment is melting, thinning and retreating rapidly, contributing to global sea level rise.

Using two twin otter aircraft the teams collected over 65,000 line-kilometers of multi-instrumented aerogeophysical data covering both the Thwaites and Pine Island Glacier catchments. Results of the surveys are providing a wealth of new information for glaciologists to use in their attempt to determine to what extent this portion of the West Antarctic ice sheet is at risk of collapse.

Initial interpretations suggest that the Thwaites Glacier is more likely than its neighbor, the Pine Island Glacier, to contribute to a massive release of ice from the West Antarctic ice sheet because it is more directly connected to the vast Bentley Subglacial Basin and the rest of the ice sheet. Extensive data sets will be made available to the entire community soon so that work can progress on this very important topic.

For more information see: www.ig.utexas.edu/research/projects/agasea/

This work is notable because:
This is the first time in many years that an international team of scientists have worked together on an aerogeophysical survey to address a problem of worldwide societal relevance and coordinated logistics to gather the data.

Primary Goal Indicator: Collaborations
Secondary Goal Indicators: Data collection/analysis
Other Indicators:

OI-3: This work involves multidisciplinary research.
This work is very multidisciplinary as it in-volves a combination of glaciology, geophysics, technology and numerical modeling.

OPP/ANT 2006

Program Officer: Julie Palais

NSF Award Numbers:
0230197
Award Title: Airborne Geophysical Survey of the Amundsen Sea Embayment, Antarctica (AGASEA)
PI Name: John Holt
Institution Name: University of Texas at Austin
PE Code: 5116

Submitted on 10/19/2005by Julie M. Palais
ANT: Approved 02/04/2006 by Kimiko S. Bowens-Knox
OPP: Approved for OPP on 02/04/2006 by Kimiko S. Bowens-Knox

Antarctic Temperature Changes, 1958-2002

Nugget ID: 12271

This project is the first to make a realistic estimate of antarctic climate change through a quantitative trend assessment of observed surface temperatures in Antarctica since the International Geophysical Year in 1957. While antarctic temperature changes have potentially major consequences for the global system, the large area and the highly heterogeneous network of surface stations in Antarctica had previously limited quantitative studies and had led to a mix of results reported to the public.

Utilizing temperature time series from 21 antarctic manned observing sites and 73 automated weather stations (AWS) for which the record exceeded two years, together with cooperative ship reports from the surrounding oceans, the investigators produced an Antarctic temperature trend assessment that makes optimum use of the available information, and is technically justified by demonstrable statistical properties of the data.

The most prominent feature in the linear trends of annual surface air temperature for 1958-2002 is the significant warming over the Antarctic Peninsula. Other characteristics are the slight warming in coastal Antarctica, and actual cooling over regions of central Antarctica and parts of the Southern Ocean. The Antarctic Peninsula warming is strongest in autumn and winter, but is apparent in all seasons. Results of the research are available at http://igloo.atmos.uiuc.edu/ANTARCTIC/

This work is notable because:
It is the first time that advanced statistical techniques have been applied to observed surface temperature measurements from the International Geophysical Year to the present.

Primary Goal Indicator: Contributions (AC/GPA selected)

Secondary Goal Indicators:
Other Indicators:

OI-2: This work involves transformative research.
This research provides, for the first time, a rigorous observational framework for validating climate model results.

OPP/ANT 2006

Program Officer: Bernhard Lettau

NSF Award Numbers:
0229430
Award Title: Synthesis of Antarctic Temperature Observations and Model Output
PI Name: John Walsh
Institution Name: University of Illinois at Urbana-Champaign
PE Code: 5113

Submitted on 02/27/2006by Bernhard Lettau
ANT: Approved 03/03/2006 by Kimiko S. Bowens-Knox
OPP: Approved for OPP on 03/03/2006 by Kimiko S. Bowens-Knox

Arcminute Cosmology Bolometer Array Receiver (ACBAR) at the U.S. Amunsen-Scott South Pole Station signifciantly improved accuracy of the Cosmic Microwave Background (CMB) observations

Nugget ID: 11944

The Arcminute Cosmology Bolometer Array Receiver (ACBAR) is a 16 element 230 microKelvin bolometer array designed to image the sky in three-millimeter wavelength radio bands with approximately 4' resolution. Observing from the South Pole on the 2.1-meter VIPER telescope, ACBAR has sensitivity that rivals high-altitude balloon and Earth's satellite experiments coupled with angular resolution that the current generation of experiments, including the proposed Planck spacecraft, cannot achieve. This unique combination of resolution and sensitivity allows ACBAR to play a key role in testing and refining the current cosmological model.

One of the primary goals of the ACBAR project is to produce a high angular resolution measurement of the Cosmic Microwave Background (CMB) power spectrum. The attached figure shows the high-l (multipole) portion of the latest ACBAR CMB power spectrum compared with the first ACBAR release and the current best observations from the Cosmic Background Imager experiment. The errors on this new power spectrum are more than a factor of two smaller, and have higher resolution in multipole space, than the first release. These results, which will be submitted for publication in the next few weeks, will allow the cosmology community to place exciting new constraints on the dark matter density and spectral index of the initial matter fluctuations.

The 2004-2005 austral winter seasons were remarkably successful in expanding both the sky coverage and depth of the ACBAR observations. The new data should improve significantly constraints on the CMB power spectrum by an additional factor three over the current release. An accurate calibration is essential to realizing the full potential of this powerful new data set. The large sky coverage allows a direct comparison with maps produced by the high-altitude balloon BOOMERanG and NASA's WMAP spacecraft experiments. The complete analysis of the full data set should result in a relative calibration between the experiments of less than one percent.

This work is notable because:
This research is notable because it extends the limits of the CMB power spectrum to higher multipoles. While a number of experiments address the lower end of the spectrum, only two experiments focus to higher angular resolution measurements. The new data improve significantly constraints on the CMB power spectrum models.

Primary Goal Indicator: Contributions

Secondary Goal Indicators: Identifying new opportunities

Other Indicators:

No other indicators apply.

OPP/ANT 2006

Program Officer: Vladimir Papitashvili

NSF Award Numbers:
0232009
Award Title: High Resolution Observations of the Cosmic Microwave Background (CMB) with Arcminute Cosmology Bolometer Array Receiver (ACBAR)
PI Name: William Holzapfel

Institution Name: University of California-Berkeley
PE Code: 5115

Submitted on 02/17/2006by Vladimir Papitashvili
ANT: Approved 03/03/2006 by Kimiko S. Bowens-Knox
OPP: Approved for OPP on 03/03/2006 by Kimiko S. Bowens-Knox

Collapsing ice shelves and new life

Nugget ID: 11356

Eugene Domack of Hamilton College and colleagues conducted a marine survey of the seabed exposed by the 2002 collapse of the Larson Ice Shelf, Antarctica. Apart from increasing our understanding of how ice shelves collapse, important for understanding the sea level change associated with global warming, the team also discovered a whole new type of ecosystem. Apparently, clams, bacterial mats, and other marine life existed beneath the ice shelf. The thick ice above would have prevented sunlight from reaching the area, so rather than photosynthesis, this system's primary food producers are chemotrophs, possibly existing on methane seeps. This is the first time such a ecologic system has been observed in a cold region. Other chemotrophic systems are generally associated with hot areas such as volcanism on the sea floor. The results of this cruise were covered in various ways, from the covers of Nature (4-August-2005) and EOS (19-July-2005) to some popular articles, and even radio, including international programs (http://www.abc.net.au/am/content/2005/s1431011.htm).

This work is notable because:
This research has many strengths, but it is also easily communicable to the public because of the exciting discovery involving life.

Primary Goal Indicator: Data collection/analysis

Secondary Goal Indicators: Global S&E workforce, Collaborations, Next generation facilities and platforms

Other Indicators:

OI-2: This work involves transformative research.
This was truly exploratory research--we didn't know what we would find beneath the ice shelf.

OI-3: This work involves multidisciplinary research.
This research involves a range of scientists, from biologists to glaciologists.

OPP/ANT 2006

Program Officer: Thomas Wagner

NSF Award Numbers:
0338142
Award Title: Collaborative Research: Paleohistory of the Larsen Ice Shelf System: Phase II
PI Name: Eugene Domack
Institution Name: Hamilton College
PE Code: 5112

Submitted on 10/20/2005by Thomas P. Wagner
ANT: Approved 02/04/2006 by Kimiko S. Bowens-Knox
OPP: Approved for OPP on 02/04/2006 by Kimiko S. Bowens-Knox

Heating of the solar chromosphere by low-frequency magneto-acoustic waves

Nugget ID: 11946

It has long been known that the temperature of the Sun's chromosphere (~30,000 K) is significantly higher than that of its visible surface (~6,000 K). The main theories that have been put forward to explain this enigma, that has baffled scientists for over seventy years, are heating by upward propagating acoustic and/or magnetic waves, magnetic dissipation associated with magnetic reconnection, and resistive dissipation of electric currents. However, recent results suggest that the heating provided by (high-frequency) acoustic waves, magnetic reconnection, and electric currents, is too meager to heat the solar chromosphere and has prompted speculation that magnetic waves must play the dominant role. Using measurements of the Sun's velocity field at two heights in its atmosphere, obtained in January 2003 from the geographic South Pole, we demonstrated that low-frequency (less than 5 mHz) propagating magneto-acoustic waves with an energy flux of at least 1.6 kW per sq. m at the base of the Sun's chromosphere, provide a significant source of energy for balancing the radiative losses of the ambient solar chromosphere (~4.3 kW per sq. m.).

These waves, which are normally thought to be evanescent in the solar atmosphere (and therefore show no phase delay between different heights), are in fact able to propagate through "acoustic portals" that exist in areas of strong, significantly inclined (more than 30 degrees with respect to the vertical), magnetic field. Such conditions are found in active regions, at the boundaries of convection cells (e.g., supergranules) and at the locations within the convective cell interiors where new magnetic flux emerges from beneath the solar surface. This implies that acoustic portals are omnipresent over the solar surface and throughout the magnetic activity cycle, an essential prerequisite for any baseline heating mechanism for the solar atmosphere. In addition, the leakage of low-frequency acoustic waves on inclined magnetic field lines has recently been associated with the formation of chromospheric spicules. As spicules are usually found close to supergranular lanes in regions of quiet Sun, it is likely that acoustic portals explain the observations of oscillatory motions in chromospheric spicules. Acoustic portals may also explain other oscillatory phenomena in the solar atmosphere, including the presence of low-frequency waves in network bright points and polar plumes, and five-minute oscillations in the corona above active regions.

This work is notable because:
This work is notable because it identifies where the energy required to heat the Sun's outer atmosphere comes from (a long standing puzzle in solar physics), and the novel means by which it can travel through thousands of kilometers of gas. As the Sun is a typical main-sequence star, the result also provides a very straightforward explanation of non-thermal emission from stellar atmospheres in general.

Primary Goal Indicator: Contributions

Secondary Goal Indicators: Collaborations

Other Indicators:

No other indicators apply.

OPP/ANT 2006

Program Officer: Vladimir Papitashvili

NSF Award Numbers:
0338251
Award Title: Tomographic Imaging of the Velocity and Magnetic Fields in the Sun's Atmosphere
PI Name: Stuart Jefferies
Institution Name: University of New Mexico
PE Code: 5115

Submitted on 02/10/2006by Vladimir Papitashvili
ANT: Approved 02/17/2006 by Kimiko S. Bowens-Knox
OPP: Approved for OPP on 02/17/2006 by Kimiko S. Bowens-Knox

ITASE (International Trans Antarctic Scientific Expedition)

Nugget ID: 11564

ITASE (International Trans Antarctic Scientific Expedition) A Basis for Understanding Past, Present, and Future Climate Change Over Antarctica and Adjacent Southern Ocean The International Trans Antarctic Scientific Expedition (ITASE) is a 20-nation oversnow traverse consortium that is developing a continent-wide array of annually resolved, instrumentally calibrated records of past climate (temperature, net mass balance, atmospheric circulation, chemistry of the atmosphere, and forcing) covering the last 200-1000 years (Fig 1, 2). The initial phase of US ITASE concentrated on West Antarctica. During the 06-08 austral field seasons US ITASE will extend its traverses into East Antarctica (Fig 1). Key results from the West Antarctic phase of US ITASE are as follows. Temperatures are still within the range of natural variability of the last 200 years, exclusive of the Antarctic Peninsula, and are closely associated with changes in major atmospheric circulation patterns. Mass balance variability is primarily controlled by surface/bed topography with significant variability in regions displaying large gradients in topography. Initial phases of the inland migration of marine air masses can be detected along the Amundsen Sea coast. A significant portion of the natural variability in the strength of the westerlies surrounding Antarctica is attributed to decadal and longer scales of solar variability that impact production of ozone and as a consequence the thermal gradient over Antarctica and the Southern Ocean.

This work is notable because:
The combination of disciplines represented by US ITASE provides a unique, logistically efficient, multi-dimensional view of the atmosphere, the ice sheet and their histories. Data collected by US ITASE and its international partners is available to a broad scientific community and will contribute to many of the goals of the upcoming International Polar Year (IPY). US ITASE has an extensive program of public outreach and provides significant opportunities for many students to experience multidisciplinary Antarctic research.

Primary Goal Indicator: Collaborations (AC/GPA selected)

Secondary Goal Indicators: Public understanding of science, Connections, Data collection/analysis

Other Indicators:

OI-3: This work involves multidisciplinary research.
US ITASE is the terrestrial equivalent of a polar research vessel. It offers the ground-based opportunities of traditional style over-snow travel coupled with the modern technology of GPS navigation, crevasse detecting radar, satellite communications, and multi-disciplinary research.

Program Officer: Julie Palais

NSF Award Numbers:
0440679
Award Title: A Science Management Office for the United States Component of the International Trans Antarctic Expedition (US ITASE SMO) - A Collaborative Program of Research from Taylor Dome to
PI Name: Paul Mayewski
Institution Name: University of Maine
PE Code: 5116

Submitted on 01/10/2006by Julie M. Palais
ANT: Approved 02/17/2006 by Kimiko S. Bowens-Knox
OPP: Approved for OPP on 02/17/2006 by Kimiko S. Bowens-Knox

Ocean Turbulence under the Antarctic Sea Ice

Nugget ID: 12299

The Maud Rise Nonlinear Equation of State Study (MaudNESS) was an oceanographic study of the thermodynamic basis for the formation of the Weddell Polynya, a 300,000 square kilometer area of open ocean within the winter sea ice of the Weddell Sea that was observed by satellites from approximately 1975 to 1979. The polynya has not recurred since, although indications of much smaller and less persistent areas of open water do occur in the vicinity of the Maud Rise seamount. The answer to the question how can warm deep water be brought to the surface in winter to melt an existing oceanic ice cover, was hypothesized to lie in the unique topography of the seamount, and the dependence of sea water density on both temperature and salinity.

In much of the Southern Ocean, a shallow layer of very cold low-salinity surface water overlies warmer but more saline deep water with nearly the same density. However any water of intermediate temperature and salinity formed by mixing of the two, has a greater density than either precursor and will sink. This small-scale process has the potential to erode the cold surface layer, bring the warmer water in contact with the ice and melt it.

The project brought together oceanographers, meteorologists, sea ice experts, and modelers from the University of Washington, the Naval Postgraduate School, New York University, Earth and Space Research, and McPhee Research Company. The observations were made on a sixty-day cruise of the RVIB Nathaniel B. Palmer between July and September, 2005, and are currently being analyzed.

This work is notable because:
It was an integrated observing and modeling study to gain an understanding of a major antarctic oceanographic feature.

Primary Goal Indicator: Contributions

Secondary Goal Indicators: Collaborations

Other Indicators:

OI-3: This work involves multidisciplinary research.
It brought together modelers and observational experts in the areas of oceanography, meteorology and sea ice.

OPP/ANT 2006

Program Officer: Bernhard Lettau

NSF Award Numbers:
0337159
Award Title: Collaborative Research: The Maud Rise Nonlinear Equation of State Study (MaudNESS)
PI Name: Miles McPhee
Institution Name: McPhee Research Company
PE Code: 5113

Submitted on 02/24/2006by Bernhard Lettau
ANT: Approved 02/25/2006 by Kimiko S. Bowens-Knox
OPP: Approved for OPP on 02/25/2006 by Kimiko S. Bowens-Knox