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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

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Final Report for Period: 09/2008 - 08/2009

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Organization: University of Maine

Submitted By:

Mayewski, Paul - Principal Investigator

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

Project Participants

Senior Personnel

Name: Mayewski, Paul

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Hamilton, Gordon

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Kurbatov, Andrei

Worked for more than 160 Hours: Yes

Contribution to Project:

Computer software generation.

Post-doc

Graduate Student

Name: Dixon, Dan

Worked for more than 160 Hours: Yes

Contribution to Project:

Undergraduate Student

Name: Obatolu, Mary

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Nurse, Caroline

Worked for more than 160 Hours: Yes

Contribution to Project:

Caroline assists with website management and general office duties for the Science Management Office.

Technician, Programmer

Name: Zielinski, Ann

Worked for more than 160 Hours: Yes

Contribution to Project:

Other Participant**Research Experience for Undergraduates****Organizational Partners**

University of Washington

Saint Olaf College

U.S. Army Cold Regions Research and Engineering Laboratory

Other Collaborators or Contacts

Arcone, Steven USA CRREL High Resolution Radar Profiling of the Snow and Ice Stratigraphy Beneath the ITASE traverses.

Meese, Debra, Univ. Maine, The Physical Properties of the US ITASE Ice Cores.

Steig, Eric, Univ. of Washington, Stable Isotope Studies.

Jacobel, Robert, Welch, Brian, Saint Olaf College, Radar Studies of Internal Stratigraphy and Bedrock Topography along the US ITASE Traverse

Activities and Findings**Research and Education Activities: (See PDF version submitted by PI at the end of the report)**

The Science Management office hosted a planning meeting at last fall's WAIS conference. Many PIs were in attendance along with representatives from Raytheon and NSF. As a result of this meeting, coordination of the 06 - 07 field season has gone quite smoothly.

Dan Dixon has continued to analyse the cores collected during the LGT as well as those from previous traverses.

A major overhaul of the US ITASE web site is underway to provide a logical inclusion of US ITASE phase 2.

Science Management is preparing for the SCAR XXIX/COMNAP XVIII 2006 conference in Hobart, Tasmania in July.

Year 2: With a slow start to the field season, we did not go as far as planned, but still managed a significant amount of science. We collected 460 meters of cores, 500 km of radar profiles were recorded, including the entire traverse route and multiple local along-flow profiles near the ice core sites. Ice thickness ranged from a few meters near Mt. Crean at Taylor Dome to nearly 3 km in the Byrd Glacier basin. Shallow stratigraphy was recorded to within 50 m of the ice surface allowing comparisons with Steve Arcone's 400 MHz data, optimal positioning of the ice core sites, and analysis of near-surface voids.

GPS, Shallow and Crevasse Radar Sounding (Steve Arcone, CRREL, Gordon Hamilton, U. Maine). 580 km continuous.

Mass Balance (Gordon Hamilton, U. Maine). GPS sites placed at 06-01, 06-02, 06-03.

High Resolution Density (Dan Breton, U. Maine). A prototype of the Maine Automated Density Gauge Experiment (MADGE) was successfully field tested this year. The instrument provides high resolution, high accuracy and non-destructive density measurements on 2 and 3 σ ice cores using a small gamma-ray source, a fast nuclear counting system and an electronic caliper system for measuring core diameters. MADGE processed all 75m of 2 σ core drilled this season, providing density measurements with a ± 0.003 g/cm³ uncertainty every 3.3 mm along each

core. The density gauge data matches well with manual density measurements from snow pits and measurements on nearby 3 cores. Shallow GPR data collected at the drill sites will be matched with the MADGE density data in an effort to better understand the nature of the radar reflectors and stratigraphy observed along ITASE traverse routes.

35-GHz radar (Lora Koenig, U. Washington). Firn properties were investigated in the upper 2 meters of firn using very high frequency radar penetration depths. Known reflectors were placed in the firn and a 35-GHz FMCW radar was used to quantify how energy is lost as a function of depth in the firn and as a function of firn structure. This data will be used to further investigation of space-borne passive microwave models of temperature and accumulation.

Year 3: US ITASE Phase Two traveled from Taylor Dome to South Pole. During the 2007-2008 season US ITASE traveled 1200 km from the 2006-2007 winter-over site (06-4) to South Pole.

Activity Detail 2007 -2008:

Crevasse radar: Conducted in parallel with all travel.

Shallow radar: Firn stratigraphy in the upper ~100 m of the ice sheet was imaged using a 200 MHz Ground Penetrating Radar (GPR) system. The system operated continuously along the entire traverse route, and several local profiles were collected at each ice core site.

Deep radar: The 3 MHz (deep) radar collected data along all but 15 km of the traverse route, plus local profiles at each of the ice core sites for a total of more than 1300 km of data. Ice thickness ranged from 1500 to 3100 m and internal stratigraphy was detected to depths up to 2750 m. At least one subglacial lake was found along the traverse route just north of Titan Dome.

Ice coring: Ice coring was conducted using both the 2ö Rongbuk and the 3ö Eclipse drill. The Rongbuk drill was used for recovery of shallow cores (<25m) dedicated to studies described below under surface glaciology. The Eclipse drill was used to recover cores up to 100m depth at four sites (Fig. 4). At all sites the cores represent at least 200 years and more probably several hundred to >1000 years of record at some sites. Stratigraphy was conducted on all ice cores recovered this season.

Surface snow sampling: Surface snow sampling was conducted at 30 km intervals along the 2007-2008 traverse route and every 10k between site 07-4 and South Pole (Fig. 6). This sampling consists of IC/isotope and ICPMS sample collection at the surface, 0-5cm and 0-15m. This data is part of a continent wide ITASE surface sampling scheme that has already demonstrated the spatial distribution of major ions and stable isotopes over Antarctica.

US ITASE 1999-2008 Summary

Since 1999 US ITASE has traversed >8000 km throughout West and East Antarctica (Fig. 7) and collected a total of 3945m of ice core. Together with six shallow cores collected as part of LGT, US ITASE has conducted scientific investigations (ice coring, surface glaciology, radar) at 45 sites and radar (crevasse, shallow, and deep) along almost all of the US ITASE routes. US ITASE has therefore sampled the ice climate record surrounding the Ross Ice Shelf and hundreds of km inland. US ITASE has now completed six field seasons of multi-disciplinary research setting a new benchmark for Antarctic climate multi-disciplinary research.

Findings:

Through the collaborative research efforts of US ITASE and associated endeavors a significant sampling of ice cores throughout the Ross Sea Embayment and adjacent regions has been achieved. The sampling includes >60 annually resolved ice cores and a subset of 12-15 longer annually or multi-annually resolved ice core records covering the past ~1000 years. The purpose of this effort has been and is to reconstruct the physical and chemical climate record for the last 200+ to in some cases 1000 years. The last 200 years include the transition from pre-industrial to industrial era and the past 1000 years include the öMedieval Warm Periodö and öLittle Ice Ageö (generalized terms for the last two notable examples of naturally occurring warm and cold climates, respectively). US ITASE has significantly raised the bar on the use of multiple ice core records to investigate local to regional scale climate variability. Antarctic climate change has in the past and will in the future impact the Southern Hemisphere and the planet as a whole. US ITASE provides the baseline information necessary to assess recent climate change and to understand future change. This project represents a major step forward in the use of ice core climate reconstructions for understanding past, present, and future climate.

Training and Development:

Daniel Dixon, PhD candidate at UMaine, taught a portion of a course (spring 06) on the use of MatLab programs developed through a previous US ITASE grant.

UM graduate students who participated in the 07 traverse to Pole (Dan Dixon, Elena Korotkikh, Nicky Spaulding, Sharon Sneed) have all been involved in research programs associated with samples and data from the traverse.

Dan Dixon will complete his PhD in 2009. Both Nicky Spaulding and Elena Korotkikh completed their MSc degrees in 2009 and are now in our PhD programs. Sharon Sneed will finish her PhD in 2010-2011.

Outreach Activities:

The US ITASE Science Management Office maintains an active outreach program. Daily journal entries covering all years of the US ITASE traverses are maintained on the following web site:

<http://www2.umaine.edu/USITASE>

We plan to continue this program with the upcoming field seasons.

There is also an extensive section for Teachers containing lesson plans and links.

The Boston Museum of Science maintains their web site:

<http://www.mos.org/soti/index.html>

with many activities and information and links with the US ITASE site for journal entries.

Faculty and graduate students visit local schools and conduct lectures and tours of our lab facilities for elementary through high school students.

UM graduate students who participated in the 07 traverse to Pole (Dan Dixon, Elena Korotkikh, Nicky Spaulding, Sharon Sneed) have all been involved in presentations to the public and school groups including Climate Change Institute Science Day activities which occur every year.

PI Mayewski has lectured extensively (20-30 per year) nationally and internationally on topics related to Antarctic climate change including appearances on several media venues (eg., CBS 60 Minutes).

Journal Publications

Bertler, N., Mayewski, P.A. et al. (too many author names to allow in this space), "Snow chemistry across Antarctica", *Annals of Glaciology*, p. 167, vol. 41, (2006). Published,

Mayewski, P.A., Frezzotti, M., Bertler, N., van Ommen, T., Hamilton, G.H., Jacka, J., Welch, B., Frey, M., Dahe, Q., Ren, J., Simoes, J., Fily, M., Oerter, H., Nishio, F., Isaksson, E., Mulvaney, R., Holmund, P., Lipenkov, V. and Goodwin, I, "The International Trans-Antarctic Scientific Expedition (ITASE) An Overview", *Annals of Glaciology*, p. 180, vol. 41, (2006). Published,

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Mikesell, T.D., van Wijk, K., Kurbatov, A. and Mayewski, P.A, "Ice core tomography with laser ultrasonics", *Jour. Glaciology*, p. , vol. , (). Submitted,

AGCS (P.A. Mayewski, M. Meredith, C. Summerhayes, J. Turner, S. Aoki, Barrett, P. N.A.N. Bertler, T. Bracegirdle, D. Bromwich, H. Campbell, G. Casassa, A. N. Garabato, W.B. Lyons, K.A. Maasch, A. Worby, C. Xiao), "State of the Antarctic and Southern Ocean Climate System (SASOCS).", *Reviews of Geophysics*, p. , vol. 47, (2009). Published, 10.1029/2007RG000231

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Books or Other One-time Publications

Daniel Dixon, Massimo Frezzotti, Elisabeth Isaksson, Thamban Meloth, "ITASE Synthesis Workshop (2-8 September 2008) Report", (2008).

Workshop Report, Published
Bibliography: SCAR and PAGES Newsletters

Web/Internet Site

URL(s):

<http://www2.umaine.edu/USITASE>
<http://www.icereader.org/icereader/>
<http://nsidc.org/data/nsidc-0273.html>
<http://nsidc.org/data/nsidc-0264.html>

Description:

Description:

<http://www2.umaine.edu/USITASE>

The US ITASE site is maintained by the Climate Change Institute, University of Maine, as the official science web site. Science and Implementation Plans, links to researchers, abstracts of projects, field reports, and draft proposals are all available here. Daily logs and photos from the team for the 6 years they were in the field are archived here for use by schools and the general public. An extensive Teacher's Resource section including activities and lesson plans is here as well.

<http://www.icereader.org/icereader/IceREADER> contains metadata and data thus far available from ITASE and other Antarctic ice cores.

IceREADER was established by the Climate Change Institute, University of Maine, at the request of SCAR.

<http://nsidc.org/data/nsidc-0273.html> contains US International Trans-Antarctic Scientific Expedition (US ITASE) Glaciochemical Data.

<http://nsidc.org/data/nsidc-0264.html> contains US ITASE Ice Thickness and Internal Layer Depth Along the 2001 and 2002 US ITASE Traverses

All data are listed here:

ftp://sidads.colorado.edu/pub/DATASETS/AGDC/dixon_nsidc_0273/

Other Specific Products

Product Type:

Software (or netware)

Product Description:

The ice core dating software is a program designed to create a depth-age scale from ice core glaciochemical records. It reads data from comma separated files that contain depth vs. concentration of elements information. The user selects the elements he wants to plot, and then dynamically perform the dating process on the charts drawn. The User generates a report at the end of the process that contains depth-age information

Sharing Information:

The software is shared free of charge through the Climate Change Institute website at:

<http://www.climatechange.umaine.edu/Research/software/index.html>

Contributions

Contributions within Discipline:

US ITASE is providing significant input in the form of ice core records and radar to the science goals of IPICS, SCAR, and IPY.

US ITASE and ITASE

Since 1999 US ITASE has traversed >8000 km throughout West and East Antarctica and collected a total of 3945m of ice core. Together with six shallow cores collected in conjunction with LGT, US ITASE has conducted scientific investigations (ice coring, surface glaciology, radar)

at 45 sites and radar (crevasse, shallow, and deep) along almost the entire >8000 km of the US ITASE routes. US ITASE has therefore sampled the ice climate record surrounding the Ross Ice Shelf and hundreds of km inland. US ITASE has now completed six field seasons of multi-disciplinary research setting a new benchmark for Antarctic climate multi-disciplinary research. This program has been extremely successful resulting in more cores than can reasonably be processed and analyzed within the scope of the funding cycle for this project. While there are still more US ITASE cores to be processed and analyzed a sufficient number have been completed to provide dramatic advances to our understanding of Antarctic climate change.

US ITASE is part of the ITASE multi-national effort to understand the past 200-1000 years of climate change over Antarctica and the Southern Ocean. ITASE is organized under the auspices of SCAR and now comprises twenty-one countries. Several of the countries that have recently joined SCAR ITASE such as India, Korea and Poland are still in the process of planning their ITASE activities. Several such as Italy, France, Germany, Sweden, Japan, China, Chile, Brazil, and the US are currently involved in IPY traverses for which results may not be available for another 1-3 years. An emerging compilation of all ITASE and other ice core sites is available through Ice READER (<http://www2.umaine.edu/itase/content/icereader/index.html>) and summaries of ITASE national products is available through (<http://www2.umaine.edu/itase/content/nationals/index.html>).

The international representatives from ITASE have met several times in the past to: discuss national traverse plans; coordinate efforts; synthesize results; develop statistical techniques for interpretation; and interact with the broader scientific community. These all-ITASE meetings started with a workshop that led to the development of an international Science and Implementation Plan for ITASE (Mayewski and Goodwin, 1997) followed by meetings in Durham, New Hampshire (March 1999), Potsdam, Germany (September 2002), Milan, Italy (August 2003), and most recently Hobart, Australia (2006). These meetings provide the primary opportunity for ITASE researchers to meet and exchange information. They typically range in duration from several days (Durham) to a few hours (most meetings).

Short Overview of ITASE Results

ITASE findings have been published in many peer-reviewed publications (eg., see summaries in Mayewski (2003, 2006) and Mayewski et al. (2006)). A few examples are listed below. All publications noted here that are solely by US ITASE researchers are in italics, those that are solely non US ITASE, ITASE are underlined, and all others are joint US ITASE and ITASE. There is a clear bias towards US ITASE publications in the following, because they are better known to this PI, but this does not mean that there are not many other non US ITASE contributions. ITASE meetings offer the opportunity to update and further synthesize all ITASE research products.

Examples of US ITASE and ITASE scientific contributions follow:

- ò Identification of seasonal timing, source contributions, controls on spatial distribution, and covariance association with moisture flux for all major ions (e.g. *Kaspari et al., 2005*, *Kaspari et al., 2004*, *Dixon et al., 2004*, *Pruett et al., 2004*, *Han et al., 2001*, *Isaksson et al., 2001*, *Curran et al., 2002*).
- ò Precise annual layer counting of ice cores resulting in estimates of past mass balance, identification of moisture source regions, and environmental interpretations (e.g. *Palmer et al., 2002*, *Kaspari et al., 2004*, *Kaspari et al., 2005*, *Dixon et al., 2004*, *Spikes et al., 2004*).
- ò Glaciochemical differentiation of annual layers demonstrating that shallow and deep radar reflectors are isochrones (e.g. *Spikes et al., 2004*, *Arcone et al., 2005*).
- ò Highly resolved temporal and spatial volcanic event records (e.g. *Palmer et al., 2002*; *Dixon et al., 2004*, *Kurbatov et al., 2006*).
- ò Identification of stratospheric versus tropospheric source volcanic emission input pathways to Antarctica and utilization of stratospheric source events as evidence of emission plume history over the ice sheet (e.g. *Palmer et al., 2002*; *Dixon et al., 2004*).
- ò Differentiation of the relative influence of sea salt spray and salt flowers on Na⁺ loading over Antarctica (e.g. *Kaspari et al., 2005*; plus several non ITASE publications).
- ò Instrumental record calibrated proxies using ice chemistry tracers from multiple ice cores for: strength of the zonal westerlies, Amundsen Sea Low, East Antarctic High, ENSO, ice surface wind drainage, and the Antarctic Oscillation (eg., *Meyerson et al., 2002*; *Bertler et al., 2004b*; *Kreutz et al., 2000*; *Souney et al., 2002*; *Goodwin et al. 2003, 2004*; *Proposito et al., 2004*; *Shulmeister et al., 2004*; *Becagli et al., 2004*; *Ekaykin et al., 2002*; *Xiao et al., in press*; *Kaspari et al., 2005*; *Yan et al., 2005*; *Mayewski et al., 2004, 2005*).
- ò Integration of ITASE spatial records and existing shallow with deep ice core records to significantly refine paleoclimate reconstructions and other global scale abrupt climate change correlations (eg., *Mayewski et al., 2004, 2005*; *Shulmeister et al., 2004*; *Mayewski and Maasch, 2006*).
- ò Proxies for sea ice, a critical component in the climate system, through studies of sulfur compounds such as sulfate and MSA (eg., *Curran et al., 2003*; *Dixon et al., 2005*).
- ò The ôSolar Polarö hypothesis for the initiation of annual to decadal scale climate variability over Antarctica and the Southern Ocean and potentially for global scale abrupt climate change events (eg., *Mayewski et al., 2005*, *Maasch et al., 2005*).
- ò Demonstration of the current state of the Antarctic climate system relative to the last few hundred years (*Mayewski and Maasch, 2006*).
- ò Testing meteorological reanalysis products (e.g. *Genthon et al., 2005*).
- ò Large-scale calibrations between satellite-deduced surface temperature and ITASE ice core proxies for temperature (eg., *Schneider and Steig, 2002*; *Schneider et al., 2005*).
- ò ENSO û sea ice connections utilizing ice core MSA and sulfate series over the Ross Sea embayment region (eg., *Meyerson et al., 2002*; *Becagli*

et al., SCAR abstract 2004).

- ò Partitioning of the sources of sulfate using sulfur isotopes as an aid to further refining air mass trajectory fingerprinting and the sulfur cycle over Antarctica (Pruett et al., 2004).
- ò Documentation of the impact of solar forcing (via UV induced changes in stratospheric ozone concentration) on zonal westerlies at the edge of the polar vortex (Mayewski et al., 2005; van Ommen and Morgan, SCAR abstract 2004; Bertler et al., 2006a).
- ò Distribution of snow precipitation over the Antarctic continent on varying spatial and temporal scales and dependence on wind and surface slope (eg., Frezzotti et al., 2002, 2004; Ekaykin et al., 2002; Richardson and Holmlund, 1999; Rotschky et al. 2004; Spikes et al., 2005).
- ò Contributions to the development of a global array of high resolution, multi-proxy records of Holocene climate (e.g. Mayewski et al., 2004, Maasch et al., 2005).
- ò Compilation of an Antarctic wide array of glaciochemical data (eg., Bertler et al., 2006b).
- ò Comparison between ITASE climate proxies and model results (eg., Steig et al., 2006; Genthon et al., 2005; Schneider et al., 2006; Monaghan et al., 2006).

ITASE Contributions to the Understanding of Antarctic Climate Change in the Broader Context of SCAR

The Antarctic and Southern Ocean instrumented climate record is particularly sparse. What we do know about pre-instrumental and even recent climate change has been significantly enhanced by ice core records and most assuredly very significantly bolstered by contributions from ITASE. Our current understanding of Antarctic and Southern Ocean climate change is summarized in a report initiated by Mayewski and developed with other members of the AGCS (Antarctica and the Global Climate System) SCAR group entitled: *State of the Antarctic and Southern Ocean Climate System (SASOCS)* and it includes significant contributions by ITASE. A summary of SASOCS was presented to the Antarctic Treaty Consultative Meeting (May 2007) by C. Summerhayes (Exec. Dir. SCAR) on behalf of SCAR and AGCS as follows (the full SASOCS document (SCAR AGCS) is in press in *Reviews of Geophysics*). Sections in italics benefited directly from ITASE research contributions.

- ò Antarctica and the Southern Ocean play a major role in the Earth's climate system. They are being and will continue to be affected by global climate change. Their responses to such change will have significant impact on global conditions, especially sea level.
- ò Modern climate in the region results from the interplay of the ice sheet - ocean - sea ice - atmosphere system and its response to past and present climate forcing.
- ò Superimposed on the long-term trend of post-glacial warming are millennial and finer scale oscillations whose causes are not well understood aside from some associations with the 11-year sunspot cycle.
- ò In the past 50 years unprecedented climatic changes cut across these trends. They include the near-surface atmospheric warming observed on the west of the Antarctic Peninsula, with associated rapid warming of the surface ocean, retreat of glaciers and the collapse of ice shelves around the Antarctic Peninsula.
- ò While ice is being lost from glaciers in the Peninsula and in West Antarctica, East Antarctica shows little change.
- ò Consistent with global warming, the Antarctic troposphere has warmed while the stratosphere has cooled. Part of the reason for stratospheric cooling is ozone depletion.
- ò Cooling of the stratosphere appears to have encouraged the development of polar stratospheric clouds, which may have exacerbated ozone depletion.
- ò The atmospheric pressure gradient between mid latitudes and Antarctica has steepened over the past 50 years, intensifying the westerlies over the Southern Ocean, and warming the Antarctic Peninsula; this change in pressure and wind has had no significant effect as yet on temperature in East Antarctica, which remains cool.
- ò The upper kilometer of the circumpolar Southern Ocean has warmed, as have the densest components of Antarctic Bottom Water in the Weddell Sea.
- ò The coastal ocean has freshened between the Ross Sea and the Southern Indian Ocean, making the Antarctic Bottom Water formed there less saline.
- ò Since the early 1970s sea ice has reduced west of the Antarctic Peninsula, and in the Weddell Sea. These decreases are balanced by an increase in the Ross Sea.
- ò Projections of Antarctic climate change over the 21st century with a doubling of CO₂ in the atmosphere indicate warming of the sea ice zone; a reduction in sea ice extent; and warming of the Antarctic interior, accompanied by increased snowfall.
- ò Climate models need further development to forecast change at the regional level.
- ò The retreat of the Antarctic ice sheet since the Last Glacial Maximum could be significantly accelerated by global warming. Ice sheet models are not yet adequate to answer pressing questions about the effect of warming on ice melt and sea level. This topic requires significant research.

ò Threshold effects may have a significant impact on the ice sheet and sea ice extent. During the last glacial and current interglacial, such effects resulted in massive reorganizations of the ocean-atmosphere-cryosphere system, leading to rapid climate change events. Comprehensive sampling and modeling of the ocean-ice-atmosphere system is needed to forecast such events with confidence.

A significantly expanded version of SASOCS that will combine physical, chemical, and biological understanding of the Antarctic environment is currently under development to be completed by late 2008 or early 2009 as a SCAR contribution entitled: ôAntarctic Climate Change and the Environment (ACCE) (eds. Turner, J., Convey, P., Bindshadler, R., di Prisco, G., Fahrbach, E., Hodgson, D., and Mayewski, P.).

Contributions to Other Disciplines:

US ITASE is providing reconstructions of past temperature, precipitation, atmospheric circulation, and atmospheric chemistry covering the last ~200-100 years over a region inclusive of West Antarctica and the East Antarctic drainage into the Ross Ice Shelf. Other than short multi-annual automatic weather station records and station data from limited coastal stations and South Pole little is known concerning climate in this region. The US ITASE records provide the first spatially distributed set of climate records for assessing current state of the Antarctic climate and controls on climate over Antarctica.

Contributions to Human Resource Development:

US ITASE offers opportunities to students, faculty, and technical staff to experience field operations and science in the remote interior of the continent.

US ITASE has contributed notably to the most recent set of syntheses of Antarctic and Southern Ocean climate change through significant input to SCAR compilations (eg., SASOCS and ACCE referred to in this report).

Contributions to Resources for Research and Education:

Developed ice core dating software designed to create a depth-age scale for ice core glaciochemical records. It reads data from comma separated files that contain depth vs. concentration of element series information. The user selects the elements to plot, and then dynamically performs the dating process. The User generates a report at the end of the process that contains depth-age information. For details see: <http://www.climatechange.umaine.edu/Research/software/index.html>

Contributions Beyond Science and Engineering:

US ITASE has contributed substantially to the recently completed and first assessment of: 'State of the Southern Ocean and Antarctic Climate System'. This document proxies the first compliment to similar assessments conducted for the Arctic.

Conference Proceedings

Categories for which nothing is reported:

Any Conference

2007-2008 US ITASE
(International Trans Antarctic Scientific Expedition)
Field Report

Submitted by Paul Mayewski and Gordon Hamilton (University of Maine) and Brian Welch (St. Olaf College) on behalf of US ITASE

Introduction: US ITASE is foremost a scientific endeavor that seeks to collect the highest quality scientific data under the safest and most efficient conditions possible. It has been operating successfully as a traverse platform since 1999 for a total of six field seasons and over this period has traversed >8000km.

US ITASE is a multi-disciplinary project that as of the 2007-2008 field season includes six separately funded science projects:

- Surface radar (PI Steve Arcone, CRREL)
- Surface glaciology and remote sensing (PI Gordon Hamilton, UMaine)
- Deep radar (PIs Bob Jacobel and Brian Welch, St. Olaf College)
- Ice core chemistry (PIs Paul Mayewski and Kirk Maasch)
- Ice core stratigraphy (PI Deb Meese, UMaine)
- Ice core stable isotopes (PI Eric Steig, UWashington).

These science activities are coordinated logistically under the umbrella of a science management office (PIs Paul Mayewski and Gordon Hamilton, UMaine)

This report includes a brief introduction to ITASE, US ITASE Phase 1 (1999-2003) and details of the second portion (2007-2008) of Phase 2 US ITASE. Previous US ITASE Annual Field Reports (1999-2000, 2000-2001, 2001-2002, 2002-2003, 2006-2007) describing logistics and science are available at www.climatechange.umaine.edu.

Introduction to ITASE: ITASE is a multi-national (21 nations), multi-disciplinary field research program with the broad aim of understanding the recent environmental history of Antarctica and the Southern Ocean. Primary emphasis is placed on collecting records covering the last ~200 to 1000 years of past climate over Antarctica to allow examination of the modern anthropogenic era plus at least the previous 100 years of naturally forced climate. We conduct our research at selected sites to include the two most recent analogs for cold and warm climates, the Little Ice Age and the Medieval Warm Period, respectively.

ITASE evolved from discussions between representatives from several national ice coring programs during a meeting hosted by the European Science Foundation in Grenoble, France in 1990. Twelve nations formulated the original concept (Australia, Canada, China, France, Italy, Germany, Japan, Russia, Sweden, Switzerland, the United Kingdom and the United States) at the suggestion of the US representative to that

meeting (P. Mayewski). Scientists from Belgium, Brazil, Chile, Canada, India, Korea, New Zealand, Norway and Poland have since joined the program.

ITASE was formally accepted in 1991 by the overarching international committee for Antarctic research, the Scientific Committee on Antarctic Research (SCAR), as one of its primary initiatives. ITASE is officially recognized as a Scientific Program Group. It was adopted as an IGBP (International Geosphere-Biosphere Program) Project in 1993. The SCAR ITASE Project Office is located at the University of Maine along with the US ITASE Scientific Management Office. Phase 2 of US ITASE (2006-2008) is one of the US contributions to IPY (International Polar Year).

Since the initiation of ITASE, several international workshops have been held for purposes of organization and data interpretation. One of these workshops led to the development of an international Science and Implementation Plan for ITASE (Mayewski and Goodwin, 1997, see www.climatechange.umaine.edu). Other international workshops have taken place in Durham, New Hampshire (1999), Potsdam, Germany (2002), Milan, Italy (2003), Bremen, Germany (2005), and Hobart, Tasmania (2006). The next SCAR sponsored ITASE meeting will be held in St. Petersburg, Russia. These workshops have provided important venues for data sharing, concept development, preparation of joint publications, and coordinated logistics planning.

Introduction to US ITASE: US ITASE is effectively a polar research vessel. It offers the ground-based opportunities of traditional style traverse travel coupled with the modern technology of GPS navigation, crevasse detecting radar, remote sensing, satellite communications and multi-disciplinary research. By operating as a ground-based transport system US ITASE offers scientists the opportunity to experience the dynamic environment they are studying. US ITASE also offers an important interactive venue for research through multi-disciplinary interactions similar to that afforded by oceanographic research vessels and large polar field camps, without the cost of the former or the lack of mobility of the latter. More importantly the combination of disciplines represented by US ITASE provides a unique, multi-dimensional (space and time) view of the atmosphere, the ice sheet and their histories (Fig. 1). When US ITASE Phase 1 reached South Pole at the end of the 2002-2003 field season, it had sampled the physical and chemical environment of West Antarctica over spatial scales in excess of 5500 km and 3500 m in depth, and over time periods ranging from several hundred years (at sub-annual scale) from ice cores to thousands of years from geophysical techniques.

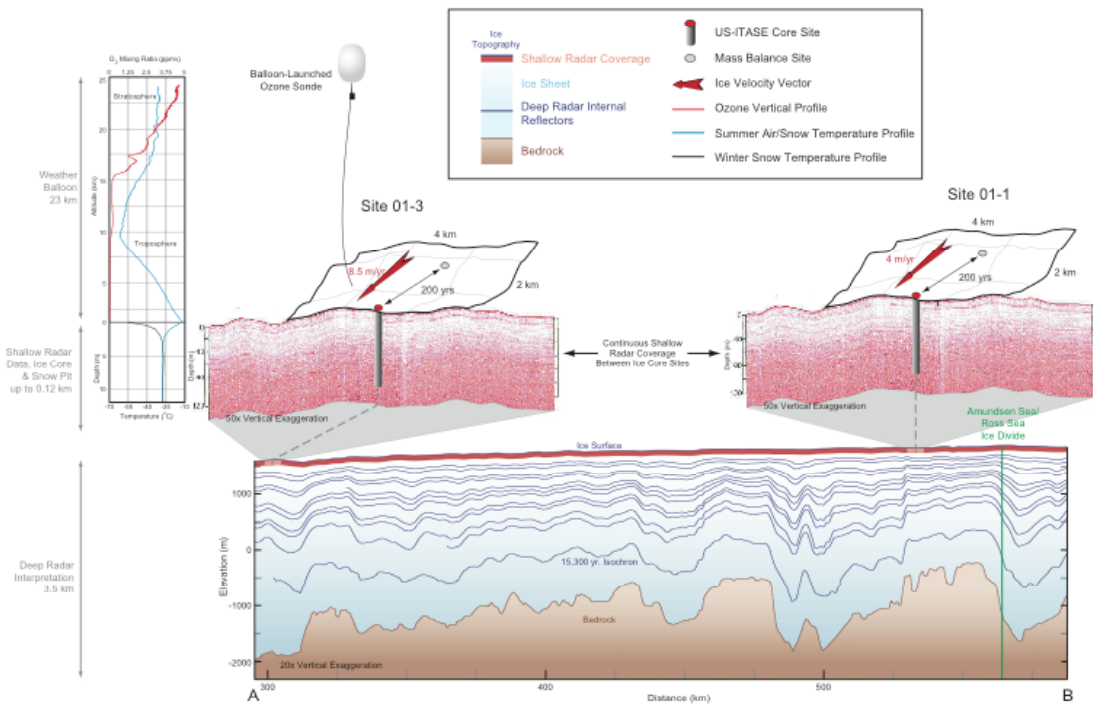


Figure 1 – US ITASE multi-disciplinary view of ice and climate over Antarctica. Figure prepared by B. Welch.

A list of scientific products (abstracts, papers, reports) produced by research teams involved in US ITASE is available in: “Toward a High Resolution Southern Hemisphere Climate Reconstruction: Mapping the Antarctic ice sheet in space and time” produced by Members of US ITASE available at www.climatechange.umaine.edu. Among the scientific accomplishments of US ITASE thus far are: (1) high resolution detailing of surface and deep radar reflectors as continuous stratigraphic time horizons across the thousands of km of traverse route, (2) ice core calibration of radar reflectors in the upper 100 meters of the ice sheet to determine the source of these reflectors, (3) mapping of spatial and temporal variability in accumulation rates over large distances using ground penetrating radar, and investigating the causes of these variations, (4) examination of physical causes of radar backscatter variations in RADARSAT imagery and other remote sensing validation work, (5) examination of spatial variability in chemistry over West Antarctica and relationship to changes in source regions and source strengths, (6) ice core reconstructions of seasonal, inter-annual and decadal scale variability in accumulation rate, temperature, atmospheric circulation, volcanic activity, and sea ice extent with climate model validation, (6) identification of ENSO (El Niño Southern Oscillation), ACW (Antarctic Circumpolar Wave), PDO (Pacific Decadal Oscillation), EAH (East Antarctic High), and ASL (Amundsen Sea Low) atmospheric circulation structure in glaciochemical time-series with implications for understanding climate over the Antarctic and Southern Ocean, (7) assessment of modern global climate

change (short-term variability in snowfall, temperature, and atmospheric circulation, pollution) in the context of decadal to centennial-scale climate and sea level change, (8) deconvolution of local-scale variability in ice core-derived accumulation rate compared to regional scale variability, (9) glaciological reconnaissance for deep drilling in West and East Antarctica (inland WAIS deep drilling, Hercules Dome, Titan Dome), (10) high resolution mapping of subglacial topography, and subglacial lakes in previously unexplored region and as validation for previous surveys such as SPRI and BEDMAP, (11) characterization of ice flow dynamics based on deformation of internal stratigraphy, basal and ice surface topography, (12) characterization of basal reflectivity based on changes in basal temperature and/or geology, (13) identification of zones of basal melting in the interior of West Antarctica and ice stream shear along the coast utilizing satellite-derived (GPS) ice flow measurements, (14) air sampling in the interior of West Antarctica, (15) snow and firn permeability and microstructure measurements at locations with greatly differing accumulation rates and average temperatures, (16) physical property measurements of annual layer stratigraphy, depth/density profiles and crystal growth profiles as a function of age and in situ temperature in snowpits and ice cores, and (17) causes of variability in firn stratigraphy including the effects of ice speed, wind and topography. The results of many of these projects are contained in peer-reviewed papers in a dedicated special volume of *Annals of Glaciology* (volume 41) plus in several other journals (www.climatechange.umaine.edu/usitase).

In addition to the foregoing US ITASE and ITASE have been instrumental in producing a document entitled: “State of the Antarctic and Southern Ocean Climate System (SASOCS)” prepared for the Antarctica and the Global Climate System committee of SCAR. This document provides a basis for assessing and understanding future climate change over Antarctica and the Southern Ocean and will be released over the next few months. SASOCS also serves as a building block for an even larger SCAR initiated document entitled: “Antarctic Climate Change and the Environment (ACCE)” that will be finalized by 2009.

The 2007-2008 FIELD SEASON

Field Party Members and brief list of qualifications:

Dan Breton (Graduate Student, GPS, surface radar, Maine Automated Density Gauge Experiment, high resolution borehole logging measurements, 2nd Antarctic season, UMaine)

Dan Dixon (Graduate Student, ice core processing oversight and surface snow sampling, 5th Antarctic season, UMaine)

Gordon Hamilton (PI, GPS, surface radar, accumulation rate, 12th Antarctic season, Associate Professor, University of Maine)

Elena Korotkikh (Graduate Student, ice core processing and field assistant, 1st Antarctic season, UMaine)

Paul Mayewski (PI, Field Leader, ice coring, 21st Antarctic season, Director/Professor, UMaine)

Luci Pandolfi (Cook, oversight for food and water supply, weather obs, WFR, 5th Antarctic season, UMaine)

Sharon Sneed (Geochemist, ice core processing, 1st Antarctic season, UMaine)

Nicky Spaulding (Graduate Student, ice core processing and field assistant, 1st Antarctic season, UMaine)

Joshua Swanson (Lead mechanic (mechanical oversight for Challengers and Pisten Bulley, traverse platform organization, WFR, 7th Antarctic season, 5 winter-overs, UMaine)

Luke Wagner (Camp organization (weather obs, field communications, aircraft operations, light mechanical equipment maintenance), WFR, 5th Antarctic season, UMaine)

Mike Waszkiewicz, Driller (oversight for ice core drilling, 5th Antarctic season, Data Logging North and UMaine)

Brian Welch (PI, deep radar, 5th Antarctic season, Assistant Professor, St. Olaf College)

Logistics

Travel conditions:

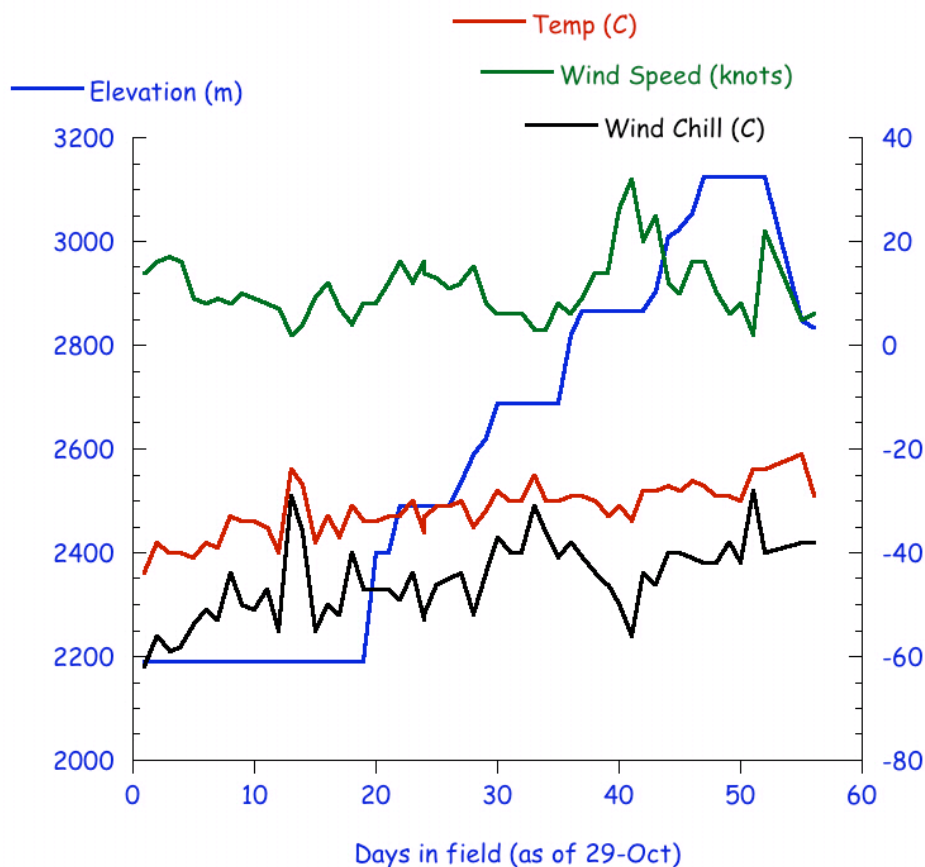


Figure 2 – Change in elevation, temperature, wind speed and wind chill during the season. Note increased wind speeds 8-11 Dec (days 40-43) and 20 Dec (day 52) resulting in two and one days lost for research, respectively due to poor travel and drilling conditions.

Surface conditions over the traverse route varied from hard packed firn (first half of the route) to soft snow (second half of the route) with alternating regions of variable height (cm to >1m) sastrugi.

Shift Schedule During Travel: During travel the team was divided up into two groups that operated as separate shifts. Each shift required two Challenger 55 drivers, one Pisten Bulley driver, one crevasse detector operator, one shallow radar operator). The deep radar was operated by one person throughout the traverse (B. Welch). After some experimentation with number of shifts per day it was decided that a maximum of 3 shifts would operate per day, Shifts lasted nominally 3 waypoints (10km/waypoint) that averaged out to 4.5-5.5 hours per shift. Following the day's shifts the team stopped travel, rested for 8 hours, had a hot meal and then returned to travel.

Monitoring Team Member Fatigue: Pulse and oxygen saturation were measured every morning for every member of the team to assess acclimatization to field conditions. Unfortunately the O₂/pulse meter was not made available to US ITASE until several days into the field season so only one individual (who arrived later in the season) could be monitored from their season's start to end.

Data for O₂/pulse can be viewed in Oxygen_Pulse.xls (attached to this report). Team member's names are not listed in order to protect their medical privacy. Team average O₂ shows a decline with elevation within expected limits. Team average pulse shows considerable variability over time. This variability can be ascribed to a combination of changing work and environmental conditions.

O₂/pulse meters are inexpensive and easy to use. They should be standard issue to field teams working at elevation. Previous use by P. Mayewski in high altitude (>20,000') environments has been invaluable in identifying individuals under stress and those likely to suffer from altitude effects.

Route reconnaissance: US ITASE has had considerable success in finding safe crevasse routes utilizing RADARSAT, Landsat and MODIS imagery (G. Hamilton and L. Stearns). During the 2006-2007 season crevasse-like features were encountered several km from site 06-4. Landsat imagery examined following this season revealed the location of these features. Unfortunately Landsat imagery only extends to 82°S and this season's traverse went from 80 to 90°S. The entire route south of 82°S was crevasse free except for one series of several en echelon crevasses (average width 50-100') revealed during a Basler reconnaissance flight of the region from site 1 to site 3. This fortunate finding allowed us to correct our route by a few km, sufficient to avoid the crevasses. While satellite imagery is an excellent tool for investigating traverse routes it should always be followed by aircraft reconnaissance.

Environmental Spills: One incident occurred. A Challenger 55 radiator broke at winter-over site (06-4, long 144.6988309, lat 80.30768631) during season start-up resulting in one gallon of glycol spilled onto the snow surface. All of the glycol was recovered with a spill kit and returned to McMurdo prior to departure of the traverse from the site.

Challenger 55s and Traverse Platform Configuration: One forklift-equipped, one plow-equipped; the same units used on previous US ITASE traverses. The plow unit pulled in a single line: one Lehman, one Polar Haven Berco, 3 Siglin sleds, and the Polar Pooper. The fork unit pulled in a single line: one Lehman, one Kitchen module mounted on a Berco, Blue Room (sleeping and science) mounted on a Berco, and the deep radar sled. Both 55s operated well this season although they are beginning to show wear. The plow 55 has been in the field since 2000 and the fork since 2001. Throughout phase one, the Challengers were almost new, but since their introduction to the field they have traveled ~8000 km with US ITASE and >1500km with LGT RPSC oversnow traverse. See “Mechanic’s Repair” section later on this report for details of repairs and the mechanic’s (Josh Swanson) recommendations.

Spreader Bars: Spreader bars were introduced to the traverse platform at the onset of the 2006-2007 season by the RPSC camp manager at that time. Spreader bar construction and related complications resulted in US ITASE losing several weeks of work. The spreader bars were introduced to reduce sled drag by spreading out sled loads and by reducing re-use of sled tracks. This system has apparently worked well for the SPIT traverse. However, the SPIT traverse has operated largely over the Ross Ice Shelf and apparently does not use spreader bars on the plateau due to issues related to sastrugi (G. Blaisdell, pers. comm. 2007 US ITASE out brief). As it turns out spreader bars enhance sled torque in sastrugi regions and as demonstrated by US ITASE in 2006-2007 create unsafe conditions for individuals riding in modules towed on the ends of spreader bars in sastrugi fields. For the first half of the 2007-2008 season we configured one train in line and one utilizing a spreader bar primarily because the Siglin sleds were not equipped (as requested) with rear towbars. Once we encountered softer snow (midway on the traverse) the in-line train performed well and the spreader bar train was repeatedly stuck requiring extrication by double-teaming the two Challengers. In addition following storms the spreader bars posed additional digging challenges because they are wider than the rest of the train. Further the spreader bar skis were poorly constructed and they dug into the snow acting as anchors. In summation, the spreader bars wasted time at the onset of 2006-2007 and have served as little more than additional weight plus something extra to have to drag and deal with on traverse. It is unfortunate that so much US ITASE time and effort was wasted on the spreader bars.

Pisten Bully (PB): As of 2006 the PB has served as lead vehicle for the traverse since it houses the crevasse radar. The PB is highly maneuverable and has proven to be an excellent vehicle for the task. It was also excellent for conducting deep radar traverses around ice core sites. The mechanic’s report (later in this section) suggests that the PB be returned to McMurdo for overall this season

Generators: Qty 2 diesel 12kw (primary camp energy supply, second unit for back-up) for heating of the kitchen and Blue Room plus powering the snow melter and the Eclipse drill plus other lesser uses (e.g. recharging batteries). Qty 1 gasoline 5kw (back-up power – never used). Qty 2 gasoline 2kw (primary use deep radar). Qty 1 gasoline 1kw (radar back up).

Use of the 12kw generators during the 2007-08 season reduced dependence on less safe systems such as propane and increased available power. A make-shift chimney was built in the field to divert generator fumes from shelters. This system requires upgrade.

Fuel Consumption: AN8 usage for two Challenger 55s, one Pisten Bully, two 12kw generators). See ITASE Fuel 2007-2008_chart.xls for details (prepared by Luke Wagner).

Aircraft support: US ITASE was supported this season primarily by Basler and by Twin Otter for delivery of small items. The Basler provided support for all put-in requirements, fuel caching, and pick up of expended fuel drums. The Basler is a perfect aircraft for traverse support.

Food: Food quality was excellent this season. Luci Pandolfi prepared hot dishes for all three daily meals.

Shelters (Blue Room, Kitchen, Polar Haven): The same Berco mounted shelters available during previous US ITASE traverses were available this season. As reported in previous field reports the Kitchen and Blue Room while adequate for their purpose are far heavier than necessary and both shelters are extremely top heavy.

The Blue Room and Kitchen shelters are attached to Berco sleds by a small number of bolts that have regularly sheared or fallen out. More substantial attachments were requested following the 2006-2007 season, but no repairs were made during the put-in phase of 2007-2008.

Lehman Sleds: Qty two Lehman sleds were provided for the 2006 traverse. As in the past they were used for the heaviest loads (e.g., fuel drums) and served well.

Berco Sleds: Qty three Berco sleds were available for the 2007 traverse. As in the past the Berco sleds did well. The state of the rear hitches turned out to be a major issue in 2006-2007 and we had one failure this season. The rear hitches are designed to fail under excessive stress to save the Berco frames. One Berco rear hitch failed in 2006-2007 after having traveled >8000km. Rear hitches for each Berco were replaced, by US ITASE team members at the start of the 2007-2008 season.

Plastic sleds: Qty three Siglin designed plastic sleds were specially ordered for the 2006-07 traverse. Their intended purpose was to be for light-weight transport (e.g., empty fuel drums and air drop materials). The Siglins turned out to be excellent even for heavier loads (up to 12,000 lbs) once equipped with pallets and draw bar chains attached to the pallets. Although two pallets failed and one Siglin was slightly damaged the concept of plastic sleds proved to be very promising and four heavy-duty plastic sleds equipped with heavy-duty tow bars and rear hitching capability were requested for the 2007 season. The three 2006-07 sleds were upgraded. These sleds are relatively inexpensive compared to Bercos and Lehmans and can be shipped in pieces (although the bolt holes for assembling the sleds in the field should not be pre-drilled since the pieces have different rates of

thermal expansion). For this season the Siglins were reinforced structurally. Unfortunately, lightweight carriage bolts were employed and several bolts failed necessitating stops to rip away the structural segments damaged after bolt failure. The design for the structural reinforcement seems to be successful but the quality of materials and repair were inadequate.

Mechanic's Repairs (prepared by Josh Swanson):

- (1) Eberspacher heater unit 12 volt. Both Fork and Dozer Cat units failed and were replaced in 2007.
- (2) Old unit from Fork Cat needs a glow plug. It is reboxed and good for spare parts.
- (3) Grid heater failed on the PB 11-2007 and was replaced. If a PB is used with this train again that part should be re-inventoried.
- (4) One 25 volt coolant heater failed on the PB and was replaced.
- (5) PB front axle has a crack on the top left gusset on the left side of vehicle. Needs a new front axle or repair by cutting a V and welding shut.
- (6) Voltage regulator sent out for Onan generator when installed to fix an over charge on the DC side of 15.5 volts. After installed DC charger was back in range to 13.2 volts. But the AC volt range was 136-145 volts when adjusting by the dial.
- (7) The Boom for the Ground Penetrating Radar on the front of the PB had a few failures. First one Rune tower was bent due to using the winch and the new front sled being far too heavy to be lifted. It broke apart en route and was replaced with a new extension at drill site 1. Then the front bracket broke due to the extra stress from the added leverage and weight that the new GPR sled added. This was fixed by strapping the boom directly to the plastic sheet. It appears to have been a solid fix.
- (8) Siglin upgrade failed in route to site 2. The under plate appears to have caught a strong piece of ice shearing the carriage bolts on the right side and wrapping the metal under the sled. The upgrade was removed and the sled was used as a light haul only sled. Two rear plates were ruined later in the season with the same result. One had no weight on the rear so possible sled flex caused the weak carriage bolts to break. Recommend if this upgrade is wanted for future traverses with Siglins to use grade bolts and more of them.
- (9) Another Siglin sled split at the welded seam in the middle. This happened last year as well on a different Siglin, same left side. Repaired by drilling end of crack and bolting in rubber strips to hold the split ends together. This sled was hauling a light load of food boxes. Last year it was a heavy load of fuel barrels.
- (10) Magneto failed on a Herman burner. It was replaced. The spark plug insulation to the burner failed as well causing spark in wrong location or not at all and was replaced.
- (11) Rear wiper arm replaced on Dozer Cat.
- (12) Starter relay replaced on Dozer Cat.
- (13) Coolant radiator and fan replaced on Dozer Cat.
- (14) Throttle cable on fork Cat was not moving up or down. Removed and warmed up cable which freed it to move again. Water found a way in and froze it unmovable. Added alcohol in sleeve to help remove any left over moisture and to help keep from happening again.

Mechanic's recommendations:

PB should go back to MCM to be torn apart and inspected for cracks. Have a complete full pm done including calibrations of hydraulic pressures and synchronizing of moog units. Inspection for frame cracks and cracks in axles. Bogie wheels removed and bearings inspected, replaced or repacked.

The Challenger 55s need a thorough go through. Leak down test of engine, undercarriage measurements. Track replacement and full fluids change. Batteries are old and working fine but replacement would add reliability if used on traverse again.

Fork Cat has an exhaust leak on the manifold. It has been leaking since I started with ITASE last year. Parts are here and ready to be installed. Didn't install in field due to fear of studs breaking and not being able to get them out with tools here. Decided it best to be done in a warm shop with easy outs and other tools to remove broken studs from head.

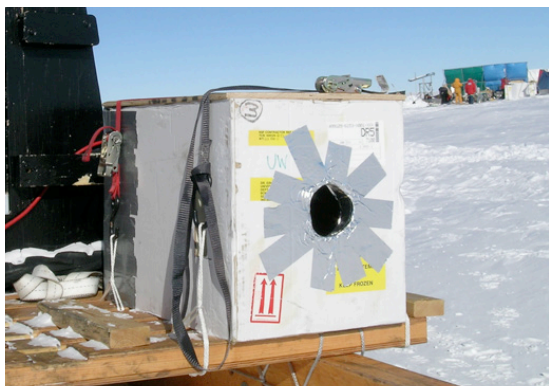
Dozer Cat needs a hydraulic cable installed from lever to valve body. It is on hand. Wasn't a priority in field since I changed hoses to a different lever control valve. Due to time restraints it may or may not be done in the field.

Communications: Primary communications this season were made using Iridium phones. HF base stations were used between vehicles and VHF for close heavy equipment use.

Deep Radar: (prepared by B. Welch, St. Olaf College): The radar system was essentially the same as previous years. Some requests for improvements to the radar sled and shelter were made this year:

1) Solution to generator problems of 2006

- a. Surging and stalling of generator motor. Two new Honda 2 kW generators were purchased. These did not solve the problem alone and continued stalls meant the loss of 15 km of radar data along the traverse route and delays. Josh Swanson diagnosed the problem as icing in the carburetor, so an insulated box was made from a spare ICDS ice core box (Fig. 3). Small holes for exhaust and air intake allowed for ventilation and could be covered when not in use. The generator was stored in the heated



Blue Room at night. This solution: keeping the generator warm when not in use and running in the insulated box, seemed to resolve the problem of

stalling in temperatures below -30°C .

Figure 3: ICDS ice core box converted for use as an insulated generator box. Exhaust vent is shown with metal duct tape to protect box. Air intake vent is hidden behind strap.

- b. The original request was for a diesel generator to reduce electrical noise that interferes with the radar signal reception. The hope was that the Honda generators with the RF “chip” would solve the problem. This year’s data proves that the RF chip does NOT reduce RF noise even to the level of the old Honda 1.8 kW alternator-type generator. While it’s possible that the newer inverter-type generator might work for relatively shallow surveys (<1,500 m ice thickness), they reduce the signal/noise too much for use in deeper ice surveys. Alternator-type gasoline generators or solar-powered systems should be used for deep surveys.
- 2) Solar power for receiver computer was still inhibited by the lack of new reliable 100 amp-hr batteries (all were tasked to the power systems in the shelters). The solar panels and charge controller were used to assist in charging the smaller 35 amp-hr batteries for the transmitter. At least one of the new (“Vessel 2007”) 35 amp-hr batteries never held a charge. It might be necessary to look into solar charge controllers that are compatible with the new AGM batteries since they have a different voltage range than the older gel-cells.
- 3) A suspension system for the radar shelter was requested last year in order to protect the radar equipment from the large sastrugi found on the plateau. A request for pneumatic air pillows (e.g. Firestone or Goodyear) was turned down based on concerns about temperature. Three ATV tires with inflated inner tubes were sent out to the winter-over site. These were sent back because there was no way to install them under the shelter in a manner that would distribute the weight properly. Josh Swanson (ASE-certified in suspension systems) believes that the pneumatic air suspensions should be just as reliable as tire inner tubes at cold temperatures. The addition of stabilizer bars would help keep the shelter in place.

Suggestions for US ITASE Platform as of 2007 season end:

As recommended by J. Swanson (mechanic) we suggest that the PB be returned to McMurdo for inspection and overhaul. The PB worked well for two seasons, but it is a fairly delicate vehicle and prone to fractures that are best inspected and repaired in a warm shop.

Swanson also recommended a complete inspection and overhaul of the two Challenger 55s. To return these vehicles to McMurdo will require considerable effort since the 55 cabs must be partially deconstructed. If these vehicles are to be used away from stations on future traverses they must be carefully inspected and given significant overhauls. This is well worth the time and cost since the vehicles served their purpose. Ideally mechanics should be deployed to South Pole to conduct inspection/overhaul there allowing these vehicles and their accompanying traverse sleds to remain as complete platforms. To reassemble these platforms requires considerable time, experience and care.

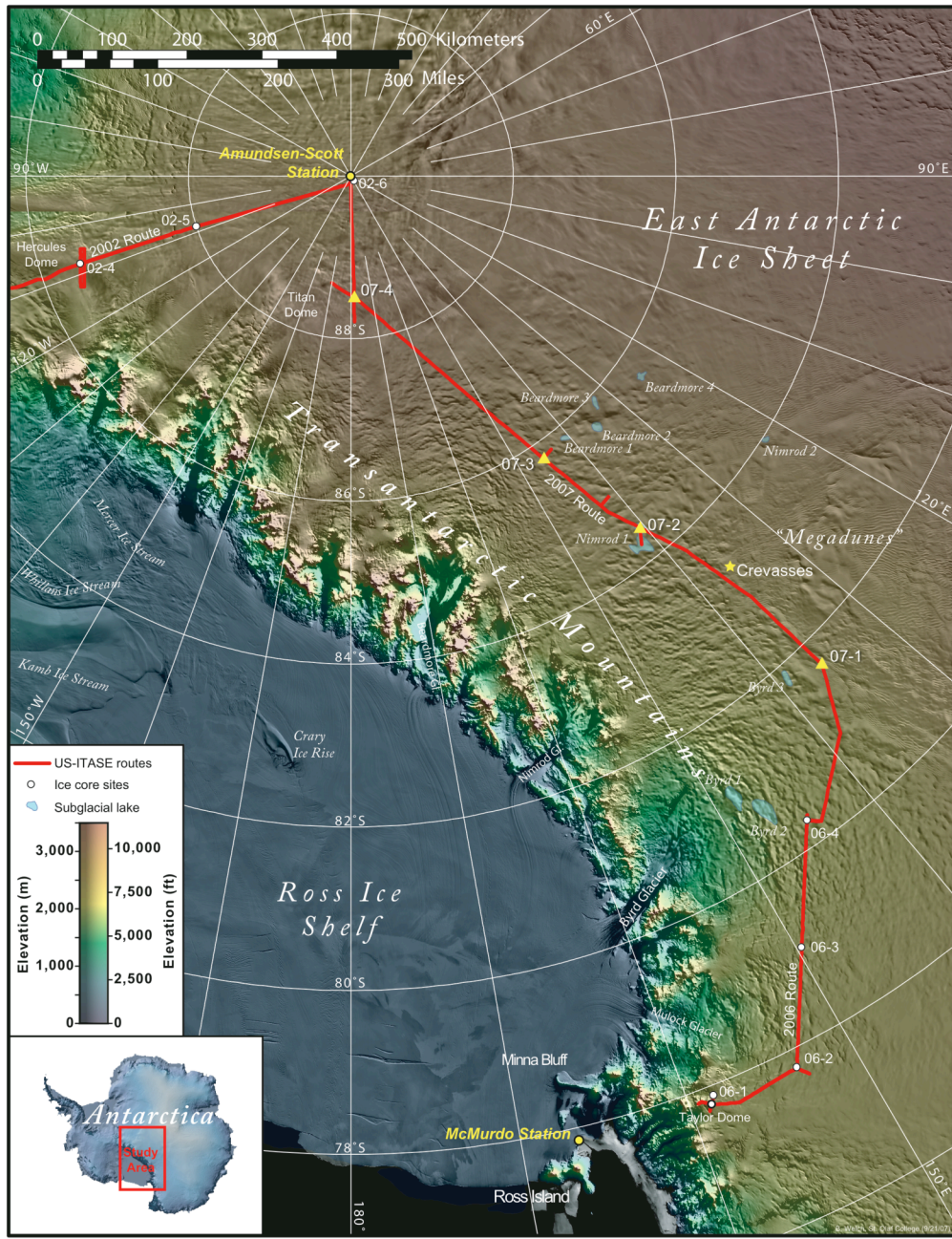
The traverse trains (Lehmans, Bercos with modules) should be left at South Pole intact. They are not the perfect traverse platform, but they are highly functional for certain activities.

We would welcome the opportunity to work with OPP and RPSC to advise future projects concerning use of the existing US ITASE traverse platform.

We would also welcome the opportunity to work with OPP and RPSC to develop a new generation of traverse platforms. US ITASE has successfully completed >8000 km of safe, efficient multi-disciplinary research using traverse techniques.

Science

US ITASE Phase Two traveled from Taylor Dome to South Pole (Fig. 4). During the 2007-2008 season US ITASE traveled 1200 km from the 2006-2007 winter-over site (06-4) to South Pole. For details of the traverse route coordinates see ITASEWaypointsScience.xls attached to this report.



US-ITASE in East Antarctica
 The U.S. contribution to the International
 Trans-Antarctic Scientific Expedition




Surface topography courtesy The Ohio State Univ.
 MODIS mosaic courtesy National Snow & Ice Data Center
 Projection: South Pole Ster. (Lat. of true scale: 71°S, Datum: WGS84)

Figure 4 – US ITASE route in red and work sites (yellow triangles). Note also location of crevasses discovered on aerial reconnaissance. Original traverse route was changed slightly to avoid these crevasses.

Fig. 5 is a summary of science products resulting from this season. Details are provided in the following text.

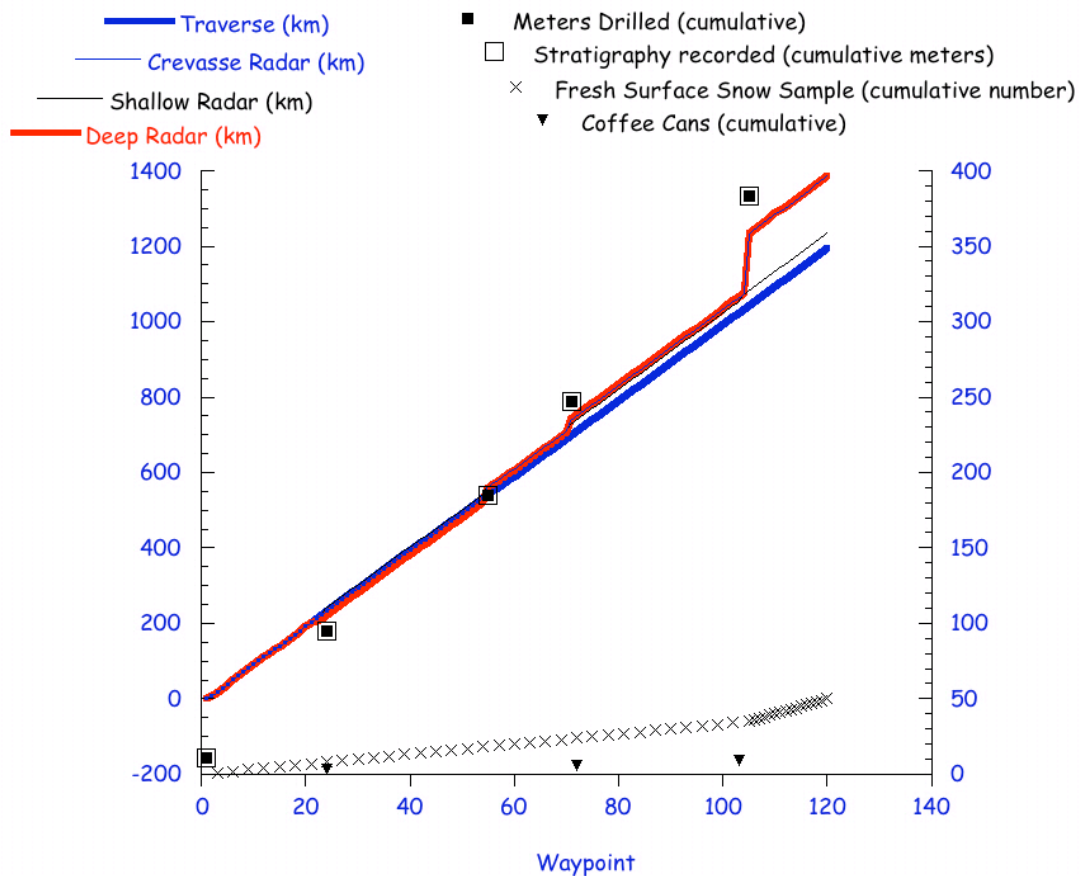


Figure 5 – Science products as a function of traverse distance.

Crevasse radar: Conducted in parallel with all travel.

Shallow radar: Firn stratigraphy in the upper ~100 m of the ice sheet was imaged using a 200 MHz Ground Penetrating Radar (GPR) system. The system operated continuously along the entire traverse route, and several local profiles were collected at each ice core site.

Deep radar: The 3 MHz (deep) radar collected data along all but 15 km of the traverse route, plus local profiles at each of the ice core sites for a total of more than 1300 km of data. Ice thickness ranged from 1500 to 3100 m and internal stratigraphy was detected to depths up to 2750 m. At least one subglacial lake was found along the traverse route just north of Titan Dome.

Ice coring: Ice coring was conducted using both the 2” Rongbuk and the 3” Eclipse drill. The Rongbuk drill was used for recovery of shallow cores (<25m) dedicated to studies described below under surface glaciology. The Eclipse drill was used to recover cores up

to 100m depth at four sites (Fig. 4). At all sites the cores represent at least 200 years and more probably several hundred to >1000 years of record at some sites. Stratigraphy was conducted on all ice cores recovered this season.

Surface snow sampling: Surface snow sampling was conducted at 30 km intervals along the 2007-2008 traverse route and every 10k between site 07-4 and South Pole (Fig. 6). This sampling consists of IC/isotope and ICPMS sample collection at the surface, 0-5cm and 0-15m. This data is part of a continent wide ITASE surface sampling scheme that has already demonstrated the spatial distribution of major ions and stable isotopes over Antarctica.

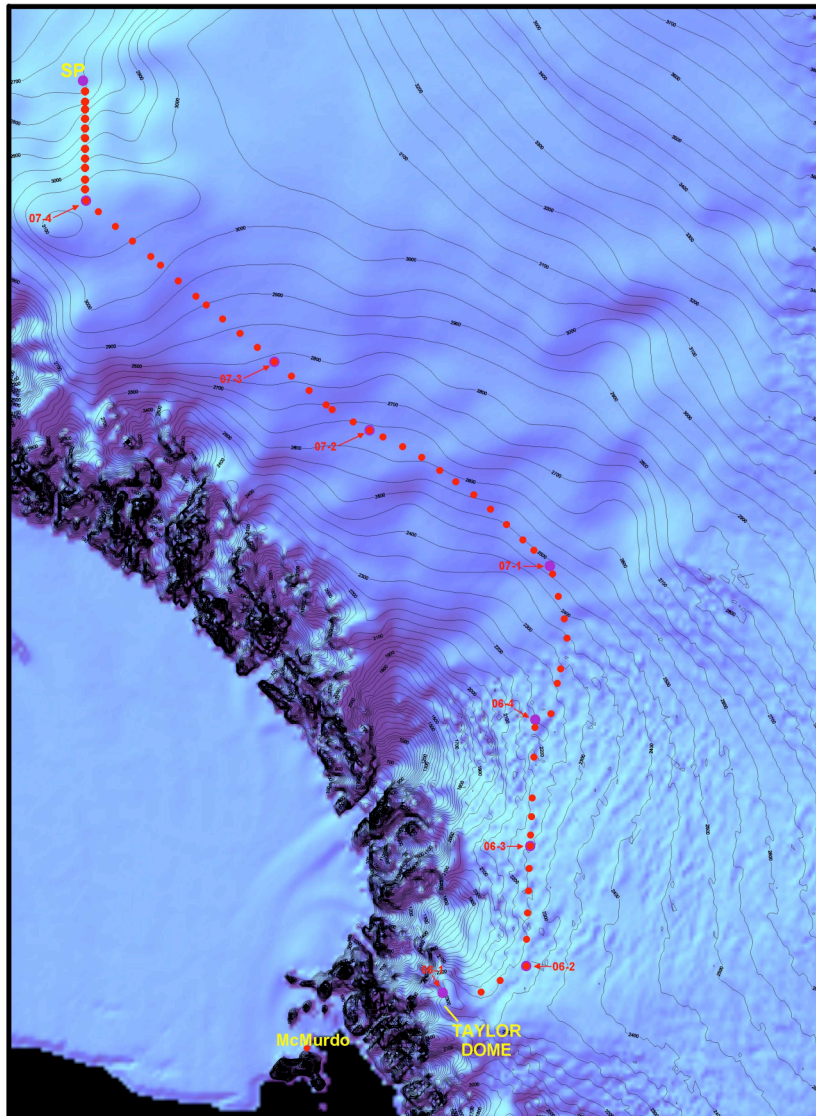


Figure 6 – Surface snow sampling coverage for Phase 2 US ITASE (Taylor Dome to South Pole).

Surface Glaciology: Geodetic-quality kinematic GPS data were recorded continuously along the traverse route for the purpose of characterizing ice sheet surface elevations and for geolocating radar data. Three mass balance measurement sites (“coffee cans”) were installed at ice core sites (each site consists of 4-5 markers at depths from 4-25 m). Novel geophysical techniques were used to investigate properties of the surface firn. MADGE (Maine Automated Density Gauging Experiment) uses a high-energy nuclear source to make fine resolution (~3 mm) measurements of density along cores collected with the 2” drill. A second instrument, deployed down the boreholes, makes *in situ* measurements of borehole wall strength (an indicator of possible locations of missing core, reflectivity (an indicator of grain size), and temperature.

US ITASE 1999-2008 Summary

Since 1999 US ITASE has traversed >8000 km throughout West and East Antarctica (Fig. 7) and collected a total of 3945m of ice core. Together with six shallow cores collected as part of LGT, US ITASE has conducted scientific investigations (ice coring, surface glaciology, radar) at 45 sites and radar (crevasse, shallow, and deep) along almost all of the US ITASE routes. US ITASE has therefore sampled the ice climate record surrounding the Ross Ice Shelf and hundreds of km inland. US ITASE has now completed six field seasons of multi-disciplinary research setting a new benchmark for Antarctic climate multi-disciplinary research.

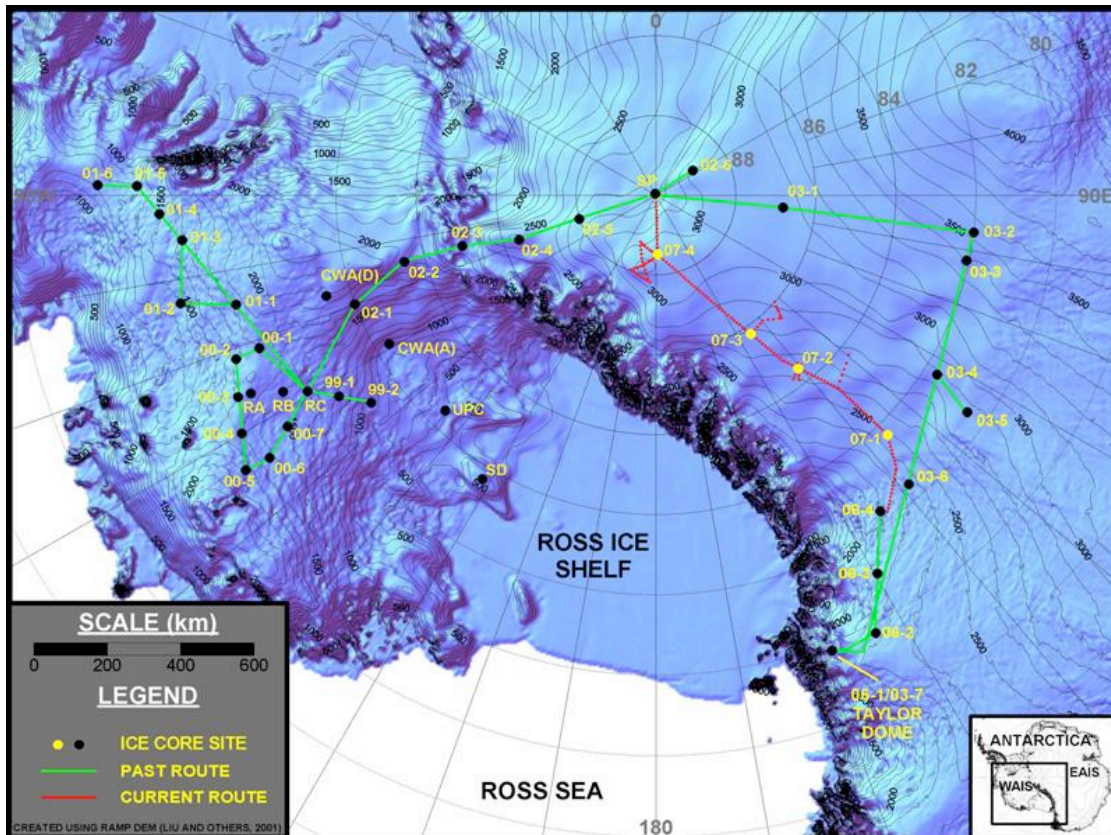


Figure 7 – US ITASE routes and study sites.