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A Science Management Office for the U. S. Component of the International Trans Antarctic Expedition (US ITASE SMO)âA Collaborative Pgrm of Research from S. Pole to N. Victoria Land

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Final Report for Period: 03/2003 - 02/2006**Submitted on:** 03/31/2006**Principal Investigator:** Mayewski, Paul A.**Award ID:** 0229573**Organization:** University of Maine**Title:**

A Science Management Office for the U. S. Component of the International Trans Antarctic Expedition (US ITASE SMO)âA Collaborative Pgrm of Research from S. Pole to N. Victoria Land

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:****Post-doc****Graduate Student****Name:** Dixon, Dan**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Dan was the only representative from US ITASE on the LGT this year.

Undergraduate Student**Name:** Lacey, Jessie**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Student worker assigned to assist with web site maintainence as well as other general office duties.

Technician, Programmer**Name:** Zielinski, Ann**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Ann serves as web master for the US ITASE web site as well as maintaining communication with Raytheon and the field team. She organizes and plans the workshops and planning meetings. Ann coordinates, compiles and submits the Support Information Package for all of the participating projects. She supervises any undergraduate student help.

Other Participant**Research Experience for Undergraduates****Organizational Partners****Ohio State University**

University of Maryland

University of Nevada Desert Research Institute

University of Colorado at Boulder

University of Arizona

University of Washington

Boston Museum of Science

Saint Olaf College

US Army CRREL

Other Collaborators or Contacts

Albert, Mary USACRREL Snow and Firn Microstructure and Transport Properties: U.S. ITASE
 Arcone, Steven USA CRREL High Resolution Radar Profiling of the Snow and Ice Stratigraphy beneath the ITASE Traverses
 Bales, Roger, U. of Arizona, McConnell, Joe, U. of Nevada Desert Research Institute, Hydrogen Peroxide, Formaldehyde, and Sub-Annual Snow Accumulation in West Antarctica: Participation in West Antarctic Traverse
 Hamilton, Gordon, University of Maine, Whillans, Ian, Ohio State Univ. Mass Balance and Accumulation Rate Along US ITASE Routes
 Jacobel, Robert, Saint Olaf College, Radar Studies of Internal Stratigraphy and Bedrock Topography along the US ITASE Traverse
 Meese, Deb, Gow, Tony, Elder, Bruce USACRREL The Physical Properties of the US ITASE Ice Cores
 McConnell, Joe, U of Nevada, DRI, Deposition of the HFC Degradation Product Trifluoroacetate in Antarctic Snow and Ice
 Steig, Eric, Univ. of Washington, White, James, U. of Colorado, Shuman, Christopher, U. of Maryland, NASA Stable Isotope Studies at West Antarctic ITASE Sites

Activities and Findings

Research and Education Activities:

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, crevasse detecting radar, 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 (currently eleven integrated science projects) 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 (x, y, z and time) view of

the ice sheet and its history. Over four field seasons (1999-2003) US ITASE sampled the environment of West Antarctica into East Antarctica over spatial scales of >5000 km, depths of >3000 m, heights in the atmosphere of >20 km, and time periods of several hundred years (sub-annual scale) to hundreds of thousands of years (millennial scale).

The accomplishments of the Light Ground Traverse (LGT) 2003-2004 that included a limited scope of US ITASE sciences are many.

The United States Component of the International Trans Antarctic Scientific Expedition from South Pole to Taylor Dome accomplished the following:

Traveled 2469 kilometers, 6 short cores for chemical and isotope analyses. Sampled two 2 meter snow pits and five 1 meter snow pits, took surface snow samples every 30 km from South Pole to Taylor Dome and drilled two beta cores for Ted Scambos.

Science team participants on the Light Ground Traverse:

Daniel Dixon and Tom Neumann were full team members and assisted Raytheon personnel in all aspects of the logistical accomplishments.

US ITASE SMO hosted an NSF sponsored meeting for US ITASE PIs and potential PIs at the December 2003 AGU meeting in San Francisco.

US ITASE SMO also organized and hosted a Workshop in Castine Maine in July 2003. The workshop was attended by all US ITASE funded institutions and led to the development and planning of several papers. A summary of this workshop follows:

Antarctic Based Southern Hemisphere Climate Reconstruction

Submitted by Paul Andrew Mayewski, Climate Change Institute, University of Maine.

On 2 January 2003 the United States component of the International Trans Antarctic Scientific Expedition (US ITASE) arrived at South Pole having completed, over the period 1999-2003, >5000 km of over snow traverses that included much of West Antarctica and a portion of East Antarctica. During the traverses US ITASE focused on the collection of data that will allow the reconstruction of sub-annual scale climate variability and changes in the chemistry of the atmosphere for the last 200 - 1000 years.

The International Antarctic Scientific Expedition (ITASE) is a twenty-nation strong, multi-disciplinary research program endorsed by the Scientific Committee on Antarctic Research (SCAR) and the International Geosphere Biosphere Program (IGBP) (Mayewski and Goodwin, 1997). It is designed to reconstruct the recent climate history of Antarctica through ice coring and related observations along a network of extensive intra-continental traverses.

The US component of ITASE is supported by the Office of Polar Programs of the National Science Foundation. It includes scientific projects from the following institutions: Cold Regions Research and Engineering Laboratory û US Army, Desert Research Institute, National Aeronautics and Space Administration, Ohio State University, St. Olaf College, University of Arizona, University of Colorado, University of Maine, University of Washington.

Information concerning climate variability in the middle and high latitudes of the Southern Hemisphere is obtained by US ITASE, through calibrations developed between US ITASE ice core records and direct atmospheric observations (Kreutz et al., 2000; Meyerson et al., 2002; Schneider and Steig, 2002). A primary goal of the calibration work is to document variation in the ENSO teleconnection and to better understand the relationship between global scale variability and regional Antarctic climate. This will establish a record of natural fluctuations of ENSO frequency and amplitude prior to the beginning of anthropogenic influence on climate, and will help in determining whether the frequency of El Ni±os

changed in the late 20th century relative to earlier periods. Another important goal is to better understand the Antarctic Oscillation (AAO) (also known as the Southern Annular mode or the high latitude mode). It is the dominant atmospheric teleconnection pattern in West Antarctica after ENSO, and may be the most important for the rest of the continent.

US ITASE also contributes to our knowledge of current and future projected changes in sea level by improving understanding of ice sheet mass balance. The US ITASE logistics platform provides a base for the collection of field mass balance measurements and accumulation history from shallow and deep radar sounding (Welch and Jacobel, 2003) for large portions of West Antarctica, an area which currently accounts for the greatest uncertainty in global estimates of ice sheet contributions to sea level change.

US ITASE offers the ground-based opportunities of traditional style traverse travel coupled with the modern technology of GPS, ice radar, atmospheric sampling, and satellite communications. By operating as an over snow traverse US ITASE offers scientists the opportunity to experience the dynamic range of the Antarctic environment. Most importantly, the combination of disciplines represented by US ITASE provides a unique, multi-dimensional (x, y, z and time) view of the ice sheet and its history.

Continued US ITASE research, future proposed US ITASE traverses, and collaboration with our international ITASE colleagues, will, in the next several years, provide unprecedented knowledge of past Antarctic and Southern Hemisphere climate variability, Antarctic ice sheet variability, and improve prediction capability.

For a more detailed description of US ITASE science activities and results see www2.umaine.edu/USITASE and for a more detailed description of the field program see www.secretsoftheice.org.

References:

Kreutz, K.J., Mayewski, P.A., Pittalwala, I.I., Meeker, L.D., Twickler, M.S., and Whitlow, S.I. 2000. Sea-level pressure variability in the Amundsen Sea region inferred from a West Antarctic glaciochemical record, *Journal of Geophysical Research*, 105 (D3), 4047-4059.

Mayewski, P.A. and Goodwin, I., 1997, ITASE Science and Implementation Plan, Joint PAGES/GLOCANT Report.

Meyerson, E.A., Mayewski, P.A., Whitlow, S.I., Meeker, L.D. and Kreutz, K.J. and Twickler, M.S., 2002, The extratropical expression of ENSO recorded in a South Pole glaciochemical time series, *Annals of Glaciology* 35, 430-436.

Schneider, D.P. and Steig, E.J., 2002, Spatial and temporal variability of Antarctic ice sheet microwave brightness temperatures, *Geophysical Research Letters*, 29, 20, 25-1-25-4.

Welch, B.C., and Jacobel, R.W., 2003, Analysis of deep-penetrating radar surveys of West Antarctica, *US ITASE 2001, Geophys. Res. Lett.*, 20 (6): 443-446.

Findings: (See PDF version submitted by PI at the end of the report)

Training and Development:

Daniel Dixon - PhD student at UMaine, participated in his 3rd traverse. He was in charge of the sample collection for geochemistry. The samples will be used as part of his dissertation.

Outreach Activities:

The US ITASE Science Management Office maintains an active outreach program. Daily journal entries covering all years of the US ITASE traversers are maintained on the web site, <http://www2.umaine.edu/USITASE> There is also an extensive section for Teachers containing lesson plans and links.

The Boston Museum of Science maintains the web site: <http://www.secretsoftheice.org> with many activities and information and linking 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.

Public lectures were given to municipal groups such as Rotary Clubs, Library lecture series. Assistance was extended to a local theater group in a production of 'Terra Nova', in the form of photos, audio recordings, and a discussion with the actors, as well as participating in a 'Director's Forum' for the public.

Journal Publications

Paul A. Mayewski, "Antarctic oversnow traverse-based Southern Hemisphere climate reconstruction", EOS Newsletter American Geophysical Union, p. 205, vol. 84, (2003). Published

A.J. Gow, Debra Meese and Robert Biala, "Accumulation variability, density profiles and crystal-growth trends in ITASE firn and ice cores from West Antarctica", Annals of Glaciology, p. 101, vol. 39, (204). Published

Bertler, N., Mayewski, P.A., Alberto Aristarain, P.Barrett, S.Becagli, et.al., "Snow chemistry gradients across the McMurdo Dry Valleys", Annals of Glaciology, p. 139, vol. 39, (2004). Published

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

Hamilton, G., "Topographic control of regional accumulation rate variability at South Pole and implications for ice-core interpretation", Annals of Glaciology, p. 214, vol. 39, (2004). Published

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Spikes, V.B., Hamilton, G.S., Arcone, S.A., Kaspari, S. and Mayewski, P.A, "Variability in accumulation rates from GPR profiling on the West Antarctic Plateau", Annals of Glaciology, p. 238, vol. 39, (2004). Published

- Arcone, S.A., V.B. Spikes and G.S. Hamilton, "Deformation of polar firn by differential accumulation and ice flow: interpretation of a 400-MHz short-pulse radar profile from West Antarctica", *Journal of Glaciology*, p. , vol. , (2005). Accepted
- Arcone, S.A., V.B. Spikes and G.S. Hamilton, "Stratigraphic continuity in 400-MHz radar profiles in West Antarctica", *Annals of Glaciology*, p. 195, vol. 39, (2004). Published
- Dixon, D., Mayewski P.A., Kaspari S.D., Kreutz K.J., Hamilton G.S., Maasch K., Sneed S.B., Handley M.J., "A 200-year sulfate record from sixteen Antarctic ice cores and associations with Southern Ocean sea ice extent", *Annals of Glaciology*, p. , vol. 41, (2005). Accepted
- Mayewski, P.A., Maasch, K.A., Yan, Y., Kang, S., Meyerson E.A., Sneed, S.B., Kaspari, S.D., Dixon D.A., Oestreberg, E.C., Morgan, V.I., van Ommen, T., and Curran, M.A.J, "Solar forcing of the polar atmosphere - Data, Mechanism, and Implications", *Annals of Glaciology*, p. , vol. 41, (2005). Accepted
- Arcone, S.A., V.B. Spikes, G.S. Hamilton, "Phase structure of radar stratigraphic horizons within Antarctic firn", *Annals of Glaciology*, p. , vol. 41, (2005). Accepted
- Kaspari, S.D., P.A. Mayewski, D.A. Dixon, S.B. Sneed, M.J. Handley, "Sources and transport pathways of marine aerosol species into West Antarctica", *Annals of Glaciology*, p. , vol. 41, (2005). Accepted
- Schneider, D.P., E.J. Steig, T. Van Ommen, "High resolution ice core stable isotopic records from Antarctica: towards interannual climate reconstruction ", *Annals of Glaciology*, p. , vol. 41, (2005). Accepted
- Steig, E.J., P.A. Mayewski, D.A. Dixon, S.D. Kaspari, M.M. Frey, D.P. Schneider, S. A. Arcone, G.S. Hamilton, V.B. Spikes, M. Albert, D. Meese, A.J. Gow, C.A. Shuman, J.W.C. White, S.B. Sneed, J. Flaherty, M. Wumkes, "High-resolution ice cores from US ITASE (West Antarctica): development and validation of chronologies and determination of precision and accuracy ", *Annals of Glaciology*, p. , vol. 41, (2005). Accepted
- Welch, B. & R. Jacobel, "Bedrock topography and wind erosion sites in East Antarctica, observations from the 2002 US-ITASE traverse ", *Annals of Glaciology*, p. , vol. 41, (2005). Accepted
- Yan, Y., Mayewski, P.A., Kang, S. and Meyerson, E.A, "An ice core proxy for Antactic circumpolar zonal wind intensity", *Annals of Glaciology*, p. , vol. 41, (2005). Accepted

Books or Other One-time Publications

Web/Internet Site

URL(s):

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

Description:

The US ITASE site is maintained by the University of Maine as the official science web site. Science and Implementation Plans, links to reserchers, abstracts of projects, field reports, and draft proposals are all available here. Daily logs from the team while they were in the field for the last 5 years along with photos 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.

The site "Secrets of the Ice" is maintained by the Boston Museum of Science, with the assistance of the Science Management Office, University of Maine, and contributions from US ITASE PIs. Resources for teachers, general information about Antarctica, and activities designed for school children are available on this site.

Other Specific Products

Contributions

Contributions within Discipline:

Data resulting from US ITASE will contribute to the understanding of the following disciplines within US ITASE: meteorology, geophysics, remote sensing, surface glaciology and ice cores.

Contributions to Other Disciplines:

Contributions from US ITASE will be important to climate modelers, glacier modelers, meteorologists, remote sensors, glaciologists, atmospheric chemists, and geophysicists.

Contributions to Human Resource Development:

All students involved have used the data or are using the data as part of their graduate program. Undergraduates have been invited to use data and the experience as the basis for senior thesis. Data collected as part of this program will be used as an integral part of a senior/graduate level course in Paleoclimate Analysis. Data is shared with other US ITASE colleagues in order to maximize multi-disciplinary interpretations, with NSIDC, NOAA Paleoclimatology and other ITASE national programs.

Contributions to Resources for Research and Education:

Data sets are regularly incorporated in upper level undergrad and grad courses. A data set was made available to the National Public Broadcasting' NOVA program for an activity included in their Teacher's Guide. US ITASE SMO personnel assisted with development, advised and reviewed the resulting lesson. Published in 'NOVA Spring 2003 Teacher's Guide p.18.

Contributions Beyond Science and Engineering:

Results from this project have direct implications for understanding change in climate and chemistry of the atmosphere. Antarctica provides the largest storehouse on Earth for the recovery of such information. Scientific results from this project are presented to the public several times per year. Focus for talks deals with Antarctica's unique resources (eg., fresh water, marine biology), the continent's influence on the rest of the Earth (eg., through controls on oceanic and atmospheric circulation) and, the continent's vulnerability to human activities (eg., CFC influence on the Antarctic ozone hole and human source acidity and toxics in the Antarctic atmosphere).

Categories for which nothing is reported:

Any Book

Any Product

US ITASE Scientific Findings

A listing of scientific products (abstracts, papers, reports) and findings produced by research teams involved in US ITASE is available at

www.ume.maine.edu/USITASE/index.html

Among the scientific accomplishments of US ITASE are:

- (1) high resolution detailing of surface and deep radar reflectors as continuous time stratigraphic 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 major ions over west Antarctica and relationship to sources
- (6) ice core reconstructions of seasonal, inter-annual and decadal scale variability in accumulation rate, temperature, atmospheric circulation, volcanic activity, and sea ice extent and relation to models
- (7) identification of ENSO, ACW (Antarctic circumpolar Wave), PDO (Pacific Decadal Oscillation), EAH (East Antarctic High), and ASL (Amundsen Sea Low) atmospheric circulation structure in glaciochemical time-series and implications and relationship to models and forcing (notably solar variability)
- (8) assessment of modern global climate change (short-term variability in snowfall, temperature, and atmospheric circulation, pollution) in the context of decadal to centennial-scale variability
- (9) deconvolution of local-scale variability in ice core-derived accumulation rate compared to regional scale variability
- (10) glaciological reconnaissance for deep drilling
- (11) high resolution mapping of subglacial topography in previously unexplored regions
- (12) characterization of ice flow dynamics based on deformation of internal stratigraphy, basal and ice surface topography
- (13) characterization of basal reflectivity based on changes in basal temperature and/or geology
- (14) 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
- (15) air sampling in the interior of West Antarctica and air snow processes
- (16) snow and firn permeability and microstructure measurements at locations with greatly differing accumulation rates and average temperature
- (17) 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