


6-3-2003

Antarctic Oversnow Traverse-based Southern Hemisphere Climate Reconstruction

Paul Andrew Mayewski

University of Maine, paul.mayewski@maine.edu

Follow this and additional works at: https://digitalcommons.library.umaine.edu/ers_facpub

 Part of the [Atmospheric Sciences Commons](#), [Climate Commons](#), [Geochemistry Commons](#), [Glaciology Commons](#), and the [Hydrology Commons](#)

Repository Citation

Mayewski, Paul Andrew, "Antarctic Oversnow Traverse-based Southern Hemisphere Climate Reconstruction" (2003). *Earth Science Faculty Scholarship*. 253.

https://digitalcommons.library.umaine.edu/ers_facpub/253

This Article is brought to you for free and open access by DigitalCommons@UMaine. It has been accepted for inclusion in Earth Science Faculty Scholarship by an authorized administrator of DigitalCommons@UMaine. For more information, please contact um.library.technical.services@maine.edu.

of the observational evidence. This evidence from two solar cycles of radiometry, and from various diagnostics of solar and stellar luminosity variation, so far reveals no direct evidence for any luminosity variation exceeding that produced by photospheric magnetic structures.

However, the increasing evidence of positive correlation of climate and solar activity is of sufficient societal importance that we cannot rule out multi-decadal variations in S sufficiently large to influence climate, yet overlooked so far through limited sensitivity and time span of our present observational techniques. For instance, global changes in solar plasma opacity driven by changing surface magnetism might generate significant luminosity variation roughly proportional to slow trends in solar activity level, yet elude the measurements used so far.

Interesting instrumental advances are now becoming available to pursue this important problem. Cryogenic radiometers an order of magnitude more accurate than the ambient-temperature pyrheliometers used on present NASA satellites have been in routine use in national and industrial standards laboratories for a decade. This technology should be tried in space, where it could help remove the troubling, long-term drifts that still limit our ability to discern slow trends in S.

We would also benefit greatly from imaging the Sun's disc with a telescope and detector capable of accepting the same wide spectral range of solar radiation absorbed by the radiometric cavities used to measure S. Then

we could directly subtract the variation due to spots and faculae from the radiometric signal, to look for residual trends. These might be small over 11 years, yet dominate over multi-decadal time scales of greatest relevance to climate change. Recent developments in uncooled thermal imaging arrays make possible such a novel solar irradiance imager [Foukal and Libonate, 2001] that is now being prepared for first flight on a stratospheric balloon.

Deployment in space of these complementary technologies should enable us to determine relatively quickly whether forcing of climate by variations of S remains the most likely explanation of the observed Sun-climate correlation. More detailed studies of Sun-like stars, helioseismic monitoring of the solar interior, and other diagnostics of solar convective heat flow would also be useful. Interesting investigations of climate sensitivity to the small irradiance changes so far observed, and of processes driven by variable solar UV or plasma outputs, are being actively pursued. But they involve more complex processes in the stratosphere and troposphere that we are less likely to understand soon enough to act decisively on global warming.

References

Bond, G., et al., Persistent solar influence on North Atlantic climate during the Holocene, *Science*, 294, 21–30, 2001.
 Eddy, J., The Maunder Minimum, *Science*, 192, 1189, 1976.

Foukal, P., L. Fowler, and M. Livshits, A thermal model of sunspot influence on solar luminosity, *Astrophys. J.*, 267, 863, 1983.
 Foukal, P. and S. Libonate, A total light imager with flat spectral response for solar photometric measurements, *Appl. Opt.* 40, 1138, 2001.
 Foukal, P. and L. Milano, A measurement of the quiet network contribution to solar irradiance variation, *Geophys. Res. Lett.*, 28, 883, 2001.
 Foukal, P., A comparison of variable solar total and ultraviolet irradiances in the 20th century, *Geophys. Res. Lett.*, 29, 23, doi 10.1029/2002GL015474, 2002.
 Hoyt, D. and K. Schatten, A discussion of plausible solar irradiance variations, *J. Geophys. Res.*, 98, 18,895, 1993.
 Lean, J., J. Beer, and R. Bradley, Reconstruction of solar irradiance since 1610, *Geophys. Res. Lett.*, 22, 3195, 1995.
 Livingston, W., and Wallace, L., The Sun's immutable basal quiet atmosphere, *Solar Phys.*, 212, 227, 2003.
 Radick, R., Invited review on Luminosity variation of Sun-like stars presented at the AGU Spring Meeting, Boston, Mass., June 2001.
 Spruit, H., Effect of spots on a star's radius and luminosity, *Astr. Ap.*, 108, 348, 1982.
 Woodard, M. and K. Libbrecht, Spatial and temporal variations in solar brightness, *Solar Phys.*, 212, 51, 2003.

Author Information

Peter Foukal, Heliophysics, Inc., Nahant, Mass.;
 E-mail: pfoukal@world.std.com

Antarctic Oversnow Traverse-based Southern Hemisphere Climate Reconstruction

PAGES 205, 210

On 2 January 2003, the U.S. component of the International Trans Antarctic Scientific Expedition (U.S. ITASE) (Figure 1) arrived at the South Pole after completing more than 5000 km of oversnow traverses that included much of west Antarctica and a portion of east Antarctica (Figure 2). During the traverses, which were performed from 1999 through 2003, U.S. ITASE focused on collecting data that will allow the reconstruction of sub-annual scale climate variability and changes in the chemistry of the atmosphere over the last 200+ years.

ITASE is a multi-disciplinary research program supported by 19 nations and 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 U.S. 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

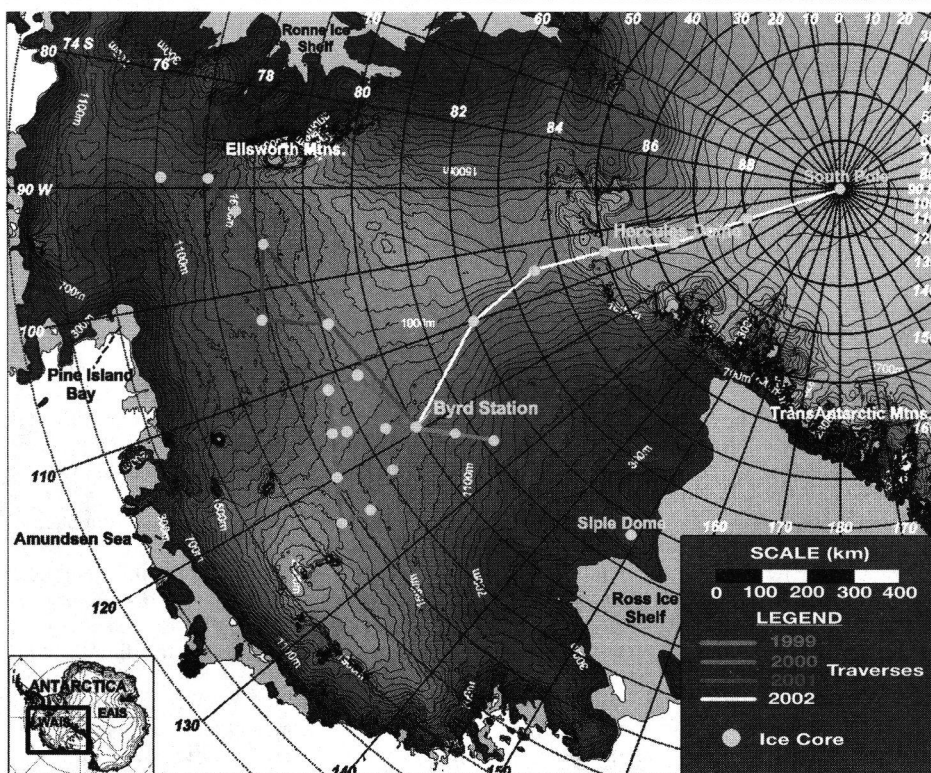


Fig. 1. U.S. ITASE traverse routes are shown, and core sites superimposed on the digital elevation model [Liu et al., 2000]. (Prepared by Blue Spikes, University of Maine.) Original color image appears at back of volume.

and Engineering Laboratory-U.S. Army, Desert Research Institute, NASA, Ohio State University, St. Olaf College, the University of Arizona, the University of Colorado, the University of Maine,

and the University of Washington. Information concerning climate variability in the middle and high latitudes of the southern hemisphere is obtained by U.S. ITASE, through calibrations

developed between U.S. 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 El Niño Southern Oscillation (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 Niños changed in the late 20th century relative to earlier periods.

Another important goal is to better understand the Antarctic Oscillation (AAO), which is 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. U.S. ITASE also contributes to our knowledge of current and future projected changes in sea level by improving understanding of ice sheet mass balance. The U.S. 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 that currently accounts for the greatest uncertainty in global estimates of ice sheet contributions to sea level change.

U.S. ITASE offers the ground-based opportunities of traditional-style traverse travel coupled with the modern technology of the Global Positioning System, ice radar, atmospheric sampling, and satellite communications.

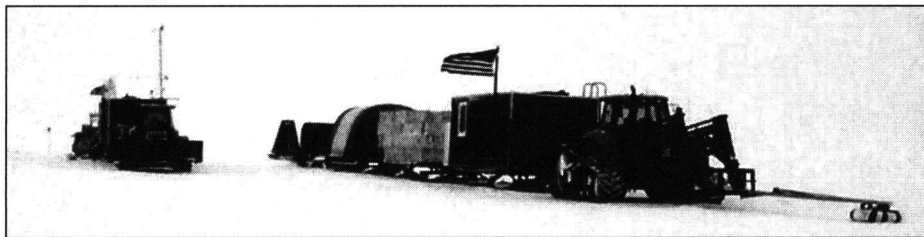


Fig. 2. U.S. ITASE traverse tractors and sleds are shown; crevasse detection equipment is mounted on lead tractor. Sleds contain berthing, kitchen, fuel drums, scientific equipment, and ice cores. Original color image appears at back of volume.

By operating as an over-snow traverse, U.S. ITASE offers scientists the opportunity to experience the dynamic range of the Antarctic environment. Most important, the combination of disciplines represented by U.S. ITASE provides a unique, multi-dimensional view of the ice sheet and its history. U.S. ITASE has sampled the environment of west 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).

Continued U.S. ITASE research, future proposed U.S. ITASE traverses, and collaboration with our international ITASE colleagues will provide unprecedented knowledge of past Antarctic and southern hemisphere climate variability, Antarctic ice sheet variability, and improve prediction capability in the next several years. For a more detailed description of U.S. ITASE science activities and results, see www.ume.maine.edu/USITASE/. For a more detailed description of the field program, see www.secretsoftheice.org.

References

- Kreutz, K. J., P. A. Mayewski, I. I. Pittalwala, L. D. Meeker, M. S. Twickler, and S. I. Whitlow, Sea-level pressure variability in the Amundsen Sea region inferred from a West Antarctic glaciochemical record, *J. Geophys. Res.*, 105, 4047–4059, 2000.
- Liu, H., K. Jezek, and B. Li, Radarsat Antarctic Mapping Project Digital Elevation Model, National Snow and Ice Data Center, Boulder, Colorado, 2000.
- Mayewski, P. A., and I. Goodwin, ITASE Science and Implementation Plan, Joint PAGES/GLOCANT Report, 1997.
- Meyerson, E. A., P. A. Mayewski, S. I. Whitlow, L. D. Meeker, K. J. Kreutz, and M. S. Twickler, The extratropical expression of ENSO recorded in a South Pole glaciochemical time series, *Ann. Glaciol.*, 35, 430–436, 2002.
- Schneider, D. P., and E. J. Steig, Spatial and temporal variability of Antarctic ice sheet microwave brightness temperatures, *Geophys. Res. Lett.*, 29, 20, doi:10.1029/2002GL015490, 2002.
- Welch, B. C., and R. W. Jacobel, Analysis of deep-penetrating radar surveys of West Antarctica, U.S. ITASE 2001, *Geophys. Res. Lett.*, 33, 8, 1444, doi: 10.1029/2003GL017210, 2003.

—PAUL ANDREW MAYEWSKI, Climate Change Institute, University of Maine, Orono

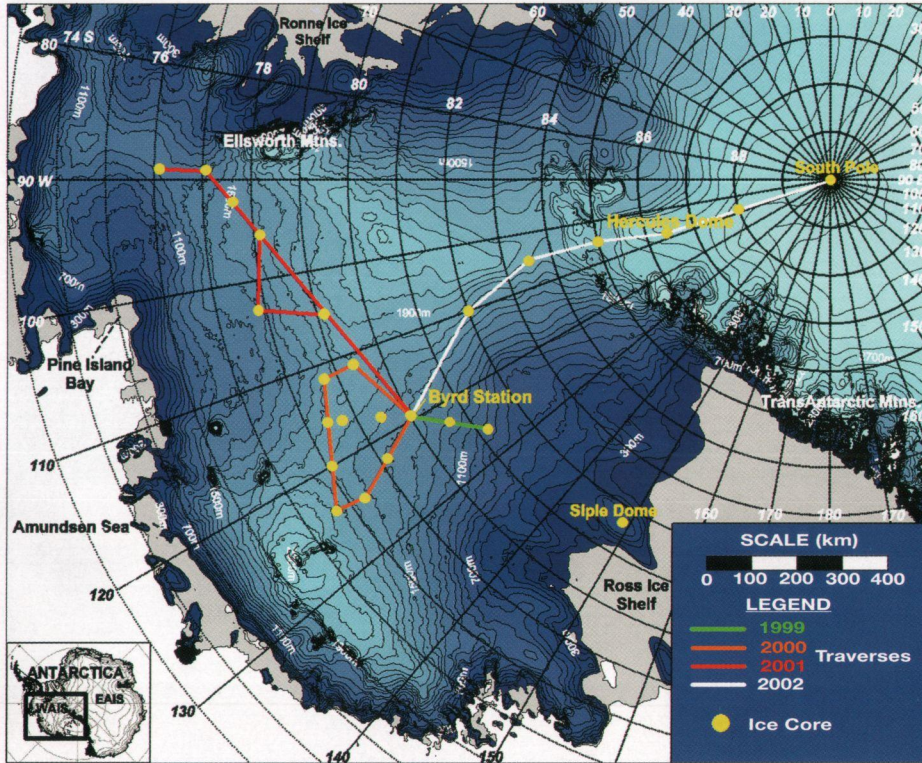


Fig. 1. U.S. ITASE traverse routes are shown, and core sites superimposed on the digital elevation model [Liu et al., 2000]. (Prepared by Blue Spikes, University of Maine.)



Fig. 2. U.S. ITASE traverse tractors and sleds are shown; crevasse detection equipment is mounted on lead tractor. Sleds contain berthing, kitchen, fuel drums, scientific equipment, and ice cores.