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(ESH) Holocene Climate Variability

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Final Report for Period: 07/2000 - 08/2002
Submitted on: 08/08/2002
Principal Investigator: Mayewski, Paul A.
Award ID: 0096331
Organization: University of Maine
Title:
(ESH) Holocene Climate Variability

Project Participants

Senior Personnel

Name: Mayewski, Paul
Worked for more than 160 Hours: Yes
Contribution to Project:
PI in overall charge of project.

Name: Meeker, Loren
Worked for more than 160 Hours: Yes
Contribution to Project:
co_PI in charge of statistical analyses.

Post-doc

Name: Kang, Shichang
Worked for more than 160 Hours: Yes
Contribution to Project:
Involved in preparation of manuscripts as first and co-author

Graduate Student

Name: Souney, Joe
Worked for more than 160 Hours: Yes
Contribution to Project:
MSc student project dedicated to developing glaciochemical rec9ord from Law Dome ice core, Antarctica.

Name: Horsman, Jennifer
Worked for more than 160 Hours: Yes
Contribution to Project:
MSc student project dedicated to conducting statistical analyses on Mt. Logan ice core, Yukon Territory.

Name: Kaspari, Susan
Worked for more than 160 Hours: Yes
Contribution to Project:
Assisted in procesing

Name: Meyerson, Eric
Worked for more than 160 Hours: Yes
Contribution to Project:
Assisted in processing and utilized data for thesis papers.

Undergraduate Student

Name: Story, Susan
Worked for more than 160 Hours: Yes
Contribution to Project:
Assisted in core processing

Technician, Programmer

Name: Sneed, Sharon
Worked for more than 160 Hours: Yes
Contribution to Project:
In charge of chemical analyses.

Name: Michael, Handley
Worked for more than 160 Hours: Yes
Contribution to Project:
Assisted with IC analyses and core processing

Other Participant

Research Experience for Undergraduates

Organizational Partners

Geological Survey of Canada
Collaboration concerning interpretation of Mt. Logan ice core.

Australian Antarctic Division
Provided access to and expertise related to Law Dome ice core.

University of Newcastle
Close collaboration with a faculty member - Ian Goodwin

University of Colorado at Boulder
Collaboration with facult member - Jim White

Chinese Academy of Sciences
Collaboration with several researchers on paper writing - including Qin Dahe, Xiao Cunde, Hou Shugui

Stockholm University
Collaboration on papers with faculty - Wibjorn Karlen

Southampton Oceanography Center
Collaboration on papers with faculty - Eelco Rohling

Paul Smiths College
Collaborate on papers with faculty - Curt Stager

Other Collaborators or Contacts

Ian Goodwin - University of Newcastle, Australia
Vin Morgan - Australian Antarcic Division
Tas van Ommen - Australian Antarctic Division
Mark Curran - Australian Antarctic Division
Roy Koerner - Geological Survey of Canada
Dave Fisher - Geological Survey of Canada
Curt Stager - Paul Smiths College
Wibjorn Karlen - Stockholm University
Eelco Rohling - Southampton Oceanography Center

Activities and Findings

Research and Education Activities:

With the successful completion of deep drilling at Summit Greenland there is now a well-dated, high resolution, multi-parameter record of climate change (response and forcing) for the Northern Hemisphere that covers the last glacial cycle. This record reveals evidence of rapid and dramatic change in climate. Recent examination of the Holocene portion (last 11,500 years) of the Greenland record has demonstrated that, while relatively stable by comparison with glacial age climate, the Holocene does contain subdued versions of glacial age millennial scale and rapid climate change events. The Holocene is also characterized by significant annual to centennial scale variability plus significant and complex climate forcing and response histories. Understanding Holocene climate is essential to the differentiation of natural versus anthropogenic climate response and forcing and to any prediction of future climate.

Scientific questions dealt with in this proposal focus primarily upon seeking an understanding of natural climate variability over the North Atlantic and Antarctica. Both areas contain well-preserved records in the form of ice cores which can be compared to existing records of climate variability from many other locations. The ultimate goal is to characterize changes in atmospheric circulation over these regions and contribute to understanding those factors which control their regional climate.

To address these objectives we propose to further refine and expand our investigation of the Holocene GISP2 ice core glaciochemical record and utilize several other existing paleoclimate records (e.g., ice cores, marine sediments) for comparison. Well-dated, continuous Holocene climate records from the Antarctic are rare and large region-to-region differences are expected over the continent. Thus, we plan to develop a bipolar comparison by utilizing records developed from our involvement in the Siple Dome (West Antarctica) ice core and an East Antarctic glaciochemical record being developed from Law Dome in collaboration with Australian colleagues.

Our adds a new dimension to the classic stable isotope-temperature reconstruction of climate by defining, through the examination of glaciochemical series, complementary measures of variability in atmospheric circulation.

We have extended the goals of our initial project to also include the analysis and interpretation of an ice core from Mt. Logan, Yukon Territory (collected 1980) plus interpretation of a 40 m core from Mt. Everset, plus comparison of a variety of ice core records from this project and others with 50 published Holocene length records of climate forcing and response.

Findings:

(1) Developed a glaciochemical proxy for the East Antarcti8c High, the major high pressure system centered on Antarctica.
(2) Developed a glaciochemical proxy for the Aleutian Low, a major atmospheric feature of the North Pacific.
(3) Compared the last 700 years of climate variability assessed from three Antarctic ice cores to assess potential behavior and forcing of modern Antarctic climate, demonstrating ENSO and Pacific Decadal Oscillation patterns.
(4) Compared 50 records of Holocene climate variability from our ice core records plus marine, lake, cave, and terrestrial paleoclimate records to assess major styles of climate variability during the Holocene and most likely controls on this variability.
(5) Investigated the influence of solar forcing on several 2000 year long, globally distributed record through direct comparison of the 14C proxy for solar variability and the response records.

Training and Development:

(1) Project results were integral to the following student projects:
Joe Souney (MSc)
Jennifer Horsman (MSc)
Eric Meyerson (PhD)
Shichang Kang (post-doc)

(2) Data used in courses taught be PI and co-PI, notably graduate level Paleoclimate Analysis and Climate Analysis with emphasis on environmental statistics, climatology, and geochemistry.

(3) Sample analysis and core processing for this project led to new techniques for rapid, high resolution, glaciochemical analyses advanced by technical staff on project (Sneed and Handley).

(4) Project led to several multi-author papers from a diverse array of disciplines and institutions that allowed paleoclimate synthesis well beyond that originally proposed for this project.

Outreach Activities:

Results of project used frequently in public lectures (K-8, civic groups).
Research results part of IGBP symposium dedicated to sustainability in Amsterdam (July. 2001).
Results of potential significance in determining potential patterns of drought in Australia via teleconnection betyween Antarctic and Australian climate.
Results utilized in book prepared for the public that documents climate change - 'The Ice Chronicles' by Paul Andrew mayewski and Frank

White (rated #41 on Amazon.com at peak).
Results utilized in several media channels, eg., Fresh Air NPR, The Environment NPR, Archaeology Magazine.

Journal Publications

Meyerson, E.A., Mayewski, P.A. and Kreutz, K.J., "Variance decomposition of Antarctic sea ice extent time series.", Journal of Climate, p. , vol. , ( ). final preparation

Stager, J.C. and Mayewski, P.A., "Century- to millennium-scale insolation cycles, monsoons, and the dessication of Lake Victoria, East Africa.", Science, p. , vol. , ( ). Submitted

Stager, J.C. and Mayewski, P.A., "Late Holocene aridity at Lake Victoria, East Africa, linked to ~500 year cycles, polar winds and variable sun.", Science, p. , vol. , ( ).

Stager, J.C., Mayewski, P.A. and Meeker, L.D., "Cooling cycles, Heinrich events, and the dessication of Lake Victoria.", Science, p. , vol. , ( ).

Meeker, L.D. and Mayewski, P.A., "A 1400 year long record of atmospheric circulation over the North Atlantic and Asia.", Holocene, p. 257, vol. 12, (2002). Published

Meyerson, E.A., Mayewski, P.A., Whitlow, S.I., Meeker, L.D.and Kreutz, K.J. and Twickler, M.S., "The extratropical expression of ENSO recorded in a South Pole glaciochemical time series.", Annals of Glaciology, p. , vol. , ( ). Accepted

Steig, E.J., Morse, D.L., Waddington, E.D., Stuiver, M., Grootes, P.M., Mayewski, P.A., Twickler, M.S. and Whitlow, S.I., "Wisconsinan and Holocene climate history from an ice core at Taylor Dome, western Ross Embayment, Antarctica", Geografiska Annaler, p. 213, vol. 82A, (2000). Published

Alley, R.B., Mayewski, P.A. and Saltzman, E.S., "Increasing North Atlantic climate variability recorded in a central Greenland ice core, Polar Geography.", Pola rGeography, p. , vol. , ( ). Accepted

Mayewski, P.A., Meyerson, E., Souney, Kreutz, K., Morgan, V., van Ommen, T., and Goodwin, I., "Antarctic multi-decadal scale climate variability.", Climate Dynamics, p. , vol. , ( ). Submitted

Mayewski, P.A., Rohling, E., Stager, C., KarlÚn, K., Maasch, K., Meeker, L.D., Meyerson, E., Gasse, F., van Kreveld, S., Holmgren, K., Lee-Thorp, J., Rosqvist, G., Rack, F., Staubwasser, M., and Schneider, R.,, "Holocene climate variability.", Climate Dynamics, p. , vol. , ( ). Submitted

Souney, J., Mayewski, P.A., Morgan, V., van Ommen, T., and Goodwin, I.
, "A late Holocene climate record from Law Dome, East Antarctica.", Journal of Geophysical Research, p. , vol. , ( ). Accepted

Murphy, A.M. , G.A. Zielinski, C.P. Wake, P.A. Mayewski, R.M. Koerner, D.A. Fisher, "A glaciochemical proxy of the Canadian North Water Polynya", A glaciochemical proxy of the Canadian North Water Polynya, p. , vol. , ( ). Accepted

Rohling, E.J., Mayewski, P.A. and Challenor, P, "On the timing and mechanism of millennial-scale climate variability during the last glacial cycle", Climate Dynamics, p. , vol. , ( ). Accepted

Rohling. E., Mayewski, P.A., Abu-Zeid, R,.H., Casford, J.S.L., and Hayes, A, "Holocene atmosphere-ocean interactions: records from Greenland and the Aegean Sea", Climate Dynamics, p. 587, vol. 18, (2002). Published

Goodwin, I.D., Mayewski, P.A., and Curran, M.,, " Antarctic ice core evidence of Holocene circumpolar circulation variability", The Southern Hemisphere Westerlies in the PEPII transect: A synthesis of progress and pitfalls, p. , vol. , ( ). Accepted

Palmer, A.S., Van Ommen, T., Curran, M.A., Morgan, V., Souney, J., and Mayewski, P.A.,, "High-precision dating of volcanic events (AD 1301-1995) using ice cores from Law Dome, Antarctica", Jour. Geophys. Res, p. 28080, vol. 106, (2001). Published

Dawson, A., Elliott, L., Mayewski, P.A., Lockett, P., Noone, S., Hickey, K., Holt, T., Wadhams, P., and Foster, I.,, "Late Holocene North Atlantic climate "seesaws" and Greenland ice sheet (GISP2) paleoclimates", Holocene, p. , vol. , ( ). Submitted

Gill, R. Hodell, D., and Mayewski, P.A.,, "Drought and the Maya Collapse", Archaeology, p. , vol. , ( ). Submitted

Palmer, A.S., Morgan, V., Curran, M.J., van Ommen, T.D., and Mayewski, P.A.,, "Antarctic flux ratios from Law Dome", Annals of Glaciology, p. , vol. 35, ( ). Accepted

Curran, M.J., Palmer, A.S., van Ommen, T.D., Morgan, V., Phillips, K.L., McMorrow, A.J., and Mayewski, P.A.,, "Post-depositional methanesulphonic acid movement in Law Dome and the effect of accumulation rate", Annals of Glaciology, p. , vol. 35, ( ). Accepted

Kang, S., Mayewski, P.A., and Yan, Y.,, "Spring aerosol transport patterns inferred from relationships between dust records from three ice cores and atmospheric circulation over the Northern Hemisphere", Jour. Geophys. Res., p. , vol. , ( ). Submitted

Kang, S., Mayewski, P.A., and Yan, Y.,, "20th century intensification of the Aleutian Low", Science, p. , vol. , ( ). Submitted

Maasch, K., Mayewski, P.A., Rohling, E., Stager, C., KarlÚn, K., Meeker, L.D., and Meyerson, E.,, "Climate of the past 2000 years", Nature, p. , vol. , ( ). Submitted

Books or Other One-time Publications

Mayewski, P.A. and White, F., "The Ice Chronicles", (2000). Book, Accepted
Editor(s): University of New England Press
Bibliography: not yet available

Mayewski, P.A., "An Ice Core Time Machine", (2001). Book, Published
Editor(s): Mathez, E.A.
Collection: American Museum of Natural History
Bibliography: American Museum of Natural History

Web/Internet Site

URL(s):

http://www.ngdc.noaa.gov/paleo/icgate.html
www.ume.maine.edu/iceage

Description:

NGDC site contains data released thus far from this project. More will be exported to the website once all project related papers are in press or within next one year, whichever comes first.

UMaine site contains information re projects, pictures, related information

Other Specific Products

Contributions

Contributions within Discipline:

We have developed sea level pressure proxies for major atmospheric circulation systems in Antarctica, the North Pacific, the North Atlantic, and southeast Asia that expand by several hundred years the observed instrumental series for these regions.

We have developed perhaps the most comprehensive summary and interpretation of Holocene climate variability thus far available.

Contributions to Other Disciplines:

same as within disciple:

We have developed sea level pressure proxies for major atmospheric circulation systems in Antarctica, the North Pacific, the North Atlantic, and southeast Asia that expand by several hundred years the observed instrumental series for these regions.

We have developed perhaps the most comprehensive summary and interpretation of Holocene climate variability thus far available.

Contributions to Human Resource Development:

Results of our Law Dome ice record may potentially be of use to predicting periods of drought in Australia.

We have developed sea level pressure proxies for major atmospheric circulation systems in Antarctica, the North Pacific, the North Atlantic, and southeast Asia that expand by several hundred years the observed instrumental series for these regions.

We have developed perhaps the most comprehensive summary and interpretation of Holocene climate variability thus far available.

Contributions to Resources for Research and Education:

Data from this project were utilized for one completed MSc thesis (Souney, 2000), one nearly completed MSc thesis (Horsman) (S. Kang), one PhD thesis (Meyerson, 2003), and one post-doc.

Data is used in classes taught by PI and co-PI.

Contributions Beyond Science and Engineering:

Rsults from this project were instrumental in the production of a book written by Paul Andrew Mayewski and Frank White, entitled: The Ice Chronicles. The book is designed so that the interested public can put major issues of modern environmental change in a longer term perspective that is based upon ice core research. The book has recieved considerable praise in print and radio venues and at its peak was #41 on Amazon.com. Since release 1 April 2002 the book has gone through three printings because of demand.

Categories for which nothing is reported:

Any Product