Prospectus for Synthesis and Assessment Product 3.4

Abrupt Climate Change

Lead Agency: USGS
Supporting Agencies: NOAA, NSF

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1. Overview: Description of Topic, Audience, Intended Use, and Questions to be addressed

1.1 Description of Topic

This prospectus provides an implementation plan for developing and producing Climate Change Science Program (CCSP) Synthesis and Assessment Product 3.4, "*Abrupt Climate Change.* " Paleoclimate records of climate and environmental change derived from archives such as tree rings, ice cores, corals, speleothems and sediments indicate that global and regional climate has experienced repeated abrupt changes, many occurring over a time span of decades or less. The National Research Council (NRC) report "Abrupt Climate Change" (Alley, et al., 2002) offers two definitions of abrupt climate change. A mechanistic definition defines abrupt climate change as "*Transition of the climate system into a different state (of temperature, rainfall, and other aspects) on a time scale that is faster than the responsible forcing*." This definition implies that abrupt climate changes involve a threshold or non-linear feedback within the climate system from one steady state to another. An impacts-based definition defines abrupt climate change as "*Change of the climate system that is faster than the adaptation time of social and/or ecosystems*." Abrupt climate changes might have a natural cause (such as volcanic aerosol forcing), an anthropogenic cause (such as increasing carbon dioxide in the atmosphere), or might be unforced (related to internal climate variability). Regardless of the cause, abrupt climate change presents potential risks for society that are poorly understood. An improved ability to understand and model future abrupt climate change is essential to provide decision-makers with the information they need to plan for these potentially significant changes.

Current research on abrupt climate change is focused on documenting evidence of past abrupt climate change, refining the temporal and geographic extent of the change, proposing mechanisms to explain the change, and performing atmosphere-ocean model experiments. Examples of abrupt climate change that have received special attention include the Younger Dryas cold reversal event that occurred during the last deglaciation, the rapid onset of widespread periods of drought that have been documented in hydrologic records of the past 2,000 years in the American West, and abrupt shifts in modes of ocean-atmosphere interaction (e.g., El Nino-Southern Oscillation and the Arctic Oscillation) seen in both paleo and instrumental records. Although the Younger Dryas event occurred during a time when a large ice sheet was present on North America, causing some to question whether an event of comparable magnitude could occur in the near future, understanding its cause is critical if we are to evaluate scenarios of future climate change.

Abrupt climate changes can affect regions or the entire globe. Many of the abrupt changes examined so far are regional rather than global in extent. Such abrupt changes reflect reorganizations of the climate system from one stable state to another, and are characterized by changing patterns in the transfer of heat and energy with accompanying shifts in temperature, precipitation, winds, and other variables. For example, one region may warm as another cools, or become drier as another becomes wetter. Regional impacts could be large while the global mean change is small. In the modern world of increasing population and limited resources, regional changes are particularly significant in terms of the challenges or risks that they pose to society. Abrupt climate changes with either regional or global impacts will be considered in this assessment.

Much debate exists as to what types of climate change should be considered under the umbrella of abrupt climate change. The El Nino-Southern Oscillation (ENSO) and Arctic Oscillation (AO) are examples of climate processes that appear to have different stable modes. Typically, as these processes develop, climate variables such as temperature and sea level pressure remain in one mode for a period of time, change to a different mean state, and change back again. Proponents argue that different stable modes exist, and that the shift between modes constitutes an abrupt climate change. The contrary view questions whether stable modes exist at all, or argues that these changes do not fit the definition of an abrupt climate change event. This assessment follows the lead of the NRC report in including these processes under the umbrella of abrupt climate change, and supports the NRC recommendation to examine in more detail the processes that could lead to different modes of ocean-atmosphere interaction.

Abrupt climate changes can be accompanied by a change in the frequency of extreme events such as hurricanes, heat waves, droughts and floods. In a changing climate, an abrupt increase in extreme event frequency might be far more difficult to adapt to compared to a gradual increase. For this reason, we include abrupt changes in extreme event frequency within report 3.4 and exclude gradual changes in extreme event frequency. Climate extremes are the subject of Synthesis and Assessment Product 3.3, "*Weather and Climate Extremes in a Changing Climate.*"

1.2 Intended Use and Audience

This CCSP Synthesis and Assessment Product will be in the form of a report that (a) summarizes the present status and key findings of national and international research on abrupt climate change, and (b) discusses the strengths and limitations of existing knowledge for describing and analyzing the risks of abrupt climate change. Abrupt climate change research is in an immature stage: processes are still being identified; gaps exist in the archive of paleoclimate data; new records are currently being developed; and modeling efforts are evolving. The analysis of probability (of a specific change occurring), recently pioneered for global warming predictions (Knutti, et al., 2002), has yet to be applied to abrupt climate change. For these reasons we expect the report to be most useful to those seeking to understand what is currently known and, conversely, what is not known about the climate processes that can lead to abrupt climate change.

1.3 Questions to be Addressed

The paleoclimate record contains many examples of abrupt climate change. The NRC report on Abrupt Climate Change considered a broad array of processes and impacts to explain past and potential future instances of abrupt climate change. This Synthesis and Assessment Product will consider four types of change documented in the paleo record that stand out as being so rapid and large in their impact that they pose clear risks to society in terms of our ability to adapt. They are supported by sufficient evidence that hypotheses can be tested and risks investigated, and the research indicates that the changes could occur in the future. These changes are i) alterations of the ocean meridional overturning circulation; ii) widespread and sustained hydrologic changes to the hydrologic cycle; iii) rapid release to the atmosphere of methane trapped in permafrost and continental shelves; iv) rapid change in ice sheet mass. Note that the processes listed above closely correspond to question 4.3 from the CCSP Strategic Plan, which reads: "What is the likelihood of abrupt changes in the climate system such as the collapse of the ocean thermohaline circulation, inception of a decades-long mega-drought, or rapid melting of the major ice sheets?"

i. Meridional Overturning Circulation change and influence on climate

The Atlantic Ocean is characterized by a meridional overturning circulation (MOC) that has an important effect on the climate of the surrounding continents. The wind-driven surface circulation transports water northward in the North Atlantic, where it loses heat to the atmosphere, becomes denser and sinks in the Nordic and Labrador Seas, forming a southward-flowing subsurface water mass that eventually fills the North Atlantic as the North Atlantic Deep Water mass between 2,000-4,000 m (Talley, 1996). Much of this deep water eventually returns to the surface Atlantic via the Pacific and Indian Oceans, forming what has been alternately termed the meridional overturning circulation, the global conveyor belt or thermohaline circulation (THC). There is evidence that the overturning in the Atlantic is not independent but is instead coupled to other aspects of the climate. Independent of possible coupling, there is some evidence and ongoing research to investigate whether the impacts of the Atlantic MOC are global in extent.

One of the most remarkable discoveries in the field of paleoclimatology has been the observed coincidence between the glacial climate state and reduced or altered MOC in the North Atlantic, as observed in paleo proxies for the deep ocean circulation (McManus, et al., 2004). In contrast, the present interglacial climate state is characterized by vigorous meridional overturning, which through global feedback promotes a vigorous northeastward flow of warm surface waters of the Gulf Stream (and North Atlantic Drift) across the North Atlantic, which, in turn, sustains more equable climates in Europe. While the paleo record is still incomplete, evidence exists that some of the abrupt climate changes that occurred during the last glacial interval, such as the Dansgaard-Oeschger cycles, and during the deglacial period, such as the Younger Dryas, were caused or amplified by changes in overturning circulation. These observations motivate the paleoclimate community to improve our understanding of the overturning circulation, how it has varied in the past, what the dominant controls have been, and how widespread are the impacts.

Key parameters that influence ocean circulation are expected to change in the future. Most simulations of future climate predict a slowdown of the thermohaline circulation in response to increasing greenhouse gases in the atmosphere. As the climate warms due to the increase in greenhouse gases, the North Atlantic surface ocean will also warm and become fresher due to melting of margins of the Greenland ice sheet and precipitation increases in the mid-latitude North Atlantic. Both increasing temperature and decreasing salinity reduce the density of the North Atlantic surface ocean, hindering the convective sinking of the water and thus inducing a slowdown of the MOC. Some climate models predict an eventual complete shutdown of the overturning simulation, a change that might be permanent if the circulation has different stable states. But many different processes and feedbacks affect this circulation, leading to considerable uncertainty in these projections that must be evaluated from a combination of observational, process-based, and modeling studies. From the perspective of risk, one of the most important aspects of the MOC is the existence of a threshold level, beyond which North Atlantic surface water becomes too buoyant to convect, providing a sound conceptual basis for abrupt climate change.

The primary questions to be addressed in this section of the report are:

- What are the factors that control the overturning circulation?
- How well do the current ocean general circulation models (and coupled atmosphere-ocean models) simulate the overturning circulation?
- What is the evidence for change in the overturning circulation in the past?
- What are the global and regional impacts of a change in the overturning circulation?
- What factors that influence the overturning circulation are likely to change in the future, and what is the probability that the overturning circulation will change?
- What are the observational and modeling requirements required to understand the overturning circulation and evaluate future change?

The primary value of this section for decision-makers and policy-makers will be to provide a summary of the present level of scientific understanding and remaining uncertainties in identifying and describing the factors that influence the thermohaline circulation and its regional and global impacts.

ii. Rapid changes to the hydrologic cycle

Accurate forecasts of seasonal precipitation change are critical for managing water resources throughout the world, especially in water-stressed regions such as the American West and northern Africa. Such forecasts have also proven to be crucial in the mitigation of floods and landslides. Measurements from satellites and oceanic and atmospheric monitoring are used in developing and testing sophisticated model forecasts. In recent years, significant advances have been made in predicting precipitation in the western US using Pacific and Atlantic sea surface temperatures. These analyses assume that future variability in these parameters will be similar to that which has been experienced during the past 100 years (the reanalysis period).

During 2002, more than 50 percent of the coterminous US experienced moderate to severe drought conditions. Detailed study of the North American paleoclimate record of the past 2,000 years, however, has revealed numerous periods of extended drought exceeding in duration and geographic extent the 7-year-long, epic drought of the 1930s Dust Bowl. For example, a prolonged dry event occurred throughout much of North America between AD 1575 and 1595, the so-called 16th Century Megadrought. This 20-year long megadrought, however, pales in comparison to a 400-year long period of elevated aridity and epic drought that was experienced throughout the western United States between AD 900 to 1300 during the Medieval Climate Anomaly (MCA). The MCA megadrought likely resulted from oceanic and atmospheric conditions unlike those that we have experienced during the past 100 years, possibly from a prolonged and sustained La Niña state in the Pacific. A sustained La Niña favors drought conditions in the American Southwest, while the Northwest experiences increased precipitation and a greater likelihood of floods. The debate continues as to whether climate processes such as ENSO will be affected by human induced global warming. Understanding the causes and impacts of past megadroughts and associated oceanic/atmospheric conditions is therefore crucial to assessing the risk of abrupt hydrologic change that we might experience in the future.

Questions to be considered in this section are:

- What is our present understanding of the causes of major drought and hydrologic change over the historical record, including the role of the oceans or other natural or non-greenhouse gas anthropogenic effects as well as land-use changes?
- What is our present understanding of the duration, extent and causes of megadroughts of the past 2,000 years?
- What states of oceanic/atmospheric conditions and the strength of land-atmosphere coupling are likely to have been responsible for sustained megadroughts?
- How might such a state affect the climate in regions not affected by drought? (For example, enhanced floods or hurricanes in other regions.)
- What will be the signatures of change in the state of natural variability of the ocean and atmosphere that will signal the abrupt transition to a megadrought?

The primary audience for this section is policymakers, who require an improved basis for ascertaining the present state-of-knowledge, as well as uncertainties, in our scientific understanding of the causes of past major droughts and the likelihood future ones. This understanding will allow the early implementation of programs to limit the impact of major droughts such as a those outlined by the National Drought Mitigation Center at the University of Nebraska, Lincoln. These impacts include loss or damage to agriculture, forest production, and fisheries; increased energy costs; loss to tourism industry; decreased water supply for public consumption; damage to ecosystems and biodiversity; increased fires; decreased air quality (dust, fires); increased health risk, both through rise of drought-related diseases and from diseases associated with famine and poorer nutrition; and increased political unrest. At the same time, this report will also benefit policymakers attempting to implement programs that limit societal losses in other areas where increased precipitation and/or increased likelihood of floods may be forecast from abrupt hydrologic change.

iii. *Rapid release of methane from hydrates*

Methane is produced naturally during the anaerobic decomposition of organic matter by bacteria and is regularly released to the atmosphere. Vast amounts of methane, however, are stored in the frozen form of methane hydrate (molecules containing methane and water in the solid state) in Arctic permafrost and in sea floor sediments below a depth of about 250 m. It is estimated that there are 1000-6000 Gigatons (Gt) of carbon stored as methane hydrates in ocean sediments and about 400 Gt stored in sediments under permafrost regions (Buffett and Archer, 2004). For comparison, the atmosphere currently contains ~730 Gt of carbon. A warming of bottom ocean waters or the land surface caused by greenhouse gases could cause the hydrates to melt and release methane to the atmosphere. Methane is a powerful greenhouse gas, and is about 24 times more effective at absorbing long wave radiation than is carbon dioxide. Such a release of methane to the atmosphere could amplify the initial warming. Following its rapid oxidation, carbon initially released as methane will persist for centuries as carbon dioxide.

Questions to be addressed in this section of the report are:

- What is the volume of methane in terrestrial and marine sources and how much of it is likely to be released in various climate change scenarios?
- What is the impact on the climate system of the release of varying quantities of methane over varying intervals of time?
- What is the evidence in the past for abrupt climate change caused by massive methane release?
- How much methane is likely to be released by thawing of the topmost layer (3 m) of permafrost? Is thawing at greater depths likely to occur?
- What conditions (in terms of sea level rise and warming of bottom waters) would allow methane release from hydrates locked up in sea floor sediments?
- What are the observational and modeling requirements necessary to understand methane storage and its release under various future scenarios of abrupt climate change?

iv. *Rapid change in ice sheet mass balance*

Glaciers and ice sheets grow or recede due to differences between accumulation and ablation. Traditionally these processes were thought to change slowly, over centuries to millennia. Recent observations (Rignot, et al., 2006) and process-based studies (Zwally, 2002) indicate that ice loss can occur much more rapidly, within decades, driven by mechanical processes that include the formation of meltwater at the surface and subsequent flow to deeper layers, seasonal cycles in melt and flow, warming and lubrication at the base, acceleration of outlet glaciers, and disintegration of ice shelves. Some observations indicate that ice loss of the Greenland Ice Sheet and West Antarctic Ice Sheet has accelerated in the last decade. If these rates continue to increase, sea level rise will occur much faster than predicted in the Intergovernmental Panel on Climate Change (IPCC) 2001 assessment, which did not consider mechanical processes in the ice sheet models. New data from process-based studies and observations of ice sheet mass balance could significantly shift predictions in future climate models.

The paleoclimate record provides evidence that ice melt is an abrupt climate change that can occur much faster than the forcing. The rapid melting of the large Northern hemisphere ice sheets at the end of the last Ice Age, observed as the rate of sea level rise, occurred much faster than the orbital forcing thought to drive these changes. It is likely that individual ice sheets and glaciers responded even faster. Sea level records integrate the effects of many ice sheets melting at different rates in both hemispheres. Improved paleoclimate records of ice sheet and glacier melt can contribute to our understanding of abrupt melting of the remaining ice sheets and glaciers. Some of these topics are also considered under the CCSP report titled "Past climate variability and change in the Arctic and at high latitudes" (Synthesis and Assessment Product 1.2).

Questions to be addressed in this section of the report are:

- What is the paleoclimate evidence regarding rates of rapid ice sheet melting?
- What are the recent rates and trends in ice sheet mass balance?
- What is the impact on sea level if the recently observed rapid rates of melting continue?
- What is needed to model the mechanical processes that accelerate ice loss?

2. Contact Information for Responsible Individuals at Lead and Supporting Agencies

The US Geological Survey (USGS) is the lead agency for this CCSP Synthesis and Assessment Product, with the National Oceanic and Atmospheric Administration (NOAA) and National Science Foundation (NSF) as the supporting agencies. Because USGS is the lead agency, the product will be subject to USGS guidelines implementing the Information Quality Act (IQA). Contact information for responsible individuals at lead and supporting agencies is:

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3. Lead Authors

The following individuals are proposed as lead authors:

Dr. Peter Clark
Dr. Ed Cook
Dr. Thomas Delworth
Dr. Carrie Morrill
Dr. Daniel Muhs
Dr. Jonathan Overpeck
Dr. Richard Seager
Dr. Konrad Steffen
Dr. Andrew Weaver
Dr. Robert Webb

Appendix A provides brief biographies for each of the authors proposed thus far. It is anticipated that additional authors will be added to the team in order to ensure comprehensive and balanced subject matter expertise, in conformance with requirements for the Federal Advisory Committee Act (FACA). The author team will also depend extensively on solicitation of relevant information from experts in the Federal and academic research community during the preparation of this report.

4. Stakeholder Interactions

Stakeholder input will be solicited through the public comment period tied to the development of this prospectus and all subsequent draft documents put forth by the authors of SAP 3.4. The authors in collaboration with the lead and supporting agencies may call upon a set of stakeholders to broaden the input for this study as necessary. Additionally, special conferences and meetings will be held in which authors will solicit information and feedback from stakeholders. These meetings will be advertised in advance and will be open to the public. The process of drafting and incorporating public comment will comply with the rules set forth in the Federal Advisory Committee Act

5. Drafting

The lead authors will draft answers to the key questions in their respective sections. They will also prepare an introductory section to describe the topic, the audience, and the intended use of this product. The lead author for each section may assign primary responsibility for drafting to a specific contributing author. The scientific/technical synthesis of the document will utilize published, peer-reviewed scientific literature.

Two workshops are envisioned, perhaps run jointly, as a means to help the research community provide input and identify divergent opinions on as many as four abrupt climate change topics, 1) meridional overturning circulation, 2) abrupt hydrologic change, 3) methane hydrate release, and 4) rapid ice melt. The lead authors will be responsible for incorporating materials from contributing authors and from the workshop participants in the draft product.

The discussion of risk will be facilitated by initial outreach and interaction with stakeholders and experts in the field of risk assessment, the development of a list of questions to be addressed by climate scientists during the workshop phase, and finally by a section of the report identifying potential risks and impacts to society of abrupt climate change.

After the product is drafted, the lead authors (or coordinating lead author and the authors responsible for each of the sections) will write a non-technical summary. Lead and contributing authors will base their writing on published, peer-reviewed scientific literature. Where appropriate, the product and its non-technical summary will identify disparate views.

6. Review

USGS will ensure that Synthesis and Assessment Product 3.4 is reviewed at all stages as specified in the *Guidelines for Producing CCSP Synthesis and Assessment Products* and consistent with the *Information Quality Act* and *Information Quality Bulletin for Peer Review*. All comments and responses will be documented and made publicly available.

The public is invited to nominate Expert Reviewers to participate in the peer review of the draft of CCSP Synthesis and Assessment Product 3.4. Nominations should be sent to John McGeehin, USGS lead, at the address given in Section 3 of this prospectus. Nominations are due by 30 November 2006. All nominations will be forwarded to the USGS IQA representative for consideration. Nominations must include an up-to-date curriculum vitae and listing of publications. As IQA Lead Agency, USGS will ensure that selected reviewers are technically qualified, as demonstrated by scientific experience, published work, and stature within and across the scientific community. USGS will ensure that the slate of reviewers reflects a balance of scientific and technical perspectives. USGS will also be responsible for screening the nominees for real or perceived conflict of interest and independence. Peer reviewers who are Federal employees will be subject to Federal requirements governing conflict of interest [see 18 U.S.C. 208, 5 C.F.R. Part 2635 (2004)]. Reviewers who are not Federal employees will be screened pursuant to the National Academy of Sciences policy for committee selection with respect to conflict of interest.

The Expert Review will consist of technical experts who will submit comments similar to those solicited as part of a journal peer review. In addition, independent reviews may be obtained from non-climate scientists, selected by USGS, to comment on how understandable and useful the draft product is to non-specialists.

USGS will provide a charge statement for reviewers, which will be distributed with the draft product and posted at USGS's IQA website, and linked and/or replicated on the CCSP web site <http://www.climatescience.gov>. The charge statement will be posted on the above sites as soon details become available. The names and affiliations of the reviewers that are selected will be posted on these sites.

Following the Expert Review, the lead authors will revise the draft product by incorporating comments and suggestions from the reviewers. USGS will prepare a written response to the peer reviewers' comments explaining its agreement or disagreement with the views of the peer reviewers, and the actions taken in response to the peer review. The draft product will then be released for a 45 day public comment period following CCSP guidelines. The lead authors will prepare a third draft of the product, taking into consideration the comments submitted during the Public Comment Period. The scientific judgment of the lead authors will determine responses to the comments.

Once USGS, as IQA Lead Agency, determines that the report conforms to CCSP and IQA guidelines, it will submit a draft of the product and a compilation of the comments received to the CCSP Interagency Committee. If the CCSP Interagency Committee determines that further revision is necessary, their comments will be sent to USGS and supporting agencies for consideration and resolution by the lead authors. If needed, USGS may ask an independent science advisory group to provide additional scientific analysis to help resolve scientific uncertainty associated with specific issues. Once the CCSP Interagency Committee has determined that the report has been prepared in conformance with the CCSP guidelines, the IQA and FACA, it will submit the report to the National Science and Technology Council (NSTC) for final review and approval. The CCSP Interagency Committee in consultation with the lead and supporting agencies and the lead authors will address issues raised during the NSTC review.

7. Communications

Once NSTC clearance has been obtained, USGS will coordinate publication and release of the Synthesis and Assessment Product. The published report will follow the standard format for all CCSP Synthesis and Assessment Products.

8. Proposed Timeline

<u>Prospectus</u>
Drafting, January - October 2006
Stakeholder interactions (including other scientists), Ongoing during prospectus development
CCSP review, September 2006
Draft Prospectus public review, October/November 2006
Revised draft, November/December 2006
Final, December 2006

Report

Drafting, January 2007-June/July 2007
Workshop 1. January 2007
Workshop 2. June/July 2007
Stakeholder involvement ongoing during drafting process
Draft 1 provided to expert reviewers, August/September 2007
Draft 2 made available for public comment, December 2007
Draft 3 submitted to CCSP for review April 2008
Product released June 2008

References

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Buffett, B., and D.E. Archer. (2004). Global inventory of methane clathrate: Sensitivity to changes in environmental conditions. Earth and Planetary Science Letters 227: 185-199.

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McManus, J. F., R. Francois, et al. (2004). "Collapse and rapid resumption of Atlantic meridional circulation linked to deglacial climate changes." Nature 428: 834-837.

Rignot, E., and P. Kanagaratnam. (2006). "Changes in the velocity structure of the Greenland Ice Sheet." Science 311: 986-990.

Talley, L. D. (1996). "North Atlantic circulation and variability." Physica D 98: 625–646.

Zwally, H. J., W. Abdalati, et al. (2002). "Surface melt-induced acceleration of Greenland Ice-Sheet Flow." Science 297: 218-222.

Appendix A. Biographical Summaries for Proposed Authors

Peter Clark is a professor in the Oregon State University department of Geosciences. His research interests include the history and dynamics of former glaciers and ice sheets, and paleoclimatology. Dr. Clark co-edited the American Geophysical Union Monograph titled “Mechanisms of Millennial-Scale Global Climate Change” published in 2002.

Ed Cook is a Senior Scholar in the Lamont-Doherty Earth Observatory and director of the Lamont Tree Ring Laboratory. Dr. Cook’s research focuses on tree-ring records of drought throughout the world.

Tom Delworth is a research scientist in the climate dynamics and prediction group of NOAA’s National Geophysical Fluid Dynamics Laboratory. Dr. Delworth’s research involves both models and observations, and focuses on the ocean’s role in climate, in particular decadal to centennial scale climate variability and change.

Carrie Morrill is a CIRES scientist at the University of Colorado and a staff member of the NOAA Paleoclimatology Branch of the National Climatic Data Center, and a former NCAR post-doctoral scientist. Dr. Morrill's research focuses on the paleoclimate record of abrupt climate change and the role of sea ice in the Atlantic meridional overturning circulation.

Daniel Muhs is a research geologist for the United States Geological Survey (USGS) at the Denver Federal Center in Lakewood, Colorado. His research focuses on the paleoclimate of the last interglacial period and paleoclimatic records of eolian deposits.

Jonathan Overpeck is a Professor and Director of the Institute for the Study of Planet Earth at the University of Arizona. Dr. Overpeck's research focuses on global change dynamics. Dr. Overpeck is one of two coordinating lead authors of the paleoclimate chapter of the 2007 Intergovernmental Panel on Climate Change assessment.

Richard Seager is a senior research scientist at Lamont-Doherty Earth Observatory, The Earth Institute at Columbia University. His work involves how coupling between the atmosphere and ocean causes climate variability and change around the world on timescales ranging from seasons to glacial–interglacial cycles. . Dr. Seager is a principal investigator with the Consortium on the Ocean's Role in Climate Abrupt Climate Change Studies (CORC-ARCHES).

Konrad Steffen is director of the Cooperative Institute for Research in Environmental Sciences (CIRES) at the University of Colorado, Boulder. His work involves the study of processes related to climate and cryosphere interaction in polar and alpine regions based on in-situ and satellite measurements, and using climate system modeling to study their sensitivity.

Andrew Weaver is a Professor at the School of Earth and Ocean Sciences at the University of Victoria. Canada. Dr. Weaver's research focuses upon the large-scale ocean circulation and the role of the oceans in climate, with a special emphasis upon three-dimensional numerical modelling. Dr. Weaver is co-chair of the CLIVAR/PAGES Intersection working group, where one of the focus areas is abrupt climate change.

Robert Webb is a physical scientist and interim Leader of the Climate Diagostics Branch of NOAA's Earth System Research Laboratory. Dr. Webb is the co-editor of the American Geophysical Union Monograph titled "Mechanisms of Millennial-Scale Global Climate Change" published in 2002. Dr. Webb's research interests include paleoclimatology, climate variability, and change.