

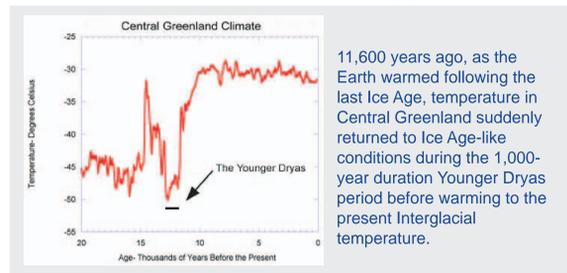
CCSP Goal 3: Reduce uncertainty in projections of how the Earth's climate and related systems may change in the future.

## I. Background

Definition of abrupt climate change from the National Research Council Report "Abrupt Climate Change":

(Mechanistic definition) A transition of the climate system into a different mean state (of temperature, rainfall, and other aspects) on a time scale that is faster than the responsible forcing.  
 (Impacts-based definition) A change in the climate system that is faster than the adaptation time of social and/or ecosystems.  
 -Abrupt changes are different than extreme events (floods, hurricanes) because extreme events do not change the mean state  
 -Extreme events can become more or less frequent in the new climate state

Abrupt changes in climate are commonly observed in the paleo record during glacial times



Its not just a glacial story: Abrupt changes in climate have occurred in the past when climate was like it is today.

The 14th century brought profound changes in climate in widespread regions of the world. In the North Atlantic sea surface temperatures cooled and sea ice expanded, causing severe hardship for the Viking settlers in Greenland. In Europe warm summers disappeared, glaciers advanced and famine and economic hardship spread (the Black Death swept across Europe in 1347 A.D.). In North America, cold winters became more intense after ca. 1350 A.D. and a period of widespread drought in the American West was abruptly terminated.

### Recommendations from the NRC Report

- \* **Improve the fundamental knowledge base related to abrupt climate change**  
 Research programs should be initiated to collect data to improve understanding of thresholds and nonlinearities in geophysical, ecological, and economic systems
- \* **Improve modeling focused on abrupt climate change**  
 New modeling efforts that integrate geophysical, ecological, and social-science analyses should be developed to focus on investigating abrupt climate changes.
- \* **Improve paleoclimatic data related to abrupt climate change**  
 The quantity of paleoclimatic data on abrupt change and ecological responses should be enhanced, with special emphasis on: Selected coordinated projects to produce especially robust, multiparameter, high resolution histories of climate change and ecological response.
- \* **Improve statistical approaches**  
 The conceptual basis and the application of climatic statistics should be re-examined with an eye to providing realistic estimates of the likelihood of extreme events
- \* **Investigate "no-regrets" strategies to reduce vulnerability**



# Risks of Abrupt Climate Change (P-DS1.3)

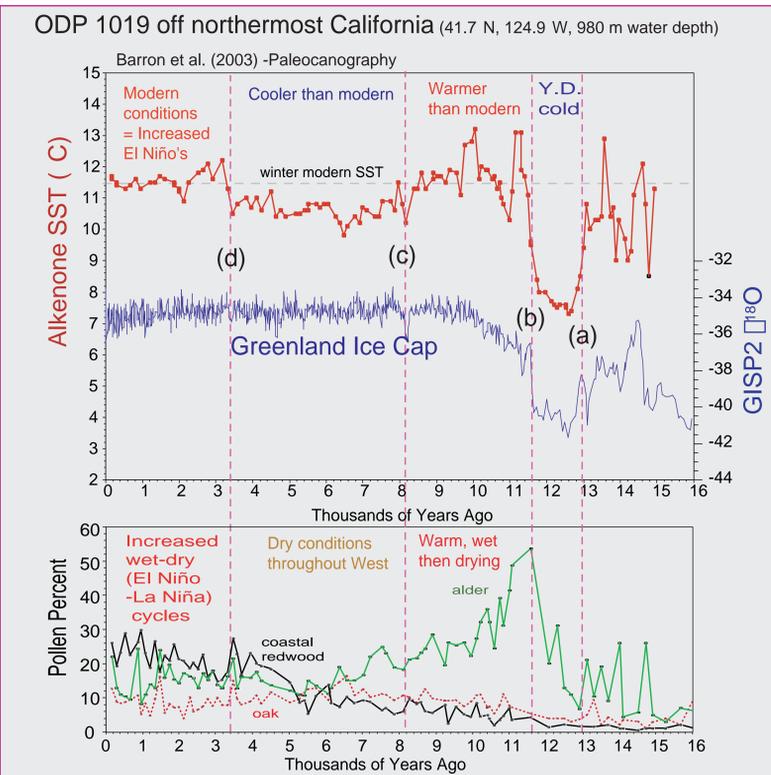


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## II. Examples of Abrupt Climate Change During Past Millennia.

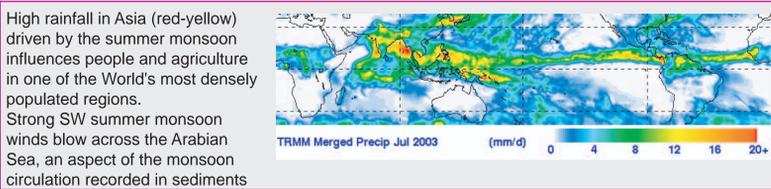
### 1. Changes in climate in the Western United States and the Pacific Ocean during the past 16,000 years



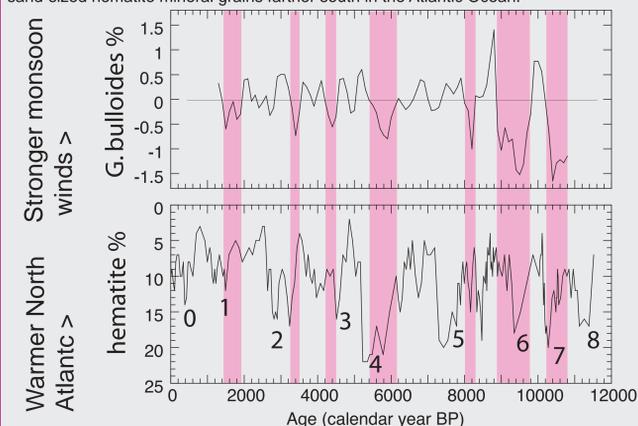
Top - Abrupt changes in sea surface temperature (SST) off northern California closely follow changes in the Greenland Ice Cap at (a) 12,900 years ago (Younger Dryas cooling); (b) 11,600 years ago (Holocene warming), and (c) 8,200 years ago (cooling). (d) Stepwise warming of SST at 3,400 years ago reflects increased frequency of El Niño events.

Bottom - Onshore vegetation responses to SST events suggest abrupt change to warm, wet conditions at (b); increased dry conditions following (c), and increased wet-dry cycles at (d).

### 2. Changes in the Asian summer monsoon



For the last 12,000 years, the monsoon winds have been stronger and weaker (pink bands) at the same time the North Atlantic was warmer, and cooler, according to proxies found in marine sediments. Abundant fossil *G. bulloides* found in Arabian Sea sediments reveals the presence of strong SW summer monsoon winds, while hematite found in North Atlantic sediments reveals cool conditions when icebergs carried sand-sized hematite mineral grains farther south in the Atlantic Ocean.



## III. Science Initiatives Underway

**PAGES-CLIVAR Working Group**  
 New focus on abrupt climate change and the last millennium.  
 -Workshop planned for April 2006  
 -Journal special issue planned

**NSF-ESH -Research initiative on abrupt climate change started in 2003, with an emphasis on last 120,000 years.**  
 \* What are the characteristics and causes?  
 \* Is abrupt climate change predictable and/or is it affected by background evolving state of climate?  
 \* What are the regional and global connections?  
 \* What are the impacts on earth systems, the environment, and the hydrologic cycle?

**USGS, ESD Program Objective 1.3: Document rates & degree of change associated with intervals of abrupt climate change.**  
 \* Identify terrestrial and marine sites that contain well-resolved records of abrupt climate change at various times.  
 \* Investigate rates and degree of climatic and environmental change associated with abrupt events using paleoenvironmental proxies.  
 \* Evaluate synchronicity and magnitude of change of climate change of climate parameters (such as temperature, precipitation) during intervals of abrupt climate change at sites throughout North America and elsewhere.

**NOAA Paleoclimatology (www.ncdc.noaa.gov/paleo)**  
 \* Provide data sets, information products on abrupt climate change  
 \* Research on abrupt climate change  
 \* Contribute to synthesis and assessment report

## IV. The CCSP Synthesis and Assessment Report

Synthesis and Assessment Product (SAP) 3.4 will bring together and report on the current state of scientific information and our understanding of the processes and consequences of abrupt changes in global climate, and on the types of risks related to these events. The report from this effort will be used to build a conceptual framework within which both future research can be developed and related management actions can be addressed, vetted, and ultimately used for better decision-making. Results from the report will lead to a better understanding of the causes, interconnections, and feedbacks related to abrupt climate changes and the physical responses that occur as a result of these events. The report will focus on synthesizing peer-reviewed studies that provide the best available science on abrupt climate changes, and also will compile and discuss the ramifications of studies that report on sudden climate changes and the associated ecological responses to their forcings.

### Timetable for the CCSP Synthesis and Assessment Report

Planning		Workshop		Comment Period and Review		Report	
2005	2006	2006	2007	2007	2007	2008	2008

## V. Special Focus: Drought in the Western U. S.

Drought is a major threat to regional economies and ecosystems, particularly in the Western United States. **In human terms, the sudden intensification of drought (both in its duration and its geographic extent) is an abrupt climate change that has greatly impacted the U.S. in the past.** The paleo record of the last 2,000 years shows that extended, multi-year droughts are not unprecedented. Drought in the Western United States will receive special attention in both the CCSP report and the science initiatives mentioned above.