Learning From The Past

The Importance of Paleoscience for Global Change Research

What is Paleoscience?

Paleoscience is the study of climatic and environmental processes before there were instrumental records.

Paleoscientists traditionally study the last hundreds to millions of years. Data from the past (paleorecords) are extracted from natural and cultural archives, such as marine and lake sediments, ice cores, tree rings, corals, stalagmites, archeological remains and other historical records.

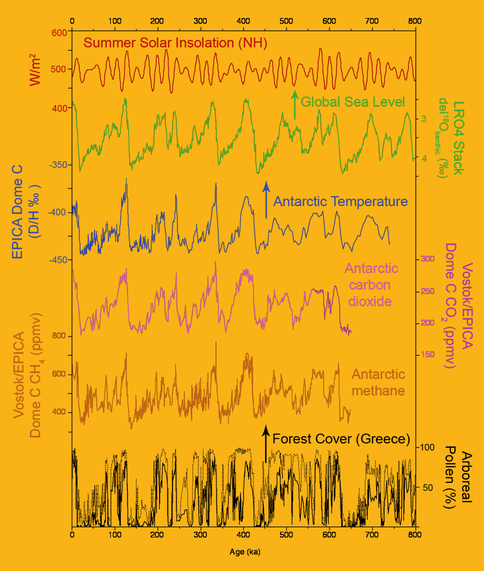
Together with climate models, paleorecords provide information about the past variability of the Earth System and the underlying processes. Knowledge of what has happened before is essential to understanding current and future global changes.

While not a definitive guide to the future, ***the past can be used as the basis for evaluating present-day trends, future probabilities and likely human consequences.***

Why is Paleoscience Important?

1) Clues to Earth System understanding:

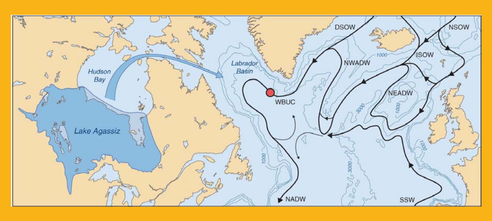
- Different scenarios can be used as ***case studies*** to better understand the ***sensitivity*** of the Earth System to changing conditions.
- Some time periods in the past show ***similarities*** to the climate and environment of today and the near future, thus providing information on the behavior of the Earth System under present and projected future conditions.

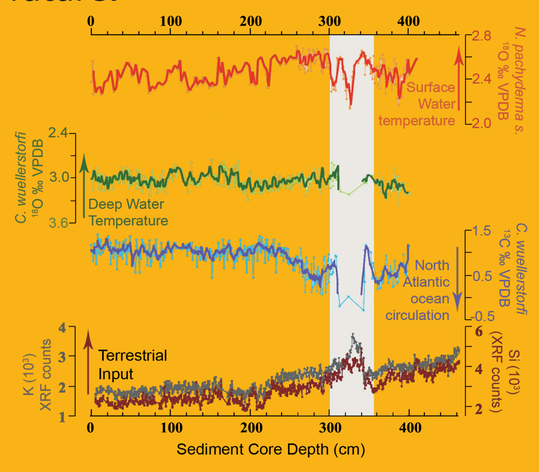


This figure shows a number of paleo-datasets that clearly illustrate the cyclical changes from a glacial climate, to an interglacial climate. Past interglacials are of growing interest due to aspects of the climate and environment of these periods that are simlar to the present and partly to the projected near future. Studying interglacials can provide information on the sensitivity, feedbacks and thresholds of the climate system.
(Figure courtesy of P.C. Tzedakis)

2) What has happened, *can* happen:

- Paleorecords show that, for example, abrupt climate change (within decades), ice sheet collapse and changes in the chemistry of the ocean have occurred in the past. Therefore, in principle, these things ***could happen again*** in the future.



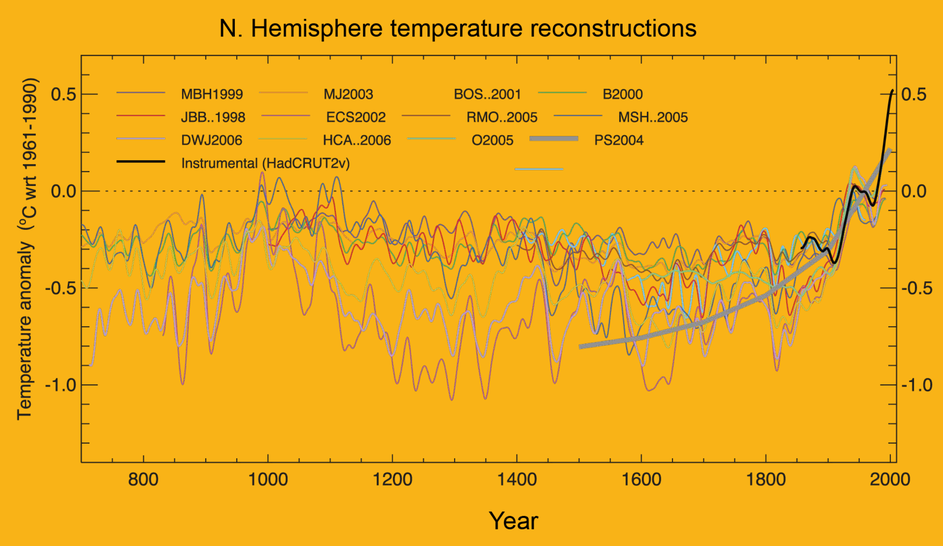


The figure to the right shows paleodata collected from a deep-sea sediment core in the North Atlantic (red dot on map). All data show an abrupt anomaly at 8,200 years ago. This represents a sudden, dramatic decrease in the ocean circulation of the North Atlantic, due to the sudden input of large amounts of freshwater from the drainage of Lake Agassiz (see map above).

Many paleo-studies have now shown that this resulted in abrupt cooling in the northern hemisphere. These findings become particularly relevant when considering that freshwater is currently entering the N. Atlantic from the melting of the Greenland ice sheet and increased precipitation in the region.
(Both figures from Kleiven et al., 2008, *Science*, Vol 319)

3) Long-term context for recent climatic changes:

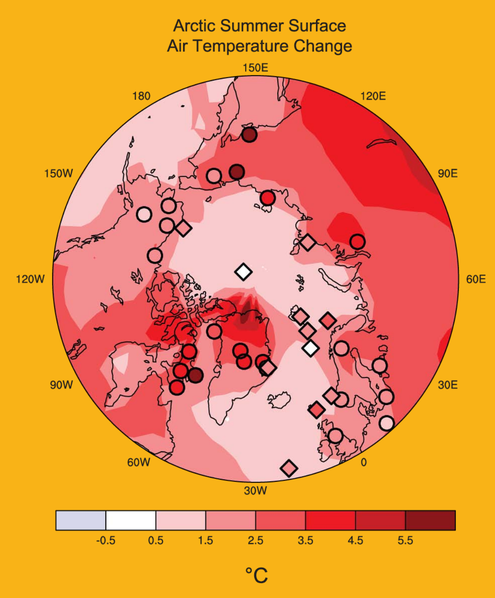
- Paleorecords provide a ***long-term context*** for the recent climatic and environmental changes that have been observed (e.g., changes in greenhouse gases).
- Paleorecords provide information on the natural state of the Earth System before human influence, thus allowing an assement of which changes are ***natural*** and which are ***human-induced***.



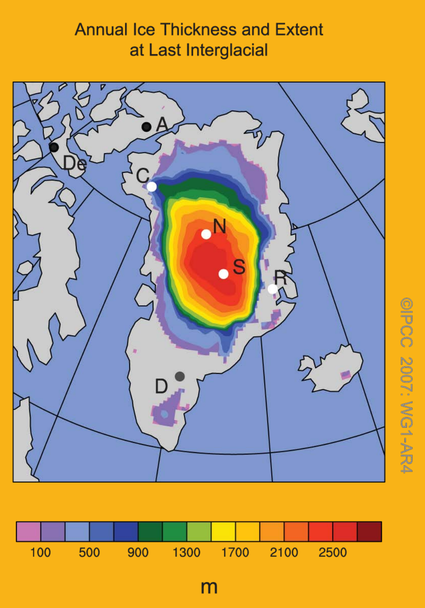
This figure shows the changes in northern hemisphere temperature over the last 1300 years, as reconstructed using mulitple climate proxy records. Without such records from the past, we would not know whether current temperatures were encompassed in the natural variation of the climate system. (Figure modified from Fig. 6.10, AR4 IPCC Working Group 1). Similar reconstructions have been done for global greenhouse gas concentrations and show that the modern concentration far exceeds any previous concentrations over the last 650,000 years.

4) Test beds for models that predict climate:

- Paleodata can be used to ***test the models*** that make projections of future climate. If a model produces data that match the paleodata, then this is a measure of the model's accuracy.



The summer surface air temperature change over the Arctic at the last interglacial (~125,000 years ago) relative to the present, simulated by a climate model. This model output shows clear agreement with temperatures reconstructed using paleodata (diamonds = marine sites; circles = terrestrial sites).



This figure shows the minimum thickness and extent of the Greenland ice sheet at the last interglacial (~125,000 years ago), reconstructed by a climate model. This model agrees well with ice core observations, which show ice cover during this period at the white dots, and no ice at the sites with black dots (Both figures modified from Fig. TS.21, IPCC AR4 Working Group 1).

PAGES
PAST GLOBAL CHANGES

PAGES is a community-driven, international project that coordinates and promotes paleoscience research.

PAGES facilitates activities that address past changes in the Earth System in a quantitative and process-oriented way in order to improve projections of future climate, environment and sustainability.

PAGES was founded in 1991 and is one of the nine core projects of IGBP. It is funded by the Swiss and U.S. National Science Foundations, and the National Oceanic and Atmospheric Administration (NOAA).

GLOBAL CHANGE IGBP · NSF · FNSNF Fonds national suisse / Schweizerischer Nationalfonds / Fondo nazionale svizzero / Swiss National Science Foundation · NOAA