

Extracting the Underlying Dynamics from Ice-Core Data

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Research objectives of the mini-project:

- Apply advanced statistical methods to ice-core data to objectively identify abrupt climate changes.
- Derive systematic nonlinear stochastic models from ice-core data which reproduce abrupt climate changes and reveal the underlying dynamics.

Why is it interesting:

The climate of the Earth changes on many different time and spatial scales. In order to understand the dynamical causes of the changes and to predict them we need very long climate records. The past climate record is also the background on which possible future climate changes due to greenhouse gas emissions need to be assessed. Unfortunately, the instrumental records of climate only cover about the last century, which is a too short record to understand climate variability and its causes. Past climate changes dating much further back are recorded in so called proxy data like tree-rings, corals, lake and ocean sediments and ice cores. In climate research, a proxy variable is something that is probably not in itself of any great interest, but from which a variable of interest can be inferred. Ice core records constitute some of the longest time records with a high temporal resolution and provide proxy data for temperature amongst other things. Ice cores from Antarctica reveal climate changes over the last 800000 years, whereas ice cores from Greenland reveal rather abrupt climate changes occurring over the last 120000 years. In ice-cores from Greenland are encoded the abrupt climate transitions between cold and warm climate states during the last glacial period (100000 - 150000 years BP), the so-called Dansgaard-Oeschger (DO) events. These events are characterized by rapid fluctuations of temperature of up to 15K. In the Northern Hemisphere they take the form of rapid warming episodes within a decade or so followed by gradual cooling over a longer period. Their discovery has challenged the previous dominant view of relatively slow climate change and demands a nonlinear view of climate change in order to identify mechanisms which can explain such dramatic events. In this mini-project we want to objectively identify and extract the underlying dynamics of rapid climate change events.

Background to be assimilated:

Literature on time series analysis, stochastic processes and basic climate theory.

Techniques required:

Basic knowledge of Applied Mathematical methods, Brownian Motion Theory, Time Series Analysis from your Msc courses.

Prospective deliverables:

- Analysing of ice-core data with advanced statistical tools.
- Fitting nonlinear stochastic models to ice-core data.

Relation to end/downstream users: who should benefit from this line of research:

The Natural Complexity Group at the British Antarctic Survey is working on related issues for various observed data sets. Also the wider complexity and paleoclimate research communities will benefit from this research. Ultimately government and society will benefit from an improved understanding of climate variability and its causes.

Prospects for this mini-project leading into a PhD project:

The British Antarctic Survey would like to support a complexity PhD project in this area.