Project: Causes of regional climate variability over the last millennium

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Background:
For reliably predicting the impacts of future climate change it is essential to understand the causes and expressions of past climate variability on regional scales. Reconstructions of climate for the last 1-2 millennia indicate substantial climate variability and change. For example, climate reconstructions in North America over the last millennium show periods of severe drought. Such 'megadrought' events would have a severe societal impact if they happened again, and it is unclear if current climate change could trigger such severe droughts in the future. Temperature reconstructions are available for parts of North America and Eurasia, and new reconstructions of temperature and precipitation/drought have recently been developed (e.g. PAGES2k initiative; New and Old world drought atlases) or are being developed, in collaboration with the supervisors. These will provide an opportunity to shed new light on past rainfall and temperature variability and its causes. This project will focus both on simulated and reconstructed/observed records of climate variability, with the goal of identifying causes and contributors to past drought and temperature variations in Europe, the Mediterranean and North America. Possible contributors include external influences such as volcanic eruptions, and internal climate variability such as El Nino and its decadal relatives, or long-term variations of the North Atlantic Oscillation. This project provides an excellent research opportunity, as many new reconstructions and climate model simulations have recently become available.

Hypothesis:
Changes over several years to a decade in regional climate, such as long-term drought, or anomalously warm or cold conditions can be caused by natural variations in climate, such as those linked to the El Nino phenomenon. However, influences outside the climate, such as volcanic eruptions or changes in the sun also cause climate variations. This project aims to quantify both contributions for key events in the past, and evaluate if climate models, which are used for future predictions, reliably simulate past changes.

Methodology:
The research will rely on using reconstructions as well as climate model simulations to attribute the “causes” of past climate variability. A large ensemble of climate model simulations of the last millennium, both done locally in Edinburgh and from the worldwide CMIP5/PMIP3 modelling effort will be available for the student to work with. The work will be initiated by studying the role of external forcing on key regions (Mediterranean, Central Europe, North America) in the simulations, allowing an opportunity to study the variability seen in proxy records, by undertaking a like-with-like comparison. Reconstructions of past climate will be used to identify evidence for similar mechanisms in past regional climate variability and change. The thesis will assess how well models reproduce past instances of climate variability, focusing on few selected large-scale regions, including North America, parts of Europe and the tropics. It will be tested if the climate model simulations are capable of simulating drought of similar magnitude and severity as observed, and if they show similar temperature variability and change in tropics and high latitudes. The ultimate aim is to better understand causes for past regional climate variability.

Techniques:
The student should be comfortable working with quantitative analysis methods under guidance, using Matlab or R, and will learn to manipulate space-time data using statistical methods. The work will largely rely on statistical analysis of reconstructions of past climate and climate model data, using regression analysis, averaging across multiple events, and similar techniques in climate research.

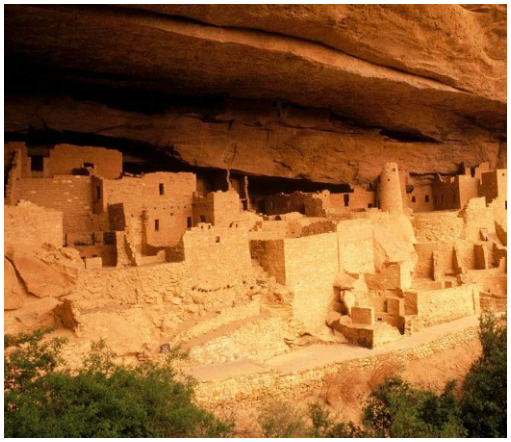
Details of research training:
The supervisors will train the student in climate research and paleoclimatology, familiarizing the student with statistical tools and methods of research in that area, as well as with climate change research methods and background. Further training, such as summer school attendance, will be available. If desired by the student, participation in fieldwork coring treering data, or involvement with climate modelling is possible as part of the training. For more detail, please contact Prof Gabriele Hegerl. The student will be part of a vibrant research team around the project team of the ERC project TITAN and a large European consortium 'PACMEDI', and by extensive contacts of the research team with the PAGES community.

Requirements
The project would suit a student with quantitative background (e.g. physics, mathematics, geophysics) or geologists/geographers with some quantitative skills. The student should be familiar with programming, and have an interest in climate science and past climates.

Resources required
This project does not depend on any facilities, software or expenditure which is not already in place, apart from a workstation for the student. Meetings with Rob Wilson will generally be conducted in Edinburgh with a possibility of site visits in St Andrews.

Summary:
Reconstructions of climate over the last millennium show evidence for substantial climate variability in temperature and precipitation. This project attempts to identify causes of this variability and to what extent it has been influenced by external influences on climate.

Picture: Anasazi ruins: The collapse of that civilization was linked both to societal changes and climate change, for example, drought (Photo credit: wikinut.com)



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