Climate signals from the North American subsurface

With the swift development of modern society in the past century, increased attention has been paid to the changes in the behaviour of our spinning planet and the associated harmful effects on present and future societies. To increase our understanding of the range of potential variations of the climate system, we look to the past to see how the system has responded to previous climatic variations. Such past climate information can then be used to ascertain the reliability of projections of future climate change from climate models. Since we cannot travel back in time to make these observations ourselves and the global meteorological record extends back, at best, 150 years, climate scientists rely on indirect measures of past climate, commonly called paleoclimatic indicators from proxy data, such as tree-ring widths, pollen accumulation, and ice-cores. Sources of information about past climatic changes also include the vertical variation of underground temperatures measured in mining exploration boreholes in the continental areas of the world.

Since the times of Kelvin and Fourier, it has been known that temperatures in the first few kilometers of the Earth's crust are significantly affected by the past surface conditions. In fact, the changes in the long-term ground surface energy balance propagate as heat anomalies downwards and are recorded as climatic fingerprints in the underground. These climate signals were originally found in temperature-depth profiles by geophysicists studying the Earth's internal thermal regime. While they were originally considered as noise, in the last few decades subsurface climate signals have been isolated from the full profile and processed to infer ground surface temperature histories.

In a recent paper published in the PAGES Special Issue of the European Geophysical Union journal Climate of the Past, MSc student Fernando Jaume-Santero and PhD candidate Carolyne Pickler (both at GEOTOP-UQAM and StFX's Climate & Atmospheric Sciences Institute and NSERC-CREATE Training program in Climate Sciences), Dr. Hugo Beltrami (Climate & Atmospheric Sciences Institute at StFX), and Dr. Jean-Claude Mareschal (GEOTOP-UQAM) examined 510 North American geothermal profiles, within the framework of the PAGES NAm2k project. Jaume-Santero's team performed a regional analysis of

ground surface temperature histories for the past 500 years. Their results indicate that the average North American ground surface temperature increased about 1.8 °C for the last 200 years. However, although the warming is widespread and persistent, these temperatures increases exhibit a wide range of spatial variability among North American's regions. Reconstructed regional ground surface temperature mean trends for seven different climatic regions suggest a warming range of 0.5 to 2.0°C. Furthermore, geographical representations of regional variations revealed a warming range of 1 to 2 K between 1780 and 1980, with all regions experiencing an increase in ground surface temperature, but this warming is more marked in Arctic regions. Jaume-Santero's et al. work shows, conclusively that the warming experienced by the planet globally is also well documented in the North American continental subsurface. Such warming shows no ambiguity in the last two centuries; the warming is persistent and widespread in North America, and larger in the Arctic.

These results will contribute, along with other available long-term paleoclimatic records of climate change, to improving climate model simulations of present day climate dynamics and will provide insights into the potential consequences of future climate change on society.

The relevant full text of the paper can be found at:

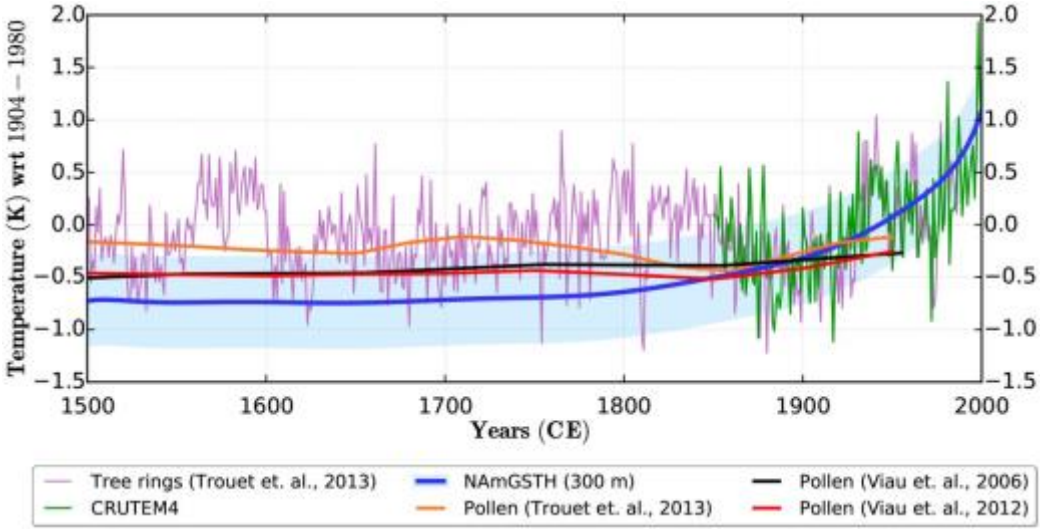
North American regional climate reconstruction from ground surface temperature histories Jaume-Santero F, Pickler C, Beltrami H & Mareschal J-C Climate of the Past, vol. 12(12), 2181-2194, 2016 DOI:10.5194/cp-12-2181-2016.

Climate of the Past, Highlight:

http://www.climate-of-the-past.net/highlight_articles.html

PAGES Press Release:

http://pastglobalchanges.org/news/all-news-items/9-latest-news/1621-nam2k-recon-surf-clim-past-16



Note: Mean North American ground surface temperature history (blue). Also shown are proxy-based surface air temperature reconstructions for North America from 1500 to 2000 CE, andi nstrumental data obtained for the past 150 years (CRUTEM4). All temperature trends are displayed as departures from 1904-1980 mean.