Part I : Paleoenvironmental changes

The world's climate had always been changing and those changes have had considerable impact on aspects of the environment that are now important resources, among them human habitat, forests, and water. Paleoenvironmental change shows us what the planet can do, and gives us insights regarding how climate change and its impacts occur.

Discerning paleoenvironmental change is a detective story, in which researchers unearth clues and attempt to infer exactly what happened. A theme that arises from many of these papers is the great difficulty of discerning the past. The proxy data are themselves the result of complex physical processes and therefore their development needs to be understood before one can extract data, much less information, from the record. The temporal resolution and length of proxies vary greatly, with these papers covering four orders of temporal magnitude (from centuries to millions of years). Thus one researcher's conclusions on a trend may refer to phenomena that another paleo researcher would consider noise.

Nevertheless, in the first paper *Alverson et al.* encourage us to aim high in paleoreconstructions, specifically to abandon the story telling mode and to move toward quantitatively calibrated records based on multiple lines of evidence. They offer two examples of how to improve inference from annually resolved proxy records at the century scale.

Shafer et al. focus on key physical questions: how mesoscale factors such as topography modified the larger scale forcing of climate in the past, and from that, to infer how future forcing might change the climate. They examine changes in an E-W gradient across the northern Rocky Mountains at the scale of tens of thousands of years.

Thompson et al. discuss ice cores from tropical mountain glaciers as unique archvies of past climate and environmental change on the scale of decades to millennia.

Gosse returns to methods, in this case to the use of nuclides in rocks exposed to cosmic rays to provide data at scales up to millions of years. He provides excellent examples of how an understanding of proxy development can improve inference.

Nesje et al. consider glaciers as sources of information. They use estimates of summer temperature to estimate precipitation in a variety of sites in Norway over the past ten thousand years

Solomina summarizes multiple lines of evidence (tree rings, lichen, pollen, lake sediments) for environmental change over the last thousand years gathered at widely dispersed sites in Russia. While she tentatively identifies a general pattern across this immense area, she emphasizes the need for accurate and intercomparable data sets to support accurate assessments.

Kerschner focuses on the use of glaciers for the estimation of precipitation in the Alps over the Holocene. He raises the interesting image of an extremely arid central Alpine region but as with other authors, pleads for much for accurate temperature reconstructions in order to improve estimation of precipitation.

Overpeck et al. take us to the Himalaya and Tibet and note evidence for past abrupt changes in the monsoon that today would have huge impacts on the population. They see the need for much more extensive data principally from lakes on the Tibetan Plateau to understand the full range of potential climate behavior.

Grosjean and *Veit* study a quite the opposite environment, the arid Atacama of South America. They point out the roles of previously humid phases during the late glacial and the Holocene and rare extreme events in the more recent past in creating the water resources of today.

The next three papers focus on lakes as recorders of environmental information. *Lotter* describes some of the limitations of the use of biological data from lakes, such as the lack of sensitivity to winter conditions and the great sensitivity to thermal stratification. He notes the need to disentangle human from climate impacts on the biology of lakes.

Battarbee et al. focus on pollutants in European lakes with data gathered from a wide network of study sites. They conclude that climate change can affect multiple biological and chemical properties of lakes. They note a particularly interesting possibility of cold trapping serving to concentrate certain volatile organic compounds.

Rose et al. go further to emphasize that even remote lakes, particularly those in cold locations cannot be considered as pristine. Concentrations of certain pollutants reach their highest levels in remote, cold lakes.

Tinner and *Ammann* summarize information on forest composition in the Alps as a measure of environmental change over the last several thousand years. They emphasize that while some plant communities have remained relatively intact, others have exhibited large scale species replacement. They note several issues related to inferences from pollen data.

The last two papers focus on climate variability in the central and southern Andes in both Chile and Argentina. *Lara et al.* present a picture of climate changes along the length of the Cordillera over the past 1000 years from tree ring data. *Villalba et al.* look at both tree ring and glacial data. They note that data from trees must be interpreted with an understanding of tree demography: that mortality can be triggered by severe droughts on a short annual scale, while recruitment requires more favorable conditions over the course of many years.