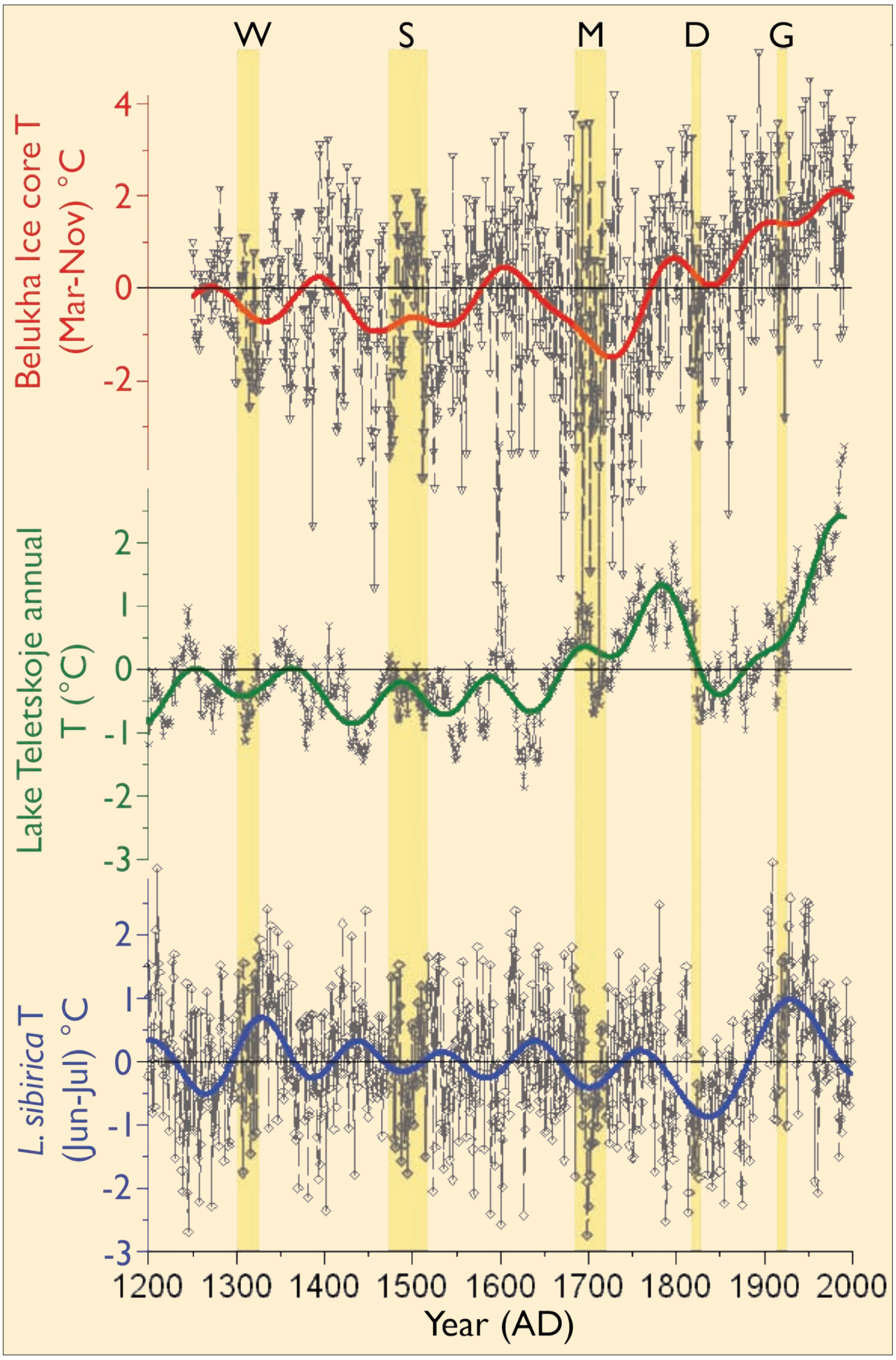

*Figure 2: Annual values (**gray lines**) and 100-year lowpass filtered (**colored lines**) temperature anomalies reconstructed from the Belukha ice core $\delta^{18}O$ record (March-November T; **red**; Eichler et al., submitted), the Lake Teletskoye sediment geochemistry (annual T; **green**; Kalugin et al., 2007), and the tree ring width chronology for* Larix sibirica *at the upper timberline in the SE Altai (June-July T; **blue**; Ovtchinnikov et al., 2000). Periods of low solar activity are indicated by yellow bars (W = Wolf, S = Spörer, M = Maunder, D = Dalton and G = Gleissberg minima).*

based temperature reconstructions and solar activity, suggesting solar forcing as an important driving force for temperature variations during the last 750 years in this region.

There was general consensus on the high potential of the Altai region for multiproxy climate reconstructions. Suggestions for future work included extending the existing records further back in time, combining results from different proxies, and incorporating reconstructions from other archives, like archeological data (e.g., from Plateau Ukok), documentary data, phenological data from Katun National Park, and geomorphologic studies for reconstructing glacier history.

Acknowledgments

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Climate extremes during recent millennia and their impact on Mediterranean societies

University of Athens, Greece, 13-16 September 2008

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The complexity of the Mediterranean climate makes the reconstruction of its past variability a challenging task. There is, therefore, a strong need for more high quality and high temporally resolved paleo-records from the region. Currently, spatial coverage is lopsided with little information available from northern Africa. The increase in research conducted on natural proxies in the Eastern Mediterranean, especially in Turkey, could help to compensate the scarcity of documentary records in that area. This interdisciplinary Symposium aimed to bring together researchers from natural and human sciences working in the Greater Mediterranean Region, to identify the datasets available, the spatial and temporal gaps in our knowledge as well as climate extremes during recent millennia and their impact on Mediterranean societies. This Symposium builds on the achievements of the 2006 ESF-MedCLIVAR/PAGES workshop "Reconstruction of Past Mediterranean climate" (*PAGES news*, 2006(2)). A number of topical sessions were held, covering a broad range of archives and methods.

An important conclusion drawn from a number of the presentations is that it is mainly single years of extremes in growing-season precipitation that are reflected in human history. Other periods of extreme spatial variability, such as shifts from regional to local precipitation patterns, did not have a clear impact on societal behavior. The need for a multi-proxy approach was also discussed. Every natural proxy has limitations and uncertainties, and responses of proxies to changes in the environment are often non-linear. Additionally, anthropogenic impacts on the environment are seen to limit the reliability of certain proxies, and there may also be subtle and non-obvious effects on even apparently "objective" proxies like isotopes from speleothems. A multi-proxy approach will also help to bridge the large communication gap between the scientists producing paleorecords, and those from the modeling/dynamical community.

The impact of volcanoes on climate was addressed through both instrumental data and proxy reconstructions. Documentary sources can be used to describe volcanic effects on climate and society. Paintings created by artists, representing sunsets (measured red/green ratios) can provide proxy information on the aerosol optical depth following major volcanic eruptions. The seasonal impacts of tropical and extratropical volcanic eruptions over the last centuries on Mediterranean climate were also examined. Generally, GCM experiments support proxy reconstructions and seem logically consistent with the circulation reaction to the global re-distribution of heat following tropical eruptions.

The symposium ended with a session devoted to the impacts of climate extremes on Mediterranean societies. It covered the impacts of and adaptation to climatic events of the last millennia to today. In particular, the events of 8.2, 5.2, and 4.2 kyr BP were discussed. Such events had severe impacts on the Neolithic Mediterranean societies, including changes in mobility patterns and reduced demographic status due to reduced food supplies.

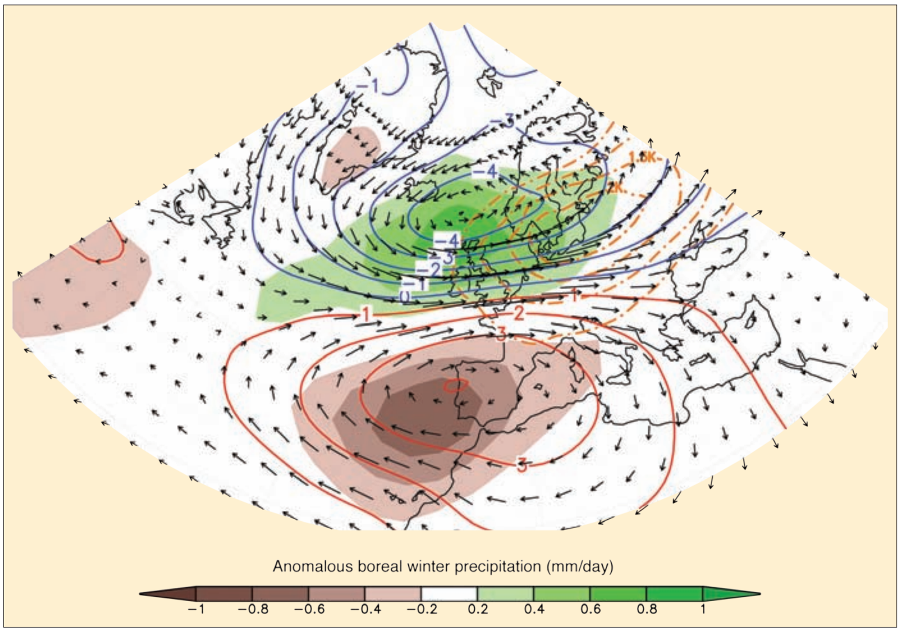

*Figure 1: Estimated composite of anomalous boreal winter precipitation (mm/day), temperature (**dashed orange line**, in °C), sea-level pressure (**blue** (-) and **red** (+) contours in hPa) and near surface geostropic wind anomalies (arrows) during Medieval times. The composite was produced using Proxy Surrogate Reconstruction (PSR, Graham et al., 2007) in which the temporal order of coupled model output is constrained by the agreement between climate proxy data (Morocco drought severity reconstruction, Austrian Alps speleothem-based winter temperature reconstruction and northern Scotland speleothem-based reconstruction of the temperature / precipitation (T/P) ratio) and corresponding data drawn from the coupled model from a 1150-year radiatively forced simulation with NCAR Community Climate System Model (Ammann et al., 2007). The composite map shown here is the difference between the average of the PSR reconstruction for AD 1049–1298 and the average for AD 1449–1923, thus it depicts an estimate of anomalies during Medieval times. The results indicate that Medieval winters were dominated by a positive NAO-like pattern bringing wetter conditions to NW Europe (up to 115% of post-Medieval times precipitation, mm/day), drier conditions in Iberia and Morocco (about 60% of post-Medieval times values), and warmer conditions in central and northern Europe. The maximum changes depicted in near-surface westerlies across western Europe are approximately 1.4 m/s compared with typical mean values of 9-10 m/s.*

A discussion forum followed each session and culminating from these are several issues that were identified to improve research on past Mediterranean climate extremes:

- More high quality and high-resolution records - this task will take years to resolve, thus we suggest a "location sensitivity analysis" in conjunction with the climate system dynamical/modeling community to identify areas of particular sensitivity.
- Development of new proxies - currently employed proxies are of great use, however, we urge the development of new proxies, such as trace elements and fluid inclusion analysis of speleothems.
- Calibration of proxy data against instrumental data - it is vital that the calibration period be as long as possible. Initiatives towards this goal are being undertaken in the MEDARE project (www.omm.urv.cat/MEDARE/index.html).
- Synthesis of these pre-existing records – this will aid understanding of the spatial distribution (especially inhomogeneities) and magnitude of abrupt climate events. Such data interchange will be enhanced by the MedCLIVAR metadatabase (www.medclivar.eu).
- Integration and exchange between paleo-researchers and dynamicists/modelers - paleo-scientists can provide results that serve to validate model results, or provide initial and/or boundary conditions for forcing models. In turn, dynamicists/modelers can provide insight into understanding and interpreting the signals seen in paleorecords (see Fig. 1 as an example).
- Concentration on different time slices and/or scales – to provide information on the variability and contributions of different mechanisms at differing frequencies.

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