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Large-scale atmospheric circulation changes recorded by Saharan dust analysis in an Alpine ice core.

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The Colle Gnifetti glacier, located in the Monte Rosa massif (Swiss-Italian border, 4455 m a.s.l.), satisfactory conserves the accumulation history of summer precipitation chemistry and climatic conditions over relatively long time-period (i.e. a few hundred years). In fact, the Colle Gnifetti archive offers a unique possibility for reconstructing i) regional (pre-)industrial carbonaceous aerosol emissions, and ii) changes in the dynamic of the southwesterly dust-laden winds from the Sahara.

The Colle Gnifetti ice core analysis demonstrates that the elemental black carbon (BC) aerosol record is independent of the large-scale climatic control affecting the transport of mineral dust to the Southern Alps, but primarily reflects regional-scale anthropogenic activity (Thevenon et al., 2009). More precisely, the delta 13C composition of BC suggests that wood combustion was the main source of preindustrial atmospheric BC emissions. Moreover, biomass burning activity and especially C4 grassland burning abruptly dropped between 1560 and 1750, suggesting that agricultural practices strongly decreased in Europe during this cold period of the 'Little Ice Age'.
Unlike the BC deposition, the mineral dust transport to the summits of the Southern Alps is primarily controlled by large-scale climatic patterns (i.e. drier winter in North Africa and stronger North Atlantic southwesterlies), leading to transport of massive dust plumes from the Sahara around 1560-1685, 1775-1785, and after 1860. In contrast, the periods of low Saharan dust deposition around 1515-1560, 1690-1770 and 1790-1850 may indicate weaker meridional atmospheric circulation at that times, leading to colder and drier spring/summer conditions over Western and Central Europe. Beside the recent anthropogenic climate forcing, our results suggest that such atmospheric features were probably influenced by coupled ocean-atmosphere patterns, primarily forced by changes in solar irradiance rather than by explosive volcanism activity. Moreover, the unprecedented strong Saharan dust event that occurred in the late eighteen century strikingly coincided with low-latitude atmospheric changes, providing a useful analog for a better understanding of large-scale atmospheric teleconnection patterns.

REFERENCE

Thevenon, F., F. S. Anselmetti, S. M. Bernasconi, and M. Schwikowski (2009). Mineral dust and elemental black carbon records from an Alpine ice core (Colle Gnifetti glacier) over the last millennium. J. Geophys. Res., 114, D17102, doi:10.1029/2008JD011490.