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End of the "Little Ice Age" in the Alps not forced by industrial black carbon

Michael Sigl (1,2), Dimtri Osmont (2,3), Jacopo Gabrieli (4), Carlo Barbante (4), Margit Schwikowski (1,2,3)

(1) Paul Scherrer Institut, Villigen, Switzerland (michael.sigl@psi.ch), (2) Oeschger Centre for Climate Change Research, University of Bern, Bern, Switzerland, (3) Department of Chemistry and Biochemistry, University of Bern, Bern, Switzerland, (4) Department of Environmental Sciences, Informatics and Statistics, University of Venice, Ca' Foscari, Venice, Italy

Light absorbing aerosols present in the atmosphere and cryosphere play an important role in the climate system. Their presence in ambient air and snow changes radiative properties of these media, thus contributing to increased atmospheric warming and snowmelt. High spatio-temporal variability of aerosol concentrations in these media and a shortage of long-term observations contribute to large uncertainties in properly assigning the climate effects of these aerosols through time.

Glaciers in the European Alps began to retreat abruptly from their mid-19th century maximum, marking what appeared to be the end of the Little Ice Age. Radiative forcing by increasing deposition of industrial black carbon to snow has been suggested as the main driver of the abrupt glacier retreats in the Alps (Painter et al. 2012). Basis for this hypothesis were model simulations using ice-core measurements of elemental carbon at low temporal resolution from two ice cores in the Alps.

Here we present sub-annually resolved, well replicated ice-core measurements of refractory black carbon (rBC; using a SP2 soot photometer), mineral dust (Fe, Ca), biomass burning (NH4, K) and distinctive industrial pollution tracers (Bi, Pb, SO4) from an ice core in the Alps covering the past 250 years. These reconstructions allow to precisely compare the timing of observed acceleration of glacier melt in the mid-19th century with that of the increase of soot deposition on ice-sheets caused by the industrialization of Western Europe. Our study suggests that at the time when European rBC emission rates started to significantly increase Alpine glaciers have already experienced more than 70% of their total 19th century length reduction. Industrial BC emissions can therefore not been considered as the primary forcing of the rapid deglaciation at the end of the Little Ice Age in the Alps.

References:

Painter, T. H., M. G. Flanner, G. Kaser, B. Marzeion, R. A. VanCuren, and W. Abdalati (2013), End of the Little Ice Age in the Alps forced by industrial black carbon, Proceedings of the National Academy of Sciences of the United States of America, 110(38), 15216-15221, doi:10.1073/pnas.1302570110.