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Siberian δ^{13}C tree-ring cellulose chronologies as indicator of hydrological changes after stratospheric volcanic eruptions

Olga Churakova (Sidorova) (1,2), Matthias Saurer (3,4), Sebastien Guillet (1), Christophe Corona (5), Rolf Siegwolf (4), Vladimir Myglan (2), Eugene Vaganov (2), and Markus Stoffel (1)

(1) University of Geneva, Geneva, Switzerland (olga.churakova@unige.ch), (2) Siberian Federal University, Krasnoyarsk, Russia, (3) Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Birmensdorf, Switzerland, (4) Paul Scherrer Institute, 5232 Villigen - PSI, Switzerland, (5) Université Clermont-Auvergne, Geolab, Clermont-Ferrand, France

Significant precipitation changes are expected after stratospheric volcanic eruptions. According to climate simulations and observational records, significant changes in the precipitation regime can be expected; these include, among others, rainfall deficit in monsoon prone regions and in Southern Europe as well as wetter than normal conditions in Northern Europe (Robock and Liu 1994; Wegmann et al., 2014). However, regional effects on precipitation in Siberia after stratospheric volcanic eruptions remain unknown.
We aim to derive information about precipitation and changes in vapour pressure deficit after stratospheric volcanic eruptions (AD 535, 1257, 1640, 1815 and 1991). This information about hydrological changes can be derived from δ^{13}C values in larch tree-ring cellulose chronologies from Russian subarctic regions (northeastern Yakutia, eastern Taimyr) and the mountainous region in the Russian Altai.
To reveal the influence of water availability and air humidity as a result of the climatic impact on photosynthesis, carbon isotopes in tree-ring cellulose are analyzed (Farquhar et al. 1989). In our study, low carbon isotope values in tree ring cellulose indicate a high carbon isotope fractionation reflecting increasing stomatal conductance. This suggests increasing humid conditions at all high-latitude study sites after the volcanic eruption AD 535 in subarctic regions and after the Samalas eruption (AD 1257). In contrast, higher carbon isotope values in tree ring cellulose indicate increasing drought conditions as a consequence of reduced precipitations for two years after the eruption events in AD 535 and 1640 in Russian Altai, and AD 1815 and 1991 in the Siberian North (Yakutia, Taimyr). Indications for a local drought were also observed for Yakutia in AD 1643 and at the Altai during the summer AD 1817. No extreme hydroclimatic anomalies were found at high-altitude sites in the aftermath of the Pinatubo eruption (AD 1991). Our results indicate that not all stratospheric volcanic eruptions systematically induced a widespread and intense reduction of precipitation over Siberian regions.

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