



## **Last millennium climate and glacier variations in the Northern Caucasus, Russia**

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Archeological data, a buried soil horizon ( $1280 \pm 100$   $^{14}\text{C}$  yr BP), pollen evidence, and absence of dated moraines indicate a relatively warm climate at the end of the first and the beginning of the second millennium AD in the Northern Caucasus. It was suggested (Tushinsky, 1964) that this time was so warm that many glaciers disappeared. The legends of native inhabitants of Osetiya report about major change in climate (abrupt cooling), but they most probably date back to earlier time. Here we provide an overview of archeological data, showing that though the climate was rather mild, no major changes had happen in the Northern Caucasus in the beginning of the 1<sup>st</sup> millennium in comparison to the mid 20<sup>th</sup> century.

Both pollen data and lichenometrically dated moraines indicate a period of significant cooling in 13<sup>th</sup> century. A number of glacier advances occurred both on the northern and southern slopes of the Central Caucasus in the 13<sup>th</sup>, 14<sup>th</sup>, 16<sup>th</sup>, late 17<sup>th</sup>, early and late 18<sup>th</sup>, 19<sup>th</sup>, and early 20<sup>th</sup> century. A new approach based on extreme value theory was applied to better constrain the lichenometric dates and estimate the statistical error of the datings in the Central and Western Caucasus.

Historical data on glacier variations in Caucasus is very sparse, the oldest dating back to the late 19<sup>th</sup> century. We found an archive of a famous French mountaineer V.Sella containing pictures of Caucasus glaciers that he visited in 1880s-1890s. The pictures yield evidence of much larger glaciers than at present from the mid-19<sup>th</sup> to the early 20<sup>th</sup> century, in agreement with moraine evidence. We used space images to reconstruct the former glacier sizes in the last millennium in Teberda valley basing on moraine dates and historical data. On average, glaciers in the Caucasus have retreated

by more than 1000 m in length since the end of the 19<sup>th</sup> century, and the altitudes of glacier fronts have risen by 200 m and they continue to retreat. The timing of glacier fluctuations in the Caucasus, revealed by moraine dating, is roughly similar to the Alps. In order to reconstruct the climatic background of glacier fluctuations we constructed two composite pine chronologies both covering the last four centuries. One of them is sensitive to the relative humidity and positively correlates to the river runoff (Dolgov et al., 2007); another one reflects summer temperature.