Mountain glacier fluctuations in the Holocene

Olga Solomina

IGRAS, 119017, Russian Federation, Moscow, Staromonetny, 29

Mountain glaciers are sensitive climatic indicators. The reconstructions of glacier fluctuations in the past are based on the dates of moraines (by ^{14}C, TCN, OSL, lichenometry, and tree rings - discontinuous time series) as well as on continuous records of sediments from proglacial lakes, and of speleothems. In this talk I'll discuss the potentials and limitations of these methods and some results based on the analyses of 189 time series to assess the long-term trends and centennial variability of glacier fluctuations. I will compare the glacier variations with orbital, solar and volcanic forcings and consider the scale and the rate of modern glacier retreat in the context of Holocene natural variability. I'll focus on the updated reconstructions of the glacier variations in Caucasus and Altay Mts.

The general trends of Holocene glacier fluctuations in the extra-tropical areas of the Northern Hemisphere are coherent and agree with the dynamics of the Northern and mountain tree lines. Overall summer temperature, forced by orbitally-controlled insolation, is the most probable driver of Holocene glaciation in these regions.

The glaciers in New Zealand and in the tropical Andes also seem to follow the orbital trend, i.e. they were decreasing from the Early Holocene to the present day, whereas the glacier oscillations in some monsoonal areas of Asia and southern South America generally do not correlate with the orbital trends, instead responding to more high-resolution forcing.

Glacier advances during Neoglacial time clustered at 4.4-4.2, 3.8-3.4, 3.3-2.8, 2.6, 2.3-2.1, 1.5-1.4, 1.2-1.0, 0.7-0.5 ka BP, correspond to general coolings in the North Atlantic, possibly forced by multidecadal periods of low solar activity at 4.3, 3.8, 3.2, 2.6, 2.3, 1.3, 0.9, 0.7, 0.4 ka BP (Renssen et al., 2006). One cluster of glacier advances at 1.7-1.6 ka does not fit this pattern and it corresponds to a very strong volcanic eruption (232$\pm$5 CE) (Sigl et al., 2013). Thus, no single mechanism driving glacier variations at the global level is suggested, but multidecadal variations of solar activity supported by positive feedbacks in the climate system may have played an important role in Holocene glacier fluctuations at the global scale.

The rate and the global character of glacier retreat in the 20th-early 21st centuries looks unusual in the context of Holocene glacier changes, though the retreating glaciers in most regions are still larger today than they were in the Early and/or Mid-Holocene. However the current retreat is occurring during an interval of orbital forcing that is favorable for glacier growth and it is therefore due to a combination of factors other than orbital forcing, primarily strong anthropogenic effect. Due to the delayed reaction of glaciers to climatic changes, glacier retreat will continue into future decades.