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## Multiproxy records of climate variability for Kamchatka for the past 400 years

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**Abstract.** Tree ring, ice core and glacial geologic histories for the past several centuries offer an opportunity to characterize climate variability and to identify the key climate parameters forcing glacier expansion in Kamchatka over the past 400 years. A newly developed larch ring-width chronology (AD 1632–2004) is presented that is sensitive to past summer temperature variability. Individual low growth years in the larch record are associated with several known and proposed volcanic events from the Northern Hemisphere. The comparison of ring width minima and those of Melt Feature Index of Ushkovsky ice core helps confirm a 1–3 year dating accuracy—for this ice core series over the late 18th to 20th centuries. Decadal variations of low summer temperatures (tree-ring record) and high annual precipitation (ice core record) are broadly consistent with intervals of positive mass balances measured and estimated at several glaciers in 20th century, and with moraine building. According to the tree-ring data the 1860s–1880s were the longest coldest interval in the last 350 years. The latest part of this period (1880s) coincided with the positive anomaly in accumulation. This coincidence led to a positive mass balance, which is most likely responsible for glacier advances and moraine deposition of the end of 19th-early 20th centuries. As well as in some other high latitude regions (Spitsbergen, Polar Urals, Franz Jozef Land etc.) in Kamchatka these advances marked the last millennium glacial maximum. In full agreement with subsequent summer warming trend, inferred both from instrumental and tree ring data, glacier advances since 1880s have been less extensive. The late 18th century glacier expansion coincides with the inferred summer temperature decrease recorded by the ring width chronology. However, both the advance and the summer temperature decrease were less prominent than in the end of 19th century. Comparisons of the glacier history in Kamchatka with records from Alaska and the Canadian Rockies suggests broadly consistent intervals of glacier expansion and inferred summer cooling during solar irradiance minima.

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