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Ice core from Akademii Nauk ice cap, Severnaya Zemlya (Russian Arctic), dated with a Nye model modified for a growing glacier

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From 1999 to 2001 a 724 m deep ice core has been drilled from surface to bedrock close to summit of the Akademii Nauk ice cap, Severnaya Zemlya (Russian Arctic), within a joint German-Russian project. The analysis of stable water isotopes and major ion concentration in high resolution were used for reconstruction of past climate and environmental changes. The upper 304 m of the core were dated by counting annual stable isotope cycles considering radioactive (1986, 1963) and volcanic events (1956, 1912, 1783, 1259) as reference horizons. The resulting depth-age relationship and the corresponding annual-layer thickness imply that the ice cap was not in dynamic steady state but had been growing until recent times. That does not comply with requirements of a standard Nye or Dansgaard-Johnson flow model approach.

To take into account the peculiarities of Akademii Nauk ice cap a Nye model was modified by adding a growing term according to the found relationship between annual layer thickness and depth. Using the volcanoes identified an average increase of altitude of about 0.08 m w.e. per year was calculated since AD 1259. The model enables us to reconstruct the altitude changes of the ice cap with time and to consider an altitude effect to correct the stable isotope values and to explain decreasing sea-salt ion data. Using the suggested model annual layer thickness can be decompressed to accumulation rates at the altitude where the precipitation was originally deposited. The model can also be used for dating deeper parts of ice core where volcanoes are not identified up to now. Applying this model, the ice core has an age of about 2 500 years, much less than claimed for an older core from Akademii Nauk ice cap. Consequently, the ice cap is much younger and only of Late Holocene age, as also assumed for most Arctic ice caps and glaciers outside Greenland. However, the lowest part of Akademii Nauk ice cap is probably a remnant of an older ice cap stage.