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Potentially oldest continuous high-resolution methane record from alpine ice core

Content

Cold mountain glaciers and ice caps, where the 10 m firn temperature is below 0, are of great interest to the ice core and paleoclimate community revealing the regional climate change in more detail. The 96.1 m Elbrus Eastern Summit ice core was drilled in August 2020 down to bedrock in the Caucasus (42°20'50"N, 42°27'15"E, 5600 m a.s.l.), and analyzed in October-December 2021.

Here we present a high-resolution methane record obtained using the continuous flow analysis (CFA) system at the British Antarctic Survey. The system uses a three-step gas extraction line and optical-feedback cavity-enhanced absorption spectroscopy (OF-CEAS). Absolute values of methane mixing ratio were independently calibrated versus NOAA gas standards. The instrumental uncertainty is 10 ppb and the resolution is 0.5-2 cm. The calibrated mid-latitude methane record provides further constraints for flux models verification and relevant high-resolution data for calculations of historical inter-polar gradient

The record captures the lock-in zone and shows a pronounced anthropogenically-induced rise in methane concentration. A comparison with existing Northern Hemisphere alpine records shows that the record reaches the oldest known part (~1550 AD) at a depth of 62 m. The remaining 34 m are to be dated using wiggle matching with late Holocene CFA methane records from Greenland and a firn densification modeling-like approach as the site is tricky to apply traditional models for identifying delta age. Sulfate, nitrate, and ammonium exhibit an onset of a three-fold 1950 AD rise as shallow as 7 m.

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