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# Evidence of 2003 European Heatwave Signal Preserved via δ18O Post-Depositional Effects in an Alpine Ice Core

## Content

While ice core δ18O has proven a valuable paleothermometer, post-depositional effects complicate the interpretation of δ18O as a proxy for air temperature at the time of precipitation. The 2003 European Heatwave was one of the hottest summers on the continent in at least 500 years. Theoretically, this extreme temperature signal would be preserved in three high altitude Alpine ice cores collected from Mt. Ortles (3859 m, Eastern Alps, Italy) as a spike in δ18O within the cores' 2003 annual layer. However, our high-precision seasonal pollen chronology places an anomalous δ18O spike in the 2002 annual layer, and no extreme δ18O values in the 2003 annual layer. We advance the hypothesis that this decoupling between air temperature and ice core δ18O could be due to post-depositional effects leaving an isotopic "fingerprint" on 2002 snow re-exposed at the surface during the 2003 European Heatwave. We started to test this idea by employing EISModel to investigate whether the 2002 δ18O spike was in fact incongruous with 2002 modeled temperatures, and whether 2002 firn was re-exposed at the surface due to the intense surface ablation during the 2003 European Heatwave. EISModel confirmed the decoupling between 2002 δ18O values and concurrent modeled air temperatures and found all snow that fell between November 2002 and August 2003 ablated during the 2003 European Heatwave, thereby re-exposing 2002 firn directly to the atmosphere. Melt-induced isotopic fractionation and refreezing are unlikely explanations for the 2002 δ18O spike, as melt rates during the heatwave far exceeded melt rates that Lee, 2014 found to maximize isotopic enrichment, and the isothermal snowpack at Mt. Ortles during the heatwave would have prevented meltwater refreezing within the snowpack. This leaves isotopic exchange between surface snow and the atmospheric moisture or sublimation/deposition within the snowpack during the heatwave the most likely explanation for the 2002 δ18O spike. Air moisture-surface snow isotopic exchanges and fractionation due to sublimation/deposition within the snowpack have only been studied in polar environments; additional work should be performed to further investigate what role these processes may play in high altitude/low latitude environments such as Mt. Ortles.

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