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A New Approach for Ultra-High-Resolution Ice Core Data Processing

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Ice core archives provide the most direct and detailed evidence of past climate and atmospheric conditions. However, the resolution of traditional ice core sampling methods limits the scope of information that can be extracted from the ice regarding meteorological events (e.g., dust storms, volcanic eruptions, anthropogenic emissions) that are captured at inter-annual to sub-annual scales. Using laser ablation inductively coupled mass spectrometry (LA-ICP-MS), a novel ultra-high-resolution multi-element sampling method for ice cores, we recovered the highest-resolution continuous glacio-chemical record yet from an ice core, measuring close to 5 million samples from 40 meters of core. This unique record was compiled using samples from the 2013 Colle Gnifetti ice core, located in the Swiss-Italian Alps. Here we present the first results from a new approach to high-resolution ice core data analysis through a new array of statistical tools, data processing algorithms and statistical machine learning tools adapted for ice core data sets. Our new data processing framework is designed to detect, extract and synthesize environmental signals from ultra-high-resolution glacio-chemical time series in concert with more traditional ice core sampling data to further refine paleoenvironmental signals. The authors gratefully acknowledge the Climate Change Institute at the University of Maine, funding from grant AC3862 of the Arcadia Fund and NSF grant PLR-1443306.