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An automated approach for annual layer counting in ice cores

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The temporal resolution of some ice cores is sufficient to preserve seasonal information in the ice core record. In such cases, annual layer counting represents one of the most accurate methods to produce a chronology for the core. Yet, manual layer counting is a tedious and sometimes ambiguous job. As reliable layer recognition becomes more difficult, a manual approach increasingly relies on human interpretation of the available data. Thus, much may be gained by an automated and therefore objective approach for annual layer identification in ice cores.

We have developed a novel method for automated annual layer counting in ice cores, which relies on Bayesian statistics. It uses algorithms from the statistical framework of Hidden Markov Models (HMM), originally developed for use in machine speech recognition. The strength of this layer detection algorithm lies in the way it is able to imitate the manual procedures for annual layer counting, while being based on purely objective criteria for annual layer identification. With this methodology, it is possible to determine the most likely position of multiple layer boundaries in an entire section of ice core data at once. It provides a probabilistic uncertainty estimate of the resulting layer count, hence ensuring a proper treatment of ambiguous layer boundaries in the data. Furthermore multiple data series can be incorporated to be used at once, hence allowing for a full multi-parameter annual layer counting method similar to a manual approach.

In this study, the automated layer counting algorithm has been applied to data from the NGRIP ice core, Greenland. The NGRIP ice core has very high temporal resolution with depth, and hence the potential to be dated by annual layer counting far back in time. In previous studies [Andersen et al., 2006; Svensson et al., 2008], manual layer counting has been carried out back to 60 kyr BP. A comparison between the counted annual layers based on the two approaches will be presented and their differences discussed. Within the estimated uncertainties, the two methodologies agree. This shows the potential for a fully automated annual layer counting method to be operational for data sections where the annual layering is unknown.

References:
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