# A novel method for calculating periodic behaviour in glacial ice cores

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**In this work, a novel method for estimating the periodic behaviour of the earth's historic climate variations is presented. It is designed such that multiple cores can be used simultaneously to produce one single frequency estimate that can be used to differentiate between natural and anthropogenic climate change. Data is simulated such that the ground-truth is known, meaning that the performance of the estimator can be quantified and compared to two traditional methods. It is shown to outperform these two methods, and is shown to attain the theoretical lower bounds on the estimation error when the signal strength is high enough. Finally, it is applied on three real world ice cores from Antarctica and Greenland.**

Working with ice cores, or other paleoclimatologic records presents a number of characteristic challenges. The first being that the measuring pattern is not, in general, equidistant in time but in depth, the second that the time of measurement of a data point is uncertain. Different records, measured at different times, should also contain similar frequency content in certain frequency bands, due to variations in global mean temperature. The historical, natural variation in global mean temperature can be used to distinguish between anthropogenic and natural climate change. It can also be used to analyze earlier responses in the climatic system to rising global mean temperature.

In this degree project, the final characteristic is used to mitigate the second. Assuming that the frequency content should be similar, it is possible to use multiple records to form a global frequency estimate which is robust towards errors in time measurement. This is done in an optimization problem where one can balance the importance of the estimates being similar and sparse, vs. how much of the variation in the record that each individual estimate explains.

It is shown that by properly assigning importance to different characteristics of the global and individual spectral estimates, it is possible to achieve a highly accurate frequency estimate which attains theoretical lower bounds on the errors, even with error in sampling time, meaning no other frequency estimator can perform better. This theoretical lower bound is calculated for the case where the model is misspecified, which is the case since the error in sampling time is unknown.