What drives the glacial-interglacial cycle? A Bayesian approach to a long-standing model selection problem.

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The current ice age began approximately 2.5-3.5 Myr ago. Since then, the climate has fluctuated between glacial and inter-glacial periods, with the current inter-glacial period having lasted approximately 12 kyr. In recent decades scientists have tried to understand the climate by constructing large numerical simulators that include as many of the physical mechanisms of the climate system as possible. However, these are computationally expensive and are typically designed to simulate only a few hundred years of the climate. Such models are ill-suited to study processes that evolve over 100 kyr timescales, such as glacial-interglacial cycles. Instead, low-order dynamical models, typically cast as SDEs, are used to model gross dynamics phenomenologically; these are simple enough to enable principled inference from palaeoclimate data.

In this talk, I will describe our approach to answering the long running debate about the impact of the solar forcing on the glacial cycle and demonstrate whether it is possible to discriminate between the numerous proposed models using a principled statistical approach given the paucity of the data and the intractability of the models. We will compare the computational efficiency of the leading statistical techniques, including ABC-SMC and SMC^2.

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Approximate Bayesian computation; sequential Monte Carlo; model selection; stochastic differential equations; state space models; palaeoclimate.