BISP8

Eighth Workshop on
BAYESIAN INFERENCE IN STOCHASTIC PROCESSES

Bayesian Layer-Counting in Ice Cores -

- Reconstructing the Time Scale of Multivariate Signals

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The ice sheets of Antarctica and Greenland hold a continuous record of climatic and environmental information dating back hundreds of thousands of years. The concentrations of various chemicals, particles and gasses are measured at high resolution from drilled ice core samples, and recorded as a multivariate depth series. In order to interpret these data we must first learn about their underlying, unobserved time scale. Some of these signals have annual cycles, which show as quasi-periodic seasonality in the depth series. Layer-counting uses this periodicity to count back in time, year by year, and is currently achieved by eye, at considerable effort. We present a fully Bayesian approach to automating the layer-counting process which provides a marginal posterior distribution for the time of year, as well as the date, at each depth. Using a simple, flexible model for the signals, we use a Markov chain Monte Carlo approach to reconstruct the underlying periodic process - allowing for the frequent clusters of missing values and the continuously varying phase differences between the signals. The latent chronology is sampled directly in a way that allows the number of cycles in the reconstruction to be changed without the need for dimension-changing algorithms such as Reversible Jump. We allow for the dependence in observation error and the lack of stationarity by modelling means, amplitudes and errors as continuous functions of depth.

Keywords:
Markov chain Monte Carlo; time-axis uncertainty;
multivariate time series; ice-core chronology.

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