Efficient high-dimensional emulation and calibration

Computer models of physical systems are often expensive to run, resulting in a small number of model evaluations, hence the use of statistical emulators (usually Gaussian process-based) to predict the model output at unseen inputs, and to search for plausible matches to real-world observations (calibration/history matching). Many such computer models have high-dimensional spatial and/or temporal outputs, all of which we may wish to emulate and calibrate rather than only considering summaries of the output, so that dimension reduction is an attractive option in terms of computational efficiency.

We explore the benefits of the basis approach to emulation of such fields, compared to emulating every output individually, through climate, palaeoclimate and engineering examples. We discuss how to select a suitable calibration basis, and how exploring model discrepancy (missing processes in the model) fits into our framework.