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Extrapolation and interpolation of climate analogues using Gaussian Processes

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The analogue method is a data-driven function between predictor and predictand that is based on a look-up library of previously available predictor-predictand data. This method has been applied to a wide range of problems, ranging from short-term weather prediction, statistical downscaling and climate field reconstructions of paleoclimate. Some questions remain not clearly solved, for instance when no clear analogues are found for a particular value of the predictor or, in contrast, when several diverging analogues are potentially possible. This situations require an 'extrapolation' or 'interpolation' of the available analogues.
Both operations are not straight forward, since the predictor analogues are in general defined a high-dimensional space, for instance large-scale sea-level-pressure patterns defined over the Northern Hemisphere. In this contribution we explore the application of a Gaussian Process theory to achieve a meaningful extrapolation of analogues in situations in which extreme events (previously not observed in the look-up table), or interpolation of analogues in situations where several, but none of them optimal, analogues can be identified in the available look-up table. A Gaussian Process is then defined to locally approximate the the empirical function defined by the look-up table in the vicinity of a particular stance of the predictor.
The definition of a Gaussian Process requires the prescription of the functional form of a covariance kernel. In the case of multidimensional predictands, the covariance kernel takes the form of a vector kernel, which further complicates the interpolation or extrapolation of the Gaussian Process.
The poster will show preliminary results of the application of this approach to the reconstruction of spatially resolved climate of the past millennium based on sparse information provided by point proxy data, e.g. dendroclimatological data.
We test the method in the virtual reality provided by paleoclimate simulations with Earth System Models, in which pseudo-proxies can be constructed by sampling from simulated data at the grid-cell level, and in which the 'true' solution - the past climate fields - is also provided by the climate model.