An open source tool to analyse heat waves using flow analogues and weather regimes

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Studies on the relation of atmospheric circulation patterns and heat waves using flow analogues or weather regimes often miss an assessment of the uncertainties related to internal climate variability and the analysis method itself because of the limited length of the data sets used. However, considering this type of uncertainty is important when interpreting changes found in a transient climate using this type of methods.

We used several hundreds of years long preindustrial control runs of CMIP5 climate models to address this issue in a constant model climate. Several heat waves over central Europe as simulated by the climate model were selected and then reconstructed using circulation analogues, that is by searching for days with similar pressure fields in the simulation and recombining the temperatures of these similar days to form uchronic events. The variance of these uchronic events is supposed to vary with the rarity of the original event. We therefore present the relationship between the variance of the uchronic events and the distance between the original event and its analogues. Further we present the variation of the distances due to internal climate variability. Weather regimes are typical atmospheric circulation patterns obtained for example using a cluster analysis. Each day is then assigned to a cluster, the weather regime. The frequency of the weather regimes is supposed to be constant in a constant climate, but variations of these frequencies can occur due to internal climate variability. We therefore show these variations for the weather regimes associated with the heat waves.

The web processing service (WPS) flyingpigeon is an open source WPS featuring processes for studying weather extremes and climate change impacts. Flyingpigeon is part of the open source project birdhouse, a collection of WPSs following the Open Geospatial Consortium (OGC) standard and available on github. The WPS allowed to first select the data sets needed from the ESGF archives through its integrated data search capabilities and second to perform the flow analogue and weather regime analysis via the integrated processes based on open source software such as the Circulation Analogue Simulation Tool in fortran90 (CASTf90). The use of the WPS and the open source software renders the study reproducible and in addition allows to make use of remote computing resources close to the data archives.