## Short manual

The code is intended to run on climate proxy data covering the last glacial (+120-20 ka BP). It searches for rapid transitions, which resemble Greenlands Dansgaard Oeschger events. The basics of the methods are described in the appendix below.

**This is how to run the code:**

- Download and install Julia and an appropriate editor (e.g., Atom, Juno, VS-Code)
- Save each file of this GitHub directory in a directory of our choice on your machine
- Everything is prepared for a test run with test data (speleothem HUN14, Moseley et al 2020) – so, run the program

[If some packages are not installed, do so by: *using Pkg*; *Pkg.add("Plots")* for the Plots package]

**This is how to run the code with your data:**

- Replace the test data set with your data (maintain the column meaning!)
- Run the program again

**This will be your output:**

You will receive two figures, which are saved as *.pdfs in your working directory. In addition, there will be a "DetectedEvents.txt" file, which contain the timing of the transition and the interstadial minus stadial proxy record difference.

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Appendix

**Method:**

As previously shown, e.g., for Greenland ice cores, transitions from stadial to interstadial conditions are more abrupt and larger (e.g., Rasmussen et al., 2014) than the transitions from interstadials to stadials. Thus, we focus on the offset during the beginning of a DO event. For the detection of transitions, the data set is linearly interpolated to annual temporal resolution first. This is necessary as the temporal resolution of some proxy records might be low.

Then the method uses two neighbouring windows of a certain temporal length in which the respective mean is calculated and the difference of both average values is computed. Those two windows are shifted through the interpolated proxy time series. Extrema in the difference between both windows point to strong changes in the original time series, which occur in response to those rapid climate shifts.

This method reliably finds the onset of DO events for the NGRIP ice core record using a window length of 150 years for each record (Rousseau et al., 2017). However, for unequally spaced original stalagmite data and their generally lower temporal resolution, this time window appears too small

and 200 years is used instead. Nevertheless, a robustness test, using time windows of 150 and 250 years length, results usually in similar output.

The resulting curve of the difference of both neighbouring windows provides the mean of finding stadial-interstadial transitions. However, not each local maximum or minimum of the difference curve is a stadial-interstadial transition. To evaluate, if an extrema is a stadial-interstadial transition we apply a timing constraint. The time period of interest is defined as the duration between one transition and the next nearest one (Fig. 1) as defined in the NGRIP record (Rasmussen et al., 2014). This time window is centred on the stadial-interstadial transition of interest and is enlarged by the 2-sigma age error of the proxy record occurring at this period (Fig. 1). The largest extreme value of the difference curve in this time window is then used as the time point of a stadial-interstadial transition.

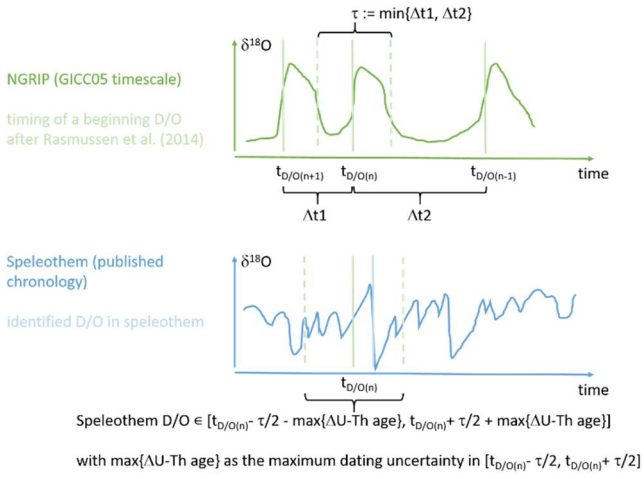


***Fig. 1:*** *This sketch illustrates the choice of the time period within which our method is allowed to detect a stadial-interstadial transition. The half width of the nearest neighboured stadial-interstadial transition as identified in NGRIP (top figure, green dashed lines) is enlarged by the age errors of the proxy record (bottom figure, green dashed line) and centred around the time point of the individual event as defined in the NGRIP record (solid green lines in top and bottom figures).*

**References**

Moseley et al. (2020), NALPS19: sub-orbital-scale climate variability recorded in northern Alpine speleothems during the last glacial period, Climate of the Past 16, 29–50.

Rasmussen et al. (2014), A stratigraphic framework for abrupt climatic changes during the Last Glacial period based on three synchronized Greenland ice-core records: refining and extending the INTIMATE event stratigraphy, Quaternary Science Reviews, 106, 14-28.

Rousseau et al. (2017), (MIS3 & 2) millennial oscillations in Greenland dust and Eurasian aeolian records–A paleosol perspective. Quaternary Science Reviews 169, 99-113.