

Supplementary material

In order to determine the timings of the GS, GI, and the DO transitions between them in an objective way, the following, stepwise algorithm was designed (see Rousseau et al., in revision):

- 1. Both records ($\delta^{18}\text{O}$ and dust) are interpolated to a time axis with equidistant time steps of five years.
- 2. An averaged derivative is computed by subtracting for each time step the average of the 30 previous time steps (i.e., 150 years) from the 30 following time steps. A threshold at the 95th percentile of this derivative is then chosen, and local maxima of time intervals above this threshold are considered as candidate time points of the DO transitions from GS to GI. For both records, we found 18 candidate time points.
- 3. For each of the candidate time points, determine the closest future maximum of the record that exceeds the the 70th percentile of the 30 time steps following the candidate time point found in step 2. These maxima mark the end points of the respective DO transitions.
- 4. For each end point found in the previous step, determine the closest minimum before the end point that falls below the 60th percentile of the 30 time steps that precede the corresponding candidate time points determined in step 2, and compute the 50th percentile of the 30 time steps prior to this minimum as GS threshold. The minimum of the record below this threshold that is closest to (but earlier than) the end point determined in step 3 is determined as the start point of the respective DO transition.
- 5. For the $\delta^{18}\text{O}$ (dust), the end of the respective IG is identified as the first time point after the DO transition end point where a 40-year (10-year) running mean of the record is again below the GS threshold determined in step 4.

Reference

Rousseau, D.-D., Boers, N., Sima, A., Svensson, A., Bigler, M., Lacroix, F., Taylor, S., and Antoine, P.: (MIS3 & 2) millennial oscillations in Greenland dust and Eurasian aeolian records: a paleosol perspective. *Quaternary Sci. Rev.*, in revision, 2017.