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Coeval dust accumulation minima in Greenland and East Central Europe over 31-23 ka

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As reflected in δ^{18}O values in ice cores, the North Atlantic area experienced a series of abrupt, dramatic climatic fluctuations over the last glacial during which oceanic and atmospheric conditions alternated between full glacial (stadial) and relatively mild (interstadial) conditions [1,2]. Beyond the δ^{18}O profiles, calcium ion concentration data (hereafter [Ca^{2+}]) also exhibit particularly clear stadial/interstadial contrasts [3]. The Ca^{2+}/dust concentration records are considered as a proxy for the amount of terrestrial dust reaching the ice sheet [4] and/or changing dust storm activity in the source areas around the Northern Hemisphere, mainly in East Asia [5,6]. The mode of the dust size distributions is thought to reflect transit times during transport, with larger modes indicating shorter transit times and transport routes, i.e. changed atmospheric circulation patterns [5]. However, based on clay mineralogy and Sr-Nd isotopic compositions of loess sediments Újvári, et al. [7] suggested that Central European dust cannot be excluded as a potential source of Greenland dust. As such, it is vital to analyze dust deposition in the key dust depocentres of Eastern Europe.

As a record of Carpathian Basin dust source activity, we therefore studied loess sedimentation and grain size changes in the Dunaszekcső loess sequence in Southern Hungary. For this record, we developed the highest resolution geochronological dataset for European loess based on 61 AMS ^{14}C dates from molluscs and charcoal fragments. This allowed us to establish a uniquely high precision Bayesian age-depth model, with the mean 95% confidence ranges that vary between 119 and 798 yr. Sedimentation rates (SR) calculated from the age-depth model vary between 0.36-1.7 mm yr^{-1} and the estimated bulk dust mass accumulation rates (MAR) range from 551 to 2525 g m^{-2} yr^{-1}. Both the SR and MAR display millennial/sub-millennial scale variations, visible uniquely due to the high precision dating, together with the bulk loess median grain size ($D50_{bulk}$) that is considered an integrated proxy of wind strength, dust source distance, aridity and vegetation cover. While an increase of dust flux and $D50_{bulk}$ with time is apparent, such a trend cannot be seen in the quartz grain size measures ($D50_{quartz}$). This observation may imply that wind speeds were relatively constant in the studied time interval, while the turbulence of the flow may have been extremely varying (i.e. strong/rapid changes in the frequency/magnitude of dust storm events).

A striking feature of the MAR record is that accumulation minima in the Dunaszekcső record are synchronous with the Greenland Interstadials (GI-5.1 to GI-3). Subsequent Ca^{2+} minima in the NGRIP record at 26.22 and 25.02 ka (b2k) are also coeval with the MAR minima in the studied loess sequence. At the same time, these patterns are barely visible in the bulk and quartz grain size records. We speculate that the synchronous changes in the NGRIP Ca^{2+} and the Dunaszekcső MAR records are results of millennial scale variations in the activity of Northern Hemisphere dust emitting regions shown in two archives from different environments. The very similar timing of MAR minima (and also some of the maxima) suggest a rapid aeolian system response in East Central Europe to abrupt climatic changes in the North Atlantic. Although such a synchronicity does not prove a Central European dust source to Greenland, it is consistent with this possibility.

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