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Long Term Seasonality Changes and Short Term Climate Variability Recorded in Eurasian Loess: Examples from Serbia, Romania, Kazakhstan, and China

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Past climate dynamics associated with the Eurasian continent are well studied. However, the impact of intra-hemispheric-scale climate variability on the entire Eurasian landmass, as well as the self-generated effects of the continent on the global climate system, is still a matter of considerable debate. While western Atlantic polar and tropical air masses penetrate into the continent and are modified and transformed as they cross Eurasia, the interior regions of Eurasia strongly influence Earth's climate system. Significant cooling and heating of Central and High Asia drive interactions between atmosphere and ocean processes and regulate teleconnection patterns of the Northern Hemisphere.

The distribution of Eurasian loess deposits allows interregional palaeoclimatic investigations along a west-east transect across the entire Eurasian loess belt of the Northern Hemisphere, offering the potential to reconstruct Pleistocene atmospheric circulation patterns and aeolian dust dynamics on a wide spatial scale.

This paper utilizes high resolution particle size data from several loess sequences across Eurasia (Serbia, Romania, Kazakhstan, and China) that provide a detailed signal of glacial-interglacial atmospheric dynamics and long term, semi-continuous trends in the aeolian dust record since marine isotope stage 10. In consideration of the modern synoptic atmospheric circulation patterns and aeolian dust transport across the Eurasian landmass, we propose that the observed data reflect oscillations superimposed on a long term signal of seasonality, triggered by changes in duration and permanency of the seasonal shift of the Eurasian polar front during the middle to late Pleistocene. As the activity of the polar front jet is intimately connected with the high level planetary frontal zone (HPFZ), the Eurasian loess archives may also serve as a recorder of intra-hemispheric climate connections in past atmospheric circulation.
Although there are large scale similarities in the dust transport record from numerous sites across Eurasia, the data reveal distinct differences in short-term climate variability along the studied transect from SE Europe over Central Asia to China. In Central and East Asia the observed dynamics in aeolian dust transport closely mirror δ18O and fine dust variations seen in Greenland ice cores, suggesting a correlation with short-term climate oscillations (DO events) recorded therein. An Asian origin of fine aeolian dust preserved in Greenland ice cores has been discussed previously, and recent papers reveal a close link between Asian aeolian dust dynamics and DO events recorded in Greenland ice cores.

In this context, the presented data represent the first Central and East Asian aeolian dust records in which DO events are recorded, providing a means to verify hypothesized links between short-term climate variability recorded in Greenland and associated climate dynamics at Asian dust source areas. Ultimately, the data extend existing theories, suggesting that the Central and High Asian mountains are a crucial element within the sensitive glacier-desert-dust response system in interior Eurasia and may be considered a pacemaker of suborbital global climate changes and an initiator of abrupt climate oscillations in the Northern Hemisphere.