Atmospheric
Chemistry
and Physics
Discussions

Interactive comment on "Linkage between Dust Cycle and Loess of the Last Glacial Maximum in Europe" *by* Erik Jan Schaffernicht et al.

Anonymous Referee #2

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This paper examines the contribution of mineral dust cycle to loess deposits in Europe during the Last Glacial Maximum (LGM) using the output from the Max-Plank-Institute Earth System Model (MPI-ESM) and simulations from the WRF-Chem model. The simulated dust deposition rates are largely consistent with site records of mass accumulation rates of the loess deposits. Using statistic dynamical downscaling, it is found that the east sector and cyclonic winds are the dominant circulation regimes during the LGM and thus result in a westward dust transport to the central and eastern Europe. The seasonal variations in dust emission and deposition are also analyzed. Overall, the paper is well organized and written. However, in some places, the purpose of the analysis and methodology need further clarification. My comments are summarized as follows.

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Major comments:

1. I'd suggest adding a discussion about the motivation to use the WRF-Chem and MPI-ESM to study dust cycles during the LGM. As mentioned in section 1, results from previous global simulations largely underestimate the mass accumulation rates (MARs) of dust depositions. Is this due to the coarse resolution of the global models or insufficiency of the dust emission schemes to capture certain processes of the dust emission and transport? Or is it related to unrealistic land surface settings for the LGM or misrepresentation of the atmospheric circulation patterns in the models? Similarly, please consider adding explanation/discussion about why current work better captures the magnitude of the MARs in the result section.

2. The purpose of using dynamic downscaling and statistic dynamic downscaling is not quite clear, and the method of dynamic downscaling is somewhat vague. For instance, 30 years of simulations are conducted using dynamic downscaling (line 82). What time period does the simulation cover? Are the 30 years consecutive? What's the setting of sea surface temperature and vegetation cover? More importantly, what's the benefit of using statistic dynamic downscaling? Why not use the results from the dynamic downscaling directly, e.g., by selecting the circulation weather types (CWTs) from the 30-year run?

3. Please consider adding the dust emission scheme (Shao 2004) to section 2, so the readers would have a clearer idea about how dust emission is initiated and constrained in the model. Information such as dust size bins is also needed.

Minor points:

1. By using the CWTs as criteria to conduct statistic dynamic downscaling, it assumes that atmospheric circulation pattern is the dominant factor influencing dust deposition, other factors, such as land surface features (e.g., vegetation coverage, soil moisture), and environmental factors (e.g., wind frequency and magnitude, precipitation) play minor roles. Is this a good assumption? You may want to add some discussion in section

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2 about this.

2. Instead of showing schematic of the atmospheric circulation patterns (e.g., Fig. 2), I wonder if you may add figures in text or in the supplement to show the composite of wind patterns either from the MPI-ESM or WRF-Chem simulations to better demonstrate the transport pathways of the dust.

3. Lines 55-56, what's the setting of sea surface temperature for the WRF-Chem? Is it also from the MPI-ESM simulation?

4. Lines 68-69, are the vegetation coverage data monthly or annually?

5. Lines 85- 87, CWT on what level? Near-surface, 850 hPa, or a higher level?

6. Lines 87-88, "to compare the prevailing wind directions over Europe during the Pre-Industrial (PI) and the LGM...". Why not compare with present-day wind direction? In the abstract, "present-day prevailing westerlies" is mentioned, is it referred to the result from the PI simulation?

7. Line 89, what's the difference between the MPI-LGM run and MPI-EMS-P run? How long are these simulations?

8. Line 90, why is this point selected? Is it the center of the Loess?

9. Line 94, what are the differences in 13 simulations? Initial conditions?

10. Line 96, what is the definition of a "CWT set"? 8 consecutive days with the same CWT? Can you please list the number of CWT sets from the MPI-ESM simulation?

11. Fig. 1, can you please add the location of the Loess to the figure?

12. Can you please add some explanation about Table 1? e.g., what's heterogeneous sequence? Why are spin-up records preferred?

13. Line 135, why do you mention Fig. 9a here?

14. Line 181, why do you select 12 and 20 μm? Is 20 μm the largest dust size bin in

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the model? The results from FD12 in Fig. 4 seem not discussed in section 3.4.

15. Line 214, add "(Fig. 7)" after "vegetation cover".

16. Can you please add the location of dust source (as displayed in Fig. 1) to Fig. 6?