Table S1: Loess mass accumulation rates; encompassing all particle sizes (MAR) or only particles with less than 10 μm diameter (MAR10). Reconstructed from fieldwork samples dated to the LGM or to a period encompassing the LGM. Proportion of particles smaller than 10 μm in diameter (Frac10). MAR ranges itemized by their limits. For sites with more than one reconstructed MAR each rate is shown separately. Missing value (0.00); country codes (CC) conform with ISO 3166.

| Site | CC | Lat °N | Lon °E | MAR g m$^{-2}$ yr$^{-1}$ | MAR10 g m$^{-2}$ yr$^{-1}$ | Frac10 |
|---|---|---|---|---|---|---|
| Achenheim [1] | FR | 48.35 | 7.38 | 331.00 | 82.75 | 0.25 |
| Achenheim [2] | FR | 48.35 | 7.38 | 257.00 | 0.00 | 0 |
| Albertirsa [3] | HU | 47.26 | 19.64 | 386.00 | 96.50 | 0.25 |
| Albertirsa [2] | HU | 47.26 | 19.64 | 841.00 | 0.00 | 0 |
| Albertirsa [4] | HU | 47.26 | 19.64 | 587.00 | 134.00 | 0.23 |
| Am Bingert Wiesbaden [2] | DE | 50.12 | 8.28 | 361.00 | 0.00 | 0 |
| Arapovychi (Arapovichi) [5] | UA | 51.95 | 33.31 | 666.00 | 166.50 | 0.25 |
| Basaharc [4] | HU | 47.80 | 18.84 | 348.00 | 79.00 | 0.23 |
| Batajnica [4] | RS | 44.92 | 20.32 | 329.00 | 75.00 | 0.23 |
| Böckingen [2] | DE | 49.13 | 9.18 | 3300.00 | 0.00 | 0 |
| Bodrogkeresztúr 1 [4] | HU | 48.13 | 21.40 | 381.00 | 87.00 | 0.23 |
| Bönnigheim A [2] | DE | 49.04 | 9.14 | 131.00 | 0.00 | 0 |
| Bönnigheim B [6] | DE | 49.04 | 9.14 | 242.00 | 60.50 | 0.25 |
| Bönnigheim B [2] | DE | 49.04 | 9.14 | 283.00 | 0.00 | 0 |
| Bönnigheim B [2] | DE | 49.04 | 9.14 | 1500.00 | 0.00 | 0 |
| Bryansk [5] | RU | 53.15 | 34.06 | 394.00 | 98.50 | 0.25 |
| Crvenka [4] | RS | 45.66 | 19.48 | 197.00 | 45.00 | 0.23 |
| Csorgókút 1 [4] | HU | 48.13 | 21.40 | 284.00 | 65.00 | 0.23 |
| Csorgókút 2 [4] | HU | 48.13 | 21.40 | 453.00 | 103.00 | 0.23 |
| Debrecen (Alföldi brickyard) [4] | HU | 47.53 | 21.57 | 237.00 | 54.00 | 0.23 |
| Dolní Vestonice [6] | CZ | 48.89 | 16.66 | 758.00 | 189.50 | 0.25 |
| Dolní Věstonice [2] | CZ | 48.89 | 16.66 | 754.00 | 0.00 | 0 |
| Dolní Věstonice [2] | CZ | 48.89 | 16.66 | 1100.00 | 0.00 | 0 |
| Dunaszekcső[4] | HU | 46.07 | 18.75 | 707.00 | 161.00 | 0.23 |
| Dunaújváros [4] | HU | 46.97 | 18.94 | 1238.00 | 282.00 | 0.23 |
| Dybawka [7] | PL | 49.79 | 22.69 | 1195.00 | 0.00 | 0 |
| Erdut [4] | HR | 45.53 | 19.06 | 215.00 | 49.00 | 0.23 |
| Gololobovo [8] | RU | 55.05 | 38.57 | 272.00 | 68.00 | 0.25 |
| Gorokhov [5] | UA | 50.31 | 24.50 | 435.00 | 108.75 | 0.25 |
| Grubgraben Kammern Niederösterreich [2] | AT | 48.50 | 15.80 | 2100.00 | 0.00 | 0 |
| Gunderding Oberösterreich [2] | AT | 48.26 | 13.23 | 10340.00 | 0.00 | 0 |
| Halytsch (Halyc) [9] | UA | 49.10 | 24.80 | 226.00 | 56.50 | 0.25 |
| Harmignies [10] | BE | 50.41 | 4.02 | 412.00 | 103.00 | 0.25 |
| Harmignies [2] | BE | 50.41 | 4.02 | 1467.00 | 0.00 | 0 |
| Harmignies [2] | BE | 50.41 | 4.02 | 3135.00 | 0.00 | 0 |
| Irig [4] | RS | 45.08 | 19.87 | 192.00 | 44.00 | 0.23 |
| Katymár [7] | HU | 46.02 | 19.20 | 1005 | 0.00 | 0 |
| Katymár [4] | HU | 46.02 | 19.20 | 632.00 | 144.00 | 0.23 |
| Kesselt [11] | BE | 50.84 | 5.60 | 446.00 | 111.50 | 0.25 |

*Table continues*

Table S1: *continued*

| Site | CC | Lat °N | Lon °E | MAR g m$^{-2}$ yr$^{-1}$ | MAR10 g m$^{-2}$ yr$^{-1}$ | Frac10 |
|---|---|---|---|---|---|---|
| Kesselt [2] | BE | 50.84 | 5.60 | 825.00 | 0.00 | 0 |
| Kesselt [2] | BE | 50.84 | 5.60 | 330.00 | 0.00 | 0 |
| Korostelevo (Korostylievo) [12] | RU | 51.84 | 42.42 | 181.00 | 45.25 | 0.25 |
| Lakitelek 1 [4] | HU | 46.88 | 20.02 | 254.00 | 58.00 | 0.23 |
| Látókép [4] | HU | 47.56 | 21.49 | 212.00 | 48.00 | 0.23 |
| Likhvin (Chekalin) [8] | RU | 54.10 | 36.27 | 272.00 | 68.00 | 0.25 |
| Madaras [4] | HU | 46.04 | 19.29 | 375.00 | 86.00 | 0.23 |
| Mende [13] | HU | 47.42 | 19.45 | 456.00 | 114.00 | 0.25 |
| Mende [2] | HU | 47.42 | 19.45 | 519.00 | 0.00 | 0 |
| Mende [4] | HU | 47.42 | 19.45 | 761.00 | 173.00 | 0.23 |
| Mezyn (Mezin) [5] | UA | 52.20 | 33.30 | 788.00 | 197.00 | 0.25 |
| Molodova V [14] | UA | 48.50 | 26.89 | 369.00 | 92.25 | 0.25 |
| Mosorin [7] | RS | 45.26 | 20.28 | 545.00 | 0.00 | 0 |
| Mošorin [4] | RS | 45.26 | 20.28 | 395.00 | 90.00 | 0.23 |
| Nussloch [15] | DE | 49.35 | 8.72 | 2114.00 | 528.50 | 0.25 |
| Nussloch [2] | DE | 49.35 | 8.72 | 1213.00 | 0.00 | 0 |
| Nussloch [2] | DE | 49.35 | 8.72 | 6129.00 | 0.00 | 0 |
| Otkaznoe (Otkaznoye) [16] | RU | 44.32 | 43.85 | 336.00 | 117.60 | 0.35 |
| Paks [13] | HU | 46.64 | 18.88 | 1325.00 | 331.25 | 0.25 |
| Paks [2] | HU | 46.64 | 18.88 | 2662.00 | 0.00 | 0 |
| Paks [4] | HU | 46.64 | 18.88 | 1422.00 | 324.00 | 0.23 |
| Patkóbánya Kopasz Hill Tokaj [17] | HU | 48.22 | 20.45 | 395.00 | 98.75 | 0.25 |
| Petrovaradin [4] | RS | 45.27 | 19.87 | 174.00 | 40.00 | 0.23 |
| Prymors'ke (Primorskoje) [18] | UA | 45.94 | 30.20 | 654.00 | 163.50 | 0.25 |
| Pyrogove [7] | UA | 50.36 | 30.53 | 1659.00 | 0.00 | 0 |
| Radymno [7] | PL | 49.96 | 22.81 | 538.00 | 0.00 | 0 |
| Remicourt [2] | BE | 50.67 | 5.40 | 560.00 | 140.00 | 0.25 |
| Remicourt [2] | BE | 50.67 | 5.40 | 453.00 | 0.00 | 0 |
| Rocourt [19] | BE | 50.68 | 5.54 | 257.00 | 64.25 | 0.25 |
| Rocourt [2] | BE | 50.68 | 5.54 | 93.00 | 0.00 | 0 |
| Ruma [4] | RS | 45.01 | 19.85 | 192.00 | 44.00 | 0.23 |
| Sables d'Or les Pins [2] | FR | 48.65 | -2.39 | 354.00 | 0.00 | 0 |
| Ságvár [4] | HU | 46.83 | 18.09 | 176.00 | 40.00 | 0.23 |
| Sanzhijka [7] | UA | 46.23 | 30.61 | 808.00 | 0.00 | 0 |
| Schwalbenberg [2] | DE | 50.57 | 7.24 | 560.00 | 140.00 | 0.25 |
| St.-Pierre-les-Elbeuf [20] | FR | 49.60 | 1.23 | 242.00 | 60.50 | 0.25 |
| St.-Romain-de-Colbosc [19] | FR | 49.54 | 0.36 | 687.00 | 171.75 | 0.25 |
| Stari Bezradychy [7] | UA | 50.18 | 30.55 | 440.00 | 0.00 | 0 |
| Stari Slankamen [4] | RS | 45.13 | 20.27 | 168.00 | 38.00 | 0.23 |
| Stillfried Gänserndorf Niederösterreich [2] | AT | 48.42 | 16.84 | 229.00 | 0.00 | 0 |
| Strelitsa [21] | RU | 51.60 | 38.90 | 290.00 | 72.50 | 0.25 |
| Surduk [4] | RS | 45.07 | 20.33 | 434.00 | 99.00 | 0.23 |
| Susek [4] | RS | 45.22 | 19.53 | 150.00 | 34.00 | 0.23 |
| Süttő[22] | HU | 47.74 | 18.45 | 1009.00 | 0.00 | 0 |

*Table continues*

Table S1: *continued*

| Site | CC | Lat °N | Lon °E | MAR g m$^{-2}$ yr$^{-1}$ | MAR10 g m$^{-2}$ yr$^{-1}$ | Frac10 |
|---|---|---|---|---|---|---|
| Süttő[4] | HU | 47.74 | 18.45 | 584.00 | 133.00 | 0.23 |
| Szeged-Öthalom I [4] | HU | 46.28 | 20.10 | 332.00 | 76.00 | 0.23 |
| Tápiósüly [4] | HU | 47.45 | 19.52 | 504.00 | 115.00 | 0.23 |
| Titel [7] | RS | 45.23 | 20.30 | 591.00 | 0.00 | 0 |
| Titel [4] | RS | 45.23 | 20.30 | 510.00 | 116.00 | 0.23 |
| Tokaj (Kereszt Hill II) [4] | HU | 48.13 | 21.40 | 222.00 | 51.00 | 0.23 |
| Tokaj (Patkó-quarry) [4] | HU | 48.12 | 21.40 | 332.00 | 76.00 | 0.23 |
| Tokaj Kopasz Hill Patkó-bánya [17] | HU | 48.22 | 20.45 | 395.00 | 98.75 | 0.25 |
| Tönchesberg Tönches-Berg Kruft [23] | DE | 50.35 | 7.35 | 779.00 | 194.75 | 0.25 |
| Tönchesberg Tönches-Berg Kruft [2] | DE | 50.35 | 7.35 | 1249.00 | 0.00 | 0 |
| Trindorf Oftering [2] | AT | 48.24 | 14.14 | 2970.00 | 0.00 | 0 |
| Üveghuta-2 borehole [4] | HU | 46.20 | 18.61 | 338.00 | 77.00 | 0.23 |
| Volgodonsk [24] | RU | 47.56 | 41.99 | 245.00 | 98.00 | 0.4 |
| Vyazivok [25] | UA | 49.33 | 32.98 | 202.00 | 50.50 | 0.25 |
| Willendorf II Niederösterreich [2] | AT | 47.79 | 16.05 | 372.00 | 0.00 | 0 |
| Willendorf II Niederösterreich [2] | AT | 47.79 | 16.05 | 886.00 | 0.00 | 0 |
| Zmajevac [4] | HR | 45.81 | 18.82 | 437.00 | 100.00 | 0.23 |

Table S2: Palaeoclimate Modelling Intercomparison Project Phase 3 (PMIP3) setup for global LGM simulations (first column) and its adapted implementation that upgrades the WRF-Chem to the WRF-Chem-LGM. Default values listed for comparison to the right of the slash (second column).

| | PMIP3-LGM [26] | WRF-Chem-LGM / WRF-Chem |
|---|---|---|
| Earth's orbit: | | |
| Eccentricity | 0.018994 | 0.018994 / 0.014 |
| Obliquity | 22.949° | 22.949° / 23.5° |
| Gas concentrations: | | |
| $CO_2$ $(10^{-6})$ | 185 | 185 / 379 |
| $CH_4$ $(10^{-9})$ | 350 | 350 / 1774 |
| $N_2O$ $(10^{-9})$ | 200 | 200 / 319 |
| CFCs, misc. $(10^{-12})$ | 0 | 0 / 169, 251, 538 |
| Mineral dust | Computed or CMIP5-PI [27] | Shao et al. [28] |
| Land-sea mask | 1° PMIP3-LGM [26] | 1° PMIP3-LGM-based |
| Orography | Offsets added (1° PMIP3-LGM) | Offsets added (1° PMIP3-LGM-based) |
| Ice sheets | 1° PMIP3-LGM | 2° CLIMAP-LGM [29]-based |
| Land use | Same as in CMIP5-PI | 2° CLIMAP-LGM-based |
| Vegetation cover | Same as in CMIP5-PI | Deduced from 2° CLIMAP-LGM and WRF geo-data [30] |
| Soil types | Not specified | Present-day WRF geo-data, EIS adapted |
| Erodibility | Not specified | Deduced [31] from 1° PMIP3-LGM topography and 2° CLIMAP-LGM bare soil |
| Sea surface temperatures | Not specified | MPI-LGM [32–34] |

Table S3: Modules and domain parameters applied to run the WRF-Chem-LGM simulations. University of Cologne (UC)

| | |
|---|---|
| WRF-Chem version | 3.5.1 |
| Time step | 3 min |
| Horizontal resolution | 50 km |
| Vertical levels | 35 |
| MPI-LGM boundary data input interval | 6 h |
| Microphysics | Lin Scheme [35] |
| Longwave, Shortwave Radiation | RRTMG [36] |
| Surface Layer | MM5 Similarity Scheme [37] |
| Land Surface Model | Unified Noah [38–40] |
| Planetary Boundary layer | Yonsei Univ. Scheme [41] |
| Cumulus convection parameter | Tiedtke Scheme [42] |
| Non hydrostatic | Yes |
| Chemistry modules active | Dust-only |
| Dry deposition | Yes [43] |
| Vertical turbulent mixing | Yes |
| Dust option | GOCART [44] |
| Dust emissions | UC Simplified Scheme [28] |
| Wet deposition | Enabled [45] |

# 1 References


[1] Rousseau DD, Zöller L, Valet JP (1998) Late Pleistocene Climatic Variations at Achenheim, France, Based on a Magnetic Susceptibility and TL Chronology of Loess. *Quaternary Research* 49(3):255–263.

[2] Frechen M (2003) Loess in Europe—mass accumulation rates during the Last Glacial Period. *Quaternary Science Reviews* 22(18-19):1835–1857.

[3] Novothny A, Horváth E, Frechen M (2002) The loess profile at Albertirsa, Hungary—improvements in loess stratigraphy by luminescence dating. *Quaternary International* 95-96:155–163.

[4] Újvári G, Kovács J, Varga G, Raucsik B, Marković SB (2010) Dust flux estimates for the Last Glacial Period in East Central Europe based on terrestrial records of loess deposits: a review. *Quaternary Science Reviews* 29(23-24):3157–3166.

[5] Mahowald NM, et al. (2006) Change in atmospheric mineral aerosols in response to climate: Last glacial period, preindustrial, modern, and doubled carbon dioxide climates. *J. of Geophysical Research: Atmospheres* 111(D10).

[6] Frechen M, Zander A, Cílek V, Ložek V (1999) Loess chronology of the Last Interglacial/Glacial cycle in Bohemia and Moravia, Czech Republic. *Quaternary Science Reviews* 18(13):1467–1493.

[7] Bokhorst M, et al. (2011) Atmospheric circulation patterns in central and eastern Europe during the Weichselian Pleniglacial inferred from loess grain-size records. *Quaternary International* 234(1-2):62–74.

[8] Little EC, et al. (2002) Quaternary stratigraphy and optical dating of loess from the east European Plain (Russia). *Quaternary Science Reviews* 21(14-15):1745–1762.

[9] Łanczont M, Madeyska T (2005) Environment of the East Carpathian Foreland during periods of Palaeolithic man's activity. *CATENA* 59(3):319–340.

[10] Frechen M, van Vliet-Lanoë B, van den Haute P (2001) The Upper Pleistocene loess record at Harmignies/Belgium — high resolution terrestrial archive of climate forcing. *Palaeogeography, Palaeoclimatology, Palaeoecology* 173(3-4):175–195.

[11] van den Haute P, Vancraeynest L, De Corte F (1998) The Late Pleistocene loess deposits and palaeosols of eastern Belgium: new TL age determinations. *J. of Quaternary Science* 13(5):487–497.

[12] Rutter NW, et al. (2003) Correlation and interpretation of paleosols and loess across European Russia and Asia over the last interglacial–glacial cycle. *Quaternary Research* 60(1):101–109.

[13] Frechen M, Horváth E, Gábris G (1997) Geochronology of Middle and Upper Pleistocene Loess Sections in Hungary. *Quaternary Research* 48(3):291–312.

[14] Haesaerts P, et al. (2003) The east Carpathian loess record : a reference for the middle and late pleniglacial stratigraphy in central Europe [La séquence loessique du domaine est-carpatique : une référence pour le Pléniglaciaire moyen et supérieur d'Europe centrale.]. *Quaternaire* 14(3):163–188.

[15] Rousseau D, et al. (2002) Abrupt millennial climatic changes from Nussloch (Germany) Upper Weichselian eolian records during the Last Glaciation. *Quaternary Science Reviews* 21(14-15):1577–1582.

[16] Molodkov AN, Bolikhovskaya NS (2002) Eustatic sea-level and climate changes over the last 600 ka as derived from mollusc-based ESR-chronostratigraphy and pollen evidence in Northern Eurasia. *Sedimentary Geology* 150(1-2):185–201.

[17] Sümegi P, Rudner ZE (2001) In situ charcoal fragments as remains of natural wild fires in the upper Würm of the Carpathian Basin. *Quaternary International* 76-77:165–176.

[18] Nawrocki J, Bakhmutov V, Bogucki A, Dolecki L (1999) The paleo- and petromagnetic record in the Polish and Ukrainian loess-paleosol sequences. *Physics and Chemistry of the Earth, Part A: Solid Earth and Geodesy* 24(9):773–777.

[19] Wintle AG (1987) Thermoluminescence dating of loess at Rocourt, Belgium. *Geologie en Mijnbouw* 66(1):35–42.

[20] Antoine P, Rousseau DD, Lautridou JP, Hatté C (1999) Last interglacial-glacial climatic cycle in loess-palaeosol successions of north-western France. *Boreas* 28(4):551–563.

[21] Virina EI, et al. (2000) Palaeoclimatic record in the loess-palaeosol sequence of the Strelitsa type section (Don glaciation area, Russia) deduced from rock magnetic and palynological data. *J. of Quaternary Science* 15(5):487–499.

[22] Novothny A, Frechen M, Horváth E, Wacha L, Rolf C (2011) Investigating the penultimate and last glacial cycles of the Süttő loess section (Hungary) using luminescence dating, high-resolution grain size, and magnetic susceptibility data. *Quaternary International* 234(1-2):75–85.

[23] Frechen M (1992) Systematic thermoluminescence dating of two loess profiles from the Middle Rhine Area (F.R.G.). *Quaternary Science Reviews* 11(1-2):93–101.

[24] Trofimov VT, ed. (2001) *Loess mantle of the Earth, and its properties.* (Moscow University Press).

[25] Rousseau DD, Gerasimenko N, Matviischina Z, Kukla G (2001) Late Pleistocene Environments of the Central Ukraine. *Quaternary Research* 56(3):349–356.

[26] Braconnot P, et al. (2012) Evaluation of climate models using palaeoclimatic data. *Nature Climate Change* 2(6):417–424.

[27] Taylor KE, Stouffer RJ, Meehl GA (2012) An Overview of CMIP5 and the Experiment Design. *Bull. of the American Meteorological Society* 93(4):485–498.

[28] Shao Y (2004) Simplification of a dust emission scheme and comparison with data. *J. of Geophysical Research* 109(D10).

[29] Climate, Long-Range Investigation, Mapping and Prediction (CLIMAP) Project Members, Ruddiman WF (1984) The Last Interglacial Ocean. *Quaternary Research* 21(2):123–224.

[30] Grell GA, et al. (2005) Fully coupled "online" chemistry within the WRF model. *Atmospheric Environment* 39(37):6957–6975.

[31] Ginoux P, et al. (2001) Sources and distributions of dust aerosols simulated with the GOCART model. *J. of Geophysical Research: Atmospheres* 106(D17):20255–20273.

[32] Stevens B, et al. (2013) Atmospheric component of the MPI-M Earth System Model: ECHAM6. *J. of Advances in Modeling Earth Systems* 5:146–172.

[33] Jungclaus JH, et al. (2013) Characteristics of the ocean simulations in the Max Planck Institute Ocean Model (MPIOM) the ocean component of the MPI-Earth system model. *J. of Advances in Modeling Earth Systems* 5(2):422–446.

[34] Jungclaus J, et al. (2012) CMIP5 simulations of the Max Planck Institute for Meteorology (MPI-M) based on the MPI-ESM-P model: The lgm experiment, served by ESGF (WDCC at DKRZ).

[35] Lin Y, Farley R, Orville H (1983) Bulk Parameterization of the Snow Field in a Cloud Model. *J. of Applied Meteorology and Climatology* 22:1065–1092.

[36] Iacono MJ, et al. (2008) Radiative forcing by long-lived greenhouse gases: Calculations with the AER radiative transfer models. *J. of Geophysical Research* 113(D13).

[37] Webb EK (1970) Profile relationships: The log-linear range, and extension to strong stability. *Quarterly J. of the Royal Meteorological Society* 96:67–90.

[38] Rosero E, Yang ZL, Gulden LE, Niu GY, Gochis DJ (2009) Evaluating Enhanced Hydrological Representations in Noah LSM over Transition Zones: Implications for Model Development. *J. of Hydrometeorology* 10(3):600–622.

[39] Case JL, Crosson WL, Kumar SV, Lapenta WM, Peters-Lidard CD (2008) Impacts of High-Resolution Land Surface Initialization on Regional Sensible Weather Forecasts from the WRF Model. *J. of Hydrometeorology* 9(6):1249–1266.

[40] Tewari M, et al. (2004) Implementation and verification of the unified NOAH land surface model in the WRF model. *20th conference on weather analysis and forecasting/16th conference on numerical weather prediction* 1115:11–15.

[41] Hong SY, Noh Y, Dudhia J (2006) A New Vertical Diffusion Package with an Explicit Treatment of Entrainment Processes. *Monthly Weather Review* 134(9):2318–2341.

[42] Zhang C, Wang Y, Hamilton K (2011) Improved Representation of Boundary Layer Clouds over the Southeast Pacific in ARW-WRF Using a Modified Tiedtke Cumulus Parameterization Scheme. *Monthly Weather Review* 139(11):3489–3513.

[43] Wesely M (1989) Parameterization of surface resistances to gaseous dry deposition in regional-scale numerical models. *Atmospheric Environment (1967)* 23(6):1293–1304.

[44] Chin M, Rood RB, Lin SJ, Müller JF, Thompson AM (2000) Atmospheric sulfur cycle simulated in the global model GOCART: Model description and global properties. *J. of Geophysical Research: Atmospheres* 105(D20):24671–24687.

[45] Jung E, Shao Y, Sakai T (2005) A study on the effects of convective transport on regional-scale Asian dust storms in 2002. *J. of Geophysical Research: Atmospheres* 110(D20). D20201.