MINERAL DUST UNDER DIFFERENT CLIMATE CONDITIONS WITH A PARTICULAR FOCUS ON THE ANTARCTIC REGION

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MOTIVATION

Global Quaternary records of dust suggest that different climatic periods are accompanied by a large variation in dust flux.

Ice core records from Antarctica and Greenland show that aeolian deposition rates at high latitudes were 20 times greater during glacial periods compared to interglacial periods, but the reasons are poorly understood.

RESEARCH FOCUS

To model, analyze and understand the effect of different climate conditions on dust emission, transport and deposition in the Southern Hemisphere, with particular focus on the Antarctic region.

MODEL DESCRIPTION

Model: Global Climate Aerosol Model ECHAM5-HAM

Model resolution: T31L19 (3.75° x 3.75°)

Dust calculation: Online

Running time: 20-years simulations after 5 years of spin up.

Tme-slices: 0ky, 6ky, 21ky, 126ky

Paleo settings:

• sea surface temperature, sea ice concentration, surface background albedo obtained from coupled atmosphere-ocean-vegetation model ECHAM/MPIOM/LPJ

• vegetation information obtained from the dynamical vegetation model LPJ

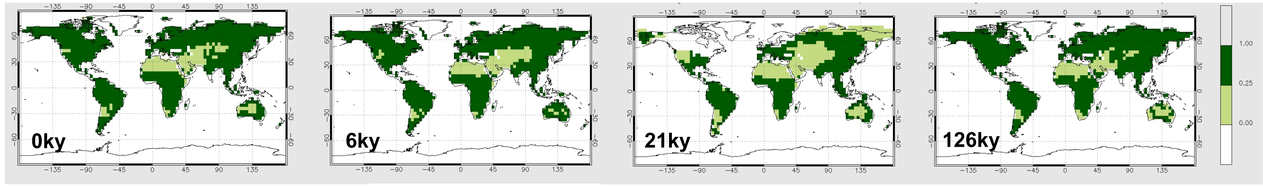
• Topography, sea-land, lake and glacial masks obtained from reconstruction

• Orbital parameters and green-house gas concentrations (CO2, CH4, N2O), according to PMIP2 protocol.

Present-day dust concentrations in Antarctic ice cores, ng/ml

	Vostok	DomeC	EDML
observations	30(+-14)	21(+-13)	6
model	48	52	18

ANNUAL MAXIMUM OF VEGETATION COVER FRACTION

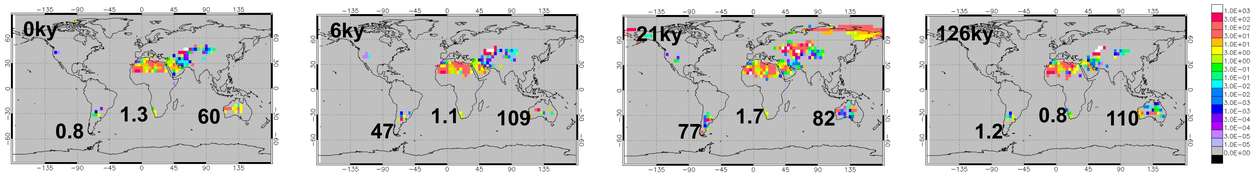


Approach: If the fraction of vegetation cover is less then 25%, the grid point considers as a dust source area.

The simulated changes in dust emissions depend strongly on the prescribed vegetation changes. Using different vegetation models yield quite different response in SH vegetation.

MULTIANNUAL MEAN OF DUST EMISSIONS, g/m²yr

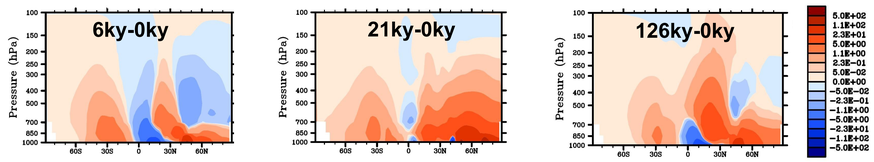
(the numbers in the plots refer to the total dust emissions over Southern America, Southern Africa and Australia, Tg/yr)



1557 Tg/yr | 1951 Tg/yr | 3106 Tg/yr | 2385 Tg/yr

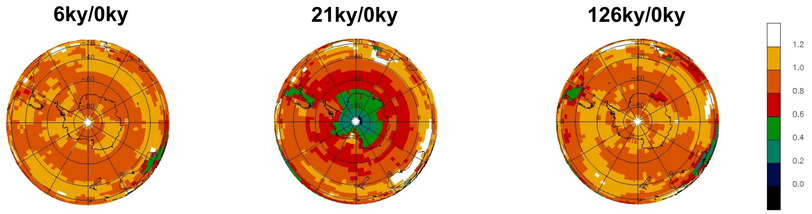
• Dust emissions vary according to the vegetation maps.
• In LGM, the Patagonian source reached its maximum, due to extended desert regions and lower sea level.
• In mid-Holocene, there is a strong increase of South American emissions, due to larger probability of higher wind speed, compared to preindustrial and Eemian runs.
• In both, mid-Holocene and Eemian time slices the Australian source increases.

ZONAL MEAN MASS CONCENTRATIN OF DUST, µg/m²



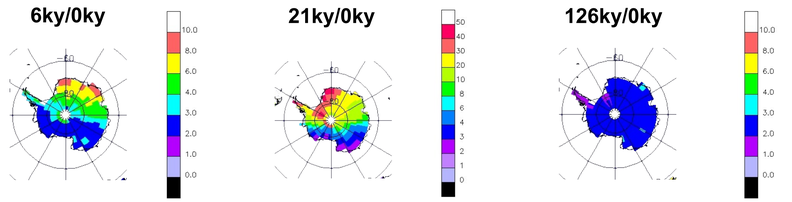
• In LGM the dust concentration is higher over the Antarctic region, due to enhance of dust emissions from Australia and Patagonia.
• In mid-Holocene there is decrease over Sahara, due to stronger monsoon effect and wet removal in summer time.

PRECIPITATION RATIO



LGM precipitation over Antarctica is half of precipitation at 0ky.

DUST CONCENTRATION IN THE ANTARCTIC ICE, RATIO



• In LGM, enhance of dust deposition and reduce of precipitation, increases the dust concentration in the Antarctic ice up to 50 times compare to present day.
• Concentration also increases up to 5 times for mid-Holocene and up to 2 times for Eemian.

CONCLISION

➢ The simulated global dust emission flux is higher by a factor of 2 for glacial and by a factor of 1.5 for mid-Holocene and Eemian compared to the preindustrial time.

➢ Both, enhanced dust deposition and reduced precipitation increase the dust concentration in the Antarctic ice by a factor of 15 for LGM compared to present day; the concentration also increases by a factor of 4 for mid-Holocene and by a factor of 2 for Eemian.

➢ In LGM the dust deposition over Antarctic increases by a factor of 7.5, compared to a global increase by a factor of 2.

➢ The vegetation information is major source of uncertainty in our dust simulation.

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