Improved dust representation in the Community Atmosphere Model

S. ALBANI[12]*, N. M. MAHOWALD[1], A. T. PERRY[1], R. A. SCANZA[1], C. S. ZENDER[3], N. G. HEAVENS[4], V. MAGGI[2], J. F. KOK[1] AND B. L. OTTO-BLIESNER[5]

[1]Department of Earth and Atmospheric Sciences, Cornell University, Ithaca NY, USA (*correspondence: s.albani@cornell.edu)
[2]Department of Environmental Sciences, University of Milano-Bicocca, Milano, Italy
[3]Department of Earth System Science, University of California, Irvine, Irvine CA, USA
[4]Department of Atmospheric and Planetary Sciences, Hampton University, Hampton VA, USA
[5]National Center for Atmospheric Research, Boulder CO, USA

Aerosol-climate interactions constitute one of the major sources of uncertainty in assessing anthropogenic and glacial radiative forcing. We recently focussed on improving the representation of mineral dust in the Community Atmosphere Model and assessing the impacts of the improvements in terms of direct effects on the radiative balance of the atmosphere and climate impacts.

We simulated the dust cycle while using different parameterization sets for dust emission, size distribution, and optical properties. Comparing the results of these simulations with observations of concentration, deposition, and aerosol optical depth allow us to refine the representation of the dust cycle and its climate impacts. Our findings indicate that the magnitude of the dust cycle is sensitive to the observational datasets and size distribution. In addition, the direct radiative forcing of dust is strongly sensitive to the optical properties and size distribution.

Our results from simulations applying the refined parameterization set indicate a net top of atmosphere direct dust radiative forcing of -0.22 ± 0.12 W/m2 for present day and -0.33 ± 0.18 W/m2 at the Last Glacial Maximum. These estimates are smaller than previous model simulations due to changes in size distribution, modeled spatial distribution and optical parameters.

We analyze the climate impatcs in response to the direct radiative forcing deriving from the refined dust parametrizations.

Isotopes of disease

FRANCIS ALBARÈDE

Ecole Normale Supérieure de Lyon, 69007 Lyon, France (albarede@ens-lyon.fr)

Transition metals are essential components of hundreds of proteins in the human body. They achieve a large spectrum of critical biological functions, such as oxygen transport (Fe), electron shuttling (Cu), structural control and protein degradation (Zn). Their binding to a variety of amino acids is controlled by bond energy, e.g., 'hard' histidine vs 'soft' cysteine, by their structural environment, and by the redox and pH conditions of biological fluids. The different cellular stores of metal are in constant flux and are regulated by gene expression which reacts to a complex pattern of physiological signals. Metal isotope compositions in organs and body fluids provide an enormous source of untapped information relevant to normal and pathological conditions. Spectacular patterns of isotope fractionation are observed in some organs such as the liver and the kidney, and in blood components as well. To a large extent, these patterns reflect the binding of metals with different amino acids, variable redox states and electronegativity. Ab initio calculations indicate that heavy isotopes tend to bind to O-rich ligands (hydroxide, carbonate, phosphate), whereas light isotopes are positively fractionated by S-bonds. Formation of blood cells (erythropoiesis) takes place with very large and coupled Cu-Fe isotope fractionation, the disruption of which clearly signal pathological, and in general, abnormal conditions. The recent years have seen the emphasis being laid on genetic diseases, such as Fe in hemochromatosis and Cu in Wilson disease, and neurodegenerative pathologies such as the Alzheimer disease for Zn. Now that preliminary ground work on metal isotopic variability in the human body is being laid, the opportunity of using some isotopes as biomarkers has never been stronger. Particularly promising are the isotopes of Cu, the concentrations of which are known to vary in multiple forms of cancer, and of Zn, which is making a forceful entry as a biomarker of prostate cancer in the wake of PSA discredit. The enormous challenge of using isotopes to quantitatively assess the parameters of metal homeostasis at the cellular level in relation with gene expression and regulation will clearly engage the upcoming generation of isotope geochemists, biochemists, and health scientists.

www.minersoc.org
DOI:10.1180/minmag.2013.077.5.1