Challenges in Understanding Past and Present Eolian Dust Dynamics

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Mineral dust is now generally recognized as a key element in global climate. However, many open questions need to be addressed to reduce the large uncertainties that still exist regarding the global dust cycle. The Atmospheric Dust During the Last Glacial Cycle: Observations and Modeling initiative (ADOM; see http://www.pages-igbp.org/workinggroups/adom) of the Past Global Changes (PAGES) tackles these questions from both modern and paleo perspectives. A 3-day workshop funded by PAGES and the Center for Marine Environmental Sciences (MARUM) in Germany brought together 50 international experts on marine, terrestrial, and polar dust archives; meteorology; remote sensing; and climate modeling. The workshop aimed to bridge gaps between disciplines and to cover all temporal and spatial scales involved in dust processes.

The following principal recommendations, divided into four main categories, resulted from the workshop:

Present-day dust. Observational gaps regarding the mineralogical and chemical composition of dust sources at known locations should be tackled in more detail. These efforts could be part of a strategic approach for remapping the world's soil distributions. In addition, current meteorological monitoring covers local and regional dust events inadequately, given that these events contribute significantly to the global dust load. Next to ground-based observations, there is a strong need for detailed and quantitative satellite observations of individual dust outbreaks. Further, seasonal to interannual changes in the atmosphere can influence dust processes and therefore should receive more attention in modern dust observation programs. Finally, more efforts should be invested in understanding present-day mechanisms of dust emission, transport, and deposition to understand the various links and feedback mechanisms between climate and mineral dust. Time series of modern dust deposition may help scientists understand these links and establish quantitative proxies for past environmental changes.

Past dust deposits. New proxies should be developed to better constrain the sources of dust deposited in Antarctica. To further elucidate dust transport across the Southern Ocean to Antarctica, ice core analysis should be flanked by the analysis of ocean sediment archives. Monitoring of radon-222 was suggested to constrain transport times of dust.

Methods. There is a strong need for standardizing methods regarding particle size and shape, bulk chemistry, and mineralogy among different scientific disciplines studying present-day mineral dust or the various archives of dust deposits. For example, standards should be created for both the emission end and the deposition end of the dust cycle. They should be developed as a community effort, which requires the involvement of experts from different disciplines such as sedimentology, meteorology, and mineralogy.

Data sets. Further efforts are recommended for global compilations of available paleoenvironmental data sets (such as dust accumulation rates) into databases as already initiated by the Dust Indicators and Records of Terrestrial and Marine Palaeoenvironments (DIRTMAP; http://www.lec.lancs.ac.uk/research/environmental_geosciences/inqua_working_group.php) and Palaeoclimates of the Southern Hemisphere: Phase Two (PASH2; http://sites.google.com/site/palcommpash2/database) initiatives. These databases should ideally aim for global coverage and proceed from the time slice approach to a higher temporal resolution. The products could then serve as valuable validation tools in aerosol modeling efforts.

The workshop agenda and more details can be found at http://www.marum.de/dust-workshop2011.html.

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