A23C CC: 520 D Tuesday 1330h

Constraining the Global Mass Distribution of Mineral Dust Aerosol I *(joint with B, GC)*

Presiding: **R L Miller,** NASA Goddard Institute for Space Studies**; C S Zender,** University of California, Irvine

A23C-01 1335h INVITED

Mineral Dust Transport to the North Atlantic and the North Pacific Oceans: Temporal Variability and the Link to Climate

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The North Atlantic and the North Pacific are heavily impacted by dust transport from North Africa and Asia respectively. The University of Miami, often in cooperation with other groups, has operated networks of aerosol sampling stations in these ocean regions for many years. In this presentation we present an overview of dust concentration data from these networks focusing on the temporal and geographical variability. Our objective is a better understanding of this variability in terms of source and transport processes. We place emphasis on two stations where we have a long record of aerosol measurements: Barbados, West Indies, (13.17N, 59.43W) and Midway (28.22N,177.35W) in the central North Pacific. The Barbados record is continuous from 1965 to present and Midway from 1981 to 2001. Dust concentrations show considerable variation over decadal and shorter time-scales. Prospero and Lamb [2003] recently showed that Barbados dust concentrations varied over a large range in a coherent way that is closely linked to rainfall (or the meteorology associated with rainfall) in the Soudano-Sahel region of North Africa. The dust record from Midway also shows large excursions especially over 1999 to 2001 reflecting intensified dust activity in Asia. During this period, large areas of China were impacted by drought. Thus both the Barbados and Midway data suggest that dust emissions increase sharply with the onset of drought. The question arises about the cause of increased dust emissions and transport. Is it simply due to drought conditions or does it reflect the combined effects of drought and human impacts? We suggest that poor land-use practices do not appear to be a major factor in these two examples. In the case of the North African dust sources, satellite images show that the major dust sources are located in exceedingly remote environments. In the case of Chinese dust sources, much literature has attributed increased dust to vastly increased agriculture and grazing in marginal lands. Yet statistics show that the frequency of dust storms has decreased markedly over the past several decades. Furthermore, there was relatively little change in dust concentrations at Midway through the late 1980s and into the 1990's when China was undergoing rapid development. In contrast North Africa has experienced a great increase in dust storm activity during the last 30 years and a concomitant decrease in visibility due to increased dust in the air. Dust sources are extremely sensitive to environmental conditions. Satellite images show that many prominent dust source regions are, in effect, composed of a series of "point" sources - that is, most of the dust is emitted from a relatively small area. This suggests that in order to better constrain the global dust budget, we need to have a much better understanding of the factors that affect the rate of emissions on scales reflecting the existence of these dust "hot spots".

A23C-02 1350h

Sensitivity of TOMS aerosol index to boundary layer height: Implications for detection of mineral aerosol sources

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The TOMS aerosol index (AI) is proposed as a powerful tool in determining the sources of mineral aerosols. The sensitivity of the AI to the height of the aerosol layer has been noted previously, but the implications of this sensitivity for deducing sources has not been explicitly considered. Here, we present a methodology and sensitivity test to show the importance of spatial and temporal variations of the planetary boundary layer height to deducing sources using the AI. These results suggest that while dry topographic low sources may be large sources of desert dust, conclusions eliminating other sources may be premature, especially when these sources occur on the edges of deserts, where boundary layer heights are lower, and human influences potentially more important. The compounding problem of differentiating downwind transport and local sources suggests it may not currently be possible to use the AI to conclusively determine mineral aerosol source regions.

A23C-03 1405h INVITED

Constraint offered by assimilation of total aerosol measurements. What can be learned about dust distributions.

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In this paper we describe our efforts to estimate the sources, transport and sinks of dust using an aerosol assimilation procedure. The assimilation procedure, which uses estimates of aerosol optical depth to constrain the values of aerosol concentrations in the model, provides information about the processes that control the destiny of aerosols over broad regions of the globe, and over many years. We discuss the lessons we have learned in using the procedure to produce a 20 year estimate of aerosol concentrations, and the sensitivity of the estimates to variations in important processes in the model. We focus in particular on mineral dust outflow from Asian and African source regions.

A23C-04 1420h

Constraining the global dust emission and load by minimizing the difference between the model and observations

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Current estimates of global dust emission are base upon models, and vary by a factor of three. Simulation of dust emission is inhibited by the model's coarse resolution compared to the scale of the circulations observed to mobilize dust, along with the localized conditions favorable for dust emission. We use a model that identifies 'preferred meteorology' for emission by subgrid circulations, in addition to 'preferred sources' for emission using a topographic criteria. Here we calculate an optimal global dust emission and load by minimizing the difference between the model and observations. We measure the robustness of this optimal value with respect to variations of the model configuration and dataset.

A23C-05 1435h

Observational Constraints on the Dust Aerosol Mineralogy in the GISS ModelE AGCM

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An improved model of soil dust aerosols in the new GISS General Circulation Model (ModelE) is presented. Whereas in the old version dust worldwide was assigned the radiative properties of far-traveled Saharan dust, the new version takes the varying mineralogical composition of the soils in the dust source regions into account. Using the model, emission, transport, and deposition of eight major minerals, quartz, feldspar, calcite, gypsum, illite, kaolinite, smectite, and hematite are simulated for one clay and four silt size classes. Modeling the dust cycle for separate minerals provides the opportunity to compare our results to the observed mineralogical composition of dust transported from the source regions to remote sites.

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A23C-06 1450h

Trans-Pacific Transport of Asian Desert Dust: Characterization of Fallout in the St-Elias Mountains, Yukon, Canada.

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In April 2001, an intense series of dust storms originated in southern Mongolia and northern China. The dust cloud raised by these storms was tracked by satellite over the North Pacific Ocean to North America. Instrumented floats deployed in the western Pacific Ocean revealed a near-doubling of the carbon biomass in the mixed layer following the passage of the dust cloud, illustrating the impact of dust on marine biological productivity (Bishop et al. 2002, Nature vol. 298). As it passed over North America, the dust cloud deposited a widespread layer of dust-laden snow in the icefields of the St-Elias mountains, Yukon Territory. The dust fallout was probably enhanced by snowfall scavenging associated with orographic uplift of the Pacific air mass over the high mountain range. Samples of dust-laden snow were collected from several sites on or near the Mount Logan massif (60 N, 140 W), during a glaciological research expedition. The samples, taken at elevations of 2400 to 5340 m, held up to 80 ppm (mass) of dust. The dust particles were analyzed to characterize their physical attributes (grain size distribution) as well as their mineralogical (XRD) and geochemical composition (ICP-MS, ICP-ES). Concentrations of over 60 elements were determined, including some nutrients, biolimiting and biointermediate elements such as P, Si, Ba and Ca. We also analyzed isotopic ratios for Sr, Nd and Pb as potential source-specific tracers of provenance. Our study provides an excellent opportunity to evaluate to what extent the physico-chemical characteristics of a dust cloud of known origin are preserved after transport over the Pacific Ocean. We also use our data to provide first-order estimates of geochemical fluxes for various elements associated with the dust fallout. These estimates may help to evaluate the biogeochemical impact of long-range dust transport events on aquatic and terrestrial ecosystems. Finally, our work highlights the potential for developing valuable paleo-records of trans-Pacific dust storm frequency and provenance from ice cores recently drilled in the St-Elias icefields.