Impact of Long-Range Aerosol Transport in Oklahoma, May 2003

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Abstract

Aerosol mass and composition were measured as a function of size (8 modes, 6 sub-micron) and time (continuous, 3 hr analyses), at the Atmospheric Radiation Measurement (ARM) Southern Great Plains (SGP) site between May 6 and June 1, 2003 as part of the May, 2003 intensive operational period (IOP). Local effects were minor, but the site exhibited changing impacts from regional, national (Houston, Texas), international (agricultural burning in Central America), and intercontinental (African dust) sources that in some cases were the most intense aerosols seen in the period. Conversely, smoke from Siberian forest fires which passed over the site in late May was not detected in ground based samples.

Introduction

In order to establish aerosol impacts on optical attenuation in the atmosphere, aerosols were continuously sampled in 8 size modes, circa 0.09 µm to 5 µm, from May 6 through June 1 at the ARM SGP site. Collection utilized the community inlet of the SGP aerosol trailer, which was teed into an 8 stage rotating DRUM sampler (Graham et al. 2001, Cahill et al. 1993, Raabe et al. 1988, Rolph 2003, Cahill et al. 1985). The rotation rate of 4 mm/day gave 3 hr time resolution when matched to the 0.5 mm soft beta ray mass analysis and the synchrotron XRF systems of the UC Davis DELTA Group (Cahill et al. 1985). Mass during the IOP is shown below in Figures 1 and 2. Note that the inlet largely suppressed particles above 5 µm and limited the particles seen in the 1 to circa 5 µm size modes.

There were many periods when the aerosol concentration at the ground was extremely low, punctuated by episodes of typically 12 to 36 hr duration events. This effect can be interpreted as very clean local conditions with transported aerosols, from elsewhere, impacting the site. The first of these episodes occurred on May 7 to 8, when the relatively coarse composition, sand soil signatures showed transported dust (Note Figure 6 showing the backward trajectory). Size distributions are shown in Figure 3 for a number of these events. Note the very fine mass signature, with significant sub-micron masses. Compositional analysis by S-XRF showed that this episode was soil, and furthermore, it had the high Ca/Fe ratio typical of Saharan dust. Trajectory analysis (HYSPLIT isentropic) indicated that indeed the source was African in origin. However, there was also a great deal of time spent in Central America, with the non-soil potassium indicating a strong biomass burning signature.

Likewise the event in May 13 had an urban signature, nicely matched to trajectories directly across Houston. The sulfur episode around May 17 was on a 2 day trajectory from Ohio.

Later in the month, smoke from Siberian fires passed over the site in late May, but little or nothing was seen on ground based samplers. (Note: Figures 1 and 2 below).

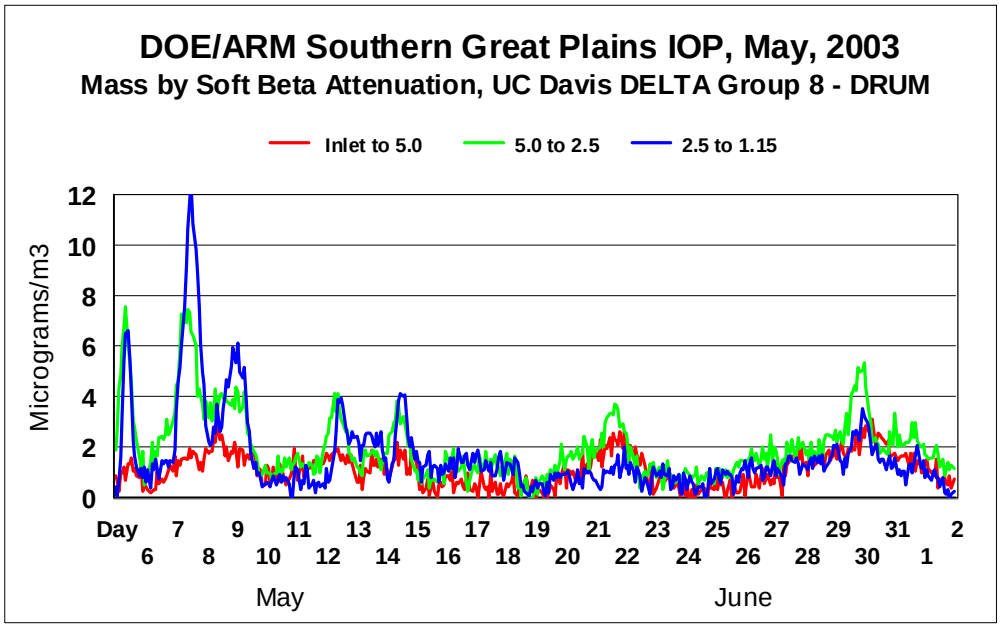

Figure 1.

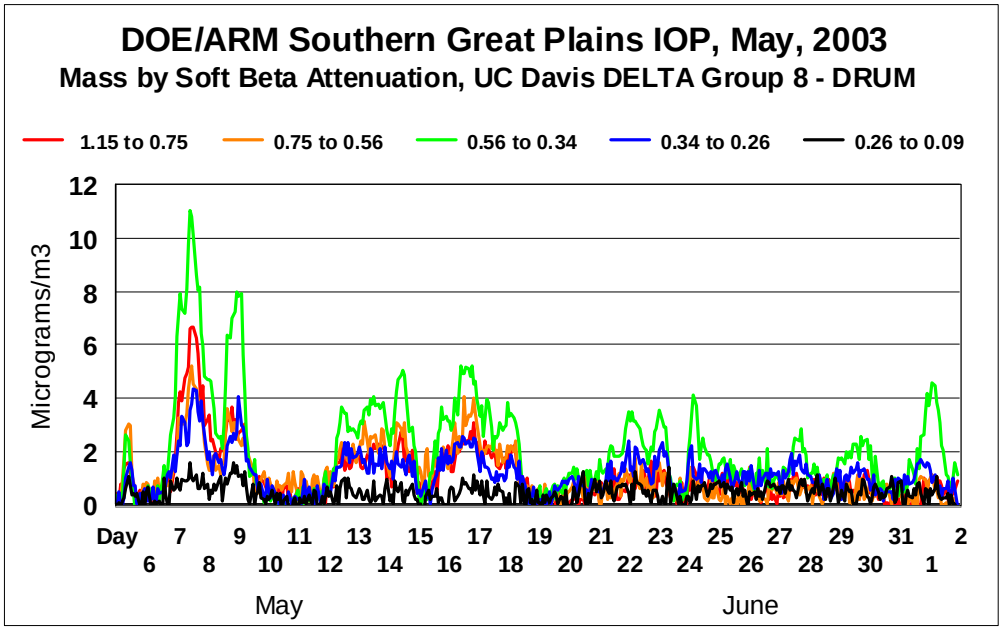

Figure 2.

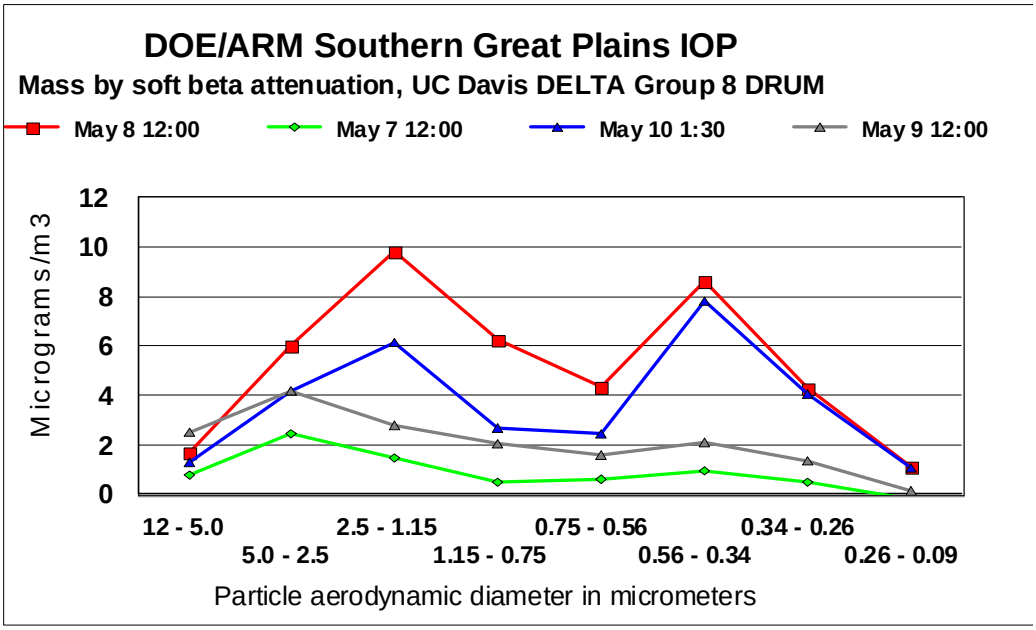

Figure 3.

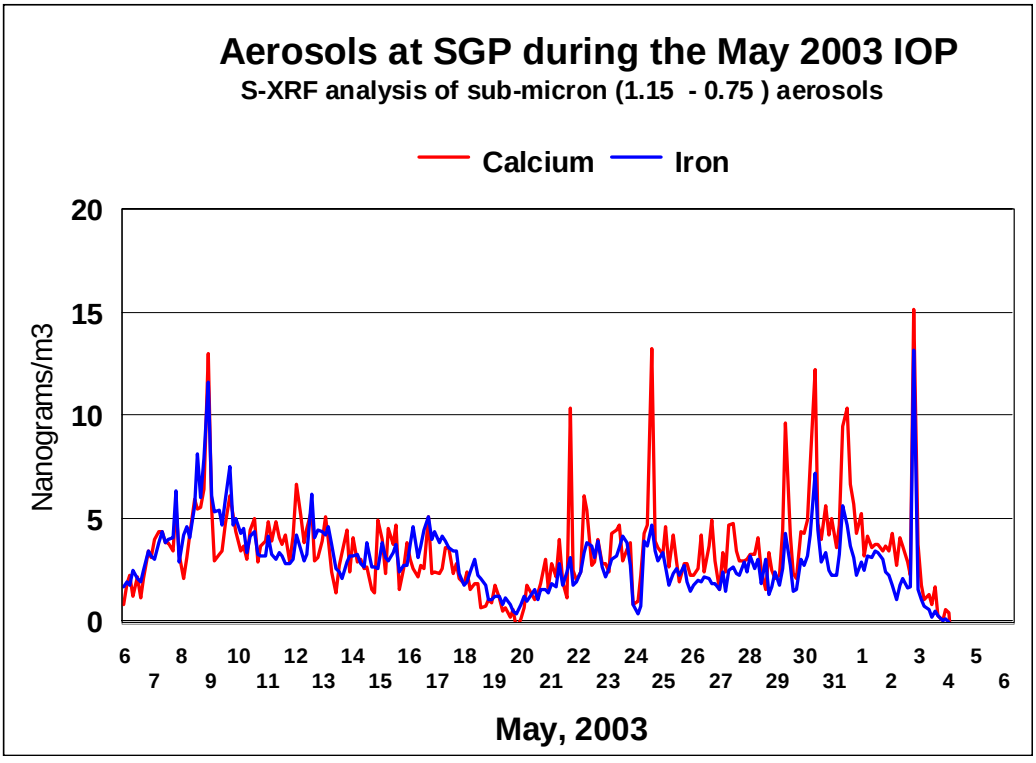

Figure 4.

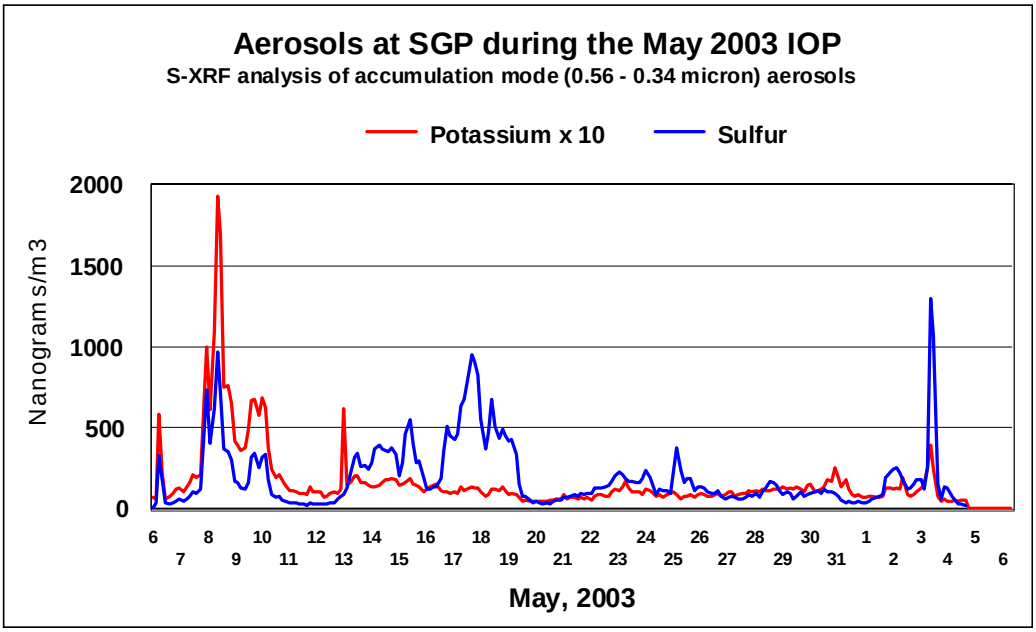

Figure 5.

Conclusions

These results demonstrate the utility of continuous size and compositional analysis of aerosols as a precursor to optical extinction measurements. The SGP site proved to be excellent, with low local sources allowing detection of regional, national, international, and intercontinental signatures.

It is important to note that this study supported the work of Perry at al. (1999), VanCuren (Reference list says Van Ainen) and Cahill (2002), and others (Draxler and Rolph 20003) that has shown that even the central region of the United States is not just influenced but dominated by distant aerosol sources.

Acknowledgments

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These measurements are a strong indication of the variability of the ground-level aerosols at the ARM site and support the first research question of the Plan of the Science Research Program for ARM (ARM and ASP/aerosol Research.

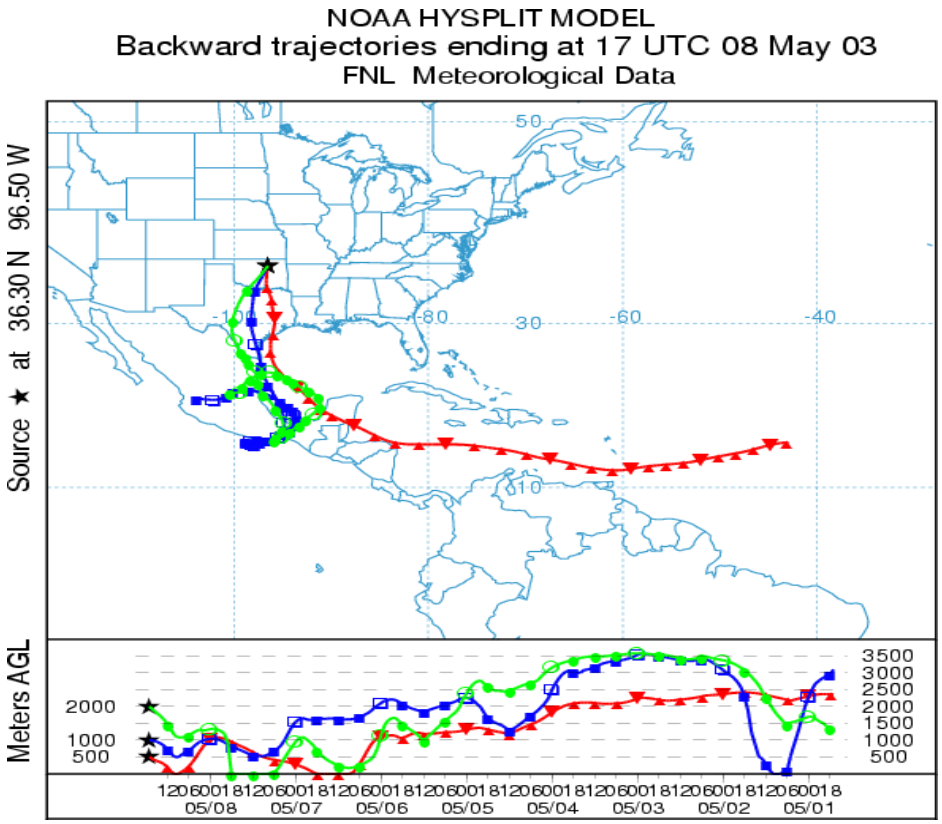

Figure 6.

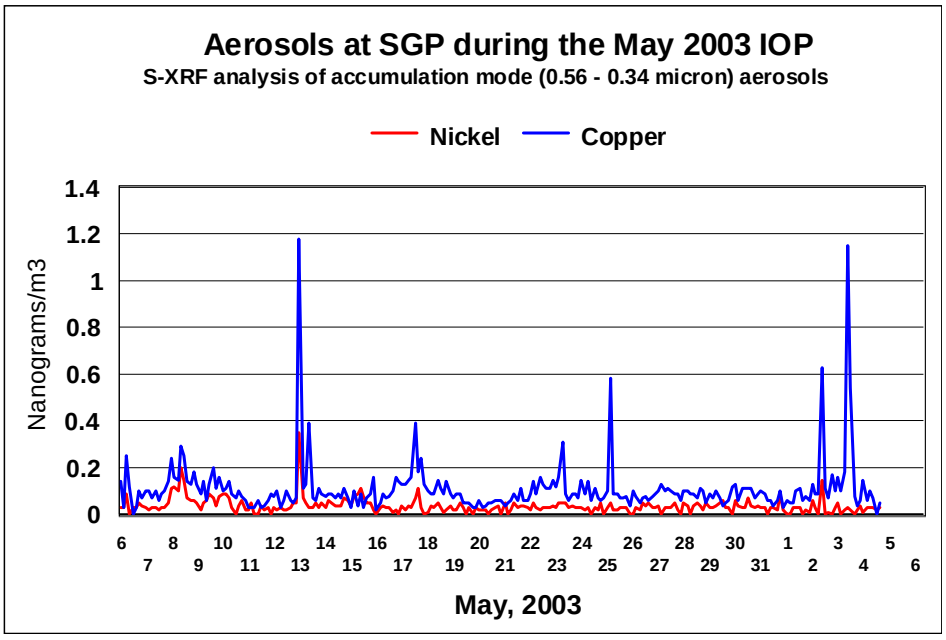

Figure 7.

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