ANALYSIS OF THE INTERACTION OF AEROSOL TRANSPORT LAYERS ON LOCAL AIR QUALITY

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1. INTRODUCTION

Air quality in New York City and elsewhere is highly dependent on the meteorological conditions that govern the transport and mixing of trace gases and aerosol particles. These processes occur on a variety of scales, from regional, to intra-continental and finally inter-continental scales. However, attempts to study how transport can effect air-quality relative to local sources are always of a statistical nature and employ tools such as positive factor analysis etc which requires a very high degree of speciation. On the other hand, direct observations of transported aerosols from satellites is very useful but these observations alone do not allow us to see whether transported plumes can interact (mix-down) . It is the purpose of this paper to combine the use of passive and active instrumentation both from the ground and from space to explore the direct interaction of pollution plumes on the PBL and to explore the effects of this interaction on measured air-quality parameters such as PM2.5 and PM10. This analysis will require us to identify aerosol plume transport from satellite sources, speciate the aerosol by pertinent optical properties such as angstrom coefficient and albedo and to observe directly the vertical profiles of the PBL and aloft plumes over events of interest and connect the observations to surface measurements. This approach also requires that a separation in plume AOD and PBL AOD is determined.

2. RESULTS

Using vertical lidar measurementts coupled with multiday satellite observations, several likely candidates of PBL and aerosol plume interactions were identified including smoke plumes from bio-mass burning as well as intercontinental dust. As a representative of the smoke case, we explored in detail Idaho and Montana forest fire plumes which were transported over the eastern United States during August 2007. Lidar observations clearly demonstrated that the aloft plume mixed down into the PBL . Trajectory analysis confirmed the origin of the smoke to Idaho and Montana, its transport at high altitudes, and the vertical winds providing the mechanism for bringing the pollutants to the surface [1] . Beyond the source tracking, the plume was clearly identified as smoke from the CCNY multi-wavelength lidar which was able to estimate a large angstrom coefficient. These lidar measurements were also shown to be consistent with radiometer and remote sensing observations (sun-photometer and GASP). We also showed that the time variability of PM2.5 and PM10 loadings are consistent with our interpretation of a smoke plume advecting into the planetary boundary layer, thereby altering the surface air quality. Furthermore, we demonstrated that to a certain extent, that a fixed relationship between PM2.5 and AOD can be satisfied to a reasonable accuracy if we correctly apportion the PBL AOD contributions from the total column AOD [2].

Beside smoke incursions on an intra-continental scale, we also observed interaction with the PBL from intercontinental transport of desert dust. Backward trajectory analysis during the April 2006 episode indicated East Asian origins and estimates a travel time of 13 days, although the dust emissions at the source were intermittent. Preliminary analysis of satellite measurements of MODIS demonstrated a fairly low angstrom property which was surprisingly incompatible with OMI absorbing aerosol measurements which were classified as biomass burning. In fact, further analysis of the OMI measurements show that current algorithms which try to separate absorbing dust from aerosols is quite poor (understandable with the lack of long wavelength channels). [3-4] However, all ground based analysis used in the smoke analysis were able to provide a consistent picture of the plume properties including angstrom coefficient < .3 (in agreement with our lidar) and SSA < .70. Analysis of PM2.5 and PM10 again provide a consistent picture of plume interaction affecting surface PM10 measurements (without a significant increase in PM2.5). Clearly, these interactions over remarkably short time periods are able to affect local air-quality and must be considered separately from regional transported sources.

3. REFERENCES

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