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MEASUREMENT BASED DETERMINATION OF AEROSOL FORCINGS AT ARM SITES: PROPOSED JOINT ASP-ARM STUDY

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ABSTRACT

It is proposed to carry out a measurement-based determination of aerosol forcings, initially at the Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) Southern Great Plains (SGP) site. There are numerous aerosol forcings, as stressed in the Climate Change Science Program Synthesis and Assessment Product SAP2.3, *Aerosol properties and their impacts on climate*, http://www.climatescience.gov/Library/sap/sap2-3/sap2-3-draft3.pdf, which identifies some six "dimensions" of aerosol forcing: top-of-atmosphere (TOA) vs. surface; direct vs. indirect; cloud-free vs. all sky; instantaneous vs. diurnal or annual average; total aerosol vs. anthropogenic aerosol; longwave vs. shortwave, Figure 1. Determination of the several aerosol forcings at a given time would require characterization through ground-based remote sensing and in-situ measurements of the three-dimensional field of atmospheric composition: temperature, water vapor, cloud boundaries (ARM), cloud microphysics, aerosol composition, aerosol microphysics; aerosol optical properties; aerosol cloud nucleating properties (DOE Atmospheric Science Program, ASP); surface reflectance; and surface and TOA radiative fluxes. The measured atmospheric and surface properties would be used to calculate surface and TOA radiative fluxes, which would be compared with observation to establish uncertainties. The calculation of the several aerosol forcings would make use of chemical identification of anthropogenic aerosol constituents (e.g., by mass spectrometry) to infer the three dimensional picture of the preindustrial aerosol; this aerosol would be input into cloud models to yield a representation of the preindustrial cloud microphysical properties, and the resulting atmospheric composition field would be input into the same radiative transfer models to calculate the corresponding preindustrial radiative flux components to yield anthropogenic aerosol forcings by difference. The measurement program would need to be carried out 24-7 over several years to establish temporal variability and statistics. Once this capability is established at SGP it would be necessary to extend the approach to other sites to characterize other aerosol types: urban, biomass burn, marine, mineral dust, and the like. The determination of forcing obtained this way would be extended globally by satellite measurements and models. The measurement based determination of aerosol forcings outlined here would require a substantial commitment of resources.

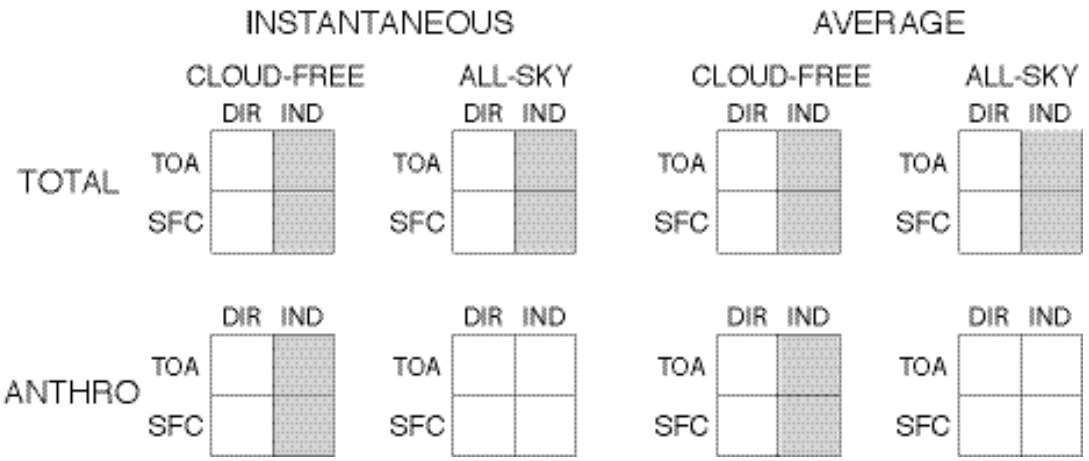

Figure 1. Five dimensions of aerosol forcings. The dimmed forcings would not be determined -- no indirect aerosol effect in cloud free sky, and indirect forcing referred to zero aerosol is not a meaningful quantity. Not shown is a sixth dimension, shortwave vs. longwave.