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Aerosol radiative forcing in a tropical urban environment - A study using ground based measurements and radiative transfer model

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Atmospheric aerosols influence climate directly by scattering and absorbing solar radiation and indirectly by modifying the microphysical and optical properties of clouds. Human activities represent an important source of airborne particulate material and indeed some studies have found substantial radiative forcing on the climate system by aerosols of anthropogenic origin. Tropospheric aerosols, such as smoke from biomass burning, dust, and pollutant aerosols, affect weather, climate and health by reducing visibility, altering the earth's radiative energy budget, changing cloud formation, affecting rainfall distribution, changing dynamics of circulation patterns and by inducing respiratory diseases when sub-micron particles penetrate the lungs. One of the greatest uncertainties in our current understanding of the climate system is the effect of aerosols on the earth's radiative energy budget. The unraveling of these complex interactions of aerosols within the earth-atmosphere system continues to be a challenge since aerosols have short-life times in the atmosphere and different chemical compositions and properties that are not readily measured at global scales. Systematic measurements at different spatial locations are important in understanding the effect of aerosols on the solar radiation reaching the ground. Black carbon (BC), the optically absorbing component of carbonaceous aerosols, has attracted a great interest recently, because of its potential to alter the radiation budget. We present results of our analysis on aerosol optical depth, black carbon aerosol mass concentration, total solar irradiance and radiative forcing estimates over the tropical urban region of Hyderabad, India during December, 2005 to May 2006. The surface aerosol radiative forcing estimated from simultaneous measurements of AOD and total solar irradiance suggested monthly average values of -21.29, -21.1, -22.04, -15.93, -15.96, -16.89 Wm-2 for December-2005, January, February, March, April and May-2006, respectively. BC aerosol mass concentration observed to play an important role on the ground-reaching solar irradiance. The model estimates on aerosol radiative forcing compared well with measurements with relatively larger deviations (˜5%) at high solar zenith angles (> 45o). Results are discussed in the paper.