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AGGREGATING AEROSOLS RADIATIVE FORCING: APPROACHES AND ISSUES

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The radiative forcing is the most important interactive processes in the Earth system that govern climate. Measured in Wm^{-2} it is defined as the change in net (down minus up) irradiance (solar plus longwave) at the tropopause after allowing for stratospheric temperatures to readjust to radiative equilibrium, but with surface and tropospheric temperatures and state held fixed at the unperturbed values. For most of the aerosol constituents stratospheric adjustment has no effect on the radiative forcing (RF), and the instantaneous RF at either the top of the atmosphere (TOA) or the tropopause can be substituted. The aerosol radiative forcing (ARF) is therefore generally obtained at the surface and TOA and is simply defined as the difference in the net fluxes (down minus up) with and without aerosol at the surface and at the TOA levels, respectively. However, the temperature changes associated with the ARF at different layers of the atmosphere are also very important. The direct ARF is relatively easier to estimate where the radiative flux in the atmosphere with aerosols can be derived from either satellite observations or model simulation using observed input data while the flux without aerosol can be derived from the model.

Over the last two decades the estimation of direct ARF has reached to a level of certain understanding in the country mainly owing to various field campaigns and long-term observational programs under ISRO-GBP, INDOEX, ARMEX etc. Still the ARF research in the country largely depends on the aerosol model OPAC (Optical Properties of Aerosols and Clouds) and the radiative transfer model SBDART (Santa Barbara DISORT Atmospheric Radiative Transfer model). OPAC is used, in absence of proper observation data, to estimate the possible aerosol structure and then to obtain their optical properties such as single scattering albedo, phase function etc to be used as inputs in the SBDART model. This introduces large errors in the estimation of aerosol optical properties and hence in the ARF estimates. It is therefore important to have an integrated measurement network for the country supported by the satellite data specific to Indian region. The I-STAG (Indian Satellite for Aerosol and Gases) program is a right step in this direction. But in order to do a comprehensive study of ARF, direct as well as indirect, we need to have not only an integrated measurement network of aerosols and their optical properties through ground based stations and/or satellite observations but also need to develop a comprehensive radiative transfer code based on our specific requirements and the available data.