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Multiyear Global Analysis of the Aerosol Direct Radiative Effect from Satellite TOMS Data

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A deterministic atmospheric spectral radiation transfer model, that uses comprehensive climatological data, is developed to compute the global distribution of mean monthly all-sky total aerosol direct radiative effect (DRE) in the ultraviolet, visible and near-infrared, spanning the spectral range 0.2–10 μm. We focus on the temporal evolution of the DRE for the periods 1984–1993 and 1996–2000. The model DRE is given for the top of the atmosphere, within the atmosphere and at the Earth's surface on a monthly mean basis. The aerosol data used in the model are taken from the Global Aerosol Data Set (GADS) and the Total Ozone Mapping Spectrometer (TOMS). The GADS aerosol data are given for various fixed relative humidity values and for 38 wavelengths within the model spectral range, both for natural and anthropogenic aerosols. Cloud information is taken from the WCRP/GEWEX Radiation Budget Project developed in NASA Langley at $1^o \times 1^o$ spatial resolution. The NASA Langley $1^o \times 1^o$ dataset also provides GEOS-1 atmospheric humidity profiles, used to compute the relative humidity in the aerosol layer. We then derive global GADS climatologies of aerosol optical thickness (AOT), single scattering albedo (ω_{aer}) and asymmetry factor (g_{aer}), for these relative humidity values. Given that GADS does not provide complete seasonal and interannual variability of aerosol properties, we use monthly mean TOMS AOT data from Nimbus 7 (1978–1993) and Earth Probe (1996–2005). The TOMS AOT data are given at two wavelengths, one at the near infrared (0.38 μm) and another at the visible (0.5 μm). The spectral profile of GADS AOT is then scaled and adjusted to the TOMS AOT values. The resulted distributions of AOT data, along with the GADS ω_{aer} and g_{aer} data are used in the model

to compute the temporal evolution of aerosol DRE over the periods 1984–1993 and 1996–2000 at $1^o \times 1^o$ resolution, on a global scale. Our model results reproduce well aerosol features associated with seasonal cycles such as the mineral cycle over Africa, or events such as the Pinatubo eruption in 1991.