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Effect of aerosol vertical profile on radiative forcing

Francisco Molero, Alfonso Fernández, Pedro Salvador, Manuel Pujadas, and Begoña Artíñano
Department of Environment, CIEMAT, Madrid, Spain (f.molero@ciemat.es)

In this work, the effect of the aerosol vertical distribution on the radiative forcing is assessed by comparing the results produced by radiative transfer models when a synthetic profile and a measured profile are considered. We computed the radiative forcing at the top and bottom of the atmosphere for shortwave and longwave using the libRadTran and GAME packages and compared the results with those provided by AERONET (AErosol RObotic NETwork) at Madrid site (40º.45N, 3.72W) for the period 2012-2015. The aerosol vertical profile was measured using an advanced lidar system integrated in EARLINET (European Aerosol Research LIdar NETwork) since 2006. Further aerosol properties required to calculate radiative forcing (single scattering albedo and phase function) are provided in column-integrated form by a close by AERONET site. Specific conditions as dust-free (local aerosol content only) and African dust (long-range transport from Sahara) have been considered for the study. A good correlation, with differences smaller than 2 W m^{-2} (15% of estimated radiative forcing) is obtained when a gaussian vertical aerosol profile is assumed. Notwithstanding, when a measured aerosol profile is inserted into the model, the difference between the radiative forcing obtained by libRadTran and that provided by AERONET can vary up to 32 W m^{-2} (96%) at BOA and 11 W m^{-2} (36%) at TOA during African dust episodes. For dust-free cases, a descending trend between the difference in radiative forcing estimations and the fraction of the aerosol optical depth within the gaussian profile was found for the BOA, but not for the TOA. These results prove that accurate information about aerosol vertical distribution is needed in order to reduce uncertainties in aerosol radiative forcing.

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