A simple parameterization of the short-wave aerosol optical properties for surface direct and diffuse irradiances assessment in a numerical weather model

Broadband short-wave (SW) surface direct and diffuse irradiances are not typically within the set of output variables produced by numerical weather prediction (NWP) models. However, they are being requested frequently by solar energy applications. In order to computed them, a detailed representation of the aerosol optical properties is important. Nonetheless, NWP models typically oversimplify aerosols representation or even neglect their effect. In this work, a flexible method to account for the SW aerosol optical properties in the computation of broadband SW surface direct and diffuse irradiances is presented. It only requires aerosol optical depth at 0.55 μm and the type of predominant aerosol. Other parameters needed to consider spectral aerosol extinction, namely, Angström exponent, aerosol single-scattering albedo and aerosol asymmetry factor, are parameterized. The parameterization has been coded in the RRTMG SW scheme of the Weather Research and Forecasting (WRF) NWP model. However, it can be adapted to any other SW radiative transfer band model. It has been verified against a control experiment using five radiometric stations in the contiguous US. The control experiment consisted of a clear-sky evaluation of the RRTMG solar radiation estimates obtained in WRF when RRTMG is driven with ground-observed aerosol optical properties. Overall, the verification has shown very satisfactory results for both broadband SW surface direct and diffuse irradiances. It has proven effective to significantly reduce the prediction error and constraint the seasonal bias in clear-sky conditions to within the typical observational error in well-maintained radiometers.