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Aerosols in forecasts of the UV index: a comparison of different approaches

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The solar UV radiation reaching the earth surface has both harmful and beneficial impacts on human health. The UV Index (UVI), a measure for the erythemal UV radiation, is daily forecasted and published by the Centre for Human-Biometeorological Research of the DWD in Freiburg. In the case of exceptionally high UV radiation levels, warnings are issued to enable the population to take precautionary measures against overdosages. The UVI calculations (Staiger et al. 2005, 2008) take into account the elevation of the sun, the height above sea level, clouds, the total ozone column, ground albedo, and the aerosol load of the atmosphere.

At present, the UVI forecast algorithm is based on a monthly climatology for the total aerosol optical depth (AOD) and a semi-annual climatology for the single-scattering albedo (SSA); the former has been derived from combined multi-year observations with MODIS and TOMS (NASA), the latter from the 'Global Aerosol Data Set'(GADS).

The influence of aerosols on the UV radiation can lead to uncertainties in the determination of the UVI. Aerosol concentrations are highly variable due to inhomogeneous emissions from natural and anthropogenic sources and subsequent dispersion. Case studies show the range of aerosol impact on UVI. The relative change of the UVI can be in the order of double digits. Short term emissions from regional sources can cause unusually high values of the AOD und typically lead to an overestimation of the forecasted UVI. In longer time scales there are signs of decreasing aerosol concentrations over middle Europe that are responsible for an underestimation of forecasted UVI based on an out-dated climatology.

To improve the quality of the UVI forecasts and to enable additional health benefits, numerical experiments are carried out with the current forecast algorithm, which are based on the present and two alternative formulations of the aerosol load. The following alternative data sources are considered: (i) monthly climatologies for AOD and SSA provided by Kinne et al. (MPI-Met, Hamburg), which are based on an optimised combination of multi-annual satellite data sets with ground-based AERONET measurements, and (ii) daily AOD forecasts of the GMES project MACC provided by the ECMWF, which are based on the incorporation of data sets and parameterisations for the aerosol sources and sinks into the ECMWF Forecasting System (e.g. Mocrette et al. 2009).

The different approaches and their applicability are evaluated by comparison with ground-based observations. Based on this results an updated procedure for the inclusion of aerosols in the operational UVI forecasts of DWD is proposed. Possible implications for an improved health benefit of UVI forecasts are discussed.