Estimating PM$_{2.5}$ over southern Sweden using satellite measurements

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Retrievals of aerosol optical thickness (AOT) using spaceborne MERIS ENVISAT and MODIS AQUA observations in central Europe for the days 26 March to 1 April 2007 are compared with AERONET (Aerosol Robotic NETwork). The retrievals are performed using the algorithm described by von Hoyningen-Huene et al. (2003). On the whole the agreement between satellite and ground retrievals is good (MERIS, $R^2=0.86$; MODIS, $R^2=0.92$). However, for higher values the satellite instruments somewhat underestimate AOT compared to AERONET. This could be caused by aerosol absorption effects that are not included in the present approach. Polluted air masses contain significant quantities of soot particles and have therefore a lower single scattering albedo compared with 0.98, which is assumed in the present work. Furthermore, for low aerosol loadings (AOT $<$ 0.15) the satellite retrieved AOT is a factor of 2 higher than AERONET. This is probably caused by too low surface reflections described in the retrieval model.

Here we have also combined satellite retrievals of AOT over southern Sweden with ground measured PM$_{2.5}$. MODIS (~1 km) mean AOT versus in-situ PM$_{2.5}$ over southern Sweden for the days 26 March to 1 April 2007. Results are shown in Figure 1. The AOT and PM$_{2.5}$ have been averaged according to eight pixels surrounding the pixel corresponding to the in-situ station and approximately half an hour before and after the satellite overpass, respectively. The relative humidity (ECMWF) was low over the southern Sweden during these days and hygroscopic growth of the aerosols has therefore been neglected in this study. Figure 1 shows that a relatively good correlation ($R^2 = 0.59$) is obtained between satellite retrieved AOT and ground measured PM$_{2.5}$. Similar slope (with $R^2 = 0.58$) as the one shown in Fig.1 is obtained between MERIS full resolution (FR) data (300 m) and in-situ PM$_{2.5}$ (not shown). The slope values (0.012 µg$^{-1}$ m$^3$ and 0.013 µg$^{-1}$ m$^3$ for MERIS and MODIS, respectively) agree reasonable well with 0.014 µg$^{-1}$ m$^3$ and 0.019 µg$^{-1}$ m$^3$ found by Wang and Christopher (2003) and Shinozuka et al. (2007), respectively. A relative humidity value of 80% (Shinozuka et al., 2007) and a growth factor according to polluted aerosol are assumed in the present estimations.

The relationship between satellite estimated and ground measured PM$_{2.5}$ has been applied on MERIS FR data over Stockholm and surrounding area. Our preliminary analysis shows that the geographic variations in particle emissions from road traffic in Stockholm correlate with satellite derived measurements of PM$_{2.5}$.

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