Estimating PM2.5 in the Stockholm region from spaceborne AOT measurements

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The aim of this study is to deduce surface PM2.5 for the region of Stockholm from satellite observations of aerosol optical thickness (AOT). Previous studies showed the potential for using aerosol observations from space for air-quality monitoring (e.g., Wang and Christopher, 2003; Hoff and Christopher, 2009 and references therein) — especially for tracking the pollution levels of in the air quality index. The present study is based on a previous work by Glantz *et al.* (2009). However, we now intended to obtain an AOT–PM2.5–relationship that is representative for the clean conditions that tend to prevail over the region of Stockholm. Note that it is yet to be explored if such methods can also be applied in a rather clean environment.

Here we use AOT at 555 nm from the MODIS collection 5 Atmosphere and Land product for MODIS–Terra (MOD04_L2, since 1999) and MODIS–Aqua (MYD04_L2, since 2002). AOT is provided with a spatial resolution (pixel size) of 10 km × 10 km. MODIS AOT was checked for reliability by means of a comparison to measurements carried out at the four long–term AERONET stations in Sweden: Gotland, Gustav Dalen Tower, Palgrunden, and SMHI. MODIS AOT was found to be well within the expected uncertainty range of $\pm 0.05 \pm 0.05 \times$AOT. It was also found that periods with AOT larger than 0.2 were scarce.

In the next step, the spaceborne AOT observations were related to surface measurements of PM2.5 at four in–situ measurement sites in the vicinity of Stockholm: Aspvreten (since 2000), Norr Malma (since 2005), Lilla Essingen (since 2005), and Uppsala (since 2007). These sites are representative for regional and urban background conditions. An AOT–to–PM2.5 relationship was obtained for cases ich which AOT values were available for at least 7 of the 9 pixels around a ground site. We use the binning approach suggested by Wang and Christopher (2003) to account for the wide spread in the data of both in–situ and MODIS observations. Furthermore, the AOT–to–PM2.5 relationship was obtained by using the median values in the respective bins of 0.05 AOT rather than the mean values. This approach reduces the impact of extreme values to the final outcome. Measurements of meteorological parameters (i.e., relative humidity, wind speed and direction) were available at the in–situ stations. Additional AOT–to–PM2.5 relationships were determined for cases in which the individual meteorological parameters showed values above and below their median values, respectively. These measurements were used to investigate possible effects of the meteorological situation on the median AOT–to–PM2.5 relationship and to properly assess the error of the PM2.5 retrieval. Note again that few cases occurred for which the PM2.5 concentration exceeded values of 30 μg m^{-3} or AOT was larger than 0.45. Hence, the obtained AOT–to–PM2.5 relationship is representative for relatively clean conditions.

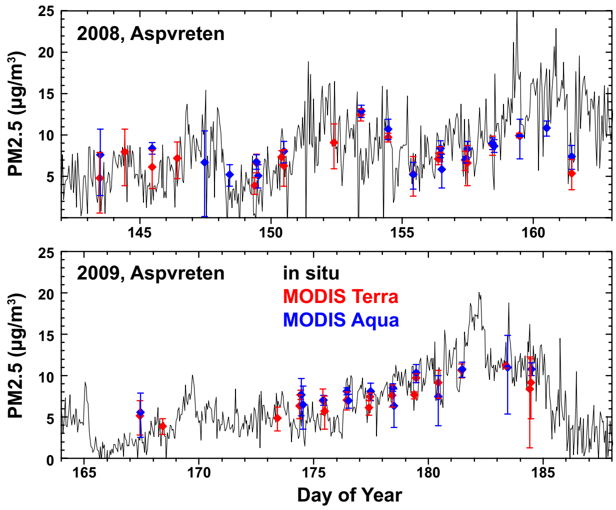

Figure 1: Retrieved (diamonds and error bars) and measured (black line) PM2.5 concentration at Aspvreten for selected time periods in 2008 and 2009.

Figure 1 presents PM2.5 time series for two selected periods in 2008 and 2009. PM2.5 as retrieved from MODIS observations agree with the surface measurements and follows the variation that occurred during the respective time periods.

Note that the AOT–to–PM2.5 relationship is established based on an assumption of homogeneous aerosol conditions within the planetary boundary layer (PBL) and an absence of elevated aerosol layers. While these conditions are widely given for the Stockholm region, future developments will focus on how seasonal differences in PBL development influence the retrieval of PM2.5 from satellite observations.

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Glantz *et al.* (2009) *Atmos. Environ.* **43**, 5838–5846.

Hoff, R. M. and Christopher S. A. (2009) *J. Air Waste Manag. Assoc.* **59**, 645–675.

Wang, J. and Christopher, S. A. (2003) *Geophys. Res. Lett.* **30**, doi:10.1029/2003GL018174.