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Particulate matter mapping in the European Alps from MODIS, SEVIRI, and in-situ measurements

E. Emili (1,2), C. Popp (3), M. Zebisch (2), S. Wunderle (1), and M. Petitta (2)

(1) Institute of Geography, University of Bern, Bern, Switzerland, (2) EURAC, Institute for Applied Remote Sensing, Bolzano, Italy (marcello.petitta@eurac.edu), (3) Empa, Swiss Federal Laboratories for Materials Science and Technology,Dubendorf, Switzerland

In this study, we investigate the spatially homogenous mapping of particulate matter over the complex topography of the European Alpine region by means of remote sensing and ground-based measurements. Knowledge about the spatio-temporal distribution and atmospheric evolution of particulate matter is of great interest because higher levels of PM can affect human health and therefore, such information can be used by authorities to take counteractions like e.g. traffic restrictions. The study area is frequently influenced by high PM concentrations, especially when atmospheric inversions occur during winter. Major anthropogenic aerosol sources in the European Alps include traffic, wood burning for heating and cooking, and industrial activities. Wefirst apply a linear model to relate aerosol optical depth (AOD) from the geostationary Spinning Enhanced Visible and InfraRed Imager (SEVIRI) and polar orbiting Moderate Resolution Imaging Spectroradiometer (MODIS) together with boundary layer height (BLH) to surface PM10 concentrations in order to derive spatially homogenous maps of PM10 over the study region for 2008-2009. In parallel, maps of PM10 are computed by inverse distance interpolation of in-situ measurements. Both (SEVIRI and MODIS) satellite based PM10 estimates reveal a moderate performance with a correlation coefficient (R) of $\sim$0.6 and a root mean square error (RMSE) of around 10 μg m-1. In contrary, the sole inverse distance interpolation of in-situ measurements produces more accurate PM10 maps (R$\sim$0.8, RMSE < 6 μg m-1). Subsequently, the two separate maps are combined through an assimilation scheme where the interpolated maps serve as background field which is up-dated by the satellite product. However, this step only leads to a small improvement in accuracy when most of the in-situ sites are excluded from the interpolation simulating a much sparser network. We conclude that satellite based PM10 maps in the European Alpine region are of limited additional value due to the relatively good coverage of the existing in-situ network, difficult terrain for remote sensing applications (topography, snow and cloud coverage), and inaccuracies with regard to spaceborne AOD retrievals. However, PM remote sensing is of great interest in regions with a sparser in-situ network (> 100km) and the presented approach can be generally applied to test the additional information provided by PM estimates based on remote sensing data.