Estimating surface reflectance for aerosol retrieval SYNAER Envisat and MetOp, based on analysis of ASRVN and spectrometer data

Miriam Kosmale

1German Aerospace Center (DLR), German Remote Sensing Data Center (DFD)
contact: Miriam.Kosmale@dlr.de

Introduction

A constant factor B can be analytically defined to describe the dependency between the red and shortwave infrared channel reflectance. B is dependent of measures, which are characteristically for different surface types. Figure 3 shows the dependency as 3-dimensional plot. The higher the NDVI, as for Vegetation and the higher the NDII, describing the loss of water stress of the surface type, then the higher is the factor B. This mountainside function for B describes the dependency between RED and SWIR channel.

For satellite measurements it has been kept in mind, that the NDVI and NDII are calculated from reflectances, which have contributions of aerosol loading (see also Kaufman et al., 1997). This leads to slightly different vegetation indices, than assumed in the idealized relationship. An iterative corrections scheme dependent on aerosol loading has to be implemented within the aerosol retrieval, as the B-factor is going to be used.

Conclusions and outlook

The new suggestion for the surface treatment within SYNAER, with a vegetation index dependent regression from infrared to red channel, will be applied to different sensors.

For each radiometer in a first step the “B-factor” has to be tabulated. This will be done by analysis of selected pixels, which were atmospheric corrected with available AERONET-measurements. The B-factor is sensor sensitive, so this analysis has to be done once per sensor.

Implementing the B-factor to the aerosol retrieval could be a way to get the surface albedo in the visible channels.

Analysis

In SYNAER version 2.0 (Hobel-Popp, et al. 2008b) surface reflectance of the red channel is estimated by reflectance at 1.6μm with a NDDI dependent regression function (analogous to equation 2). This function was previously calculated from 2500 AATSR dark field pixels in vicinity of an AERONET measurement, where aerosol loading could be assumed as low (AOD at 550nm < 0.1).

\[ \rho_{\lambda_{RED}} = A + B \cdot \rho_{\lambda_{NDDI}} \]

\[ \Delta = \rho_{\lambda_{SWIR}} - \rho_{\lambda_{RED}} \]

For further analysis of the correlation between RED and SWIR channel, ASRVN, a MODIS collection 5 based validation dataset of ground reflectances was used.

Fig. 1: Coefficients for linear fit between infrared channel at 1.6μm and red channel at 0.67μm. Color coded are the absolute differences between NIR channel 870nm and infrared channel at 1.6μm, to show the dependency on moisture of the surface. The greener the dots are, the higher is the moisture of the surface, corresponding to healthier vegetation.

Fig. 2: above: correlation between red and shortwave infrared channel, dependent on vegetation index NDVI based on ASRVN dataset. Adding a second vegetation index NDII can yield to a much better linear fit between the two channels.

Fig. 2 below: two typical measured surface spectra. In grey the location of the three channels of interest are marked.

ASRVN dataset is available at 1km resolution selection of boxes 50km surrounding AERONET measurements, which were used for atmospheric correction of the MODIS data. This dataset is globally distributed, and covers a wide range of surface types. This high resolution, atmospherically corrected and stable dataset of surface reflectances, gave a much denser dataset, than the 2500 darkfield pixels by AATSR previously used for regression analysis. Regression analysis of ASRVN-data showed (figure 2), that the dependency between 1.6μm and 870nm surface reflectance is not only linearly with respect to NDVI (see figure 1). Another measure has to be added, to describe the dependency between these two channels properly.

In a first approach the absolute reflectance difference between 1.6μm and near infrared (870nm) was used, contributing to the water content within the surface, which influences the reflectance in the short wave infrared. The advantage of the latter parameterization, adding the reflectance difference between NIR and SWIR channel measurements, is the expansion to water content of the surface, and not only vegetation amount, as before.

Methodology

To avoid absolute values in a parameterization, in a second approach the NDDI (normalized differential infrared index) was introduced, which is defined similarly like NDVI, but between near infrared 870nm and water affected short wave infrared channel 1.6μm, and is a measure for the water content within the surface. For sensors with absence of the 1.6μm channel, the NDDI should be replaced by the VIS-Index (introduced by Kaufman et al., 1994), which is the differential difference between the near infrared channel at 870nm and the mid infrared channel at 3.7μm.

A constant factor B can be analytically defined to describe the dependency between the red and shortwave infrared channel reflectance.

B = \frac{\rho_{\lambda_{RED}} - \rho_{\lambda_{SWIR}}}{\rho_{\lambda_{NDDI}}}

For each radiometer in a first step the “B-factor” has to be tabulated. This will be done by analysis of selected pixels, which were atmospheric corrected with available AERONET-measurements. The B-factor is sensor sensitive, so this analysis has to be done once per sensor.

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Reference


