REFLECTANCE COMPARISON BETWEEN SCIAMACHY AND MERIS

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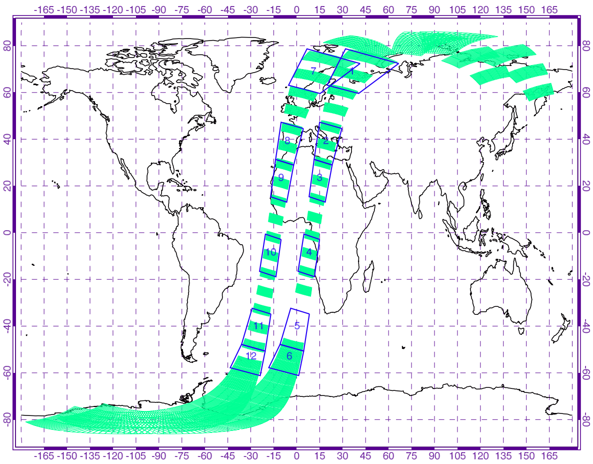

Fig. 1. SCIAMACHY nadir states for the ENVISAT orbits 2509 and 2510 dated August 23, 2002 (green) compared with the MERIS images (blue boxes) of the same orbits.

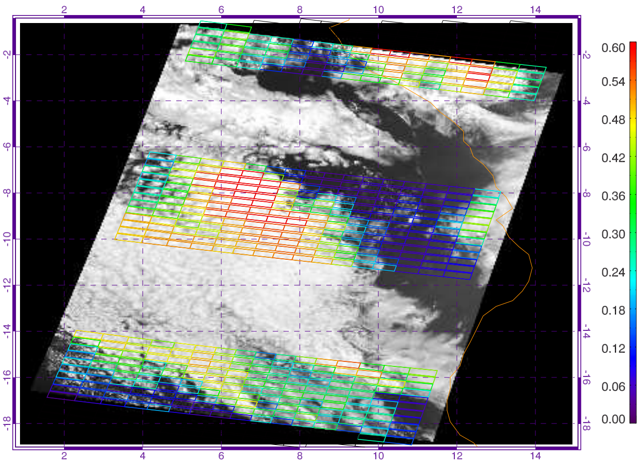

Fig. 2. Common projection for a MERIS image (gray, background) and SCIAMACHY data (color, foreground). The color bar (right) shows the SCIAMACHY reflectance at 665 nm.

ABSTRACT

In this work we present a comparison of the current SCIAMACHY and MERIS reflectance calibrations at wavelengths between 442 and 885 nm. For that purpose we, firstly, locate all the SCIAMACHY pixels within a given MERIS image and, secondly, we calculate the median and standard deviation of all the MERIS pixels ($\approx$1000) within each SCIAMACHY pixel. Results show that SCIAMACHY underestimates the reflectance by 13% at 442 nm reaching up to 21% at 885 nm as compared to MERIS.

1. INTRODUCTION

MERIS is a pushbroom spectral imager with a spectral range 400-1000 nm [1], in which 5 narrow (10 nm) bands have been selected, with a ground pixel size of 1×1 km^2. On the other hand SCIAMACHY [2] is a spectrometer with continuous spectral measurements between 240-1750 nm. In this work SCIAMACHY has a pixel size equal to 60×30 km^2 for the clusters 15, 24, 26 and 32.

Two ENVISAT orbits for August 23, 2002 have been chosen to compare SCIAMACHY with MERIS (Fig. 1). The SCIAMACHY calibration corresponds to the latest version of the key data (December 2003) and processor version SciaL1C 2.2.4. The MERIS images (e.g. Fig. 2) have been calibrated by ESA (version 3.53). Interestingly, both orbits contain clear and cloudy pixels over ocean, vegetated land and the Sahara desert.

The aim of this work is twofold. First, we want to see how the reflectance measured by SCIAMACHY compares with the reflectance measured by MERIS. A second goal consist of verifying that a linear relation between the two reflectances is representative for all the situations encountered. The procedure for performing the comparison is shown in Section 2. Our conclusions are presented in Section 3.

2. COMPARISON PROCEDURE

In this work we define the reflectance R as:

$$R = \frac{\pi I}{\mu_o E} \tag{1}$$

where I is the Earth radiance (W m^{-2} nm^{-1} sr^{-1}), E is the solar irradiance (W m^{-2} nm^{-1}) and μ_o is the cosine of the solar zenith angle. Note that these quantities are available in the L1 SCIAMACHY and MERIS products.

We follow a two step approach for comparing the reflectances measured by SCIAMACHY and MERIS. First, we define $R_S(\lambda_c)$ as the SCIAMACHY spectrum convolved with the MERIS slit function for each MERIS channel λ_c. Second, we define $R_M(\lambda_c)$ as the spatially averaged reflectance of all the MERIS pixels inside a given SCIAMACHY pixel. As a result, a linear relation for the reflectance is established between MERIS and SCIAMACHY:

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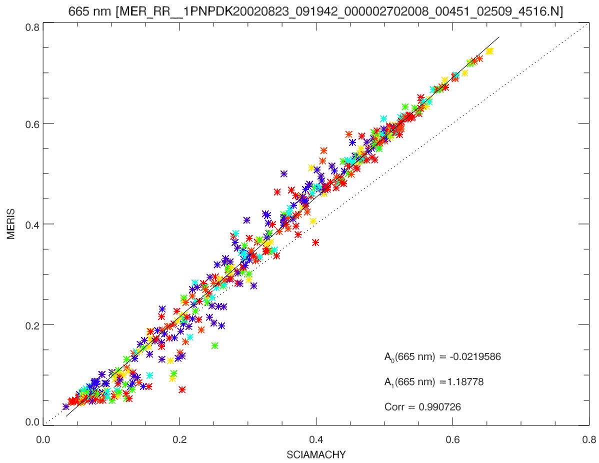

Fig. 3. Correlation at 665 nm between SCIAMACHY and MERIS reflectances for the pixels shown in Fig. 2. The color shows the SCIAMACHY scanning angle between 0 and 30 degrees (coded red-green-blue).

$$R_M(\lambda_c) = A_0(\lambda_c) + A_1(\lambda_c) \times R_S(\lambda_c) \quad (2)$$

The procedure has been applied to the twelve MERIS images shown in Fig. 1. In general, the quality of the fits is similar for all the MERIS images and channels used in this work. We show an example of our results for the wavelength 665 nm in Fig. 3. Note that the residues are in general $\leq$0.05 reflectance units. A summary for the parameter A_1 as a function of the wavelength is shown in Table 1. Concerning the parameter A_0 (not shown) typical values are $\sim 10^{-2}$ reflectance units.

3. CONCLUSIONS

In this work a comparison between the SCIAMACHY and MERIS reflectances is presented. Using two ENVISAT orbits we have shown that there is a linear relation (Eq. 2) that holds for all the situations encountered. The offset for zero reflectance (parameter A_0 in Eq. 2) is for practical purposes negligible. Thus, we can approximate Eq. 2 as $R_M(\lambda_c) \approx A_1(\lambda_c) \times R_S(\lambda_c)$ with $A_1(\lambda_c)$ given in Table 1.

We have found, in agreement with our previous results ([3], [4]) that SCIAMACHY underestimates the reflectance in the visible by 10%-20%. We point out that this underestimation of the reflectance has also been detected following other approaches ([5] and references therein). The accuracy of MERIS has been established to be $\approx$4% [6]. Hence, we conclude that the SCIAMACHY reflectance should be corrected using the factors given in Table 1.

Table 1. Mean values of $A_1(\lambda_c)$ (see Eq. 2) and 1σ error for the relation between MERIS and SCIAMACHY reflectance, for two SCIAMACHY orbits (see Fig. 1). The first column shows the wavelength in nm (between parenthesis is the corresponding MERIS channel).

Wavelength (channel)	Mean A_1	Std. Deviation
442 nm (2)	1.13	0.04
510 nm (4)	1.13	0.04
665 nm (7)	1.15	0.02
708 nm (9)	1.18	0.02
885 nm (14)	1.21	0.03

Acknowledgments

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