PROBA-V aerosol and surface reflectance retrieval: methods and validation

J. Blommaert[1], E. Wolters[1], E. Swinnen[1], and Y. Govaerts[2]

[1] Flemish Institute for Technological Research (VITO), Mol, Belgium

[2] Rayference, Brussels, Belgium

Introduction

A correct estimate of the atmospheric contribution to observed Top-of-Atmosphere (TOA) reflectances is essential to accurately derive the surface (or Top-of-Canopy, TOC) reflectance. Atmospheric correction (including aerosols) for PROBA-V observations is performed similar to SPOT-VGT in order to ensure data continuity between the two missions. Here, we first describe the aerosol optical thickness ($\tau_{0.55}$) and atmospheric correction method currently applied in the PROBA-V image processing chain [1]. Subsequently, a proposed methodology based on the Optimal Estimation technique of [2] that will be applied to PROBA-V 1 km observations will be highlighted. Finally, the $\tau_{0.55}$ and TOC reflectance validation efforts are described.

Current atmospheric correction methodology

In the current PROBA-V processing, $\tau_{0.55}$ is retrieved using an optimization algorithm applied to the BLUE channel [3]. This method is similar to the dark target technique of [4], but here an exponential relation between SWIR/BLUE reflectances and the TOA NDVI is used. The following steps are performed to correct TOA to TOC reflectances:

1. Initial atmospheric correction only for gaseous absorption by water vapour and ozone for each channel.
2. Calculate $NDVI_{TOA}$: $NDVI_{TOA} = \frac{(R_{NIR,TOA} - R_{RED,TOA})}{(R_{NIR,TOA} + R_{RED,TOA})}$
3. From $Ratio = 1.305\exp(3.225 NDVI_{TOA})$, $Ratio = \frac{R_{SWIR,TOC}}{R_{BLUE,TOC}}$, and $R_{SWIR,TOC}$ known (virtual absence of aerosol extinction) → $R_{BLUE,TOC}$ is derived.
4. $\tau_{0.55}$ follows from the minimum difference between full atmospheric correction and $R_{BLUE,TOC}$ obtained in step 3.
5. For pixels with *NDVI* < 0.2 and R_{SWIR} > 0.4 → $\tau_{0.55} = f(latitude)$
6. The obtained $\tau_{0.55}$ is converted to BLUE, RED, NIR, and SWIR values and full atmospheric corrections to all TOA reflectances are performed.

The above steps are executed for every 8th pixel in along- and across-track direction, with bilinear interpolation applied to the other pixels.

Proposed atmospheric correction using Optimal Estimation (OE) technique

In ESA's "*Advanced Land, Aerosol and Coastal products for PROBA-V (PV-LAC)*" project, an OE method, originally developed for Meteosat-SEVIRI [2], will be applied to observed PROBA-V TOA reflectances (see also Govaerts et al., poster ATMO-131). It will be investigated whether this method has added value compared to the current method. One of the major challenges is to distinguish the aerosol from the surface signal in the observed TOA reflectances. Figure 1 shows the simulated PROBA-V Bidirectional Reflectance Factor (BRF) as a function of viewing angle for atmospheres without and with different aerosol loads. See Table 1 for the atmospheric optical thickness values per channel.

Table 1: *Rayleigh and aerosol optical thickness values in the PROBA-V spectral bands used for the simulation in Figure 1.*

Optical Thickness [-]	BLUE	RED	NIR	SWIR
Rayleigh	0.194	0.048	0.018	0.001
Aerosol (0.2 @0.55 µm)	0.263	0.149	0.094	0.025
Aerosol (0.6 @0.55 µm)	0.789	0.447	0.282	0.076

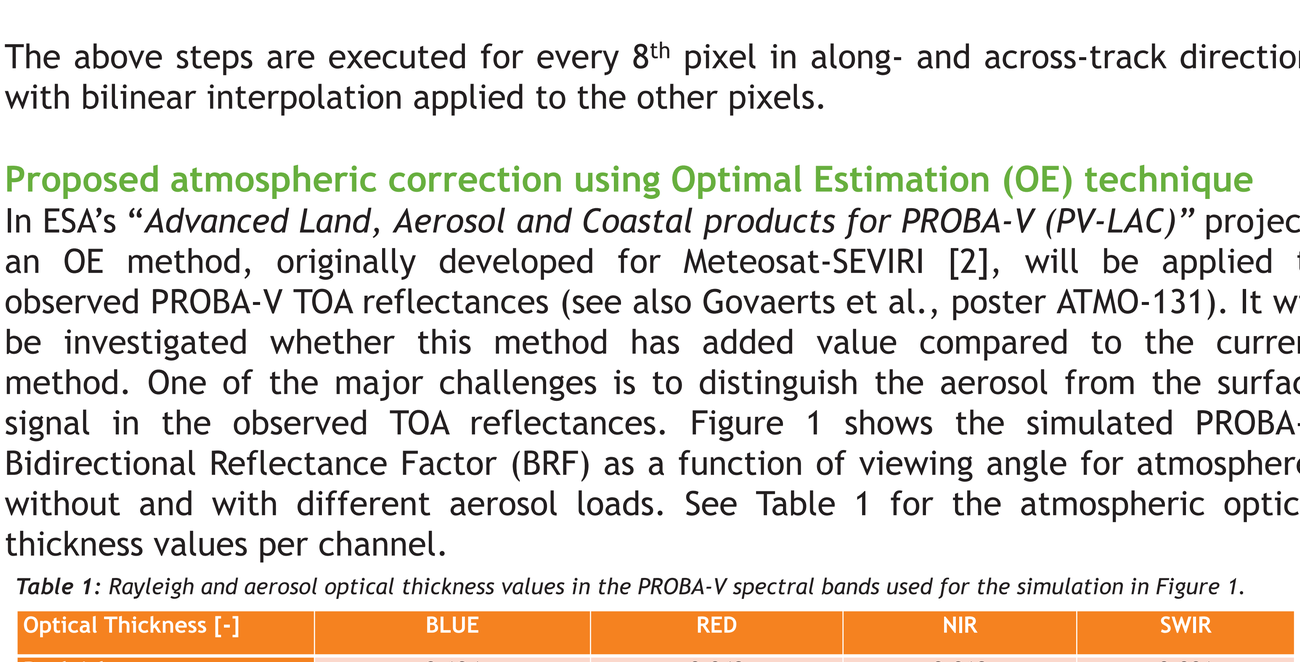

Figure 1: *Simulated surface and TOA BRFs in the principle plane for all PROBA-V spectral bands in case of no atmosphere (green lines) and for $\tau_{0.55}$ of 0.2 (red and purple lines) and 0.6 (light and dark blue lines).*

Validation

Validation will be performed on PROBA 1 km data for April 2014 – March 2015 and will be done on two levels:

- OE-retrieved PROBA-V $\tau_{0.55}$ will be compared against temporally and spatially collocated AERONET $\tau_{0.55}$ values. The latter are obtained from observed $\tau_{0.44}$ and the Ångström parameter between 0.44 and 0.67 µm (α):

$$\tau_{0.55} = \tau_{0.44}\left(\frac{0.55}{0.44}\right)^{-\alpha}$$

This validation will be carried out over 100 AERONET sites.

- TOC reflectances from the OE technique for pixels centred at the AERONET sites will be compared with collocated MODIS MCD43A3 Collection 6 surface reflectances. Additionally, the TOC reflectances from OE will be compared to TOC reflectances from the current methodology, to assess the added value of the OE technique.

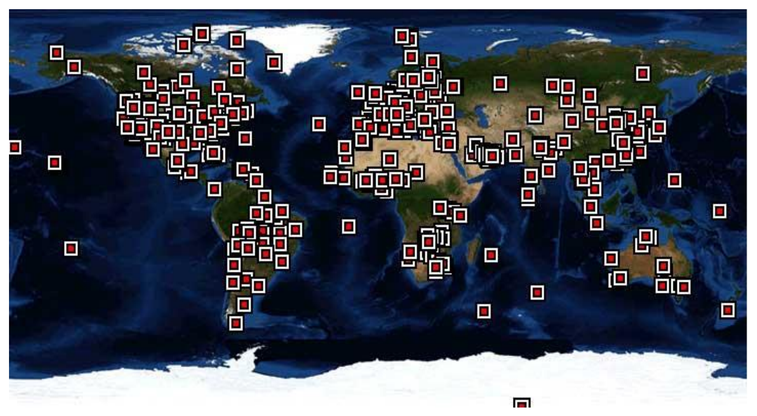

Figure 2: *Geographical distribution of AERONET sites.*

Summary and planned activities

A description of the current and proposed PROBA-V atmospheric correction was given, as well as a short description of the validation approach. Within PV-LAC, planned activities include:

- Extraction of 1-yr PROBA-V TOA BRF as input for the OE technique
- PROBA-V TOC reflectances retrieval with OE technique
- Validation of OE-retrieved $\tau_{0.55}$ and TOC reflectances
- Investigate possibilities for operational implementation (error assessment, computational burden, etc.)

References

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