

ALGOM WP4: Level 1c ATBD

Didier Fussen

28-Jun-2016

Contents

1	Virtualization of occultations	2
2	Statistical analysis	2
2.1	Detection of mono/bimodal distributions	2
2.2	Detection of outliers	2
3	Wavelength shift	3
4	Computation of weighted median transmittances	3
5	Conclusions	3

1 Virtualization of occultations

Most inversion methods in atmospheric remote sensing contain regularization methods to remove spurious oscillations produced by the amplification of the measurement noise. Therefore, very small absorbers cannot be retrieved easily because averaging many profiles leads to a mean profile contaminated by the regularization. As transmittances are by definition normalized measurements, they are excellent candidates to statistical processing (by accumulation) with the relevant error bars. It is therefore expected that the mean or virtual transmittance will show an improved S/N ratio on which the relevant inverse model can be applied once. The goal of this work package is to develop a data processing model and to build a climatology of GOMOS averaged transmittances (also named below 'virtual transmittances') as a time-latitude series covering the entire duration of the mission (121 months from 04/2002 to 04/2012). Previous scientific studies have shown that by averaging transmittance signals it is possible to retrieve some minor but important constituents like sodium and OClO from GOMOS data.

2 Statistical analysis

2.1 Detection of mono/bimodal distributions

The method of virtualization requires a thorough statistical analysis. The homogeneity of the data set being of primary importance, a detection of multimodal distributions is performed by fitting the distribution with theoretical models (using a curve fitting toolbox). For instance, some measurements are inside the polar vortex and others are outside. Each bimodal case will be studied separately by trying to understand why this particular bimodality and trying to properly separate each mode. All the bimodality case observed during the entire GOMOS mission are in high latitude regions during winters.

2.2 Detection of outliers

The second step of the statistical analysis is the detection and rejection of outliers in each data set. An algorithm has been developed based on the well known Jackknife method. This robust technique is quite simple and easy to implement. Consider a dataset with N values. Remove the first value and compute the standard deviation based on the data subset with $(N-1)$ elements and repeat this for the N values. It appears that when you remove an outlier, the standard deviation decrease strongly.

3 Wavelength shift

A problem due to slight variations of the wavelength assignments is present for spectrometer B1 and B2. This problem induces a shift in wavelength of some absorption peaks characteristic of water and oxygen absorption lines. This shift may differ slightly from one measurement to another so much so that we need to realign properly each single transmittance spectra before combining them. It is done by applying a convolution of the shifted spectrum with a reference spectrum (occultation of sirius at the beginning of the GOMOS mission).

4 Computation of weighted median transmittances

Finally, for each tangent altitude and each wavelength, the weighted median transmittance is calculated instead of the usual mean because the median is known to be more robust against the presence of residual outliers. Furthermore, as the S/N ratio of different measurements can differ considerably, we combine transmittances weighted with respect to the inverse of their estimated measurements errors. A weighted median calculation starts by sorting the transmittance values in increasing order, and rearranging the associated weights in the same fashion. The cumulative distribution of these weights is subsequently evaluated. The weighted median is then the transmittance value corresponding to the mean level of this cumulative weight distribution.

5 Conclusions

This ATBD explains the principle of virtualization and how GOMOS averaged transmittances spectra can be built. Hereafter (see Figure), we demonstrate how a very tiny absorption feature appears when more and more transmittances are combined: the sodium doublet becomes visible and a DOAS inversion scheme can be applied to derive its slant path optical thickness. Previous scientific studies have shown that by averaging transmittance signals it is possible to retrieve some minor but important constituents like sodium and OCIO from GOMOS data. Virtualization is the only way to increase the signal-to-noise ratio for an instrument like GOMOS, at the moderate price of decreasing the spatio-temporal sampling to the bin size. From the averaged transmittances, it is not only possible to detect very tiny absorbers (or emitters) but also to apply the standard retrieval algorithm (with a vir-

tual occultation on a same altitude grid) to obtain much more accurate trace species as ozone or nitrogen dioxide. Furthermore, averaged transmittances can be directly analyzed to detect trends that can be interpreted a reliable proxy of a corresponding slant column density.

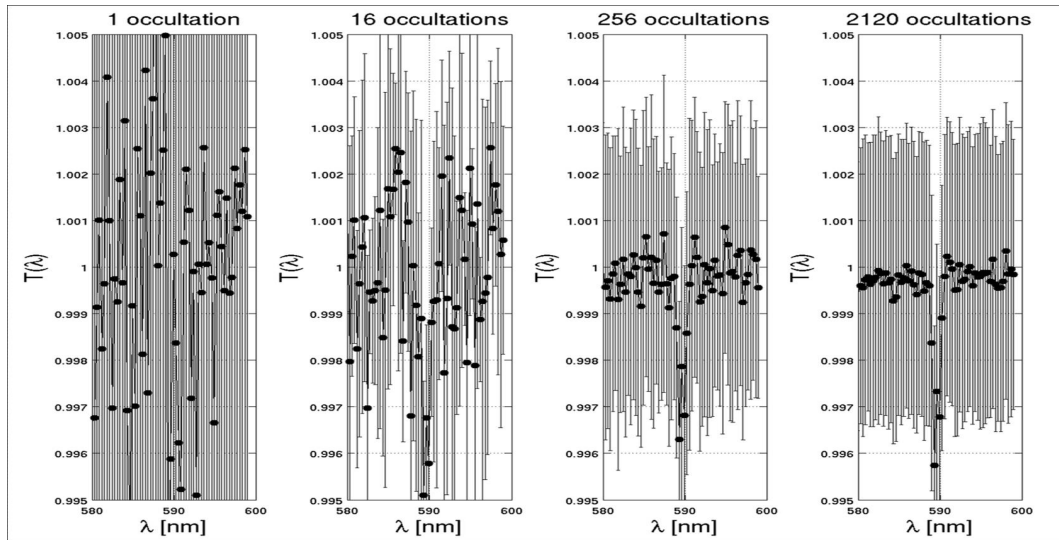


Figure 1: GOMOS weighted median transmittances as a function of the number of occultations used in the bin 70 deg.N - 80 deg.N in January 2005.