Interactive comment on Atmos. Chem. Phys. Discuss., 10, 9917, 2010.

Final Response : Interactive comment on "Global ozone monitoring by occultation of stars: an overview of GOMOS measurements on ENVISAT" by J. L. Bertaux et al.

15 September 2010

We thank both referees for their hard work to review such a long paper and their many useful comments, which helped to improve the paper. The referees comments are in blue, our answers are in black, and proposed modifications of text are in red.

We first answer on two general issues, raised by both referees: the quality of English, and the length of the paper.

1. Quality of English.

None of the initial authors is a native English speaker. Therefore, we will ask Gil Leppelmeier to re-polish the English. Though he is now retired, he accepted to do so. We request to the editor that he be put as an additional co-author. In view of his deep involvement in the preparation of GOMOS, calibration plan and participation in the algorithm developments, this is fully justified.

2. Length of the paper.

We apologize for the length of the paper, but it represent an overview of 22 years of work, by tens of individuals, with an approximate cost of more than 100 million euros.

Both referees suggest that the paper be shortened. We will try to cancel some redundant material; but we anticipate having problems to do significant cuttings. It is clear that we are talking of ozone and other species at two places: once, when we describe the scientific objectives existing in 1988 at the time of the proposal, and the corresponding instrument requirements, and another time when we summarize the results.

On the other hand, since ACP exists only in electronic form, the length of the paper will not consume any paper nor trees to make the paper. This is an attractive particularity of ACP that should be taken advantage of.

We note that the JGR paper of Yee et al., 2002, describing the results of stellar occultations MSX, is shorter only by a factor of 3; while the instrument was not done for that purpose, and acquired about 160 occultations, to be compared to the 600,000 of GOMOS.

Answers to the specific points and remarks:

Referee reports

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This paper contains an in-depth discussion of the GOMOS instrument on ENVISAT. While no new science results are presented, the authors achieve the stated goal of providing the detailed background needed for interpretation of the GOMOS data. In addition, this paper provides important guidance and insight that will be needed for planning and implementation of future stellar occultation instruments, which are sure to follow. Based on this, I recommend publication in ACP, contingent on the resolution of the same two issues described by an earlier review. First, the length of the paper should be reduced. This can be readily accomplished by removing much of redundant information and use of more succinct descriptions in many cases. Second, the overall

English should be improved

General Comments
P9945 While the "self-calibrating" nature of occultation is important, the claim that long term instrument drifts will have no significant effect is overstated. It is possible that changing optical or thermal properties (for example) could impact the long-term trends of retrieved parameters.

We were explicitly mentioning long-term drifts of the radiometric response of the instrument. However, we agree with the reviewer on two points:
-if the radiometric sensitivity is decreasing significantly, it will hamper the quality of the data (increase of error bars).
- similarly, some other long-term drifts may also introduce larger error bars, and even a bias, if they are not well taken into account. This is the case, for instance, of the large increase of the Dark Charge of the detectors. It was supposed to be a negligible correction to the signal, but it turned out that the EEV CCD detectors have seen their dark charge increasing dramatically to such a point that the DC subtraction algorithm must be accurate, and even in this case, the error is increasing for dim stars as discussed at the end of Section 4.2.

We propose to modify the last paragraph of p.9945 as follows, with new material in red:

"By its principle, GOMOS is inherently a self-calibrating instrument. This means that long-term drifts in the instrument's radiometric response are in theory compensated since only the ratio of measurements acquired in a relatively short time interval (order of 1 minute) are used to compute transmission spectra. In such short intervals, changes in the instrument response are negligible. However, if the radiometric sensitivity is decreasing significantly, it will hamper the quality of the data (increase of error bars). This did not happen with GOMOS up to now. In addition, some other long-term drifts may also introduce larger error bars, and even a bias, if they are not well taken into account. This is the case, for instance, of the large increase of the Dark Charge of the detectors. It was supposed to be a negligible correction to the signal, but it turned out that the EEV CCD detectors have seen their dark charge increasing dramatically to such a point that the DC subtraction algorithm must be accurate, and even in this case, the error is increasing for dim stars as discussed at the end of Section 4.2."

Technical Comments
P9919 L8 air should probably be air density, and aerosol is probably aerosol extinction (or extinction coefficient)
Agreed ! correction made
P9919 L17 only 5 years?
at the time of writing this paper, data were correctly processed and distributed up to 2008 included. It is 6 years, and it is already a lot of data! It is now corrected .
P9922 discussion mentions O3, but pertains to any molecular absorber.
Agreed. Still, ozone is the main absorber in the UV-Vis wavelength range of GOMOS, and we stated that we considered only ozone, for clarity of the mathematics.

P9923 Fig 3 skipped. Reference to Fig 4 seems incorrect – this is just a block diagram of the instrument
Agreed. It should read "Figure 2 at this point. Correction was done.
Fig3 and 4 are quoted later.
P9924 bullet at bottom of page. This is not an advantage of stellar over solar occultation.
Agreed. The first bullet about multi-pixels detectors has been moved upward

P9928 z > 100 km is the thermosphere
Agreed. "upper mesosphere" has been replaced by "lower thermosphere".
P9943 L24 why is the spectral resolution degraded?
The spectral resolution is degraded, because the entrance slit of the spectrometer is much wider than the image of the star. Therefore, with moon or planets which are extended objects, the actual spectral resolution is dictated by the angular size of the planet, or by the size of the slit for the moon.

We propose to complete the sentence. The new sentence is:

"The spectral resolution is degraded, because the entrance slit of the spectrometer is much wider than the image of the star. Therefore, with moon or planets which are extended objects, the actual spectral resolution is dictated by the angular size of the planet smaller than the slit), or by the size of the slit (corresponding to 10 pixels) for the moon."

P9945 Line 11: "one single" is redundant
Agreed: "single" is cancelled.
P9947 Line 14 I'm unfamiliar with the term "rallying" in this context.
"rallying" is the term which designates the motion of the mechanism when switching from one star to the next.
the sentence is clarified:
"wide angular range in rallying (when the pointing mechanism is moved toward to a new star to be occulted)"

P9968 L 23 I think earlier you stated 5 spectra were used to form the reference spectrum.
The correct number is 10. Initially, it was only 5; but it was figured out that 10 spectra could be averaged together to decrease the noise on the reference spectrum. It has been corrected where it was stated 5.
P9971 Line 10 r(s) is not defined.
r(s) is the altitude of the running point with abscissae s along the line of sight.
We propose to add this sentence:
" r(s) is the altitude of the running point with curvilinear abscissa s along the line of sight."

P9975 "spectel" should be "spectral"
The word "spectel" is often used to designate one spectral element, instead of "pixel". This is appropriate in the cas of GOMOS, since one spectral element is formed of 7 pixels in a same column of the 2D CCD.
We propose to add the definition of the spectel the first time it is used in the paper: p.9968 line 14;
"(one value per spectral element, or "spectel")".
P10003 L 23 symbol should be ~

Agreed: changed to ~

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