

Dear Reviewer,

Thank you very much for your attention to our paper “Retrievals from GOMOS stellar occultation measurements using characterization of modeling errors”. Please find below our replies to your comments.

Reviewer #1:

The main point of the paper boils down to the idea that the optimal estimation (OE) retrieval of GOMOS species is dependent on an accurate covariance matrix of measurement uncertainties. The past method that excluded scintillation produced uncertainties that were much too low that ultimately required the retrieved profiles to oscillate wildly in an attempt to fit the data. By increasing the size of the covariance components (particularly in the off diagonal elements), a smoother profile is possible while producing larger uncertainties to cover the measurement noise. As usual, I don't care for OE retrievals (although they are ubiquitous) since I often ended up wondering what was measured and what comes from the a priori. The authors, as many do, seem to assume profiles should be smooth (maybe that's true) but it would be nice to see a discussion of how the new elements in the covariance matrix impact the source of the values produced?

Authors:

We would like to note that the GOMOS spectral inversion does not use a priori. It relies on the standard maximum likelihood method, as stated in our manuscript (page 581, lines 28-29). The objective function (χ^2 statistics, Eq.1) is the squared weighted deviations of modeled spectra from the measured spectra.

The “full covariance matrix” method, which is discussed in our paper, is applied in the first step of the GOMOS inversion, the spectral inversion. We do not assume a priori profiles of horizontal column densities. Smoothness of the line density profiles is also not assumed at this step, as the spectral inversion is performed at each tangent altitude separately. We will stress this in the revised version.

Smoothness of profiles is assumed only in the second step of the GOMOS inversion, the vertical inversion, which is not discussed in our paper. This will be also stressed more in the revised version.

Reviewer #1

The only thing I have major heartburn over is contained in Figure 4 where I think this problem is very evident. As an example, at 55 km, the error bars for line-of-sight aerosol is about 20%. However, aerosol at these altitudes are for all intents and purposes 0 (or exceedingly close to it) and it is impossible to measure '0' to 20%. The error should be 100% or more since there's is no way GOMOS can measure aerosol at these altitudes. It is clear that the a priori is defected in this case and producing nonsensical results.

Authors:

As explained above, a priori is not assumed in the spectral inversion. The statistical error of the retrieved horizontal column densities, which is caused by uncertainties in experimental spectra, is estimated using the Jacobian provided by the Levenberg-Marquardt algorithm. These values of uncertainties are presented in absolute units (cm^{-2})

in the GOMOS inversion. Conversion of the absolute error estimates into relative values might be incorrect, if the retrieved quantity is very close to zero (as in case of aerosols at high altitudes).

In the revised version, the error estimates for aerosols will be shown only below 45 km.

Reviewer #1:

I suspect this problem is not limited to aerosol but is rattling around all the species (e.g., 0.1% ozone accuracy from 15 to 70 km?).

Authors:

For ozone, such small error estimates are only for the brightest star, Sirius. For dimmer stars, retrievals are less accurate (as shown, for example, in Fig.10 in [Sofieva et al., 2009]).

Reviewer #1:

The other issue which would have made my read of this manuscript more readable is the number of terms that the authors introduce but do not explain. A partial list includes: isotropic turbulence, dilution effects, Fresnel scale. What is the (cap) delta function? Full ray velocity and so forth. I know some of these terms and found others in other papers but the thickness of the terminology made this paper a fairly dense read and including some simple explanation of what these terms mean physically would be greatly appreciated and make the paper more accessible to the broader community.

Authors:

Thank you for the suggestion. The specific terms will be explained and the corresponding references will be provided.