**Atmospheric
Measurement
Techniques
Discussions**

Interactive comment on "Anisotropy of small-scale stratospheric irregularities retrieved from scintillations of a double star α-Cru observed by GOMOS/ENVISAT" *by* V. Kan et al.

Anonymous Referee #2

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General comments:

The paper is presented by a group of authors, well-known experts in the field of space-based optical remote sensing of the Earth atmosphere. Their approach is based on observations of optical scintillation of stars near the Earth's limb from the low Earth orbit satellite for retrievals of the atmospheric density structure at stratospheric and upper tropospheric heights. Similar stellar occultation technique (though from the ground) was used by astronomers since 1970's to study atmospheres of outer planets and their satellites (see, e.g., Hubbard et al., 1988). Space-based observations of stellar scintil-

lations allow one to estimate statistical characteristics of the air inhomogeneities in the stratosphere, without being obstructed by the denser layers of the lower atmosphere, a situation typical for ground observations of stellar scintillation. This type of measurements is aimed on studying turbulence caused by instability of nonlinear internal gravity waves. Such information is useful for modeling the propagation of electromagnetic waves through stratospheric turbulence on effects of the large-scale atmospheric circulation, for parameterization of wave drag in the atmosphere, for calculating the eddy diffusion coefficients, etc.

This particular work is devoted to a very challenging problem of the reconstruction of gravity wave and turbulence parameters (specifically, their anisotropy) using binary star bi-chromatic scintillation measurements by the GOMOS instrument on board of the ENVISAT satellite. The authors obtained important results regarding the behavior of the anisotropy of air density irregularities in the buoyancy sub-range. This is very significant achievement because this parameter is not well-studied experimentally.

Previously, more simple scenarios were explored by this team which included reconstruction of the atmospheric spectral parameters from single-frequency scintillation auto-spectra during satellite experiments with single stars. These experiments allowed them reconstruction of all parameters of the spectral model except for the anisotropy coefficient of anisotropic irregularities, because scintillation auto-spectra are not sensitive to this parameter. In what follows, they turned to simultaneous scintillation measurements by two GOMOS photometers in blue and red wavelengths which allowed them analyzing also cross-spectra and coherence spectra of the bi-chromatic scintillations in addition to the scintillation auto-spectra. Their previous theoretical analysis of cross-spectra and coherence spectra has shown that coherence and correlation can be used for estimating the ratio of anisotropic and isotropic components of scintillations.

Recently, the authors found that single-frequency scintillations from double unresolved stars have some specific features, such as modulation of scintillation spectra and reduced variance of scintillation. The present paper uses these previous findings and fur-

ther demonstrates additional capabilities of the scintillation method using both double unresolved stars and bi-chromatic scintillation measurements of cross- and coherence spectra.

This novel approach allows them estimating the anisotropy coefficient in the 3D spectral model of saturated gravity waves from the GOMOS/Envisat data. Using it authors managed to characterize an anisotropy structure of the atmospheric density over scales transitional from large to small ones. They found that the anisotropy reduces toward small scales. This conclusion supports existing atmospheric density models with the variable anisotropy.

The paper addresses relevant scientific questions and is well within the scope of AMT. The results are novel and substantial conclusions from the results are reached. Besides atmospheric remote sensing community, they might be of interest to the community of researchers in the field of dynamics of the upper troposphere. Generally, the scientific methods and assumptions are valid and clearly outlined. The description of experiments and calculations sufficiently complete, however, for new readers in order to get a deeper understanding of these methods it would require additional reading of the references provided by the authors. They give proper credit to related work and clearly indicate their own new/original contribution. The title clearly reflects the contents of the paper, and the abstract provides a concise and complete summary. The paper is clearly written and well structured.

Detailed comments:

P4886-4887. A description of assumptions looks somewhat sketchy. There is no mentioning of the model for the anisotropic part of the medium spectrum. A reference to a relevant work would be appropriate in this place.

Can it be specified what are limitations for the phase-screen assumption? Different aspect angles for inhomogeneities away from the perigee point might lead to some averaging of the anisotropy coefficient. Can this effect be reasonably neglected?

The weak-scintillation regime limits the applicability of the used approach for lower heights (<30 km). It would be interesting in the future to extend this method to a strong scintillation regime. For example, maybe it is possible to filter out the high-frequency part of the scintillations, so the rest would be described by a weak-scintillation theory?

P4888L1. It reads: "using the hypothesis of "frozen" field of irregularities, which is valid due to the large satellite velocity." It seems to me that the satellite velocity itself is irrelevant here. It is the speed of movement of the point of ray intersection with a limb's plane which is important for "frozen" field assumption.

P4888L4-8. A description of Figure 1 needs to be expanded. Please describe the orientation of axis x and y. It looks like axis x is oriented along the phase screen. Then, why rays from stars are going through anisotropic irregularities (ellipses) very steeply? Since this is a perigee area rays should propagate along the longer axes of the ellipses rather than across them. What is the meaning of the dashed lines connecting points 2, 4, and 3? Is notation Δc denotes a distance between points 1 and 3? Then, it would be useful to indicate this with a bracket.

P4894L4, 5. It reads: "The estimates of the parameters of irregularities presented in Table 1 exhibit rather large variations." Why? Is this because of a not sufficient averaging of limited numbers of scintillation samples, or due to a natural variability of the internal wave intensity, or both? Also, maybe, the model for the anisotropic part of the spectrum relies on an assumption that the spectrum is fully-developed which is not necessarily happens for all observations?

Minor corrections:

P4885L15. Typo: "scintillatioin"

P4890L8-9: It reads: "Coherency of bi-chromatic scintillations has been discussed in Gurvich et al. (2005), Kan (2004) and Kan et al. (2001)." It would be more appropriate to reverse the order of references to have them following chronologically.

P4900L11: Typo: "gravityy."

P4890L24. There is a typo in subscript of the second argument of the cross-spectrum: Va(f, λB, λB). It should be Va(f, λB, λR).

P4891L3. The same typo as above.

P4892L24. Replace '"autospectra" with "auto-spectra."

Terms "coherence" and "coherency" are used intermittently through the text. For example, Fig.3 caption contains both "coherency" and "coherence" terms. Choose one of them.

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