Referee Comments for manuscript: acp-2013-446

Title: Turbulent diffusivities and energy dissipation rates in the stratosphere from GOMOS satellite stellar scintillation measurements.

Author: N. M. Gavrilov ; Type: Research Article.

Referee: Dalaudier Francis (francis.dalaudier@latmos.ipsl.fr)
The referee is a member of the ESA "GOMOS Quality Working Group".

Content of the manuscript

The submitted manuscript uses a (small) portion of the database of spectral parameters estimated from GOMOS stellar scintillation measurements. This database contains estimations of 4 spectral parameters (2 vertical wavenumbers ko, kw and 2 spectral levels Cw, Ck) for specific location, altitude range and time corresponding to selected GOMOS observations, along with parameters (from ECMWF) characterizing the atmosphere. The author further processes this database in order to obtain derived parameters characterizing the turbulence and its effects (scales, dissipation rates, Eddy diffusivity). The formulas used in order to derive these parameters come from published theoretical works, models and experimental studies.
Since the altitude range where these parameters are derived is difficult to observe, and is consequently poorly known, the estimation of these turbulent parameters is a scientifically important contribution. The values obtained by the author are in satisfying agreement with previous published estimations.

General comments on the manuscript

The general objective of the manuscript is important and a publication properly covering these objectives would be valuable. However, in its present state, the submitted manuscript contains many weaknesses (see specific comments below) that should be corrected before a possible publication. The exact nature and physical signification of the spectral parameters (from the database) as well as the hypotheses necessary for their estimation should be discussed carefully. The coverage (geographic, time, altitude, number of estimations) and the resolution of the used database needs to be detailed as well as associated uncertainties (which are included in the database). The parameters calculation needs to cover the full database (all latitudes) and at least one year of measurements in order to cover seasonal and latitudinal variations. The hypotheses underlying the various formulas used in order to derive the turbulence parameters need to be discussed carefully. This is particularly important since some of these hypotheses are different (and sometimes contradictory) from the ones used in order to estimate the original spectral parameters. The exact nature and physical signification of each derived turbulent parameter need to be better discussed. Some confusion about the various derived length scales need to be clarified. Conversely, some paragraphs describing already published technical details should be removed from the manuscript and replaced by appropriate references.

Specific comments

- Because of the large spatial and temporal variability of the turbulent parameters (including length scales), covering sometimes more than one decade (your figure 5), the statistical distribution (like in your Figure 2) of a parameter is more informative than its average and its standard dispersion (as given in table 1). This is especially true for parameters with strongly non-Gaussian distribution, as clearly visible on your Figure 2.
- The physical signification of the parameters used in this study (from the GOMOS database) as well as of the calculated parameters need to be discussed. Specifically, all the

parameters in the database are "effective" parameters obtained by spectral fitting. This means that the model assumes that the whole atmosphere is filled with homogeneous turbulence with constant parameters. This is obviously not a physically realistic hypothesis and the obtained values cannot be assumed to represent accurately the "average" value of the parameter.

- The original database needs to be fully described. In this database, all latitudes and all seasons are sampled for more than one year and with the 30 brightest stars occultations. The part that was used for the present manuscript uses only 2 stars (and 60 days of data) in order to cover the "low latitudes" (-20°, +20°) and only one star (and 25 days of data) in order to cover the +34° +36° latitude band. Such coverage is clearly insufficient in order to be representative of "the stratosphere" (as stated in the title) particularly when the data exists and is available.
- The original database contains an uncertainty for each estimated parameter. This uncertainty is not used (and not discussed) in the present manuscript. When average values are calculated, weights from uncertainties need to be taken into account.
- The statement about "*Standard deviations of the mean values*" P18015L22 is incorrect because the distribution of the considered parameters is not Gaussian (see Fig. 2).
- The wavenumber kw P18011L2 is associated with the (small scales) "decay" of the anisotropic contribution. This decay can result from the transition to isotropy for small scales or from a slope change of the 3-D anisotropic spectrum (or both). The relation between such wavenumber and the turbulence properties need to be discussed.
- The relations between the various scales that are introduced need to be discussed : The transition scale (associated with kt) which is usually known as the "buoyancy" scale (Lumley), the Thorpe scale, the Ozmidov scale. The Fukao reference P18014L07 refer itself to Hocking 1987 who considers measurements in the 80-120 km altitude range.
- The equation (10) in Fukao et al. 1994 used to define "beta" is followed by the sentence "*It must be noted that (10) gives a local value of K for (locally) homogeneous turbulence (inside a layered or patchy region) and that different formulations of K may be more appropriate for different spatial and/or temporal scales (e.g., larger than those of layered structures).*" questioning again the exact physical meaning of the calculated parameters.
- The material in section 2 and 3.1 (and part of section 3.2) is mostly a duplication of already published equations and derivations. It is sufficient to give appropriate credit and references. The duplication of the derivations is not useful.
- For the spectral parameters of the original database, the geographical sampling, the vertical resolution and the horizontal extent of the sampled volume must be given. The origin of the associated atmospheric parameters must also be given (ECMWF).
- The data in Gurvich and Chunchuzov (2003) and in Gurvich and Kan (2003b) is exactly the same (cited P18018L23). This information was confirmed by Valery Kan.
- The correlation between parameters, which is discussed in section 3.3, can only result from the formulas used in order to calculate these parameters. This section is more related to the properties of the used models (sensibility study) than to the properties of the atmosphere itself. Of course, if the atmosphere behave exactly as predicted by the models (what I do not believe), this study would be relevant. This important restriction about the meaning of the obtained results need to be discussed.
- When referring to large books (Tatarskii, Monin & Yaglom, Press at al.) please give the section and/or the equation number.
- Within the submitted manuscript, 35 sentences out of 145 (24%) contains the modal verb "may". This gives the strange feeling that the author himself is not really convinced by what is written.

Technical corrections

- Please clarify the title and abstract since GOMOS is not a satellite, it is one of the instruments on board the ENVISAT satellite.
- P18008L17 "… IGWs propagating upwards …" phase or energy propagation ?
- P18009L20 stations Salute -> stations Salyut
- P18009L17 optical scintillation method
- P18009L18 "higher sampling rates" please specify
- P18009L26 reference to Bertaux et al. 2010 is more appropriate.
- P18011L01 "constant parameters" is ambiguous since these parameters are fitted for each spectrum.
- P18011L09 write (4 π/3) like for equation (3)
- P18011L14 "kk is scale …" No kk is a wavenumber (the same error is present in Sofieva et al. 2007)
- P18011L14 "smallest isotropic perturbations" is inaccurate since viscous domain is isotropic.
- P18011L17 kz << kk (wavenumber is not scale)
- P18012L21 one-dimension -> vertical
- P18012L21 in Lumley 1964 paper (an in many following ones) kt is named kb for "buoyancy"
- P18013L07 edging -> transition
- P18016L01 Differences -> Dispersion (also at other places in the manuscript)
- P18017L26 fitting : in linear or logarithmic coordinates ?
- P18018L15 Ck values can also be compared with Sofieva et al. 2007 and with Gurvich et al. 2007.

Gurvich, A. S., V. F. Sofieva, and F. Dalaudier (2007), Global distribution of CT2 at altitudes 30–50 km from space-borne observations of stellar scintillation, Geophys. Res. Lett., 34, L24813, doi:10.1029/2007GL031134.

J. L. Bertaux, E. Kyrölä, D. Fussen, A. Hauchecorne, F. Dalaudier, V. Sofieva, J. Tamminen, F. Vanhellemont, O. Fanton d'Andon, G. Barrot, A. Mangin, L. Blanot, J. C. Lebrun, K. Pérot, T. Fehr, L. Saavedra, G. W. Leppelmeier, and R. Fraisse (2010)
Global ozone monitoring by occultation of stars: an overview of GOMOS measurements on ENVISAT
Atmos. Chem. Phys., 10, 12091-12148

Within the ACP special issue on Gomos: http://www.atmos-chem-phys.net/special_issue153.html