

Interactive comment on “Progress in turbulence detection via GNSS occultation data” by L. B. Cornman et al.

Anonymous Referee #1

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General remarks

The authors discuss the turbulence detection from GNSS observational data. Their approach is based on the fact that is possible to formulate a parametric model of the atmospheric refractivity fluctuations spectrum and map this model to the signal fluctuation spectrum, using e.g. the well-established weak fluctuation theory based on the Rytov approximation. The parameters of the atmospheric refractivity fluctuations spectra can then be estimated from the measurements by using the maximum likelihood method. In this reviewer's opinion, this approach is useful. However, this approach for the parameter estimation is not new, see

A. Gurvich and I. Chunchuzov, Estimates of characteristic scales in the spectrum
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of internal waves in the stratosphere obtained from space observations of stellar scintillations, JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 110, D03114, doi:10.1029/2004JD005199, 2005.

The paper is 97 pages long (including 53 figures), which is just too large a volume. My impression is that that the authors choose for the paper a format that would more appropriate for a monograph. This can be inferred from a very detailed explanation of the weak fluctuations theory that is very well known. On the other hand, the authors failed to properly reference the previous works (even more important for a monograph than for a regular paper). In particular, they did not mention stellar occultations where all the necessary techniques has already been elaborated. Also, a more thorough analysis of the real observational data would be desirable, as discussed below. Currently, I cannot see enough justification for such a volume of the paper. My recommendation is, therefore, to publish the paper after a significant reduction.

Specific remarks

1. Introduction

It is extremely strange that the authors do not even mention the works on the turbulence detection from the optical observations, which use the same approach based on the theory of weak fluctuations. Many useful references to the works on the data acquired by ENVISAT/GOMOS instrument are available at http://earth.eo.esa.int/pes/envisat/gomos/articles/Biblio_GOMOS.doc. It is highly recommended that some of these references are included. In particular, some of the key publications belong to A.S.Gurvich.

Page 3403: *Previous efforts to study turbulence in the upper troposphere, stratosphere and ionosphere with GNSS occultations fall into ... two broad categories: ...*

The subject of the discussion of the two categories of papers (those using *appropriate theory* and those employing *inappropriate techniques based on the relevant theory*) is not clear without references.

2. Wave propagation theory

This chapter must be significantly reduced. It is recommended that the authors make much more stress on their original results rather than on a detailed reproduction of well-known classical results that can be found in many monographs. It will suffice to present the references to e.g. books by Tatarskii, Rytov, Kravtsov and the final formulas describing the fluctuations of the electromagnetic waves as operators acting on the fluctuations of the refractivity or permittivity field.

It is not quite clear what is illustrated by Figure 1. Obviously, φ_{χ_1} is proportional to C_n^2 , as noticed in the text. A general remark is that the sensitivity of the intensity fluctuations spectra to different parameters of the fluctuations spectrum of the medium have already been amply discussed in the literature:

A. S. Gurvich, A heuristic model of three-dimensional spectra of temperature inhomogeneities in the stably stratified atmosphere, *Ann. Geophysicae* 15, 856–869 (1997).

A. S. Gurvich and V. L. Brekhovskikh, Study of the turbulence and inner waves in the stratosphere based on the observations of stellar scintillations from space: a model of scintillation spectra, *Waves Random Media* 11 (2001) 163–181.

3. Parameter estimation

The authors make a correct statement that the spectral values of a random Gaussian process have an exponential distribution. But it would be a good idea to produce a reference where this statement comes from. Alternatively, it can be derived. Given

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a random process $u(t)$ and its Fourier transform $\tilde{u}(\omega) = x(\omega) + iy(\omega)$, x and y will be independent and have the same Gaussian distribution. Consider $\tilde{u}^2 = x^2 + y^2$; it is straightforward to express the distributions for x^2 and y^2 , take their convolution and arrive at the exponential distribution.

Page 3418: hereinafter the same notation L is used twice: both for the turbulence length scale and for the likelihood function.

As noticed General Remarks, here it is necessary to reference (Gurvich and Chunchuzov, 2005).

4. Simulation studies

I suggest to significantly reduce this part. Instead of 40 figures it will suffice to present just a few ones. Also, 'liklihood' in the figures should be replaced with 'likelihood'.

5. GPS-COSMIC data analysis

This section is the most interesting one in the paper. But here I do not find any analysis of the ionospheric fluctuations spectrum. The authors limited themselves to the isotropic Kolmogorov or Karman turbulence, although they did mention the paper by Gurvich and Chunchuzov where an anisotropic form of the spectrum was discussed. Finally, it is not quite clear what the practical value of this data analysis is. What is the uncertainty of the parameter estimates?

Interactive comment on *Atmos. Meas. Tech. Discuss.*, 4, 3401, 2011.