Atmos. Chem. Phys. Discuss., 7, S6655–S6658, 2007
www.atmos-chem-phys-discuss.net/7/S6655/2007/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Turbulence dissipation rate derivation for meandering occurrences in a stable planetary boundary layer" *by* G. A. Degrazia et al.

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Received and published: 8 November 2007

The paper addresses the problem of turbulence parameterisation in so-called low wind speed conditions, with special attention to the formulation of the dissipation rate and the dispersion modelling.

In general words, such conditions produces meandering of the horizontal wind, coupled with relatively low levels of turbulent kinetic energy at high frequencies (or high wave numbers). Anfossi et al. (2005), see their Fig. 5, show that in the spectral range of frequencies from 0.001 to 0.01 s^{-1} the kinetic energy density is higher (and increasing with decreasing frequency) than in the inertial subrange (frequencies higher than 0.1 s^{-1}), at variance with the standard spectra (velocity higher than 3 m/s).

At first, the authors of the paper propose an analytical solution for simplified equation of motion in order to have a simple model of meandering flow. In fact, their simplified Eq. 4 misses the dependence on x and y of the u and v components, which is explicitly contained in the need to have the coefficients $a_i \neq 0$. Moreover, the velocity field is nondivergent because the authors assume a constant (with z) vertical velocity, which is physically ridicolous. In summary, the prototype field suggested (Eq. 7) is a sound solution of the equations only if $p = 0$, namely a two dimensional nondivergent field uniform on the horizontal plane. Thus is an interesting prototypefield, characterized by a rotation of period $2\pi/q$ (relatd, in the author derivation, to the Coriolis frequency), but the derivation must be rewritten. It can be recalled that the same misleading derivation has been already suggested and published by almost the same authors (Goulart et al., 2007).

Starting from this point, the right correlation function is given by Eq. 9 with $p = 0$. Note that the statement 'considering the real part' leads to a wrong solution. In fact the correlation functions are different for the u and v components, and are dependent on the initial time, because the field is deterministic and unsteady. Only if an average over a finite number of periods (or over a long time) is taken, the correlation function turns out to be the same for both the components, and is proportional to $\cos(qs)$, where s is the lag.

Then the authors discuss the properties of the correlation function Eq. 10. In spite of the wrong derivation, this correlation function corresponds to a well defined physical model, a two dimensional velocity field with zero mean and an average rotation of the fluctuating components. To the reviewer knowledge, the issue as been introduced in the literature of stochastic models by Borgas et al. (1997), discussed by Sawford (1999) and recently used, by instance, by Veneziani et al. (2004). This correlation functionmay be used for evaluating dispersion, as made by the authors with Eq. 11, but only in the case of a steady horizontally homogeneous velocity field, namely a velocity field different from Eq. 7.

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A property of the correlation function

$$\rho(s) = \exp(-s/\tau)cos(qs) \tag{1}$$

is that the integral time scale (the Lagrangian time scale) is smaller than τ (because of the negative lobes) and reads

$$T = \frac{\tau}{1 + (q\tau)^2} \tag{2}$$

and this fact produces a reduction of the long term lateral dispersion (and thus of the diffusion coefficient which is given by the variance of the velocity times the Lagrangian time scale).

Thus the important physical point is that dissipation in the inertial subrange (for high frequencies) is smaller in low wind, or meandering, conditions because there is less kinetic energy density in that spectral range (remember the cited spectra from Anfossi et al., 2005), and the lateral dispersion for long times is smaller because of the reduction of the time scale due to low frequency behaviour. The two points are distinct as well as the frequencies and cannot be confused.

The resulting picture is that the dispersion process discussed by the authors is essentially driven by the low-frequency part of the spectrum (consistently, they use values of the meandering period $2\pi/q$ of the order of 10^3 s and the value of τ must be of the same order for the rotation to be effective). The value of τ should be related to a $f^{-5/3}$ range at low frequencies (as seen in many atmospheric and oceanic spectra, two distinct ranges with similar slopes are observed).

Finally, it may be worth to observe that in the case of a two dimensional uniform Gaussian fluctuating field with rotation the analytical solution of the Langevin equation is obtained by standard methods (Gardiner, 1990) and the exact solution could be applied

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to the horizontal components because in the dispersion simulations the turbulence is assumed by the authors homogeneous on the horizontal plane.

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Interactive comment on Atmos. Chem. Phys. Discuss., 7, 15251, 2007.