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Interactive Comment

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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First of all, we would like to sincerely thank the reviewer for the questions about of the manuscript.

Concerning to the following *referee* suggestion "A comparison of the model with and without meandering should be made".

For the case $m = 0$, when the meandering effects are eliminated, Equations (2) and (22) of the manuscript are written in terms of the exponential form $(\exp(-t/\tau_{L_i}))$ and a solution for Gaussian turbulence is obtained (a Gaussian PDF is applied in Fokker-Plack equation to obtain the deterministic coefficient of the Langevin equation). Therefore, Equation (22) will be written in terms of the exponential autocorrelation function, which Lagrangian particle models are usually employed in windy conditions. In this particular situation (without meandering) the plume evolution exhibits a “fanning” kind of behavior (typical of windy conditions) and, naturally, higher concentration values must be found.

In Table (1), we present a comparison between the simulation results, when the meandering effects are eliminated $(m = 0)$, and the observed concentration results for three INEL Experiments ($4, 9$ and 14).

According to this comparison, we can note that the simulated concentration values are higher than those observed in the experiments.

Table 1:

run	$distance\ (m)$	Observed data $(\mu g m^{-3})$	simulated data $(\mu g m^{-3})$, $m = 0$
4	100	155	1839
4	200	80	1813
4	400	39	1807
9	100	44	1355
9	200	23	895
9	400	16	592
14	100	60	1214
14	200	34	1188
14	400	6	1130

It is well known that atmospheric dispersion in low wind speed conditions is mainly governed by meandering (low frequency horizontal wind oscillations). In such conditions, differently than a diffusion generated by a fully developed turbulence, the airborne contaminants are dispersed over distinct angular sectors. Therefore, this oscillatory

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behavior is the physical mechanism that reduces the lateral turbulent diffusion of a plume. Thusly, as can be seen in figure 11 from *Anfossi et al.* (2005), Taylor's equation employing Frenkiel autocorrelation function captures well the role of meandering in altering the turbulent diffusion. As a consequence, equation 13 represents a hybrid formula that exhibits diffusive characteristics concerning the phenomena of turbulence and meandering. Therefore, following a reviewer180;s suggestion to the first version of the present manuscript, Frenkiel formulation, as well as Equation (13), present an empirical flexibility, representing the diffusive properties of hybrid flow cases, in which turbulence and meandering coexist.

Concerning the statement regarding stationarity of the turbulence and Taylor's diffusion model, in the derivation of Equation (15), the most important result of the study, we employed Equation (11) and (12) for $t < T_{L_v}$. As the meandering period is greater than T_{L_v}, our analysis applies to conditions in which $t \ll T_m$, where $T_m \approx 2000s$ is the average value of the meandering period (*Anfossi et al.*, 2005). Therefore, a quasi-stationary condition is guaranteed in the present analysis.

Regarding the comments on Taylor's equation validity range, considering a very restrictive condition, Taylor statistical diffusion theory can be applied only in the cases in which there is homogeneous turbulence. Thusly, from the application point-of-view, Taylor's theorem would be almost useless. However, in the literature, there are a number of studies that employ this theory to describe atmospheric dispersion process in real, not necessarily homogenous, turbulence. A review of the specific literature shows that Taylor's equation has been used to describe turbulent dispersion in the planetary boundary layer under different stability conditions and, therefore, involving situations of non-homogeneous turbulence. (Briggs (1985); Weil (1985); Weil (1988); Venkatram (1988); Mangia (2000); Degrazia (2001); Mangia (2002);Dosio (2003))

Concerning the equivalence of Lagrangian and Eulerian turbulent velocity variances, *Anfossi et al.* (2006), employing LES - generated turbulent data for distinct stability situations in the PBL, found that there is an agreement between the correspondent Eu-

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lerian and Lagrangian velocity variances. This result supports the above cited studies and shows that Taylor statistical diffusion theory, as given by Equation (11), can be applied to more realistic turbulent dispersion cases.

Reference

Briggs, G. A. (1985). Analytical parameterizations of diffusion: the convective boundary layer. Journal Climate and Applied Meteorology, 24, 1167-1186.

Weil, J. C. and Corio, L. A. (1985). Dispersion formulations based on convective scaling. Martin Marietta Environmental Center, Columbia, Report No. PPSP-MP-60.

Weil, J. C. (1988). Dispersion in the convective boundary layer. (In A. Venkatram and J. C. Wyngaard, (Eds.), Lectures on Air Pollution Modeling. American Meteorological Society, Boston)

Mangia C. Degrazia, G. A.; Rizza, U. (2000). An integral formulation for the dispersion parameters in a shear-buoyancy-driven planetary boundary layer for use in a gaussian model for tall stacks. In:Mangia et al Journal of Applied Meteorology, p. 1913-1922.

Venkatram, A. (1988). Dispersion in the stable boundary layer. (In A. Venkatram and J. C. Wyngaard, (Eds.), Lectures on Air Pollution Modeling. American Meteorological Society, Boston)

Degrazia, G. A., Moreira, D. M. and Vilhena, M. T. (2001). Derivation of an eddy diffusivity depending on source distance for vertically inhomogeneous turbulence in a convective boundary layer. Journal of Applied Meteorology, 40, 1233-1240

Venkatram, A., Rode, R., Lee, R., Paine, R., Perry, S., Peters, W., Weil, J. and Wilson, R. (2001). A complex terrain dispersion model for regulatory applications. Atmospheric Environment, 35, 4211-4221

Mangia C. Moreira, D. M. Schipa, I. Degrazia. G. A. T. Tirabassi; Rizza, U. (2002). Evaluation of a new eddy diffusivity parameterisation from turbulent eulerian spectra in

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different conditions. In:Mangia et al Atmospheric Environment, v. 36, p. 67-76.

Dosio, A., Arellano, J. V. and Holtslag, A. A. M. (2003). Dispersion of a passive tracer in buoyancy and shear-driven boundary layers. Journal of Applied Meteorology, 42, 1116-1130

Anfossi , D., Rizza, U. , Mangia, C., Degrazia, G.A. and Pereira Marques Filho,E (2006). Estimation of the ratio between the Lagrangian and Eulerian time scales in an atmospheric boundary layer generated by large eddy simulation. Atmospheric Environment, 40, 326-337.

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