Atmos. Chem. Phys. Discuss., 10, C4677–C4678, 2010
www.atmos-chem-phys-discuss.net/10/C4677/2010/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Why anisotropic turbulence matters: another reply" *by* S. Lovejoy et al.

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Received and published: 1 July 2010

The author doesn't contest our main technical point about the impact of anisotropic scaling turbulence on aircraft measurements, rather he points out that it is not clear how a system of partial differential equations can yield solutions which are scaling but with different exponents in the horizontal and vertical directions:

"However, as far as I could follow the literature, there is no theory to indicate that the system gradually transform from two dimensionality to three dimensionality, say, by gradually increasing the Rossby number. Will it be possible to construct such a theory?" If it is possible, how can it be done?"

He then goes on to focus on the Rossby number as a possible parameter to control the

effective dimensionality of the stratification. Up until now, the theoretical basis of the 23/9D anisotropic scaling model has been based essentially on dimensional analysis (e.g. that the scaling along the vertical corresponds to that first proposed by (Bolgiano, 1959) and (Obukhov, 1959)). Yano's basic point that anisotropic scaling ought to be derivable from dynamical equations is therefore highly pertinent. However, he missed the key point that the continuous parameter determining the degree of stratification does not correspond to the Rossby number, but has already been identified as a scale independent exponent the effective "elliptical" dimension of atmospheric motion (Schertzer and Lovejoy, 1987), which can indeed take any value between two and three. In order to go beyond dimensional analysis, and to show - as demanded by Yano - that the governing equations generate anisotropic scaling laws, we must replace the classical scale analysis of the equations (used to estimate which terms are important at various narrow ranges of space-time scales), by a scaling analysis which focuses instead on the exponents of the terms under anisotropic scale changes. In a companion paper (Schertzer, Tchiguirinskaia Lovejoy, Tuck 2010; too lengthy for this ACPD reply), we give an original scaling analysis of the vorticity equation and show that it does indeed allow for anisotropic scaling solutions as claimed.

References:

R. Bolgiano, Turbulent spectra in a stably stratified atmosphere, J. Geophys. Res. 64(1959), p. 2226. A. Obukhov, Effect of archimedean forces on the structure of the temperature field in a turbulent flow, Dokl. Akad. Nauk SSSR 125(1959), p. 1246. D. Schertzer and S. Lovejoy, Physical modeling and Analysis of Rain and Clouds by Anisotropic Scaling of Multiplicative Processes, Journal of Geophysical Research 92(1987), pp. 9693-9714.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 7495, 2010.