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Atmospheric Chemistry and Physics Discussions

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Interactive Comment

Interactive comment on "Air-chemistry "turbulence": power-law scaling and statistical regularity" *by* H.-m. Hsu et al.

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Reply to review 1:

Thank you very much for your comments for making this presentation better. It is always difficult to decide the optimal material to be included in the paper. One way to handle this situation is to include sufficient references. (All the revisions appear in blue in the revised PDF.)

1. Abstract (Revised)

2. Introduction (Revised) This is just a short summary of the main results to motivate readers who are interested in the details, should continue.

3. Detail descriptions of analysis methods (DFA, CWT) Exact formulations of CWT and DFA have appeared in a number of previous publications, and the references for both theory and applications are sufficient. Should the reviewer insist, we'll add some formulations in the next revision.

4. Chemical species descriptions (The description on the chemical species are already limited, only one paragraph for each species.)

5. Exponents '-3' and '-1' The classical atmospheric spectra of kinetic and potential energy are -3 and -5/3 for the large- and meso- scales. Large- and meso- scales refer to the length scales greater than ∼800 km and between ∼800 km and several km. However, the data used are the long-distance aircraft measurements of long flights (e.g., Nastrom and Gage, 1985; Gage and Nastrom, 1986). The assumption of stationary made the energy spectra in terms of wavelength. Our analysis is based on the temporal data, and our CWT spectral exponent of -5/3 appears in the high-frequency band (2- to 24-hour periods). Our -5/3 to theirs may be coincidence, but may be physical if they should be in the same temporal and spatial space. Mesoscale variability (turbulence-like) has been used to interpret the -5/3 scaling (see Gage, 2004). Different scaling between out -1 and their -3 may be physical, but not obvious at present. The -3 scaling has been referred as geostrophic and/or stratified turbulence (e.g., Charney, 1971; Lilly, 1983). Essentially it is quasi-two-dimensional. On the other hand, the scaling of -5/3 is essentially three-dimensional. Definitely, further investigations are warranted.

Charney, J.G., 1971: Geostrophic turbulence. J. Atmos. Sci., 28, 1087-1095.

Lilly, D.K., 1983: Stratified turbulence and the mesoscale variability of the atmosphere. J. Atmos. Sci., 40, 749–761.

6. DFA exponent 3/4 The DFA exponent 3/4 corresponds to the CWT exponent -1/2. It is the lower bound of the exponents in the large time-lag band of DFA spectra, and corresponds to the lower bound of the exponent in the low-frequency band of the CWT spectra. The upper bounds for DFA and CWT are 1 and -1, respectively. They can be

identified in Figure 5 (the blue dots), and Table 1.

7. Low frequency DFA/CWT diverse This is a very interesting question. The standard deviations on the DFA spectra (the red bars in Fig. 4) are smaller in the small time-lags than those in the long time-lags. This is generally true for the CWT spectra: Spectra are more diverse at low frequencies than those at high frequencies. In the small time-lag/high-frequency bands, one may consider the local turbulence dominates. On the other hand, various synoptic- and large-scales effects become important. Local turbulence usually is universal, but synoptic- and large-scales effects are not. Thus, the variability of low-frequency exponents is relatively large due to various large- and synoptic-scale phenomena in the lower troposphere.

8. Separation of analysis of aerosol measurements The primary reason to separate gases and aerosol is their primary physical difference between gaseous for the former and solid for the latter. In fact, there are few differences between gases and aerosol in terms of spectral and statistical structures.

9. Spectral exponents in Summary (revised)

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 9635, 2011.