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Atmospheric Chemistry and Physics Discussions

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

Anonymous Referee #2

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The paper Air-Chemistry "turbulence": power-law scaling and statistical regularity, by Hsu et al, describes the analysis of hourly-based observations of several criteria gases and PM10 from 74 air quality monitoring stations in Taiwan for the year 2004. The manuscript is well-written, presents results on the spectral nature of the observations and is of interesting nature to be published in ACP. However, I recommend its publication in ACP only after the following revisions are made.

1. One aspect that is not addressed by the authors is the potential spatial inhomogeneities of the powers spectra resulting from the various locations of the monitoring stations. It is likely that monitoring stations located within large cities would have very different power spectra than those in rural or coastal areas. Even within the cities, as a result of urban sprawl or changes in landuse, some urban monitors could eventually be

located close to large local emission sources that might induce short-term large concentration events and may approximate better to power-law behavior, whereas other monitors within the city may better represent larger spatial scale pollution/weather events (with less frequency of short term "extreme values"). Other examples of potentially large effects in regional variability of power spectral are monitoring stations that are located in coastal areas, as well as those close to complex mountain ridges. The former often have characteristic sea-land dynamics interactions whereas the later may show terrain-induced turbulence effects. However, by taking the ensemble averages of the autocorrelation or power spectra of the 74 monitoring stations most of this spatial information is lost and may hinder important spectra, or erroneously attribute scale-free regions in the data. One possibility is to obtain the spectral analysis by region or group the stations by type of monitor and observe the differences with respect to the ensemble.

2. Not surprisingly, the diurnal and semidiurnal frequencies are predominant features in the spectra as a result of meteorology-driven cycles and impacts of anthropogenic daily behavior. However, the authors may actually be quantitative rather than simply qualitatively ascribing the observed diurnal and semidiurnal features to these well-known causes. After all, this is a perennial-question often addressed in air quality modeling: How much of the observed variability of key pollutants is driven by anthropogenic activities (and therefore potentially subject to control by designed strategies) rather than to meteorology? This would indeed be a more important contribution offered by spectral analysis techniques.

3. The sampling size (1 year) is too small for obtaining any meaningful low frequency band results (e.g. seasonal). If the goal is to investigate peaks at these low frequencies the authors should consider applying the method using multiple years of measurements.

4. The authors make a good point indicating that spectral decompositions can be useful for additional model error analyses. However, given that the power-law scaling

exponents of -5/3 and -1 for regions higher/lower than the diurnal are found, the authors should also offer specific examples of their assertion that the spectral structures can be used to constrain parameterizations for un-resolved chemical and physical processes in numerical simulations at these scales. It would seem that for any parameterization of processes with higher than diurnal/semidiurnal frequencies would require, in turn, spectral analyses of highly resolved observations (perhaps 1-minute resolution) particularly for chemical processes involved short-lived species.

5. A non-explicit assumption made in this analysis is that the data precision, accuracy, and instrumental errors are adequate for this type of analyses. However, more often than wanted, data from monitoring stations can suffer from various sources of errors (e.g. data missing periods, biases, instrumental offsets, etc.) that can have an impact of spectral analyses. I would recommend including a paragraph indicating the type of quality assurance protocols followed in this analysis.

6. Please edit several typos in the manuscript.

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