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Interactive comment on "Impact of sampling frequency in the analysis of tropospheric ozone observations" *by* M. Saunois et al.

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Saunois et al. try to explore potential errors introduced into seasonal means and trends of ozone by the low frequency of profile measurements made by ozone sondes. Most sonde stations make weekly observations, with a few in Europe launching sondes three times a week. The authors seek to explore the effect of these frequencies by sub-sampling the almost daily MOZAIC aircraft profiles into and out of Frankfurt airport.

The paper states: "In order to mimic the regular sampling of the soundings, we sub-sampled the MOZAIC morning dataset using a "regular" sampling method". Indeed, the sondes are flown regularly: every Wednesday at Lindenberg and Prague; Monday, Wednesday and Friday at Hohenpeissenberg, Payerne, and Uccle; and Tuesday and Thursday at De Bilt (to complement nearby Uccle). However, the authors did not

sample the MOZAIC profiles on the dates that the sondes are flown. If they had, they could have quantified the difference that sampling can make with these frequencies, by matching dates, computing monthly and seasonal means, trends etc. They should do this. I suggested it to the lead author when she presented an early version of this work at the AGU meeting in December 2010.

In this paper the MOZAIC data are sampled in an artificial manner, taking every 5th profile. For the months where 2 aircraft were flying in and out of Frankfurt, yielding 4 profiles a day, sampling every 5th profile would sample only a short part of the month (and often consecutive days), quite unlike the weekly sampling by the sondes. Such a high frequency of sampling will likely yield samples that are auto-correlated, rather than independent of each other. With one aircraft a day going to and from Frankfurt, every 5th profile would be every second or third day. The authors seem to have chosen their sampling to build up statistics, but they do not match those in the actual world of existing data. This is unfortunate, and compromises the potential utility of this work. It would have made more sense to sample every 7th day to mimic weekly sampling, and on days 1, 3, 5, 8, 10, 12, etc (2, 4, 6, 9, 11, 13, etc) to mimic those with thrice weekly sampling.

The authors use their many sub-samples to discuss "intra-seasonal variability", but this is artificial, as it does not recognize the temporal sampling by the sondes, which is not biased towards one part of the month. Thus their sampling does not represent a realistic measure of the statistics they seek.

The authors present seasonal trends for 200 of their sub-samples, and compare them to trends at 6 European sonde stations. They state that: "our study suggests that apparent discrepancies between stations may be attributed to the low sampling frequency, in addition to specific conditions at each station". (p. 27120.) They should address the actual effect on trends of the sampling by the sonde stations, by taking one aircraft profile on each date that sonde data are available, and omitting sonde data on days there were no aircraft profiles. This of course presupposes that there is no real

geophysical variability in ozone between the location of the aircraft and sonde profiles.

There are biases between the Brewer Mast sonde and MOZAIC data, particularly in the early years of the MOZAIC record, and these are primarily what give rise to different trends for 1995-2008 between the Frankfurt aircraft data, and the Hohenpeissenberg and Payerne sondes, rather than the sampling frequency. For the period without such biases, 1998-2008, the trends for these two sonde stations, the MOZAIC data, and alpine sites in Europe are very similar, even though the sampling frequencies differ. The trends for Uccle are rather different because of a high bias late in the record. I presented preliminary results of this work at the Second International Workshop on Tropospheric Ozone Changes in Toulouse, France, in April 2011, a workshop attended by several of the authors of this paper. This work has since been completed and submitted for publication (Logan et al., 2011). As noted in our paper, sampling the Frankfurt data on the dates of the Hohenpeissenberg sondes does not remove the bias in the early years of the MOZAIC record.

I would agree that weekly sampling by the sondes is not optimal for obtaining reliable trends in tropospheric ozone. However, when the trend is large enough, as in the post-Pinatubo period in the 1990s, these trends are readily apparent (Tarasick et al., 2005; Kivi et al., 2007).

Weekly sampling is not an impediment to using many years of sonde data to form a climatology, as shown by Logan (1999). The standard error of the monthly means is <7.5% in the lower troposphere for 20 weekly observations in the lower troposphere for extra-tropical stations, and <15% in the tropics. These errors decrease with more observations(Logan, 1999). Such climatologies are useful for evaluating chemistry transport models driven by meteorological products from general circulation models (e.g., Horowitz, 2006; Considine et al., 2008)

For evaluation of interannual variability, a model can be sampled on the days of the soundings, rather than comparing a model monthly mean to a mean formed by 4 or

12 soundings. Of course more frequent measurements are ideal for assessing trends in tropospheric ozone, but that does not preclude careful use of the extant data. Of more concern is the quality of the sonde data, which has had various problems in the past (e.g., Jeannet et al., 2007; Logan et al., 2011). More studies are needed of the consistency of various ozone records in different parts of the world, one of the conclusions of the Workshop in Toulouse.

I could make many comments on this paper, but will restrict myself to a few. The first review has noted the problems with the confusing metrics. As regards the statistics, the authors need to clarify the difference between the standard deviation and the standard error, a term they do not use, but calculate (p. 27116), sigma/(square root (N-1)).

p. 27112. “We do not correct profiles based on the corrections factor provided. The correction factor was scaled to the entire column” It is unclear what this means. Some stations provide data with the integrated profile scaled to independent data for the overhead ozone column (by the so-called correction factor, CF), some do not. Did the authors divide by the CF for the stations that provided the scaled data? If they did, this would be a problem for Payerne, where the mean CF changes from about 1.1 to about 1.0 when the sonde type changed in 2002. Or are they trying to say that they did not use the CFs as a filter for data quality, as is commonly done? The correction factor is not scaled to the entire column, but rather applied to the entire profile.

p. 27121. The frequency of MOZAIC profiles at Osaka and Tokyo is mostly about 8-18 per month (or about 4-9 days of data), so I do not think these locations are suitable to test the weekly sampling of the Japanese sondes (apart from the fact this should be done with matched dates). There are large latitudinal gradients in ozone over Japan in summer and autumn (Logan, 1999), so the variability sampled by the aircraft will depend on their routes into and out of the airports. I doubt that the high variability is induced primarily by biomass burning, but rather by the dynamics of the summer monsoon which leads to the summer minimum, particularly over southern Japan.

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