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Atmospheric Chemistry and Physics
Discussions

Interactive comment on "Nitrous oxide emissions 1999–2009 from a global atmospheric inversion" *by* R. L. Thompson et al.

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This paper estimates the interannual variability in monthly N2O fluxes derived from a time-dependent atmospheric N2O inversion. Results are presented by region for years 1999-2009, which is a significant advance in temporal resolution over previous N2O inversions. The Bayesian inversion approach has been refined and adapted for N2O over a number of years, and includes some complex details (such as the extra 1 ppb observational uncertainty in the extratropical SH) but seems generally solid and well polished. Overall, this is an impressive body of work, which is also well written and nicely presented. I recommend publication, although I do have several minor comments.

First, a general comment that relates to an earlier publication (Thompson et al., GRL, 2013), which is relevant because it provides the basis for the prevailing theme in the current paper that ENSO controls much of the interannual variability in atmospheric N2O through its influence on precipitation, soil moisture and temperature, and hence tropical soil emissions, which are influenced by those variables. While this is plausible and likely true to some extent, I am concerned that the influence of atmospheric transport and mixing is being downplayed. Taking Samoa as an example, and comparing the atmospheric growth rate anomaly in AGAGE N2O data and two long-lived CFCs (which have no biogenic sources), it seems fairly clear from visual inspection that the interannual variability is related among the 3 species (although somewhat obscured by the complex growth rates of the phased-out CFCs vs. the continuing growth in N2O). Similar correspondence in growth rate anomalies is seen at all AGAGE stations.

Section 2.3, presentation of priors. These are based largely on the ORCHIDEE model, which supplies not only natural soil emissions but also anthropogenic emissions associated with agriculture. It would be useful to provide a table summarizing the total emissions from all the different sources. Do the source categories and totals correspond to the estimates in Table 7.7 of Denman et al., 2007? That table estimates a direct agricultural source of 2.8 Tg N/yr, and indirect agricultural emissions of 2.3 Tg N/yr, plus an additional 0.6 TgN/yr from atmospheric production via NH3 reaction. Are these indirect agriculture sources captured by ORCHIDEE?

Section 2.4 Correction of offsets between NOAA CCGG and AGAGE P15707, line 18, "the data were corrected to the NOAA2006A scale using the linear trend and offset calculated at each site (see Table 2)" However, Table 2 only seems to report a single scalar. This, combined with subsequent discussion on lines 23-29, makes it unclear whether a constant offset or a correlation with a linear trend is being applied.

Sections 2.6 and 3.1 Re: the sensitivity test using a low/high flux from South America to represent El Nino vs. La Nina conditions. There is an underlying assumption that changes in soil fluxes associated with temperature and precipitation changes are driving the ENSO-related variability observed in N2O. However, an additional consideration is that for species like N2O with positive north-south gradients, warm ENSO conditions result in a slowdown of the atmospheric growth rate observed in the southern tropics (e.g., Samoa) due to shifts in the low-level convergence pattern, resulting in a lessened influence of winds from the Northern Hemisphere and a heightened influence of south-easterly winds. In the current paper, ENSO is quantified using a multivariate index, which includes both SST and wind data. When these are examined separately using NOAA CPC indices: (http://www.cpc.noaa.gov/data/indices/) for Nino 4 temperature and Western Pacific 850 mb tradewind anomalies, the stronger correlations appear to be associated with the tradewind anomalies (Figures R2 and R3). This, combined with the similar growth rate anomalies shown in Figure R1, seem to indicate a substantial role for atmospheric mixing and shifts in tradewinds in bringing more/less N2O-rich air from the northern hemisphere during La Nina/El Nino conditions. Has this influence been accounted for in the sensitivity tests?

Figure 1. Is there really a NOAA CCGG station at 0 deg E, 0 deg N? I don't see one listed in Table 1.

Figure 7. It would be helpful to line up the three tropical regions, S+Tr America, Africa, and South Asia, in the middle column for easier comparison.

Figure 8. Caption should refer to Figure 7, not 6.

With respect to Figure 8, given the sparsity of monitoring stations in the tropics shown in Figure 1, including the lack of stations in the eastern tropical South Pacific, a hotspot for oceanic N2O, how well can the 20S-20N ocean source really be distinguished from tropical land sources? For that matter, how well can Africa and South America be distinguished?

Figure 10. The ECMWF anomalies, especially in precip, are stronger in South America than Africa, but the dN2O flux anomalies seem comparable between the 2 continents, if not stronger in Africa. Why?

p. 15719, lines 10-14 imply that dN2O for Africa is 0.2 Tg aˆ-1 vs. 0.6 Tg aˆ-1 in South America, but (referencing my previous comment) this seems inconsistent with the results in Figure 10.

p. 15714, re: the discussion of the surprisingly high N2O fluxes from western tropical Africa, given the low rates of fertilizer use (< 1 Tg N/yr for the whole of tropical Africa, compared to 30 Tg N/yr for South and Southeast Asia). I am somewhat skeptical of the suggestion that underestimated use of N manure is responsible. To my knowledge, the cattle in this region are small compared to western, grain-fed cattle and have relatively low N excretion rates. Could this be an underestimated natural soil source instead?

Section 2.8, line 15, extra "calculated"

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 15697, 2013.

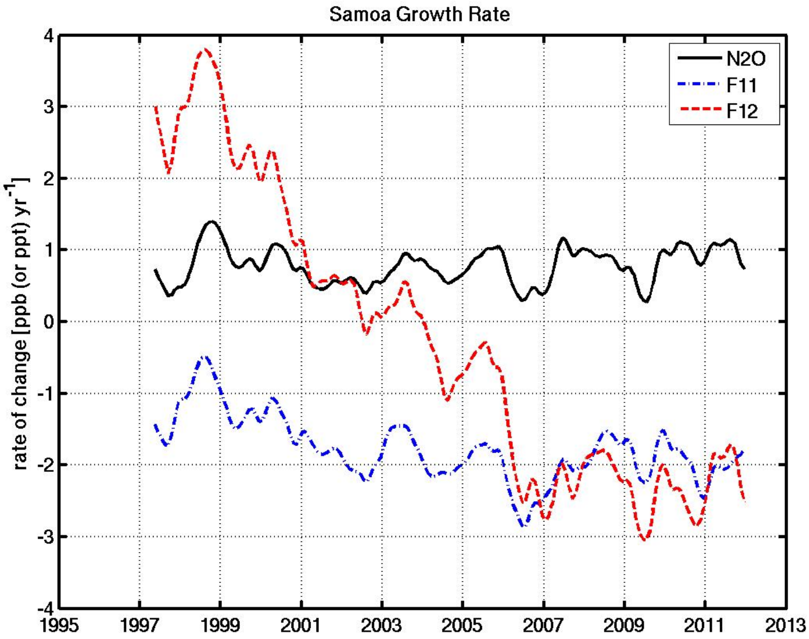

Fig. 1. Atmospheric Growth Rate Anomalies (calculated as per Nevison et al., 2007) at Samoa, using AGAGE N2O, CFC11 and CFC12 data

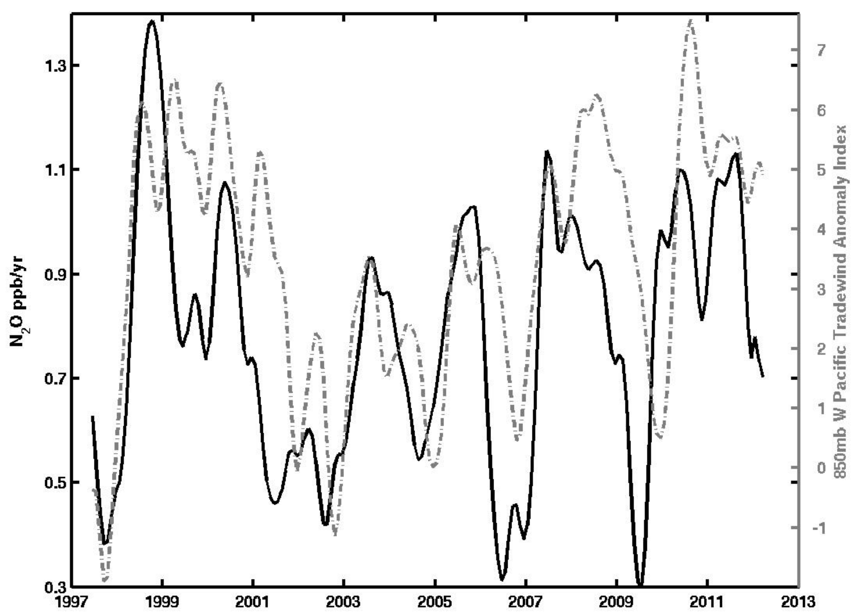

Fig. 2. Atmospheric Growth Rate Anomalies (calculated as per Nevison et al., 2007) at Samoa, using AGAGE N2O compared to the NOAA CPC 850 mb Western Pacific Tradewind anomaly index.

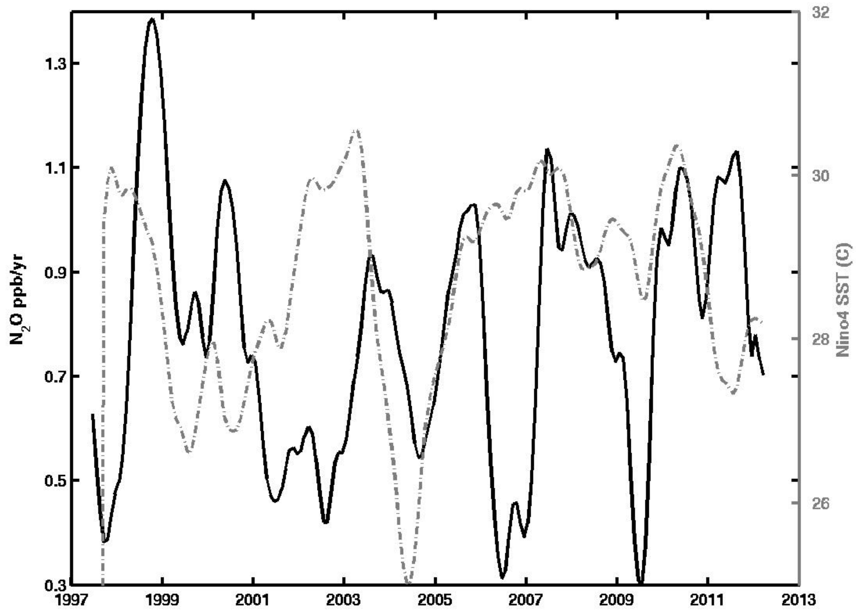

Fig. 3. Same as Fig. 2, but compared to the NOAA CPC Central Pacific Nino4 temperature index.