

Interactive comment on “Increasing synoptic scale variability in atmospheric CO₂ at Hateruma Island associated with increasing East Asian emissions” by Y. Tohjima et al.

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This review is by Owen Cooper, co-editor of ACPD/ACP and the editor of this manuscript. Please note that I commented on the original version of the manuscript submitted to ACPD, not the version published on the ACPD website, so the page numbers listed below refer to the original manuscript.

This paper presents a very interesting analysis of CO₂ and CH₄ variations at a remote island locations and gives measurement based evidence that CO₂ emissions from China are increasing. The two anonymous referees and myself have asked for additional analyses that together would require a major revision of the paper, but one

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that the authors should be able to complete within six weeks. Please respond to our comments within six weeks of the closing of the Open Discussion period.

There are two items missing from this paper that I would like to see specifically addressed.

1) I would like to see the actual CO₂ and CH₄ mixing ratios (not deviations) measured at HAT and compared to measurements at other remote locations. With HAT being so close to China, CO₂ at HAT should be much greater than at the more distant remote locations. For example it would be very informative to see a plot of the monthly average CO₂ and CH₄ at HAT from 1995-2007 along with the average CO₂ and CH₄ as measured by the NOAA GMD global monitoring network: <http://www.esrl.noaa.gov/gmd/dv/ftpdata.html> CO₂ at HAT should be greater than the global average and should also show a slightly greater rate of increase if China is having a strong impact on HAT. Similarly what are the CO₂ and CH₄ mixing ratios when the data are broken down by source region as in Figure 7?

2) Please address the impact of ship emissions. The following paper provides a very good review of global ship emissions and is available on-line from Atmos. Environment:

Eyring, V., et al., Transport impacts on atmosphere and climate: Shipping, Atmospheric Environment (2009), doi:10.1016/j.atmosenv.2009.04.059

Ships contribute only about 3% of global CO₂ emissions per year but their emissions have increased substantially over the time period of your study. Given that HAT is surrounded by shipping emissions what impact does increased shipping have on your results? I would like to see ship CO₂ emission plotted on your figure 4, if possible just for the region near China, Taiwan and southern Japan.

Other comments of a substantial nature:

- Because the CO₂ and CH₄ data are reported as volumetric mixing ratios, throughout the paper please replace “concentration” with mixing ratio. Also, instead of ppb or ppm,

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please use ppbv or ppmv.

- Thirteen years isn't really long enough to establish a true trend, which in meteorology is typically calculated over 20-30 years. It would be better to discuss increases rather than trends.

- Before submitting the revised manuscript please add continuous line numbers in the margins of the paper so that it is easier for the editor and referees to comment on specific items.

- Figure 4. EIA emissions for China in 2006 are reported as 6018 million metric tons of CO₂. Converting to tons of C rather than CO₂ using a factor of 12/44 I get Chinese emissions of 1.64 PgC/yr. Your figure 7 shows a value of approximately 1.8 PgC/yr. Please help me understand this discrepancy.

- Additional description of the trajectory model is required. Which model generated the wind fields and what are their horizontal, vertical and temporal resolutions?

Minor comments: If no reason is given for a comment then it means that the suggested text should replace the corresponding text in the manuscript.

Abstract: -shows a systematic increase over the 12-year period, with elevated excursions in 1998 and 2003; there is no clear increase in sigmaCH₄.

-increases gradually from 1996 to 2002 and rapidly after 2002

- rapid increase in fossil carbon emissions from China,

Introduction, first sentence: A reference is needed that demonstrates the link between anthropogenic activities and the rise of CO₂ in the atmosphere. IPCC 2007 would be fine.

page 2: Although there are international efforts to reduce greenhouse gas emissions,

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global CO₂ emissions from.....show an unprecedented

page 2: The website associated with Marland et al. [2007] now has emissions updated through 2006.

page 2, last sentence: - will produce a larger concentration gradient

page 3: Please indicate when measurements began on Hateruma Island

page 3: - which is located on the East Asian

page 3: - its relationship to continental

page 4, middle of page: cycles should be cycles

page 4: - show noticeably similar variations during the periods

page 5: - to within 10 ppbv on average. - and fossil fuel emissions (Olivier and Berdowski, 2001) are used simultaneously.

page 5: In the sentence that describes the transport patterns associated with the climatological winter monsoon please reference: Newell R. E and M. J. Evans, Seasonal changes in pollutant transport to the North Pacific: the relative importance of Asian and European sources, Geophys. Res. Lett., 27, 2509-2512, 2000. This is the first paper to characterize the polluted export pathway from Asia to the southeast during winter.

page 6: shows that the observations at HAT are affected

page 6, first paragraph: I don't understand what is meant by the leading and trailing edges of the CO₂ SSV peak. Is this referring to one of the figures?

page 6 first paragraph: since CH₄ has a similar emission pattern.

page 6, 2nd paragraph, 2nd sentence: "Secular" is not the right word to describe what is occurring. The sentence can be greatly shortened as follows: However, if we exclude the anomalously high sigmaCO₂ values in 1998 and 2003, the data show a gradual increase during 1996-2002 and a sharp rise during 2002-2007, resembling the growth....

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page 6 last paragraph: Slower or faster transport from an emission region won't necessarily decrease or increase the SSV peak magnitudes. What counts is the variability of CO₂ or CH₄ transported from the source to the receptor, regardless of whether the transport is fast or slow. It would be best to re-phrase the sentence as: For instance, continuous or episodic transport from the source region.....

page 6 last line: By normalizing sigmaCO₂ with respect to sigmaCH₄ interannual transport variations would be....

page 7 last line: although the amplitude of both CO₂ and CH₄ variations

page 8, first sentence of Discussion: A reference is needed that describes the impact of El Nino on wind and radiation.

page 8, beginning of Discussion: Please make it clear that the purpose of Figure 6 is to demonstrate the impact of El Nino.

page 9, middle of page: reflective of a change in fossil fuel CO₂ emissions.

page 10, middle of page: global atmospheric CH₄ burden decreased after 1980

page 11 end of first paragraph: origins are 38%.....

page 11 last line: In trajectory modeling the term footprint is mainly associated with the locations where back trajectories intersect the surface of the Earth or the lowermost boundary layer, as popularized by the many FLEXPART studies. Also, the trajectories only cover some of the CO₂ emission centers of China, mainly those in the northeast. Please re-word this sentence as: The range of transport pathways to HAT indicated by the backward trajectories covers some of the major CO₂ emission centers in China

From the bottom of Page 12 through the end of the paper I have many suggested changes as shown below:

We believe that the selected sigmaCO₂/sigmaCH₄ values better reflect the emissions from China than the unselected values. In addition, since sigmaCO₂ shows the highest

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value in 2007 (Fig. 3), it is likely that the greater rate of fossil CO₂ emissions from China continued through 2007, although the sharp dip in sigmaCO₂/sigmaCH₄ in 2006 is still difficult to explain. Our simple analysis has shown that the synoptic scale variations in CO₂ and CH₄ observed at HAT can be used to obtain a better estimate of changes in emissions from East Asia, especially China. This is important because the present estimate of fossil CO₂ emissions from China has an uncertainty greater than 15% (Gregg et al., 2008). Recently, Stohl et al. (2009) developed a new inversion method based on a Lagrangian particle dispersion model to estimate regional and global emissions and applied it to in-situ measurements of halocarbons from several globally distributed sites. They found that the emissions from China are well constrained by the measurements at HAT. Similarly, such an inversion method could be applied to our CO₂ data to obtain a quantitative fossil CO₂ emissions estimate for China during the Asian winter monsoon season.

References: the word "during" is missing from the title of Simpson et al

The journal for Gregg et al. is Geophys. Res. Lett.

Figure 4, caption: carbon emissions from fossil fuel consumption

Figure 6: The "H" depicting the location of HAT is difficult to see, please make the font bold face.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 15725, 2009.

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