Atmos. Meas. Tech. Discuss., 4, C2091–C2093, 2011
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Atmospheric Measurement Techniques Discussions

Interactive comment on "NO_2 observations over the western Pacific and Indian Ocean by MAX-DOAS on *Kaiyo*, a Japanese research vessel" *by* H. Takashima et al.

Anonymous Referee #1

Received and published: 17 November 2011

This is an interesting paper which reports unique MAX-DOAS observations of NO_2 volume mixing ratios over the western Pacific and Indian Ocean. Such observations are scarce and particularly important for validation of chemical transport models and satellites. In addition, the study reports on a technical issue related to the choice of the optimal fitting window for NO_2. This is relevant for future MAX-DOAS studies under comparable conditions. In general the paper is well-written and well-structured. I recommend it for publication in AMT after the following comments have been addressed:

General comments

- Results are obtained by making use of a MAX-DOAS type of instrument. Please discuss in more detail the reason to use for this study a MAX-DOAS instrument, whereas other methods are available. For example, the in-situ method used in reference 1 (see below) appears to have a much lower (better) detection limit. Reference 1 reports, although for a different geographical region, NO_2 volume mixing ratios of approximately 10 pptv for long periods in a row (see e.g. Fig. 8 in this paper). These values are almost a factor of 10 lower than the mode of the PDF reported in this work.

- It is mentioned that the detection limit of the method used in this study is approximately 0.1 ppbv (p.6078, l.13-15). This would imply that the MAX-DOAS method cannot be used to determine a reliable PDF of the NO_2 volume mixing ratio below this value. From this perspective, Fig. 11 may cause some confusion, since it suggests that values between 0.00 and 0.05 ppbv are very unlikely to be found and that the PDF has a mode around 0.1 ppbv (p. 6078, l.21). This value for the mode seems to quite high when compared to the values reported in reference 1 (despite the fact that a different region is studied). The mode around 0.1 ppbv may therefore not reflect the mode of the real PDF over the remote ocean, but rather be due to the relatively high detection limit of the measurement technique. Perhaps Fig. 11 could be modified, such that a single bin is used below 0.1 (or 0.2) ppbv.

- Compared to in-situ observations, a major strength of MAX-DOAS is the ability to measure tropospheric columns. In relation to transport of NO_2 (p.6071, l.3), this quantity is just as relevant as the volume mixing ratio. Please provide a figure with tropospheric NO_2 columns (preferably similar to Fig. 11 and for the same subset of all observations), or otherwise mention why it is decided not to include this MAX-DOAS product despite its relevance in this context.

- A negative correlation is reported between NO_2 (425-450nm) and H_2O (p.6076, l.9-10). This finding is used to support the claim that H_2O has a negative impact on the DOAS fit in this particular fitting window. Alternatively, one could hypothesize that the negative correlation is due to a chemical reaction (or a mechanism of reactions) involving both NO_2 and H_2O. Please provide correlations between H_2O from this fitting window (425-450) and NO_2 from the two other fitting windows (338-370nm and 460-490nm) to exclude this alternative hypothesis, or otherwise please comment on this point.

Specific comments

- p.6074, l.22-25 (Here, DSCD ... collision complex.): Please rephrase.
- p.6076, l.4: Please replace 'cause' by 'case'.
- p.6077, l.8-10: This sentence is a bit confusing, especially the part: 'the temperature dependence of trace gas in tropospheric'. Please rephrase.
- Fig. 9: The dashed line is not mentioned in the caption or in the text. Please explain it. Is it a linear fit? Which fitting method is used? It does not seem to describe well the higher values.

Reference 1:

'Oxidation photochemistry in the Southern Atlantic boundary layer: unexpected deviations of photochemical steady state', Hosaynali Beygi et al., Atmos. Chem. Phys. 11, 8497-8513, doi:10.5194/acp-11-8497-2011

Interactive comment on Atmos. Meas. Tech. Discuss., 4, 6069, 2011.