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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Contributions of regional and intercontinental transport to surface ozone in Tokyo" *by* M. Yoshitomi et al.

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We are greatly appreciative of the reviewers supportive comments and thank them for their thorough reading of the paper. We have addressed each of the points raised in turn, and have altered the text, tables and captions where appropriate to address the concerns raised. We believe that this has improved the paper, and are grateful to the reviewer for their time and effort in pointing out where improvements could be made.

Response to Comments:

abstract: 2.4±7.6 ppb is not only small but statistically significant.

The standard deviation here describes the variability in the contribution, not the uncer-

tainty associated with it, and we use the words 'variable' and 'varying' in the abstract to emphasize this. On some days the local contribution is substantially greater than 10 ppb, while at night the contribution is typically negative. This large variability leads to a small impact on a mean basis, but the contribution is clearly significant.

page 10405: TF-HTAP (2007) reference can be replaced with TF-HTAP 2010, if already available to public.

The TF-HTAP 2010 report remains in press at the current time, but we will update the citation if it becomes available before publication of this paper.

page 10405: The authors listed several papers for the evidence of increasing ozone during the past decades over Japan. More recent papers can be added here, for example, Tanimoto, Atmos. Environ. (2009) focusing on observations at Mt Happo, and Tanimoto et al. Geophys. Res. Lett. (2009) describing model analysis at nine EANET and WMO/GAW surface sites.

Thank you for drawing these papers to our attention; while both of these are very timely, the results from the latter paper are particularly relevant to this study, and we have added an appropriate citation in the introduction.

page 10409: The authors noted several factors to explain model's inability to reproduce ozone at urban area close to Tokyo. I realize that land-sea breeze affects diurnal changes and transport of ozone around Tokyo Bay. How is this treated in the model? Is this local meteorology reproduced by the T63 model, more or less?

The sea breezes affecting the east coast of Japan are not explicitly resolved in the model at the course resolutions considered here, although some larger scale effects may be captured in the offline meteorological fields used here which are generated at higher resolution (T159, 80 km). It is highly likely that sea breezes will affect ozone in the region in summer time, when there is a strong thermal contrast between land and ocean, and when oceanic air has much lower levels of ozone associated with its

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Western Pacific origin. These effects will be smaller in spring, but may still play some role; however, they are likely to influence daytime ozone and so would not explain the low ozone seen at night.

page 10409: ...The mean bias and RMSE are generally less than 10 ppb... Looking at Table 2, I would say 5 ppb instead of 10 ppb.

This is true of the mean bias, but it is perhaps more appropriate to compare the RMS error here, which remains below 10 ppb at all but two locations.

page 10410: ...CO is underestimated during pollution episodes ... Is this because of underestimated emissions, or insufficient model resolution?

The relatively small mean biases in CO at these sites suggest that the overall magnitude of emissions is represented reasonably well, but it is likely that both emissions heterogeneity and outflow/transport processes lead to features that cannot be resolved at the scales considered here. The probability distribution for CO at Minamitorishima (Fig 2) is represented reasonably well, but it is clear that conditions with CO greater than 200 ppb are under-represented at both resolutions. In this instance it is due to strong banding of CO associated with frontal systems bringing continental air, and these features cannot be sufficiently sharply resolved with the meteorology used here. This sentence in the text has been modified to make it clear that resolution of the meteorology is the contributing factor.

Table 2: Tsukuba, Ijira, and Banryu sites are categorized as "urban". "Sub-urban" would probably be better.

This is a good suggestion, and the categorization of the sites has been altered throughout the text and tables.

Figure 9: What is time resolution of these data — 3 hrs? Are these data afternoon only (similarly to Figure 3), or whole day? Surface ozone in Tokyo (x-axis) is modeled

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results, right? Maybe better to explicitly mention it in the caption.

This figure includes hourly data for the whole day, and shows model results. This information has now been added to the caption as suggested.

Table 6: The authors focused on high-ozone episodes in Tokyo and discussed source contributions. Looking at Figure 4, similar ozone enhancements occurred at Tappi and Happo on April 6, April 17–20, and April 28, 2001, suggesting that the influence of these high-episodes was spreading over wider area, say Honshu region, since behaviors at Hedo and Yonagunijima are greatly different. On the other hand, the model underestimated these episodes at Tappi and Happo. Any comments on this point?

There are strong similarities between the observed timeseries at Tappi, Happo and Tsukuba, and the reviewer is correct to point out that this demonstrates the important role of regional meteorology in controlling high-ozone episodes, particularly where they are associated with regional stagnation under anticyclonic conditions. The episodes highlighted by the reviewer were all influenced by anticyclonic conditions, while the April 12 episode was dominated by passage of a low pressure and associated fronts, and this explains the different source contributions seen for this episode. The model underestimation during the simultaneous episodes at Tappi and Happo is consistent with the underestimation at Tsukuba. A sentence has been added to the description of the episodes at the end of Section 3 to highlight the large-scale influence of anticyclonic behaviour as evidenced by the episodes at Tappi and Happo.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 10403, 2011.