

# A study of the impact of land-use change in Borneo on atmospheric composition using a global model

N. J. Warwick and co-authors

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## Overview

Warwick et al. provide an insightful 3D chemistry-transport modelling study of the impact of land-use change from rainforest to oil palm plantation in Borneo. The study provides valuable corroboration of the central conclusions of earlier work on this topic, at least in as far as modelling ever provides corroboration. The study is suitable for publication in ACP subject to the following points being addressed to the editor's satisfaction.

## General Points

The rationale for the modelling study could be more carefully drawn, so that the value added by the study is clearer, particularly with respect to the OP3 modelling studies of Hewitt et al. (2009), Pugh et al. (2010a; 2010b; 2011), Stone et al. (2011), Pike et al. (2010), and Pyle et al. (2011). Presumably this rationale will concentrate on the particular strengths of high-resolution 3D modelling compared to box or trajectory modelling.

An important complementarity in the present study with Hewitt et al. (2009) is the chosen NO<sub>x</sub> emission scenarios. The present study chooses to study only NO<sub>x</sub> emissions from oil palm plantations, rather than more general increases in NO<sub>x</sub> emissions due to urbanisation and industrialisation, which underpins the modelling study in Hewitt et al. (2009). This should be made clearer in the current ms I feel. I would not agree that the present study assesses the maximum impact of oil palm on local air quality as may be implied by the text on p7447 (lines 7-8).

Later, when considering the implications of the results it would be useful to return to the strengths and weaknesses of the modelling approach used here: some discussion of more detailed chemistry (perhaps with reference to Stone et al. (2011); discussion of sub-grid-scale effects (perhaps with reference to Pugh et al. (2010b; 2011); and discussion of ecological-climatological feedbacks such as changes of albedo (Bonan, K.W. Oleson et al. 2002; Feddema, Oleson et al. 2005), hydroclimatology (Spracklen, Arnold et al. 2012), the surface energy balance (Fowler, Nemitz et al. 2011), atmospheric roughness (Betts, Cox et al. 1997) and deposition (beyond the description on p7443/4).

In the description of model set-up and elsewhere (e.g., P7443, Line 5), I think it is important to remind the reader that there were measurements of both concentrations and fluxes during OP3. Prescribing model isoprene concentrations to fit the observed concentrations disconnects the study from the bVOC emissions observations in OP3. Pugh et al. (2010a) showed, in a box model framework, that it was not possible to reconcile isoprene emissions with isoprene concentrations and with OH concentrations simultaneously with invoking sub-grid-scale segregation. A minor related point is that it could be explained more clearly precisely how the isoprene tracer was held

constant in the Borneo grid boxes and allowed to evolve according to the chemistry in other boxes (e.g., checks that were carried out to ensure there were no spurious chemical waves formed as a result of the fix).

### Minor comments

P7435, line 14. The best summary reference for land-atmosphere exchange during OP3, including ozone fluxes, is Fowler et al. (2011). I'm not aware of any fluxes of reactive nitrogen oxides having been published for OP3.

P7437. I think that the boundary layer scheme used in the model study should be mentioned, perhaps pointing forward to the discussion on p7443 which states that Pike et al. (2010) showed the importance of boundary layer physics and ozone deposition in determining trace gas concentrations at Danum. One might add Pugh et al. (2010a; 2010b) to this latter discussion.

P7437, line 26 and throughout: Poschl should be Pöschl.

P7438, line 10ff: there are some minor discrepancies here between the text and the chemical reactions (no mention of HACET in the reactions; numbering R1, R2 referred to as Eqs. 1 and 2 in the text).

P7441, line 17. It would help the reader if the baseline NO<sub>x</sub> emission was also reported here, and both were compared to the emissions used in Hewitt et al. (2009).

P7445, line 1. Should the reference be to Hewitt et al. (2010) or (2009)?

P7445, lines 7ff (and the Conclusions). It does not make sense to compare a monthly mean to an 8-hour running mean threshold, unless some indication of the variability within the monthly mean can be given.

P7446, lines 11ff. This paragraph is a repeat of an earlier paragraph and should be merged/deleted.

Conclusions. The sensitivity of ozone changes to regional contexts and to the land-use—climate-change scenario chosen is also discussed in Sentian et al. (2011) and at length in Sentian (2009), which can be supplied to the authors by the reviewer or directly from Lancaster University.

Acknowledgements. The number of the ms in the sequence of SEARRP papers is not given.

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