We thank the reviewers for their helpful comments, which have led us to a substantially improved version of the paper. Here, the reviewers' comments are shown in boldfaced black text, and our responses are shown in non-boldfaced blue text. The page and line numbers to which we refer in our responses correspond to the updated manuscript (the comments of all reviewers are taken into account in this updated manuscript).

First and foremost, we confirm that the tropospheric chemical mechanism in GISS ModelE2 is not CBM04. The original manuscript version contained an incorrect oversimplified description of the tropospheric chemistry scheme in GISS ModelE2 that has caused our Reviewers confusion and understandable concerns. We understand that using an old-fashioned chemical mechanism developed 25 years ago for urban polluted high-NOx environments would be an inappropriate tool to apply to a study of large-scale isoprene emission perturbation in the tropics. The chemical mechanism in GISS ModelE2 has been substantially updated and improved over the past 15 years, for example, to account for important reactions, pathways, and species under low-NOx conditions (e.g. Shindell et al., 2003; 2006; 2013; Schmidt et al., 2014).

We now include a more detailed description of the chemical mechanism in Section 2.1 (ModelE2-YIBs description) (Page 4, Line 32):

"The troposphere features NO_X-O_X-HO_X-CO-CH_4 chemistry; an explicit representation of isoprene; and a lumped hydrocarbon scheme involving terpenes, peroxyacyl nitrates (PANs), alkyl nitrates, aldehydes, alkenes, and alkanes. The representation of hydrocarbons generally follows Houweling et al. (1998), which is originally derived from the Carbon Bond Mechanism-4 (Gery et al., 1989) and the Regional Atmospheric Chemistry Model (RACM; Stockwell et al., 1997), but includes several modifications aimed at representing the wide range of chemical conditions found in Earth's atmosphere, such as the addition of reactions important in low-NO_X conditions including representation of organic peroxy radical chemistry under low-NO_X conditions and introduction of organic nitrate chemistry. Shindell et al. (2013) describe in detail the recent updates to the tropospheric chemistry scheme, including the incorporation of acetone chemistry (Houweling et al., 1998) and the addition of terpene oxidation (Tsigaridis and Kanakidou, 2007). SOA formation is driven by NO_X-dependent oxidation of emissions of isoprene, monoterpenes, and other reactive VOCs following a volatility-based two-product scheme (Tsigaridis and Kanakidou, 2007). The formation of secondary inorganic aerosols, including sulfate (Bell et al., 2005; Koch et al., 2006) and nitrate (Bauer et al., 2007a), depend on both modeled oxidant levels and the availability of source gases. Primary aerosol types include dust (which provides a surface for heterogeneous chemistry; Bauer and Koch, 2005; Bauer et al., 2007b), black carbon, organic carbon, and sea salt (Koch et al., 2006). Stratospheric chemistry, introduced to the chemical mechanism by Shindell et al. (2006), includes nitrous oxide (N_2O) and halogen (bromine and chlorine) chemistry. Recent updates to stratospheric chemistry are summarized by Shindell et al. (2013) and include changes in the representations of polar stratospheric cloud formation (Hanson and Mauersberger, 1988) and heterogeneous hydrolysis of N_2O_5 on sulfate (Hallquist et al., 2003; Kane et al., 2001)."

Interdisciplinary work is challenging. We would like to emphasize the novel aspects of this project. (1) The land cover dataset for maritime Southeast Asia that we use in our study is built from an existing classification based on Landsat images (Gunarso et al., 2013). This dataset represents a wall-to-wall mapping of land cover in this region, including explicit representation of plantations of oil palm (high isoprene emitter) and rubber (high monoterpene emitter). Gunarso et al. (2013) used a consistent classification methodology for each year of their analysis, which has provided an internally consistent set of land cover maps for this period for this region. Other studies have investigated the atmospheric composition impacts from land cover change in this region: Ashworth et al. (2012) considered a projection of forest to oil palm conversion based on meeting future demand for biofuels; Warwick et al. (2013) considered the total conversion of Borneo to oil palm from forest; and Silva et al. (2016) considered the impact of 2010 oil palm cover relative to an oil-palm-free landscape in addition to considering future projections of oil palm. We consider the impacts of actual historical land cover change, which is clearly different than Ashworth et al. (2012) and Warwick et al. (2013). The Silva et al. (2016) study imposes oil palm expansion by overlaying an oil palm map for 2010 on a separate 16-PFT land cover distribution; this is a different methodology than we apply here, where we apply an internally consistent set of maps developed using a wall-to-wall classification methodology. (2) We have developed the global climate model code to add four additional land cover type PFTs, focusing on land covers that are pervasive in maritime Southeast Asia, including oil palm and rubber plantations. Previous studies have focused only on the impacts of oil palm expansion. (3) We consider the impacts of land-cover-change-driven changes in emissions of both isoprene and monoterpenes. The study by Silva et al. (2016) presumably includes dynamic changes in monoterpene emissions for the land covers that are displaced by oil palm, but their one new land cover type – oil palm – only has the isoprene emission capacity altered relative to the forest land cover type. Ashworth et al. (2012) and Warwick et al. (2013) consider only isoprene emission changes. (4) We directly quantify the global radiative forcing induced by ozone and SOA changes driven by historical land cover change in this region using a coupled global land-chemistry-climate model framework with the embedded radiative transfer model developed by A. Lacis and J. Hansen in GISS ModelE2 (e.g. Schmidt et al., 2014). (5) We provide new climate policy metrics for global ozone radiative forcing per Mha land cover change in the tropics. (6) We quantitatively identify that important factors driving uncertainty in the forcing include (a) uncertainty in the magnitude of the isoprene BER for oil palm and (b) uncertainty in the areal extent of oil palm expansion. Using an analysis based on fixed SOA yields, we additionally show that the sign of the net forcing is sensitive to uncertainty in the SOA yield from BVOCs.

Responses to Reviewer #2

Harper and Unger present a study of the radiative forcing brought about via differences in isoprene emission under different land use configurations in the maritime Southeast Asia (MSEA) region. These land use changes comprise the move towards more oil palm plantations, which emit more biogenic volatile organic compounds than the native natural forests. The changes in isoprene emitted to the atmosphere as a result of the increased oil palm leads to changes in ozone. Of particular interest is that the Enhanced BVOCs caused

bigger changes globally to ozone in the upper troposphere (0.6 ppb) than lower troposphere (>0.1 ppb), which would seem an important result. The novelty of this study is that the authors then go on to calculate the radiative forcing expected by these ozone changes, finding a small increase of +1 mW m-2 Mha-1.

This shows that impacts of land use changes in tropical regions, which are subject to stronger convective patterns that elsewhere, are very important.

My feeling is that this is a really nice idea, but the wrong tool has been used to carry out the study. The small changes in ozone seen at the top of the troposphere are probably lost in the noise of uncertainty of the chemical scheme chosen, and thus I question the impacts on radiative forcing.

The authors use the carbon bond 4 chemical mechanism to represent the oxidation of isoprene in the atmosphere. This scheme is very old and does not include some of the recent discoveries brought about via questioning the discrepancies between isoprene predicted by models, and observed mixing ratios. These particularly relate to additional OH recycling, which directly impact the influence of isoprene on O3 (eg Lelieveld et al., 2008; Peeters et al., 2009).

The authors do mention the uncertainty in the isoprene chemistry regarding increased oxidant cycling, right at the end of the paper in the conclusions, but I think there are other problems with this choice of chemistry scheme. High isoprene atmospheres, such as that found in this MSEA region, have caused more differences in chemical mechanisms than most others. Unfortunately, the carbon bond scheme has never fared well when tested alongside other chemistry schemes under similar isoprene rich atmospheres. I wonder why there has been no model development in the chemistry scheme in this work when the science behind this paper depends so highly upon it?

For example Knote et al (2015) tested two variants of the newer carbon bond 5 (CB05) scheme (neither of which contained updates to the isoprene chemistry) and found they "tended to be biased low in O3 under low NOx/high VOC conditions (e.g. biogenic emissions rich) as well as under very high NOx conditions. In general, the CB05 schemes produced 'lower than average 8 hourly O3' produced by other schemes. Mechanisms were 'found to differ more strongly in their predictions of O3 levels and other pollutants in regions with strong biogenic VOC emissions".

Archibald et al (2010) tested 8 chemical schemes in isoprene rich regions and found that the CB05 mechanism was 'unable to generate/recycle HOx at the rates needed to match recently reported observations at locations characterized by low levels of NOx.'

An older study - Emmerson and Evans (2009) tested the carbon bond 4 scheme against 6 other schemes. However the carbon bond 4 results disagreed with the majority of the other schemes, in even the sign of the changes in ozone (e.g. loss instead of production - see figure

3 panel e). Differences (and thus uncertainty) of 14 ppb were found between the resulting ozone from the Master Chemical Mechanism and the carbon bond 4 scheme, which is 14 times more than the ~1 ppb of ozone changes found in Harper and Unger's study at the top of the troposphere, and upon which the radiative forcing calculations are based.

Thus I don't agree with the authors' comment that no updates to the chemistry have occurred because of "its apparent inconsequence to the surface pollution impacts of regional land cover change". I think if a different chemistry scheme had been implemented that the changes in ozone found by Harper and Unger as a result of including more oil palm plantations in the model would lead to more significant differences in the radiative forcing than found by their study.

I'd recommend updating the chemistry scheme. Perhaps even to include a sensitivity study with a more up to date representation of just the isoprene chemistry – particularly one that agrees with the sign of ozone changes driven by our current understanding. The chemical aspect of Harper and Unger's work is my only criticism, which if rectified I would then recommend publication in ACP.

Thank you for the thoughtful comments and guidance. We confirm that the tropospheric chemical mechanism in GISS ModelE2 is not CBM04. Please see response at the top of this document at response to Reviewer #1 point (9). Certainly, we too would have major concerns about a study using CBM04 to quantify composition impacts of a large isoprene emission injection in the tropics. The revised manuscript now includes a more detailed and accurate description of the chemical mechanism.

We have removed this sentence: "its apparent inconsequence to the surface pollution impacts of regional land cover change." We now provide a more balanced assessment of uncertainties due to isoprene oxidation chemistry, which we have moved to the methodology (Sect. 2.1) as advised in point (9) below. In our expanded assessment, we have included reference to the studies noted above (Archibald et al., 2010; Emmerson and Evans (2009); Knote et al. (2015)).

General comments

(1) A map figure would be good, showing the study area with the areal extent of regions growing oil palm in 1990 and where/how these regions have increased by 2010.

The original version of the manuscript includes Figure S1 in the Supplementary Information; this figure is now labeled Figure S2 in the updated manuscript. This figure shows, for each of eight land cover types (including oil palm), the regional change in land cover for (1) 1990–2005 and (2) 1990–2010. In the manuscript, we refer to this figure on Page 11, Line 16.

We have included a new figure (known as Figure S1 in the updated manuscript) that shows the areal extent of these same eight land cover types in year 1990. We have added the following

sentence to the manuscript to point readers to this figure (Page 16, Line 14): "Figure S1 in the Supplement shows the regional land cover distribution for 1990."

(2) Page 2 line 2. "Compared to natural forests oil palm plantations are much stronger emitters of BVOCs" Some numbers would be good here. How much stronger?

Updated text (additions in bold; Page 2, Line 11): "Above-canopy flux measurements **taken in Borneo in 2008** indicate that, compared to the natural forests of maritime Southeast Asia (MSEA), oil palm plantations are much stronger emitters of the biogenic volatile organic compound (BVOC) isoprene (C_5H_8), **with mean midday fluxes about five times stronger from oil palm** (Langford et al., 2010; Misztal et al., 2011)."

The factor difference may be even stronger if comparing the canopy-level BERs, but the values of the BERs can depend on the model parameterization applied (e.g., Misztal et al., 2011), so we use the above comparison instead.

(3) Page 2 line 20. Try placing the (Baker et al., 2005; Klinger et al., 2002) references at the end of sentence to avoid breaking the flow of the sentence up too much.

Fixed. (We introduce the high-monoterpene-emitting capacity of rubber trees earlier in the revised introduction.)

(4) Page 2 line 29. How is photolysis treated in the model?

We have provided an expanded description of photolysis in the manuscript (Page 5, Line 18): "Photolysis rate calculations follow the Fast-J2 scheme of Bian and Prather (2002). At each 30 minute time step, the simulated distributions of clouds, ozone, and aerosols are passed to the photolysis code, providing a mechanism for simulated changes in aerosols to impact atmospheric chemistry through modification of photolysis rates (Bian et al., 2003)."

We have added these references:

Bian, H. and Prather, M.J.: Fast-J2: Accurate simulation of stratospheric photolysis in global chemical models, J. Atmos. Chem., 41, 281–296, doi: 10.1023/A:1014980619462, 2002.

Bian, H., Prather, M.J., and Takemura, T.: Tropospheric aerosol impacts on trace gas budgets through photolysis, J. Geophys. Res., 108, 4242, doi: 10.1029/2002JD002743, 2003.

(5) Page 3 line 27. 'the' calculation

Fixed.

(6) Page 5 line 12. It is not clear where this LAI dataset has come from?

For the four new land cover types that have been added to ModelE2-YIBs for this study, the assigned LAI values are from published literature and are shown in Table 1 in the main text (this table was previously Table S2 in the Supplement), with the references noted in the footnotes of that table. To better point readers to this information, we have added the phrase (Page 9, Line 20) "including LAI and vegetation height" to the sentence in the manuscript that describes the information that can be found in Table 1; in this sentence, we additionally replace the phrase "BVOC emissions" with the more specific phrase "leaf-level basal emission rates for isoprene and monoterpenes." (The assigned LAI applied to other vegetation is described in the following paragraph.)

(7) Page 5 line 14 (onwards in this paragraph). LAI has units of m2 m-2

Fixed in all three instances in this paragraph (Page 9, Line 11): "An analysis of the leaf area index (LAI) of rainforest plots in Central Sulawesi, Indonesia, under different land use regimes found that disturbance of the forest by selective logging reduced the LAI below the 6.2 m^2 [leaf] m^{-2} [ground] value measured for the undisturbed natural forest (Dietz et al., 2007). Removal of "small-diameter" trees reduced LAI to 5.3 m^2 m^{-2}, while removal of "large-diameter" trees reduced LAI to 5.0 m^2 m^{-2} (Dietz et al., 2007)."

We also added the units to two places in the new Table 1 (previously Table S2 in the Supplement) – once in the table and once in the footnote.

(8) Page 5 line 21. Table S2 – mention this is in the supplementary section.

We have moved this table and its footnotes to the main text (now known as Table 1).

(9) Page 19 line 21. This whole discussion of uncertainties in the chemistry scheme would be better placed in section 2.1 which introduces the method used.

Fixed. We expanded this discussion and moved it to Section 2.1.

References

Archibald, A.T., Jenkin, M.E., Shallcross, D.E., 2010. An isoprene mechanism intercomparison. Atmos. Environ. 44 (40), 5356e5364.

Emmerson, K. M., and Evans, M. J.: Comparison of tropospheric gas-phase chemistry schemes for use within global models, Atmos Chem Phys, 9, 1831-1845, DOI 10.5194/acp-9-1831-2009, 2009.

Knote, C., Tuccella, P., Curci, G., Emmons, L., Orlando, J. J., Madronich, S., Baro, R., Jimenez-Guerrero, P., Luecken, D., Hogrefe, C., Forkel, R., Werhahn, J., Hirtl, M., Perez, J. L., San Jose, R., Giordano, L., Brunner, D., Yahya, K., and Zhang, Y.: Influence of the choice of gas-phase mechanism on predictions of key gaseous pollutants during the AQMEII phase-2 intercomparison, Atmos Environ, 115, 553-568, 10.1016/j.atmosenv.2014.11.066, 2015.

Lelieveld, J., Butler, T.M., Crowley, J.N., Dillon, T.J., Fischer, H., Ganzeveld, L., Harder, H., Lawrence, M.G., Martinez, M., Taraborrelli, D., and Williams, J.: Atmospheric oxidation capacity sustained by a tropical forest, Nature, 452, 737–740,doi: 10.1038/na- ture06870, 2008.

Peeters, J., Nguyen, T.L., and Vereecken, L.: HOx radical regeneration in the oxidation of isoprene, Phys. Chem. Chem. Phys., 11, 5935–5939, doi: 10.1039/B908511D, 2009.

References

Angiola, A., Mieville, A., and Granier, C.: MACCity (MACC/CityZEN EU projects) emissions dataset [Data files], Emissions of atmospheric Compounds & Compilation of Ancillary Data, http://eccad.sedoo.fr, 2010.

Archibald, A.T., Jenkin, M.E., Shallcross, D.E.: An isoprene mechanism intercomparison, Atmos. Environ., 44, 5356–5364, doi: 10.1016/j.atmosenv.2009.09.016, 2010.

Ashworth, K., Folberth, G., Hewitt, C.N., and Wild, O.: Impacts of near-future cultivation of biofuel feedstocks on atmospheric composition and local air quality, Atmos. Chem. Phys, 12, 919–939, doi: 10.5194/acp-12-919-2012, 2012.

Atkinson, R. and Arey, J.: Gas-phase tropospheric chemistry of biogenic volatile organic compounds: A review, Atmos. Environ., 37, S197–219, doi: 10.1016/S1352-2310(03)00391-1, 2003.

Baker, B., Bai, J.-H., Johnson, C., Cai, Z.-T., Li, Q.-J., Wang, Y.-F., Guenther, A., Greenberg, J., Klinger, L., Geron, C., and Rasmussen, R.: Wet and dry season ecosystem level fluxes of isoprene and monoterpenes from a southeast Asian secondary forest and rubber tree plantation, Atmos. Environ., 39, 381–390, doi: 10.1016/j.atmosenv.2004.07.033, 2005.

Bauer, S.E. and Koch, D.: Impact of heterogeneous sulfate formation at mineral dust surfaces on aerosol loads and radiative forcing in the Goddard Institute for Space Studies general circulation model, J. Geophys. Res., 110, D17202, doi: 10.1029/2005JD005870, 2005.

Bauer, S.E., Koch, D., Unger, N., Metzger, S.M., Shindell, D.T., and Streets, D.G.: Nitrate aerosols today and in 2030: a global simulation including aerosols and tropospheric ozone, Atmos. Chem. Phys., 7, 5043–5059, doi: 10.5194/acp-7-5043-2007, 2007a.

Bauer, S.E., Mishchenko, M.I., Lacis, A.A., Zhang, S., Perlwitz, J., and Metzger, S.M.: Do sulfate and nitrate coatings on mineral dust have important effects on radiative properties and climate modeling?, J. Geophys. Res., 112, D06307, doi: 10.1029/2005JD006977, 2007b.

Beer, C., Reichstein, M., Tomelleri, E., Ciais, P., Jung, M., Carvalhais, N., Rödenbeck, C., Arain, M.A., Baldocchi, D., Bonan, G.B., Bondeau, A., Cescatti, A., Lasslop, G., Lindroth, A., Lomas, M., Luyssaert, S., Margolis, H., Oleson, K.W., Roupsard, O., Veenendaal, E., Viovy, N., Williams, C., Woodward, F.I., and Papale, D.: Terrestrial gross carbon dioxide uptake: Global distribution and covariation with climate, Science, 329, 834–838, doi: 10.1126/science.1184984, 2010.

Bell, N., Koch, D., and Shindell, D.T.: Impacts of chemistry–aerosol coupling on tropospheric ozone and sulfate simulations in a general circulation model, J. Geophys. Res., 110, D14305, doi: 10.1029/2004JD005538, 2005.

Bian, H. and Prather, M.J.: Fast-J2: Accurate simulation of stratospheric photolysis in global chemical models, J. Atmos. Chem., 41, 281–296, doi: 10.1023/A:1014980619462, 2002.

Bian, H., Prather, M.J., and Takemura, T.: Tropospheric aerosol impacts on trace gas budgets through photolysis, J. Geophys. Res., 108, 4242, doi: 10.1029/2002JD002743, 2003.

Carlson, K.M., Curran, L.M., Asner, G.P., Pittman, A.M., Trigg, S.N., and Marion Adeney, J.: Carbon emissions from forest conversion by Kalimantan oil palm plantations, Nat. Clim. Change, 3, 283–287, doi: 10.1038/nclimate1702, 2012.

Carlson, K.M., Curran, L.M., Ratnasari, D., Pittman, A.M., Soares-Filho, B.S., Asner, G.P., Trigg, S.N., Gaveau, D.A., Lawrence, D., and Rodrigues, H.O.: Committed carbon emissions, deforestation, and community land conversion from oil palm plantations expansion in West Kalimantan, Indonesia, Proc. Natl. Acad. Sci.-USA, 109, 7559–7564, doi: 10.1073/pnas.1200452109, 2012b.

Carlton, A.G., Wiedinmyer, C., and Kroll, J.H.: A review of secondary organic aerosol (SOA) formation from isoprene, Atmos. Chem. Phys., 9, 4987–5005, doi: 10.5194/acp-9-4987-2009, 2009.

Dietz, J., Hölscher, D., Leuschner, C., Malik, A., and Amir, M.A.: Forest structure as influenced by different types of community forestry in a lower montane rainforest of Central Sulawesi, Indonesia, in: Stability of Tropical Rainforest Margins: Linking Ecological, Economic and Social Constraints of Land Use and Conservation, edited by: Tscharntke, T., Leuschner, C., Zeller, M., Guhardja, E., and Biden, A., Springer-Verlag, Berlin, pp. 131–146, 2007.

Draper, D.C., Farmer, D.K., Desyaterik, Y., and Fry, J.L.: A qualitative comparison of secondary organic aerosol yields and composition from ozonolysis of monoterpenes at varying concentrations of NO2, Atmos. Chem. Phys., 15, 12267–12281, doi: 10.5194/acp-15-12267-2015, 2015.

Emmerson, K. M. and Evans, M. J.: Comparison of tropospheric gas-phase chemistry schemes for use within global models, Atmos. Chem. Phys., 9, 1831–1845, doi: 10.5194/acp-9-1831-2009, 2009.

FAO: FAOSTAT Emissions Database [Electronic database], Food and Agriculture Organization of the United Nations, http://www.fao.org/faostat/en/#data, 2014.

Fowler, D., Nemitz, E., Misztal, P., Di Marco, C., Skiba, U., Ryder, J., Helfter, C., Cape, J.N., Owen, S., Dorsey, J., Gallagher, M.W., Coyle, M., Phillips, G., Davison, B., Langford, B., MacKenzie, R., Muller, J., Siong, J., Dari-Salisburgo, C., Di Carlo, P., Aruffo, E., Giammaria, F., Pyle, J.A., and Hewitt, C.N.: Effects of land use on surface-atmosphere exchanges of trace gases and energy in Borneo: Comparing fluxes over oil palm plantations and a rainforest, Philos. T. R. Soc. B, 366, 3196–3209, doi: 10.1098/rstb.2011.0055, 2011.

Friedman, B. and Farmer, D.K.: SOA and gas phase organic acid yields from the sequential photooxidation of seven monoterpenes, Atmos. Env., 187, 335–345, doi: 10.1016/j.atmosenv.2018.06.003, 2018.

Fry, M.M., Naik, V., West, J.J., Schwarzkopf, M.D., Fiore, A.M., Collins, W.J., Dentener, F.J., Shindell, D.T., Atherton, C., Bergmann, D., Duncan, B.N., Hess, P., MacKenzie, I.A., Marmer,E., Schultz, M.G., Szopa, S., Wild, O., and Zeng, G.: The influence of ozone precursor emissions from four world regions on tropospheric composition and radiative climate forcing, J. Geophys. Res., 117, D07306, doi: 10.1029/2011JD017134, 2012.

Fuglestvedt, J., Berntsen, T., Myhre, G., Rypdal, K., and Skeie, R.B.: Climate forcing from the transport sectors, P. Natl. Acad. Sci. USA, 105, 454–458, doi: 10.1073/pnas.0702958104, 2008.

Gaveau, D.L.A., Salim, M.A., Hergoualc'h, K., Locatelli, B., Sloan, S., Wooster, M., Marlier, M.E., Molidena, E., Yaen, H., DeFries, R., Verchot, L., Murdiyarso, D., Nasi, R., Holmgren, P., and Sheil,

D.: Major atmospheric emissions from peat fires in Southeast Asia during non-drought years: Evidence from the 2013 Sumatran fires, Sci. Rep.-U.K., 4, 6112, doi: 10.1038/srep06112, 2014.

Geron, C., Guenther, A., Sharkey, T., and Arnts, R.R.: Temporal variability in basal isoprene emission factor, Tree Physiol., 20, 799–805, 2000.

Geron, C., Owen, S., Guenther, A., Greenberg, J., Rasmussen, R., Bai, J.H., Li, Q.-J., and Baker, B.: Volatile organic compounds from vegetation in southern Yunnan Province, China: Emission rates and some potential regional implications, Atmos. Environ., 40, 1759–1773, doi: 10.1016/j.atmosenv.2005.11.022, 2006.

Gery, M.W., Whitten, G.Z., Killus, J.P., and Dodge, M.C.: A photochemical kinetics mechanism for urban and regional scale computer modeling, J. Geophys. Res.-Atmos., 94, 12,925–12,956, doi: 10.1029/JD094iD10p12925, 1989.

Granier, C., Bessagnet, B., Bond, T., D'Angiola, A., Denier van der Gon, H., Frost, G.J., Heil, A., Kaiser, J.W., Kinne, S., Klimont, Z., Kloster, S., Lamarque, J.-F., Liousse, C., Masui, T., Meleux, F., Mieville, A., Ohara, T., Raut, J.-C., Riahi, K., Schultz, M.G., Smith, S.J., Thompson, A., van Aardenne, J., van der Werf, G.R., and van Vuuren, D.P.: Evolution of anthropogenic and biomass burning emissions of air pollutants at global and regional scales during the 1980–2010 period, Climatic Change, 109, 163–190, doi: 10.1007/s10584-011-0154-1, 2011.

Guenther, A., Hewitt, C.N., Erickson, D., Fall, R., Geron, C., Graedel, T., Harley, P., Klinger, L., Lerdau, M., McKay, W.A., Pierce, T., Scholes, B., Steinbrecher, R., Tallamraju, R., Taylor, J., and Zimmerman, P.: A global model of natural volatile organic compound emissions, J. Geophys. Res.-Atmos., 100, 8873–8892, doi: 10.1029/94JD02950, 1995.

Guenther, A.B., Jiang, X., Heald, C.L., Sakulyanontvittaya, T., Duhl, T., Emmons, L.K., and Wang, X.: The Model of Emissions of Gases and Aerosols from Nature version 2.1 (MEGAN2.1): An extended and updated framework for modeling biogenic emissions, Geosci. Model Dev., 5, 1471–1492, doi: 10.5194/gmd-5-1471-2012, 2012.

Gunarso, P., Hartoyo, M.E., Agus, F., and Killeen, T.J.: Oil palm and land use change in Indonesia, Malaysia, and Papua New Guinea: Reports from the Technical Panels of the 2nd Greenhouse Gas Working Group of the Roundtable on Sustainable Palm Oil (RSPO), Roundtable on Sustainable Palm Oil, Kuala Lumpur, Malaysia, 2013.

Hallquist, M., Stewart, D.J., Stephenson, S.K., and Cox, R.A.: Hydrolysis of N_2O_5 on sub-micron sulfate aerosols, Phys. Chem. Chem. Phys., 5, 3453–3463, doi: 10.1039/b301827j, 2003.

Hanson, D. and Mauersberger, K.: Laboratory studies of the nitric acid trihydrate: Implications for the south polar stratosphere, Geophys. Res. Lett., 15, 855–858, doi: 10.1029/GL015i008p00855, 1988.

Harper, K.L., Zheng, Y., and Unger, N.: Advances in representing interactive methane in ModelE2-YIBs (version 1.1), Geosci. Model Dev. Discuss., doi: 10.5194/gmd-2018-85 , 2018.

Heald, C.L. and Geddes, J.A.: The impact of historical land use change from 1850 to 2000 on secondary particulate matter and ozone, Atmos. Chem. Phys., 16, 14997–15010, doi: 10.5194/acp-16-14997-2016, 2016.

Heil, A. and Schultz, M.G.: Interpolated ACCMIP and RCP emission dataset [Data files], Available from: http://accmip-emis.iek.fz-juelich.de/data/accmip/gridded_netcdf/accmip_interpolated/, 2014.

Hewitt, C.N., Lee, J.D., MacKenzie, A.R., Barkley, M.P., Carslaw, N., Carver, G.D., Chappell, N.A., Coe, H., Collier, C., Commane, R., Davies, F., Davison, B., DiCarlo, P., Di Marco, C.F., Dorsey, J.R., Edwards, P.M., Evans, M.J., Fowler, D., Furneaux, K.L., Gallagher, M., Guenther, A., Heard, D.E., Helfter, C., Hopkins, J., Ingham, T., Irwin, M., Jones, C., Karunaharan, A., Langford, B., Lewis, A.C., Lim, S.F., MacDonald, S.M., Mahajan, A.S., Malpass, S., McFiggans, G., Mills, G., Misztal, P., Moller, S., Monks, P.S., Nemitz, E., Nicolas-Perea, V., Oetjen, H., Oram, D.E., Palmer, P.I., Phillips, G.J., Pike, R., Plane, J.M.C., Pugh, T., Pyle, J.A., Reeves, C.E., Robinson, N.H., Stewart, D., Stone, D., Whalley, L.K., and Yang, X.: Overview: oxidant and particle photochemical processes above a south-east Asian tropical rainforest (the OP3 project): Introduction, rationale, location characteristics and tools, Atmos. Chem. Phys., 10, 169–199, doi: 10.5194/acp-10-169-2010, 2010.

Hewitt, C.N., MacKenzie, A.R., Di Carlo, P., Di Marco, C.F., Dorsey, J.R., Evans, M., Fowler, D., Gallagher, M.W., Hopkins, J.R., Jones, C.E., Langford, B., Lee, J.D., Lewis, A.C., Lim, S.F., McQuaid, J., Misztal, P., Moller, S.J., Monks, P.S., Nemitz, E., Oram, D.E., Owen, S.M., Phillips, G.J., Pugh, T.A.M., Pyle, J.A., Reeves, C.E., Ryder, J., Siong, J., Skiba, U., and Stewart, D.J.: Nitrogen management is essential to prevent tropical oil palm plantations from causing ground-level ozone pollution, P. Natl. Acad. Sci. USA, 106, 18447–18451, doi: 10.1073/pnas.0907541106, 2009.

Hollaway, M.J., Arnold, S.R., Collins, W.J., Folberth, G., and Rap, A.: (2017), Sensitivity of midnineteenth century tropospheric ozone to atmospheric chemistry-vegetation interactions, J. Geophys. Res.-Atmos., 122, 2452–2473, doi:10.1002/2016JD025462, 2017.

Hooijer, A., Page, S., Canadell, J.G., Silvius, M., Kwadijk, J., Wösten, H., and Jauhiainen, J.: Current and future CO2 emissions from drained peatlands in Southeast Asia, Biogeosciences, 7, 1505–1514, doi: 10.5194/bg-7-1505-2010, 2010.

Houweling, S., Dentener, F., and Lelieveld, J.: The impact of nonmethane hydrocarbon compounds on tropospheric photochemistry, J. Geophys. Res., 103, 10,673–10,696, doi: 10.1029/97JD03582, 1998.

Hoyle, C.R., Berntsen, T., Myhre, G., and Isaksen, I.S.A.: Secondary organic aerosol in the global aerosol–chemical transport model Oslo CTM2, Atmos. Chem. Phys., 7, 5675–5694, doi: 10.5194/acp-7-5675-2007, 2007.

Indonesian Ministry of Agriculture: Tree Crop Estate Statistics of Indonesia 2015–2017, Directorate General of Estate Crops, Ministry of Agriculture, Indonesia, 2017.

Indrarto, G.B., Murharjanti, P., Khatarina, J., Pulungan, I., Ivalerina, F., Rahman, J., Prana, M.N., Resosudarmo, I.A.P., and Muharrom, E.: The context of REDD+ in Indonesia: Drivers, agents and institutions (Working Paper 92), CIFOR, Bogor, Indonesia, 2012.

Jacob, D.J.: Introduction to Atmospheric Chemistry, Princeton University Press, 1999.

Jardine, A.B., Jardine, K.J., Fuentes, J.D., Martin, S.T., Martins, G., Durgante, F., Carneiro, V., Higuchi, N., Manzi, A.O., and Chambers, J.Q.: Highly reactive light-dependent monoterpenes in the Amazon, Geophys. Res. Lett., 42, 1576–1583, doi: 10.1002/2014GL062573, 2015.

Jardine, K.J., Jardine, A.B., Holm, J.A., Lombardozzi, D.L., Negron-Juarez, R.I., Martin, S.T., Beller, H.R., Gimenez, B.O., Higuchi, N., and Chambers, J.Q.: Monoterpene 'thermometer' of tropical forest-atmosphere response to climate warming, Plant Cell Environ., 40, 441–452, doi: 10.1111/pce.12879, 2017.

Jokinen, T., Berndt, T., Makkonen, R., Kerminen, V.-M., Junninen, H., Paasonen, P., Stratmann, F., Herrmann, H., Guenther, A.B., Worsnop, D.R., Kulmala, M., Ehn, M., and Sipilä, M.: Production of extremely low volatile organic compounds from biogenic emissions: Measured yields and atmospheric implications, P. Natl. Acad. Sci. USA, 112, 7123–7128, doi: 10.1073/pnas.1423977112, 2015.

Kane, S.M., Caloz, F., and Leu, M.-T.: Heterogeneous uptake of gaseous N_2O_5 by $(NH_4)_2SO_4$, NH_4HSO_4, and H_2SO_4 aerosols, J. Phys. Chem. A, 105, 6465–6470, doi: 10.1021/jp010490x , 2001.

Kelly, J.M., Doherty, R.M., O'Connor, F., and Mann, G.W.: The impact of biogenic, anthropogenic, and biomass burning volatile organic compound emissions on regional and seasonal variations in secondary organic aerosol, Atmos. Chem. Phys., 18, 7393–7422, doi: 10.5194/acp-18-7393-2018, 2018.

Klinger, L.F., Li, Q.-J., Guenther, A.B., Greenberg, J.P., Baker, B., and Bai, J.-H.: Assessment of volatile organic compound emissions from ecosystems of China, J. Geophys. Res.-Atmos., 107, 4603, doi: 10.1029/2001JD001076, 2002.

Knote, C., Tuccella, P., Curci, G., Emmons, L., Orlando, J. J., Madronich, S., Baró, R., Jiménez-Guerrero, P., Luecken, D., Hogrefe, C., Forkel, R., Werhahn, J., Hirtl, M., Perez, J. L., San José, R., Giordano, L., Brunner, D., Yahya, K., and Zhang, Y.: Influence of the choice of gas-phase

mechanism on predictions of key gaseous pollutants during the AQMEII phase-2 intercomparison, Atmos. Environ., 115, 553–568, doi: 10.1016/j.atmosenv.2014.11.066, 2015.

Koch, D., Schmidt, G.A., and Field, C.V.: Sulfur, sea salt, and radionuclide aerosols in GISS ModelE, J. Geophys. Res., 111, D06206, doi: 10.1029/2004JD005550, 2006.

Koplitz, S.N., Mickley, L.J., Marlier, M.E., Buonocore, J.J., Kim, P.S., Liu, T., Sulprizio, M.P., DeFries, R.S., Jacob, D.J., Schwartz, J., Pongsiri, M., and Myers, S.S.: Public health impacts of the severe haze in Equatorial Asia in September–October 2015: Demonstration of a new framework for informing fire management strategies to reduce downwind smoke exposure, Environ. Res. Lett., 11, 094023, doi: 10.1088/1748-9326/11/9/094023, 2016.

Kotchenruther, R.A., Jaffe, D.A., and Jaeglé, L.: Ozone photochemistry and the role of peroxyacetyl nitrate in the springtime northeastern Pacific troposphere: Results from the Photochemical Ozone Budget of the Eastern North Pacific Atmosphere (PHOBEA) campaign, J. Geophys. Res., 106, 28,731–28,742, doi: 10.1029/2000JD000060, 2001.

Kroll, J.H., Ng, N.L., Murphy, S.M., Flagan, R.C., and Seinfeld, J.H.: Secondary organic aerosol formation from isoprene photooxidation under high-NO_X conditions, Geophys. Res. Lett., 32, L18808, doi: 10.1029/2005GL023637, 2005.

Lacis, A.A., Wuebbles, D.J., and Logan, J.A.: Radiative forcing of climate by changes in the vertical distribution of ozone, J. Geophys. Res., 95, 9971–9981, doi: 10.1029/JD095iD07p09971, 1990.

Lamarque, J.-F., Bond, T.C., Eyring, V., Granier, C., Heil, A., Klimont, Z., Lee, D., Liousse, C., Mieville, A., Owen, B., Schultz, M.G., Shindell, D., Smith, S.J., Stehfest, E., Van Aardenne, J., Cooper, O.R., Kainuma, M., Mahowald, N., McConnell, J.R., Naik, V., Riahi, K., and van Vuuren, D.P.: Historical (1850–2000) gridded anthropogenic and biomass burning emissions of reactive gases and aerosols: methodology and application, Atmos. Chem. Phys., 10, 7017–7039, doi: 10.5194/acp-10-7017-2010, 2010.

Langford, B., Misztal, P.K., Nemitz, E., Davison, B., Helfter, C., Pugh, T.A.M., MacKenzie, A.R., Lim, S.F., and Hewitt, C.N.: Fluxes and concentrations of volatile organic compounds from a South-East Asian tropical rainforest, Atmos. Chem. Phys., 10, 8391–8412, doi: 10.5194/acp-10-8391-2010, 2010.

Lathière, J., Hauglustaine, D.A., Friend, A.D., De Noblet-Ducoudré, N., Viovy, N., and Folberth, G.A.: Impact of climate variability and land use changes on global biogenic volatile organic compound emissions, Atmos. Chem. Phys., 6, 2129–2146, doi: 10.5194/acp-6-2129-2006, 2006.

Malaysian Palm Oil Board (MPOB), Economics and Industry Development Division, Statistics: bepi.mpob.gov.my, accessed: 25 August 2018.

Margono, B.A., Potapov, P.V., Turubanova, S., Stolle, F., and Hansen, M.C.: Primary forest cover loss in Indonesia over 2000–2012, Nat. Clim. Change, 4, 730–735, doi: 10.1038/nclimate2277, 2014.

McPeters, R., Kroon, M., Labow, G., Brinksma, E., Balis, D., Petropavlovskikh, I., Veefkind, J., Bhartia, P., and Levelt, P.: Validation of the aura ozone monitoring instrument total column ozone product, J. Geophys. Res.-Atmos., 113, D15S14, doi:10.1029/2007JD008802, 2008.

Miettinen, J., Hooijer, A., Vernimmen, R., Liew, S.C., and Page, S.E.: From carbon sink to carbon source: Extensive peat oxidation in insular Southeast Asia since 1990, Environ. Res. Lett., 12, 024014, doi: 10.1088/1748-9326/aa5b6f, 2017.

Misztal, P.K., Nemitz, E., Langford, B., Di Marco, C.F., Phillips, G.J., Hewitt, C.N., MacKenzie, A.R., Owen, S.M., Fowler, D., Heal, M.R., and Cape, J.N.: Direct ecosystem fluxes of volatile organic compounds from oil palms in South-East Asia, Atmos. Chem. Phys., 11, 8995–9017, doi: 10.5194/acp-11-8995-2011, 2011.

Moxim, W.J., Levy II, H., and Kasibhatla, P.S.: Simulated global tropospheric PAN: Its transport and impact on NOx, J. Geophys. Res., 101, 12,621–12,638, doi: 10.1029/96JD00338, 1996.

Myhre, G., Shindell, D., Bréon, F.-M., Collins, W., Fuglestvedt, J., Huang, J., Koch, D., Lamarque, J.-F., Lee, D., Mendoza, B., Nakajima, T., Robock, A., Stephens, G., Takemura, T., and Zhang, H.: Anthropogenic and natural radiative forcing, in: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, edited by: Stocker, T.F., Qin, D., Plattner, G.-K., Tignor, M., Allen, S.K., Boschung, J., Nauels, A., Xia, Y., Bex, V., and Midgley, P.M., Cambridge University Press, Cambridge, United Kingdom and New York, 2013.

Page, S.E., Siegert, F., Rieley, J.O., Boehm, H.-D.V., Jaya, A., and Limin, S.: The amount of carbon released from peat and forest fires in Indonesia during 1997, Nature, 420, 61–65, doi: 10.1038/nature01131, 2002.

Rap, A., Scott, C.E., Reddington, C.L., Mercado, L., Ellis, R.J., Garraway, S., Evans, M.J., Beerling, D.J., MacKenzie, A.R., Hewitt, C.N., and Spracklen, D.V.: Enhanced global primary production by biogenic aerosol via diffuse radiation fertilization, Nat. Geosci., et al., Nat Geoscience, doi: 10.1038/s41561-018-0208-3, 2018.

Schmidt, G.A., Kelley, M., Nazarenko, L., Ruedy, R., Russell, G.L., Aleinov, I., Bauer, M., Bauer, S.E., Bhat, M.K., Bleck, R., Canuto, V., Chen, Y.-H., Cheng, Y., Clune, T.L., Del Genio, A., de Fainchtein, R., Faluvegi, G., Hansen, J.E., Healy, R.J., Kiang, N.Y., Koch, D., Lacis, A.A., LeGrande, A.N., Lerner, J., Lo, K.K., Matthews, E.E., Menon, S., Miller, R.L., Oinas, V., Oloso, A.O., Perlwitz, J.P., Puma, M.J., Putman, W.M., Rind, D., Romanou, A., Sato, M., Shindell, D.T., Sun, S., Syed, R.A., Tausnev, N., Tsigaridis, K., Unger, N., Voulgarakis, A., Yao, M.-S., and Zhang, J.:

Configuration and assessment of the GISS ModelE2 contributions to the CMIP5 archive, J. Adv. Model. Earth Sy., 6, 141–184, doi: 10.1002/2013MS000265, 2014.

Schultz, M.G., Heil, A., Hoelzemann, J.J., Spessa, A., Thonicke, K., Goldammer, J.G., Held, A.C., Pereira, J.M.C., and van het Bolscher, M.: Global wildland fire emissions from 1960 to 2000, Global Biogeochem. Cy., 22, GB2002, doi: 10.1029/2007GB003031, 2008.

Scott, C.E., Arnold, S.R., Monks, S.A., Asmi, A., Paasonen, P., and Spracklen, D.V.: Substantial large-scale feedbacks between natural aerosols and climate, Nat Geoscience, 11, 44–48, doi: 10.1038/s41561-017-0020-5, 2018.

Scott, C.E., Monks, S.A., Spracklen, D.V., Arnold, S.R., Forster, P.M., Rap, A., Äijälä, M., Artaxo, P., Carslaw, K.S., Chipperfield, M.P., Ehn, M., Gilardoni, S., Heikkinen, L., Kulmala, M., Petäjä, T., Reddington, C.L.S., Rizzo, L.V., Swietlicki, E., Vignati, E., and Wilson, C.: Impact on short-lived climate forcers increases projected warming due to deforestation, Nat. Commun., 9:157, 1–9, doi: 10.1038/s41467-017-02412-4, 2018.

Scott, C.E., Monks, S.A., Spracklen, D.V., Arnold, S.R., Forster, P.M., Rap, A., Carslaw, K.S., Chipperfield, M.P., Reddington, C.L.S., and Wilson, C.: Impact on short-lived climate forcers (SLCFs) from a realistic land-use change scenario via changes in biogenic emissions, Faraday Discuss., 200, 101–120, doi: 10.1039/c7fd00028f, 2017.

Shindell, D.T., Faluvegi, G., and Bell, N.: Preindustrial-to-present-day radiative forcing by tropospheric ozone from improved simulations with the GISS chemistry-climate GCM, Atmos. Chem. Phys., 3, 1675–1702, doi: 10.5194/acp-3-1675-2003, 2003.

Shindell, D.T., Faluvegi, G., Unger, N., Aguilar, E., Schmidt, G.A., Koch, D.M., Bauer, S.E., and Miller, R.L.: Simulations of preindustrial, present-day, and 2100 conditions in the NASA GISS composition and climate model G-PUCCINI, Atmos. Chem. Phys., 6, 4427–4459, doi: 10.5194/acp-6-4427-2006, 2006.

Shindell, D.T., Pechony, O., Voulgarakis, A., Faluvegi, G., Nazarenko, L., Lamarque, J.-F., Bowman, K., Milly, G., Kovari, B., Ruedy, R., and Schmidt, G.A.: Interactive ozone and methane chemistry in GISS-E2 historical and future climate simulations, Atmos. Chem. Phys., 13, 2653–2689, doi: 10.5194/acp-13-2653-2013, 2013.

Silva, S.J., Heald, C.L., Geddes, J.A., Austin, K.G., Kasibhatla, P.S., and Marlier, M.E.: Impacts of current and projected oil palm plantation expansion on air quality over Southeast Asia, Atmos. Chem. Phys., 16, 10621–10635, doi: 10.5194/acp-16-10621-2016, 2016.

Sodhi, N.S., Koh, L.P., Brook, B.W., and Ng, P.K.L.: Southeast Asian biodiversity: An impending disaster, Trends Ecol. Evol., 19, 654–660, doi: 10.1016/j.tree.2004.09.006, 2004.

Stavrakou, T., Müller, J.-F., Bauwens, M., De Smedt, I., Van Roozendael, M., Guenther, A., Wild, M., and Xia, X.: Isoprene emissions over Asia 1979-2012: Impact of climate and land-use changes, Atmos. Chem. Phys., 14, 4587–4605, doi: 10.5194/acp-14-4587-2014, 2014.

Stockwell, W.R., Kirchner, F., Kuhn, M., and Seefeld, S.: A new mechanism for regional atmospheric chemistry modeling, J. Geophys. Res., 102, 25,847–25,879, doi: 10.1029/97JD00849, 1997.

Surratt, J.D., Chan, A.W.H., Eddingsaas, N.C., Chan, M., Loza, C.L., Kwan, A.J., Hersey, S.P., Flagan, R.C., Wennberg, P.O., and Seinfeld, J.H.: Reactive intermediates revealed in secondary organic aerosol formation from isoprene, P. Natl. Acad. Sci. USA, 107, 6640–6645, doi: 10.1073/pnas.0911114107, 2010.

Thompson, A.M., Tao, W.-K., Pickering, K.E., Scala, J.R., and Simpson, J.: Tropical deep convection and ozone formation, B. Am. Meteorol. Soc., 78, 1043–1054, doi: 10.1175/1520-0477(1997)078<1043:TDCAOF>2.0.CO;2, 1997.

Tilmes, S., Lamarque, J.-F., Emmons, L.K., Conley, A., Schultz, M.G., Saunois, M., Thouret, V., Thompson, A.M., Oltmans, S.J., Johnson, B., and Tarasick, D.: Technical Note: Ozonesonde climatology between 1995 and 2011: Description, evaluation and applications, Atmos. Chem. Phys., 12, 7475–7497, doi: 10.5194/acp-12-7475-2012, 2012.

Tsigaridis, K., Daskalakis, N., Kanakidou, M., Adams, P.J., Artaxo, P., Bahadur, R., Balkanski, Y., Bauer, S.E., Bellouin, N., Benedetti, A., Bergman, T., Berntsen, T.K., Beukes, J.P., Bian, H., Carslaw, K.S., Chin, M., Curci, G., Diehl, T., Easter, R.C., Ghan, S.J., Gong, S.L., Hodzic, A., Hoyle, C.R., Iversen, T., Jathar, S., Jimenez, J.L., Kaiser, J.W., Kirkevåg, A., Koch, D., Kokkola, H., Lee, Y.H., Lin, G., Liu, X., Luo, G., Ma, X., Mann, G.W., Mihalopoulos, N., Morcrette, J.-J., Müller, J.-F., Myhre, G., Myriokefalitakis, S., Ng, N.L., O'Donnell, D., Penner, J.E., Pozzoli, L., Pringle, K.J., Russell, L.M., Schulz, M., Sciare, J., Seland, Ø., Shindell, D.T., Sillman, S., Skeie, R. B., Spracklen, D., Stavrakou, T., Steenrod, S.D., Takemura, T., Tiitta, P.,Tilmes, S., Tost, H., van Noije, T., van Zyl, P.G., von Salzen, K., Yu, F., Wang, Z., Wang, Z., Zaveri, R. A., Zhang, H., Zhang, K., Zhang, Q., and Zhang, X.: The AeroCom evaluation and intercomparison of organic aerosol in global models, Atmos. Chem. Phys, 14, 10845–10895, doi: 10.5194/acp-14-10845-2014, 2014.

Tsigaridis, K. and Kanakidou, M.: Secondary organic aerosol importance in the future atmosphere, Atmos. Environ., 41, 4682–4692, doi: 10.1016/j.atmosenv.2007.03.045, 2007.

Turnock, S.T., Wild, O., Dentener, F.J., Davila, Y., Emmons, L.K., Flemming, J., Folberth, G.A., Henze, D.K., Jonson, J.E., Keating, T.J., Kengo, S., Lin, M., Lund, M., Tilmes, S., and O'Connor, F.M.: The impact of future emission policies on tropospheric ozone using a parameterized approach, Atmos. Chem. Phys., 18, 8953–8978, doi: 10.5194/acp-18-8953-2018, 2018.

Unger, N.: Human land-use-driven reduction of forest volatiles cools global climate, Nat. Clim. Change, 4, 907–910, doi: 10.1038/NCLIMATE2347, 2014a.

Unger, N.: On the role of plant volatiles in anthropogenic global climate change, Geophys. Res. Lett., 41, 8563–8569, doi: 10.1002/2014GL061616, 2014b.

Unger, N., Bond, T.C., Wang, J.S., Koch, D.M., Menon, S., Shindell, D.T., and Bauer, S.: Attribution of climate forcing to economic sectors, P. Natl. Acad. Sci. USA, 107, 3382–3387, doi: 10.1073/pnas.0906548107, 2010.

van der Werf, G.R., Morton, D.C., DeFries, R.S., Olivier, J.G., Kasibhatla, P.S., Jackson, R.B., Collatz, G.J., and Randerson, J.T.: CO2 emissions from forest loss, Nat. Geosci., 2, 737–738, doi: 10.1038/ngeo671, 2009.

van der Werf, G.R., Randerson, J.T., Giglio, L., Collatz, G.J., Kasibhatla, P.S., and Arellano Jr., A.F.: Interannual variability in global biomass burning emissions from 1997 to 2004, Atmos. Chem. Phys., 6, 3423–3441, doi: 10.5194/acp-6-3423-2006, 2006.

Vermeulen, S. and Goad, N.: Towards better practice in smallholder palm oil production, Natural Resource Issues Series (No. 5), International Institute for Environment and Development, London, UK, 2006.

Warwick, N.J., Archibald, A.T., Ashworth, K., Dorsey, J., Edwards, P.M., Heard, D.E., Langford, B., Lee, J., Misztal, P.K., Whalley, L.K., and Pyle, J.A.: A global model study of the impact of land-use change in Borneo on atmospheric composition, Atmos. Chem. Phys., 13, 9183–9194, doi: 10.5194/acp-13-9183-2013, 2013.

Wild, O., Fiore, A.M., Shindell, D.T., Doherty, R.M., Collins, W.J., Dentener, F.J., Schultz, M.G., Gong, S., MacKenzie, I.A., Zeng, G., Hess, P., Duncan, B.N., Bergmann, D.J., Szopa, S., Jonson, J.E., Keating, T.J., and Zuber, A.: Modelling future changes in surface ozone: A parameterized approach, Atmos. Chem. Phys., 12, 2037–2054, doi: 10.5194/acp-12-2037-2012, 2012.

Wolfe, G.M., Kaiser, J., Hanisco, T.F., Keutsch, F.N., de Gouw, J.A., Gilman, J.B., Graus, M., Hatch, C.D., Holloway, J., Horowitz, L.W., Lee, B.H., Lerner, B.M., Lopez-Hilifiker, F., Mao, J., Marvin, M.R., Peischl, J., Pollack, I.B., Roberts, J.M., Ryerson, T.B., Thornton, J.A., Veres, P.R., and Warneke, C.: Formaldehyde production from isoprene oxidation across NOx regimes, Atmos. Chem. Phys., 16, 2597–2610, doi: 10.5194/acp-16-2597-2016, 2016.

Wong, A.Y.H., Tai, A.P.K., and Ip, Y.-Y.: Attribution and statistical parameterization of the sensitivity of surface ozone to changes in leaf area index based on a chemical transport model, J. Geophys. Res.-Atmos., 123, 1883–1898, doi: 10.1002/2017JD027311, 2018.

WRI: CAIT Climate Data Explorer [Electronic database], World Resources Institute, http://cait.wri.org, 2015.

Yu, F.: A secondary organic aerosol formation model considering successive oxidation aging and kinetic condensation of organic compounds: Global scale implications, Atmos. Chem. Phys., 11, 1083–1099, doi: 10.5194/acp-11-1083-2011, 2011.

Zhang, H., Yee, L.D., Lee, B.H., Curtis, M.P., Worton, D.R., Isaacman-VanWertz, G., Offenberg, J.H., Lewandowski, M., Kleindienst, T.E., Beaver, M.R., Holder, A.L., Lonneman, W.A., Docherty, K.S., Jaoui, M., Pye, H.O.T., Hu, W., Day, D.A., Campuzano-Jost, P., Jimenez, J.L., Guo, H., Weber, R.J., de Gouw, J., Koss, A.R., Edgerton, E.S., Brune, W., Mohr, C., Lopez-Hilfiker, F.D., Lutz, A., Kreisberg, N.M., Spielman, S.R., Hering, S.V., Wilson, K.R., Thornton, J.A., and Goldstein, A.H.: Monoterpenes are the largest source of summertime organic aerosol in the southeastern United States, P. Natl. Acad. Sci. USA, 115, 2038–2043, doi: 10.1073/pnas.1717513115, 2018.