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Geoscientific Model Development Discussions

Interactive comment on "Systematic bias in evaluating chemical transport models with maximum daily 8-hour average (MDA8) surface ozone for air quality applications" *by* Katherine R. Travis and Daniel J. Jacob

Anonymous Referee #3

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Review of "Systematic bias in evaluating chemical transport models with maximum daily 8-hour average (MDA8) surface ozone for air quality applications" by Travis and Jacob.

This manuscript documents several contributors to model biases in a commonly used metric for ozone air quality (MDA8), and proposes several short-term and long-term methods for addressing this bias. While this paper focuses exclusively on a single model, biases in MDA8 ozone over the region and season studied (the Southeast US during summer/fall) is a pervasive problem in many current atmospheric chemistry

models. Presumably, this same issue would affect model-observation comparisons in other regions and seasons, as well.

The main conclusions of the study are that the biases arise from: (1) diagnostic mismatch of sampling altitudes between model and observations, (2) failure of model to produce sufficiently low ozone concentrations under rainy conditions, and (3) poor representation in the model of the diurnal cycle in boundary layer mixing and in stomatal conductance. Of these issues, (1) is the most straightforward to address, and the paper suggests an approach to diagnose more accurately the simulated ozone concentration at the altitude of the observations. This is a good recommendation that should be considered for adoption in other air quality modeling studies. The mechanisms responsible for issue (2) are not adequately addressed in the paper. The focus in the paper is on increased vertical stability resulting from evaporative cooling, but an alternative hypothesis of increased (non-stomatal) deposition of ozone under wet conditions is not adequately explored. Finally, the paper proposed to address issue (3) by focusing comparisons on afternoon ozone values rather than MDA8 in the short term, and by improving the representation of boundary layers (and presumably stomatal conductance) in the longer term.

This paper, with sufficient revisions, could provide a useful contribution to the literature and would help to address a long-standing bias of atmospheric chemistry models in simulating surface ozone. Specific comments and suggestions are included below.

1. Introduction

page 2, lines 6-7 – Mention that the use of MDA8 for comparisons between models and observations was intended to remove (some of) the known biases in the simulation of nighttime ozone, as opposed to comparing 24-hour averages.

2. Comparing simulations of mixed layer and MDA8 surface ozone

p.3, l. 9 – Is this different from how local solar time is treated in the observations?

p.3, l.14 – Add "sampled at lowest model grid level (zm=65m AGL)" here.

3. Correcting for surface layer gradients

p.4, l.5 – Not really a "correction." Instead, it is a transfer function from z=65m to z=10m.

4. Segregating rainy conditions

p.4, l. 14-16 – But, this doesn't establish that transport from GoM to SE US is correct in model (e.g., nighttime low-level jet).

p.4, l. 19-23 – How similar are the dates diagnosed as rainy/dry in the model vs obs? That is, how well does the model simulate daily variability of precipitation?

p.4, l.27 – Add "increased" before "vertical stratification."

p.4, l.27-29 – See also Clifton et al. (2017), who say:

Recent field-based evidence suggests that nonstomatal processes include ... aqueous chemical reactions on vegetation and soil [Fowler et al., 2009; Ganzeveld et al., 2015; Fumagalli et al., 2016].

p.4, l. 27-29 and elsewhere – Need more description of GC dry deposition scheme. In particular, how does dry deposition velocity respond to moisture (incl. rainfall, soil moisture, dew on leaves, relative humidity, vapor pressure deficit)? Are there potentially missing processes that could increase ozone deposition velocities under wet conditions?

5. Accounting for diurnal bias

p.5, l.6 – Or other large NOx emission sources?

p.5, l. 8-12 – Couldn't this also result from (excessive) mixing of ozone from throughout the first model grid level down to the surface. The rescaling to 10-m values wouldn't correct for this. Also, how valid are the assumption used in this rescalaing under stable nighttime conditions?

p.5, l. 11-12 – Explain what drive the (diurnal) variations in stomatal conductance in GC.

6. Implications

p.6, l.15 – Add "(e.g., non-stomatal dry deposition pathways)" here.

p.6, l.15-16 – Is the evening bias in models due exclusively to errors in vertical mixing, or could errors in the timing of the shutdown of stomatal conductance also play a role?

p.6, l. 17-18 – Is better near-surface vertical resolution in models needed?

p.6, l.22 – Not discussing predictions elsewhere in paper. Change "predicted with confidence" to "simulated more accurately."

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