

## 1. Comments from referees

**RC2: *Interactive comment on "Designing global climate and atmospheric chemistry simulations for 1 km and 10, diameter asteroid impacts using the properties of ejecta from the K-Pg impact" by Owen B. Toon et al.***

### Anonymous Referee #1

#### 1 General comments

The paper contains a comprehensive review of material relevant to study the impact of asteroid strikes on the atmosphere of the Earth. It considers particulates of all scales released or formed during or after the collision including huge amounts of soot from ignited biomass which severely perturbs the radiation budget of the Earth, but also gases like halogens and sulfur perturbing atmospheric chemistry. This includes gases and particles released during a marine impact. The tables provide data to be used for simulations with comprehensive chemistry climate models. First simulations have been performed by one of the authors using a state of the art model. The paper should be published in ACP after some minor corrections.

#### 2 Specific comments

Sometimes the word "atmosphere" can be misleading. I suppose in line 414 troposphere is meant.

The sections 2.4.1.2 and 2.4.1.3 are difficult to understand because references are messed up or not listed. At the beginning of section 2.4.1.3 (line 836) this even leads to a sentence containing nonsense.

In general, some references are cited too often, sometimes words like "they" or "the latter" would be better.

Section 4 might be slightly shortened since it contains too many details discussed earlier. Better give a reference to WACCM at the end.

#### 3 Technical corrections

Several citations have to be corrected because "et al" is missing or the paper is not listed or the author misspelled (lines 90, 310, 790, 830, 1085, 1096, 1104, 1213, 1328, 1332, 1335).

Typos in lines 792, 837(?), 879, 948, 1067, 1091, 1332, 1456, Table 5. Insert "their" in line 418 before "Figure".

Something is missing in line 265.

I cannot find Hervig et al (2006), line 561, 588, 1698. Should it be Hervig et al (2009)? C2

Gulik et al (2008) is not cited.

Please complete citation in Table 1. Also better say there "< 1  $\mu\text{m}$ ". Improve caption or first 2 rows of Table 2 concerning units and scale factor. Ambient values or burden?

Table 3, row 2: total amount and column density?

Table 2 and 4: The footnotes concerning CO<sub>2</sub> should be the same.

## 2. Authors' response

We appreciate the time that the reviewers spent reading our manuscript and providing valuable suggestions for improving the paper.

Reviewer RC2, General comments. Thank you for the synopsis. We don't see any corrections that are needed from the general comments.

Reviewer RC2, Specific comments:

**The reviewer's comment is listed and then our response is given in underlined italics.**

Sometimes the word "atmosphere" can be misleading. I suppose in line 414 troposphere is meant.

*Yes, thank you, troposphere is what we meant.*

The sections 2.4.1.2 and 2.4.1.3 are difficult to understand because references are messed up or not listed.

*We altered a number of sentences in these sections to add references or clarify the discussion.*

At the beginning of section 2.4.1.3 (line 836) this even leads to a sentence containing nonsense.

*We have corrected the line 836 as follows:*

*The new application of the Pope (2002) approach leads to estimated submicron dust emissions that are about 500 times larger than the one derived by Pope (2002). The major difference is that we have assumed the ratio of quartz to clastics is about 1000, rather than 1 as assumed by Pope (2002).*

In general, some references are cited too often, sometimes words like "they" or "the latter" would be better.

*We were not able to identify where to make these changes. We would be happy to make additional changes if the reviewer could specify the passages that would benefit from revision.*

Section 4 might be slightly shortened since it contains too many details discussed earlier.

We have not changed this section since some readers may read it without looking at the rest of the paper. It was also not clear to us what the reviewer would like to see changed.

Better give a reference to WACCM at the end.

We added:

We recently completed such simulations using the Whole Atmosphere Community Climate Model (WACCM) at the National Center for Atmospheric Research in a configuration similar to that used by Bardeen et al. (2008) and Mills et al. (2014).

### **3 Technical corrections**

Several citations have to be corrected because "et al" is missing or the paper is not listed or the author misspelled (lines 90, 310, 790, 830, 1085, 1096, 1104, 1213, 1328, 1332, 1335).

Thank you for noting these errors. We corrected them.

Typos in lines 792, 837(?), 879, 948, 1067, 1091, 1332, 1456, Table 5. Insert "their" in line 418 before "Figure".

Something is missing in line 265.

Thank you for noting these errors. We corrected them.

I cannot find Hervig et al (2006), line 561, 588, 1698. Should it be Hervig et al (2009)? C2

Yes, these should be (2009)

Gulik et al (2008) is not cited.

Thank you. This reference was not needed and has been removed.

Please complete citation in Table 1.

We assume this comment refers to the missing date in Orofino, which has been added.

Also better say there "< 1  $\mu\text{m}$ ".

1 $\mu\text{m}$  is correct, this is a value needed for a rough calculation. We added the following at line 187

Particles smaller than 1 $\mu\text{m}$  would lead to a larger optical depth than given in Tables 1 and 3.

Improve caption or first 2 rows of Table 2 concerning units and scale factor. Ambient values or burden?

*We clarified the captions. Ambient burdens.*

Table 3, row 2: total amount and column density?

*We clarified the captions. Ambient burdens.*

Table 2 and 4: The footnotes concerning CO<sub>2</sub> should be the same.

*Corrected*

In addition to these responses to the Reviewers' comments, we have also added material to the paper to update some numbers based on the work of Wolbach et al. (1990b). These reduce the magnitude of the soot emissions from Wolbach et al. (1988) by about 10% based on adding new data sets. We also slightly revised Table 1, to clarify the amount of soot that should be injected near the tropopause. This information was previously given in the text, but might have been missed by the reader. Finally, we added a few comments about a recent paper by Kaiho et al. (2016) who derived much different soot values than Wolbach et al. (1988, 1990b).