

Reply to the referee comments on the paper “Anthropogenic changes in the surface all-sky UV-B radiation through 1850–2005 simulated by an Earth system model” by S. Watanabe et al.

Dear Referee #1,

We would like to thank you for providing encouraging and constructive comments on our paper. In the following our response to the comments are underlined and revisions we have made are highlighted.

Sincerely,

Shingo Watanabe

1. Page 4226, lines 5-9. How valid is the linear approximation? It is easy to imagine changes in GHG affecting the aerosol, or changes in aerosol affecting the ozone

We think it is a really good question and is difficult to answer. For example, as you pointed out, changes in GHGs including ozone and methane eventually affect sulfur chemistry and change distributions of sulfate aerosols with natural origins, e.g., DMS. This kind of indirect effect violates the linear approximation we assumed in this paper, that is, $AERO = HIST - GHGo$. In such a case, ‘GHGo’ includes effects of aerosol changes on UV due to GHG changes. Obviously the degree of violation of the linear approximation depends on the place and time, and further decomposition studies may be needed to clarify this issue. However, we believe that anthropogenic increases in emissions of aerosol precursors, e.g., sulfur dioxide, strongly overwhelm this kind of effect, and the linear approximation generally holds.

We have added a brief comment on this issue to the text.

2. The distinction between clear-sky and all-sky is unclear and confusing. I understand you are showing the “contributions of clear-sky part (Fig. 3d–f) and cloud forcing (Fig. 3g–i) to the all-sky UV-B changes”, but I find the repeated mentioning of all-sky UV confusing. The text always refers to the all-sky UV-B change, even when discussing clear-sky processes such as ozone. Is the all-sky adjective really needed? I think it would be more accurate to say clear-sky UV when discussing clear-sky processes. I’m not sure what to call the cloud forcing component.

We have revised the text following your suggestion. (We have omitted the repeating “all-sky”.)