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Atmospheric Chemistry and Physics Discussions

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Interactive comment

Interactive comment on "Sulfate Geoengineering Impact on Methane Transport and Lifetime: Results from the Geoengineering Model Intercomparison Project (GeoMIP)" *by* Daniele Visioni et al.

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The manuscript acp-2017-593 proposed by D. Visioni et al, is very interesting and deserves publication.

Nonetheless the reader might feel that some important starting hypothesis to their study is missing and should be clearly indicated.

As a matter of fact, as it is written, the manuscript lets us make the assumption that the authors only considered the effects on the newly injected sulphates in the stratosphere

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Discussion paper

by the SRM technology, without taking into consideration the current tropospheric anthropogenic emissions of SO2 and their future evolution during the period in consideration.

First, we think that, with the assumption that current anthropogenic sulphur tropospheric emissions stay stable during all the period of this study, adding extra-sulphate emissions in the stratosphere would probably increase its global deposition more evenly distributed worldwide than current tropospheric emissions. Under sulphate SRM some wetlands that previously receive low amounts or did not receive tropospheric sulphates will receive (more) sulphates, and it is known that sulphate in acid rain suppresses methane emissions from natural freshwater wetlands (Gauci et al, 2008, J. Geophys. Res.), rice paddies, peat lands and other terrestrial landscapes (Oeste and al, 2107, ESD), which are the biggest methane emitters as the authors noted in table 7 of their manuscript; thus CH4 emissions reduction will occur.

Also, it is known that under a global warming (without sulphur SRM), warmer temperatures and increased rainfall in some regions will increase CH4 emissions. Under the cooling SRM scenarios envisioned by the authors (first column of figure 18 of page 30), the reverse should occur.

Two new columns in figure 18 can be added as follows:

Increase in planetary albedo => surface cooling => lower temperatures => lower CH4 emissions => lower CH4 atmospheric concentration => shorter CH4 lifetime

Increase in planetary albedo => surface cooling => lower rain fall => smaller wetlands area => lower CH4 emissions => lower CH4 atmospheric concentration => shorter CH4 lifetime

We believe the above mentioned assumption (current anthropogenic sulphur tropospheric emissions stay stable during all the studied period) should be stated in this manuscript, as:

a) current tropospheric sulphur anthropogenic emissions are and order of magnitude larger than the ones envisioned by the authors for stratospheric SRM;

b) since China's SO2 emissions started decreasing, the current trend is to a global decrease of tropospheric sulphur anthropogenic emissions (Klimont et al, 2013, Environ. Res. Lett.);

c) estimates of the amounts of sulphur pollution needed to reduce CH4 emissions of the total wetland source have been made (Gauci et al, 2004, PNAS). .

Second, the "clathrate gun hypothesis" has been debated by the scientific community as under a warming world, increased emissions from permafrost and/or from methane hydrates destabilisation is a risk. Recent work (Kohnert et al , 2017, Sci. Rep.) suggests that a new pathway of CH4 emissions exist and that it may increase if ongoing permafrost thaw continues. Under the cooling SRM scenarios envisioned by the authors the reverse should occur.

One new column in figure 18 page 30 can be added as follows: Increase in planetary albedo => surface cooling => lower temperatures => lower CH4 emissions by permafrost => lower CH4 atmospheric concentration => shorter CH4 lifetime. .

Third, we agree that the OH radical sink for CH4 is the most important in the troposphere, but it is known than the chlorine radical sink for CH4 is not only important in the stratosphere, but also occurs in the troposphere (Oeste and al, 2107, ESD), where it represents 3-5% of the CH4 removal. Variations in the tropospheric acidity may change the importance of the chlorine sink for methane. With the assumption that current anthropogenic sulphur tropospheric emissions stay stable during all the period of the author's study, adding extra-sulphate emissions in the stratosphere would probably increase the tropospheric Cl content, and, as the kinetics of the reaction of Cl radical with alkanes (including methane) are an order of magnitude larger than with the OH radical, thus the chlorine radical sink for CH4 will increase.

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Discussion paper

One new column and a new line in figure 18 page 30 can be added as follows: Increase in sulphur emissions => increased tropospheric acidity => more HCl increased Cl radical sink for CH4 => more Cl => lower CH4 lifetime

We believe that the authors should add in their manuscript that they made the assumption that this second CH4 sink (the Cl radiacal) is assumed to stay constant in their model.

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