Review of Caram et al., 2022

Caram et al report results from the LMDZ-INCA model after adding tropospheric reactive halogen chemistry. The chemical mechanism mainly includes gas-phase chemistry, and thus lacks some heterogeneous chemistry that has been demonstrated to be important for reactive halogen production and loss. Nonetheless, this represents an important step forward for a global chemistry-climate model. Tropospheric reactive halogens have been shown to be an important lever for controlling the oxidation capacity of the atmosphere, so chemistry models should include this chemistry. The chemistry is complex and has large impacts on ozone, making it a somewhat scary endeavor. Thus, I commend the authors for taking this step forward in their model.

They mainly compare their model with other models that have a more complex representation of tropospheric reactive halogen chemistry, CAM-Chem and GEOS-Chem. Despite lacking important heterogeneous chemistry, their model agrees reasonably well with these other models, with some discrepancies that they attempt to explain. Results comparing preindustrial and industrial simulations and the impact of reactive halogen chemistry during these two time periods also is similar to these other models.

My main suggestions are to clarify the chemistry that is included in their model. Specific examples are listed below:

- In Figure 1, does “chlorine contribution to bromine recycling” indicate the three reactions above this statement, or other reactions? If the latter, which reactions are these? Are they in Table 5?
- Also in Figure 1, “heterogeneous reactions of bromine on sea salt and sulfate aerosols” is stated, but it would be helpful to refer to specific reactions in the tables. I don’t see these reactions in Table 5.
- Table 5 lists the reaction probability for heterogeneous reactions. The reaction probability formulation is typically used for first order reactions, but some reactions listed here are second order, so I’m confused. More detail is needed on how the reaction probability is used for these second-order reactions.
- Sea salt chloride is emitted at HCl. Why is sea salt bromide not emitted as HBr? Sea-salt bromide is the largest primary source of bromine to the troposphere.
- Figure 5 says that reactive bromine is produced from N2O5, but I don’t see this reaction in Table 5.
- It is mentioned in the text that N2O5 does not produce ClNO2, but this is inconsistent with Table 5.