Greenhouse effect caused by impact-induced CO

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Impacts of large asteroids and comets on the Earth induce the release of a huge amount of climatically active gases from the impacting body and crustal material under very high temperature and pressure condition. The released gases significantly affect the global environment and the biosphere through global warming, sunlight shielding and acid rain, for example. Here, we focused on the impacts on a carbonate layer which is common on the Earth. Previous studies assumed that impact-induced gas from carbonate is wholly CO_2 [e.g. O'Keefe and Ahrens, 1989]. However, this assumption is doubtful because there is no secure experimental support. Indeed, there is a prospect that the gas from carbonate contains CO which is stable under high temperature and pressure condition. Thus, we should consider the climatic effect from not only CO_2 but also CO.

If CO is generated, methane and tropospheric ozone abundances could increase through atmospheric chemical reactions. Both methane and tropospheric ozone have strong greenhouse effects. Consequently, CO may have indirect radiative forcing through the production of methane and ozone, although CO itself has little direct radiative forcing.

One of the significant points is which (CO or CO_2) is more effective for global warming. Then we developed an atmospheric chemistry model in order to estimate the indirect radiative forcing of CO. In our tropospheric one box model, we considered the generation of CO and NO by an impact. Impact-induced CO might be lofted to the stratosphere and mesosphere accompanied with the impact vapor plume. At the same time, NO might be generated through the shock heating of the atmosphere by the reentering ejecta above 50km [Zahnle, 1990]. Consequently, the stratosphere and mesosphere might become CO and NO-rich globally. We assumed that these gases were transported into the troposphere by vertical mixing in 3-5 years. The amount of impact-induced CO and NO were varied as parameters.

With these assumptions, we conducted the calculations and derived the increases of methane and ozone abundances. Using these results, we estimated the indirect radiative forcing of CO and compared with that of CO_2. The results show that CO has a short-term (3-5years) radiative forcing and the strength is 3-10 times larger than that of CO_2. Hence, when we consider the climatic effects due to impact-induced gases from carbonate, it is very crucial problem whether the gas is CO or CO_2. Our next step is to perform impact-degassing experiments using calcite which is a representative mineral in a carbonate, and to analyze the composition (CO or CO_2) of the gas.