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Sensitivity of future ozone recovery to major explosive volcanic eruptions

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Large volcanic eruptions of magnitude comparable to that of Mt. Pinatubo (June 1991) occuring in the next 50 years may impact the ozone recovery process. Outside the polar regions, the primary effect of an increased rate of heterogeneous reactions on sulphuric acid aerosols is to cause a reduction of nitrogen oxides. In the current high-chlorine conditions, this causes an increase in reactive EESC and in ozone depletion, as seen after the eruption of Mt. Pinatubo. A major volcanic eruption within the next decades, when there will still be significant amounts of EESCs in the stratosphere, may lead to an increase in ozone destruction and a temporary delay in ozone recovery. However, going towards low clorine and bromine conditions, the heterogeneous chemical impact of future large explosive volcanic eruptions is expected to be smaller than in the Pinatubo case and may even lead to an ozone increase, due to suppressing of nitrogen oxides. The large amount of sulphuric acid aerosols injected above the tropopause is also responsible of a stratospheric heating, due to both solar-NIR and planetary radiation absorption by the particles. In addition, scattering of the incoming solar radiation by volcanic aerosol produces a significant surface cooling.
The ULAQ-CCM includes a module for aerosol formation and growth with on-line interaction with the chemistry module, which takes into account the volcanic perturbations to SOx species. This allows an interactive calculation of the radiative and climate perturbations from the volcanic aerosols, other than the heterogeneous impact. To assess all these perturbations the CCM has been run for three scenarios:
1) reference case without future volcanic episodes (2000-2050);
2) two Pinatubo-like episodes (2025 and 2035) with no radiative impact of the volcanic aerosols on climate and on stratospheric circulation;
3) as in case (2), but with full chemistry-climate coupled impact of volcanic aerosols.
The resulting effects on future O3 and stratospheric dynamics are analyzed and discussed.