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Global temperature response to century-scale degassing from the Siberian Traps Large Igneous Province

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The Siberian Traps Large igneous province is the main player in the end-Permian extinction and climatic change, likely triggered by degassing from the province and the sedimentary basins heated during magma emplacement. Although the specific degassing scenarios from the province are debated, this implies that gas release on the timescale equivalent to the cooling of lava flows and subvolcanic intrusions must have been sufficient to affect the atmospheric chemistry. Here we test this assumption by focussing on degassing of CO_2 and CH4 from high-end volumes of individual lava flows and sills from the Siberian Traps. We perform simple box model calculations to constrain the temperature perturbation of century scale degassing. The box model includes gas fluxes, atmospheric lifetimes, and radiative forcing of CH4 and CO_2, as well as the climate sensitivity in the climate system. Following the rapid emplacement of one single major sill intrusion into the Tunguska Basin in Siberia, and the emission of a range of thermogenic gas mixtures of CH4 and CO_2 we find that the global annual mean temperature perturbation is 5.2 °C in our baseline case assuming 10 GtC/yr emission and a 60% CH4 fraction. The fluxes are estimated based on contact aureole volumes and the progress of devolatilization reactions during the first 100 years following sill emplacement. We test the sensitivity to emissions up to 25 GtC/yr, CH4 fractions from 0 to 100%, ranges of climate sensitivities, pre-event concentrations and atmospheric lifetimes. Given 10 GtC/yr emission the temperature perturbation is 2.9, 4.3, 5.2, 6.0 and 6.6 °C in the 20, 40, 60, 80 and 100% CH4 fraction cases, respectively. We conclude that individual large scale volcanic events in Large igneous provinces have the potential to cause substantial global warming on a very short timescale. In addition to the emission strength, which is obviously important, the CH4 fraction and the climate sensitivity have the strongest impact on the century scale temperature perturbation.