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The Interplay between Volcanic and Solar Cooling in the Early 19th Century

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Volcanic eruptions and reduced solar radiance can individually cool our globe through both direct changes in incoming radiation and indirect influences from dynamical processes. However, whether the cooling from the combination of two forcing can be linearly additive, or if additional cooling exists when reduced solar radiance is imposed during volcanic eruptions remains unclear. In this project, by using the state-of-art climate model (MPI-ESM1-2-LR), we found that the total cooling of the two forcing can be additive, but also have additional cooling during the period when volcanic cooling bouncing back to climatology. Our experiments focus on the early 19th century (1791-1850) since the period existed multiple strong volcanic events (especially the 1809 unidentified eruption and 1815 Tambora eruption), a solar minimum (Dalton minimum from 1790-1830), and limited influence from anthropogenic greenhouse gases. In the presentation, we will discuss how volcanic eruptions and different amplitudes of solar reconstructions can individually and together cool the surface through both direct radiative changes and dynamical influences. Our main focus will be how the atmospheric circulation may influence the polar sea ice and large-scale climate patterns when imposing combinations of solar and volcanic forcing.