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Background conditions influence the decadal climate response to strong volcanic eruptions

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Background conditions have the potential to influence the climate response to strong tropical volcanic eruptions. In this contribution, we systematically assess the decadal climate response to the April 1815 Tambora eruption in a set of full-complexity Earth-system-model simulations. Three 10-member simulation ensembles are evaluated which describe the climate evolution of the early 19th century under i) full-forcing conditions, ii) volcanic forcing-only conditions and iii) volcanic forcing-only conditions excluding events preceding the Tambora eruption. We show that the amplitude of the simulated radiative perturbation induced by the Tambora eruption depends only marginally on the background conditions. In contrast, simulated near-surface atmospheric and especially oceanic dynamics evolve significantly differently after the eruption under different background conditions. In particular, large inter-ensemble differences are found in the post-Tambora decadal evolution of oceanic heat transport and sea ice in the North Atlantic/Arctic Ocean. They reveal the existence of multiple response pathways that depend on background conditions. We therefore demonstrate that background conditions are not merely a source of additive noise for post-eruption decadal climate variability, but actively influence the mechanisms involved in the post-eruption decadal evolution. Hence, background conditions should appropriately be accounted for in future ensemble-based numerical studies.