Climate and carbon cycle response to the 1815 Tambora volcanic eruption

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The sulphur released by the 1815 Tambora eruption resulted in a global cooling of the earth surface, and is believed to have at least partly caused "the year without summer" in 1816. A series of simulations have been performed using HadGEM2-ES Earth system model to assess the climate and carbon cycle responses to the 1815 Tambora eruption. The model simulates a global mean temperature decrease of 1℃ and reduced precipitation by about 4% the year after the eruption. The northern hemisphere shows generally colder temperatures than the southern hemisphere likely due to the larger continental area in the north. Precipitation patterns are dominated by tropical regions, where a southwards shift in the ITCZ leads to drier than usual conditions north of the Atlantic equator, and wetter conditions in the south. The climatic conditions after the eruption lead to an overall increase in terrestrial net primary productivity (NPP), mainly due to a strong reduction in plant respiration which more than compensates for a reduction in gross primary productivity (GPP). Globally, the land carbon inventory is increased, implying a small drawdown of atmospheric CO_2. The soil carbon pool takes up most of the carbon especially in tropical regions. The results suggest that the carbon uptake in the tropics is caused by increased litter carbon input, with only a small reduction in soil respiration. A carbon sink is found in the northern high latitudes, associated primarily within the vegetation pool. In this region the reduced litter carbon loss is not strong enough to compensate the greatly decreased carbon input from NPP. Looking into the carbon cycle in more detail, to the C3 and C4 plants and crop productivity respectively, the results show globally decreased C4 plant productivity in 1816-18 (though with large regional variability) and more uniform pattern of increased C3 plant productivity for the 1818-22 time period. These findings could improve understanding of crop responses after a large volcanic eruption.