Deciphering the climatic effects of volcanic aerosols: what will happen when the next Tambora-like event occurs?

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The twentieth century was perhaps unusually free of explosive eruptions that affected highly populated Northern Hemisphere regions, where about 90 percent of global residents live, thus our informed historic perspective on aspects of widespread volcanic-aerosol-induced climatic changes is limited. Because future eruptions will occur that will generate dense aerosol clouds, it will serve society well if we understand the climatic impact of past eruptions. Which eruption type and size should be considered in this regard? What is the most severe climatic impact that we can expect from an eruption? Highly explosive eruptions up to VEI 6 (Krakatau-size, bigger than Pinatubo), with a mean frequency over the past millennium of about 2 per century, cause ash and aerosol clouds that affect global climate, weather, and possibly communications; aerosol-induced cooling is small (less than 1 degree C).

Perhaps VEI 7 explosive eruptions (bigger than Tambora 1815) should concern us more? They are under-reported in the record of past eruptions, with a greater than 10 percent chance of one occurring in the next century. However, the radiative effects of aerosols derived from Tambora's approximately 60 Mt release of sulphur dioxide may have been limited by rapid aerosol droplet growth and sedimentation from the stratosphere; estimates of the hemispheric or global aerosol-induced cooling are quite small (1-2 degrees C). In order to assess what lies in our future, further modelling is required to attempt to isolate the effects of volcanic stratospheric aerosols from the influences of other forcings that lead to climatic variability. This is especially important for the types and sizes of eruptions in the VEI 6-7 range, that have a high likelihood of happening in the next century.

Our society should not be overly concerned about newsworthy but rare super-eruptions (greater than VEI 8); the probability of one occurring in the foreseeable future is negligible and expected climatic impacts may not be as severe as past studies have suggested, but may be prolonged above the usual 2-3 years of cooling and other effects. The magmas typically causing super-eruptions probably have low S contents, meaning that masses of sulphate aerosols may be limited. Positive effects of future eruptions include possible offset of global warming via radiatively effective stratospheric aerosols and ash-fall onto oceans, which may help decrease atmospheric carbon dioxide.