Geophysical Research Abstracts
Vol. 16, EGU2014-6981, 2014
EGU General Assembly 2014

Changes in methane concentrations after the Pinatubo eruption

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Methane is the second most abundant anthropogenic greenhouse gas. Its variability in the atmosphere in the past decades is not fully understood. Particularly large perturbations in methane concentrations were observed after the eruption of Pinatubo in June 1991.

The temporal evolution of methane concentrations in the atmosphere is determined by methane emissions and sinks, the main removal from the atmosphere being the reaction with the hydroxyl radical (OH). Natural methane emission from wetlands are influenced by changes in temperature and precipitation. The abundance of OH in the atmosphere, which determines the methane lifetime, is also sensitive to temperature, humidity and the amount of UV radiation.

The eruption of Pinatubo in 1991 was the most recent eruption that caused global scale changes in climate and radiation. Sulphate aerosols formed in the stratosphere led to a reduction of the solar radiation reaching the troposphere. Heterogeneous reactions on sulphate aerosols also caused an enhanced depletion of stratospheric ozone. Related changes in the UV radiation reaching the troposphere affected the photolysis reactions involved in the production and recycling of OH. The decrease in tropospheric temperature in the years following the eruption caused a slowdown in the reaction rate between methane and OH, and a reduction in the water vapour needed to form OH.

The impact of changes in climate and UV radiation on the concentrations of methane and OH after the eruption of Pinatubo is assessed using the global chemistry and transport model TM5 coupled to the aerosol microphysics module M7. We find the shielding effect of stratospheric sulphate aerosols to be the dominating effect in the first year after the eruption, leading to a decrease of 14 Tg in the methane sink. The decrease in methane burden in the following years is dominantly attributed to stratospheric ozone depletion.