VOLCANOES AND GLOBAL WARMING

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Introduction

Volcanic eruptions are thought to be responsible for the global cooling that has been observed for a few years after a major eruption.

The amount and global extent of the cooling depend on the force of the eruption and, possibly, its latitude. When large masses of gases from the eruption reach the stratosphere, they can produce a large, widespread cooling effect. As a prime example, the effects of Mount Pinatubo, which erupted in June 1991, may have lasted a few years, serving to offset temporarily the predicted greenhouse effect.

As volcanoes erupt, they blast huge clouds into the atmosphere.

These clouds are made up of particles and gases, including sulfur dioxide. Millions of tons of sulfur dioxide gas can reach the stratosphere from a major volcano. There, the sulfur dioxide converts to tiny persistent sulfuric acid (sulfate) particles, referred to as aerosols. These sulfate particles reflect energy coming from the sun, thereby preventing the sun's rays from heating the Earth.

Global cooling often has been linked with major volcanic eruptions.

The year 1816 often has been referred to as "the year without a summer." It was a time of significant weather-related disruptions in New England and in Western Europe with killing summer frosts in the United States and Canada. These strange phenomena were attributed to a major eruption of the Tambora volcano in 1815 in Indonesia. The volcano threw sulfur dioxide gas into the stratosphere, and the aerosol layer that formed led to brilliant sunsets seen

around the world for several years.

However, there is some confusion about the historical evidence that global cooling may be caused by volcanic emissions.

Two recent volcanic eruptions have provided contradictory evidence on this point. Mount Agung in 1963 apparently caused a considerable decrease in temperatures around much of the world, whereas El Chichn in 1982 seemed to have little effect, perhaps because of its different location or because of the El Nino that occurred the same year. El Nino is a Pacific Ocean phenomenon, but it causes worldwide weather variations that may have acted to cancel out the effect of the El Chichn eruption.

Volcanoes and Ozone Depletion

Another possible effect of a volcanic eruption is the destruction of stratospheric ozone.

Researchers now are suggesting that ice particles containing sulfuric acid from volcanic emissions may contribute to ozone loss. When chlorine compounds resulting from the breakup of chlorofluorocarbons (CFCs) in the stratosphere are present, the sulfate particles may serve to convert them into more active forms that may cause more rapid ozone depletion (see NASA Facts—Ozone).

Monitoring the Effects of Volcanoes

Even if one can get to a volcano, it’s practically impossible to measure its gas

output because one can't synoptically see the whole cloud. Even aircraft can't do it because they're too low and it's too dangerous.

Space observations from NASA's Total Ozone Mapping Spectrometer (TOMS) instrument have contributed significantly to our knowledge of the total amount of sulfur dioxide emitted into the atmosphere in the course of major volcanic eruptions.Following the eruption of Mount Pinatubo, TOMS images show Sulfer-dioxide spreading across the Pacific. Several weeks later the sulfur dioxide had spread around the world as observed by the Microwave Limb Sounder (MLS) instrument on NASA's Upper Atmosphere Research Satellite (UARS).

In addition to detecting the sulfur dioxide from Mount Pinatubo, TOMS has made similar observations of more than 100 volcanic events including a major eruption from the Cerro Hudson volcano in Chile in 1991.

A TOMS instrument was launched on the Russian Meteor-3 spacecraft in 1991; it is also scheduled to fly on a special-purpose NASA satellite, an Earth Probe, in 1994, and on the Japanese Advanced Earth Observing System (ADEOS) mission in 1996. Current plans are for TOMS to monitor volcanic eruptions well into the next century.

Data from the Stratospheric Aerosol and Gas Experiment (SAGE II) instrument on NASA's Earth Radiation Budget Satellite (ERBS) have shown that during the first five months after the Mount Pinatubo eruption, the optical depth of the stratospheric aerosol increased up to 100 times in certain locations.

Optical depth is a general measure of the capacity of a region of the atmosphere to prevent the passage of visible light through it. Greater optical depth means greater blockage of the light. In this case, the increased optical depth

means that considerably less of the sun's energy can get through the cloud to warm the Earth's surface.

Observations of the effects of Mt. Pinatubo aerosols on global climate have been used to validate scientist's understanding of climate change and our ability to predict future climate.

Researchers at NASA's Goddard Institute for Space Studies in New York City have applied their general circulation model of Earth's climate to the problem. They have reported success in correctly predicting the effects of the sulfate aerosols from Mount Pinatubo's eruption on lowering global temperatures. The following related information can be found in the EOS Reference Handbook.

NASA Missions to Study Volcanoes

The first launch in the series of EOS satellites, the key element of NASA's Mission to Planet Earth is scheduled to take place in 1998.

The High Resolution Infrared Radiometer (HRIR), first flown on NASA's Nimbus-1 satellite in 1964, has been used to observe both active and dormant volcanoes. On Nimbus-2, HRIR recorded energy changes from the volcanic activity on Surstey, Iceland in 1966. The Multispectral Scanner (MSS) and Thematic Mapper (TM) instruments on the Landsat satellite have provided a long series of images of volcanic activity, e.g., venting, volcanic ash falls, and lava flows.

The EOS program will incorporate a series of satellites that will carry advanced

instruments to provide a highly-accurate, self-consistent, and long-term data base of many aspects of Earth's atmosphere, land, and ocean characteristics. The information gained from this major effort to study Earth phenomena will expand our knowledge of the interactions of volcanoes with Earth's climate.

Source: NASA