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Storms, cold, poor harvests – the year 1816 was a “year without a summer” in European history. The reason was the eruption of the Indonesian volcano Tambora a year earlier. It had thrown huge amounts of sulfur compounds into the stratosphere (at altitudes of 15-50 km) where they spread around the entire globe and significantly weakened solar radiation for several years afterwards. Such intense volcanic eruptions are quite common in Earth's history. To better understand their impact on the climate and the atmosphere, scientists try to reconstruct those eruptions accurately. Important archives of information are ice cores from Greenland and Antarctica because the sulfur particles ejected from the volcano fall back to the surface. A portion of that fallout is trapped in the ice of the polar regions and can be analyzed even thousands of years afterwards. The former aerosol contamination of the atmosphere is derived from it using a simple ratio calculation.

But this method has its limitations. “Volcanic aerosols in the stratosphere absorb infrared radiation, thereby heating up the stratosphere, and changing the wind conditions subsequently,” said Dr. Matthew Toohey, atmospheric scientist at GEOMAR Helmholtz Centre for Ocean Research Kiel. Using an atmospheric model, he has now tested the effects of this phenomenon. “We have found that the deposition of sulfur compounds in the Antarctic after very large volcanic eruptions in the tropics may be lower than previously thought,” the atmospheric researcher summarizes the findings of the study which has just been published in the current issue of the international “Journal of Geophysical Research – Atmosphere”.

For the study, Dr. Toohey and his colleagues from GEOMAR and the Max Planck Institute for Meteorology in Hamburg have used an aerosol-climate model to track 70 different eruption scenarios while analyzing the distribution of the sulfur particles. It was based on real volcanic eruptions during the past 200,000 years in Central America, which had been investigated in the framework of the Collaborative Research Project 574. “In our calculations, we could clearly see the differences in distribution and deposition between the northern and southern hemispheres,” explains co-author and director of the working group, Dr. Kirstin Krüger. The spatial deposition of sulfur particles in the bipolar ice cores, as calculated in the model, agrees well with the actually measured deposits of large volcanic eruptions, such as Pinatubo in 1991 or even of Tambora of 1815.

“If we know how volcanic sulfur particles affect the atmospheric winds, we can have a much improved interpretation of the traces of volcanic activities in the ice cores,” says Dr. Toohey. For one, there are better estimates of the strength of an outbreak. And secondly, the previously undetermined traces of volcanic eruptions that could not be assigned to any particular event or volcano eruption, can now be clearly traced to their origin.