

Napoleon's defeat at Waterloo caused in part by Indonesian volcanic eruption

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Credit: Imperial College London

Electrically charged volcanic ash short-circuited Earth's atmosphere in 1815, causing global poor weather and Napoleon's defeat, says new research.

Historians know that rainy and muddy conditions helped the Allied army defeat the French Emperor Napoleon Bonaparte at the Battle of Waterloo. The June 1815 event changed the course of European history.

Two months prior, a volcano named Mount Tambora erupted on the Indonesian island of Sumbawa, killing 100,000 people and plunging the Earth into a 'year without a summer' in 1816.

Now, Dr. Matthew Genge from Imperial College London has discovered that electrified volcanic ash from eruptions can 'short-circuit' the electrical current of the [ionosphere](#)—the upper level of the [atmosphere](#) that is responsible for [cloud formation](#).

The findings, published today in *Geology*, could confirm the suggested link between the eruption and Napoleon's defeat.

Dr. Genge, from Imperial's Department of Earth Science and Engineering, suggests that the Tambora eruption short-circuited the ionosphere, ultimately leading to a pulse of cloud formation. This brought heavy rain across Europe that contributed to Napoleon Bonaparte's defeat.

The paper shows that eruptions can hurl ash much higher than previously thought into the atmosphere—up to 100 kilometres above ground.

Dr. Genge said: "Previously, geologists thought that volcanic ash gets trapped in the lower atmosphere, because [volcanic plumes](#) rise buoyantly. My research, however, shows that ash can be shot into the upper atmosphere by electrical forces."

Levitating volcanic ash

A series of experiments showed that electrostatic forces could lift

ash far higher than by buoyancy alone. Dr. Genge created a model to calculate how far charged [volcanic ash](#) could levitate, and found that particles smaller than 0.2 millionths of a metre in diameter could reach the ionosphere during large eruptions.

He said: "Volcanic plumes and ash both can have negative electrical charges and thus the plume repels the ash, propelling it high in the atmosphere. The effect works very much like the way two magnets are pushed away from each other if their poles match."

The experimental results are consistent with historical records from other eruptions.

Weather records are sparse for 1815, so to test his theory, Dr. Genge examined weather records following the 1883 eruption of another Indonesian volcano, Krakatau.

The data showed lower average temperatures and reduced rainfall almost immediately after the eruption began, and global rainfall was lower during the eruption than either period before or after.

Ionosphere disturbances and rare clouds

He also found reports of ionosphere disturbance after the 1991 eruption of Mount Pinatubo, Philippines, which could have been caused by charged ash in the ionosphere from the volcano plume.

In addition, a special cloud type appeared more frequently than usual following the Krakatau [eruption](#). Noctilucent [clouds](#) are rare and luminous, and form in the ionosphere. Dr. Genge suggests these clouds therefore provide evidence for the electrostatic levitation of ash from [large volcanic eruptions](#).

Dr. Genge said: "Vigo Hugo in the novel Les Miserables said of the Battle of Waterloo: 'an unseasonably clouded sky sufficed to bring about the collapse of a World.' Now we are a step closer to understanding Tambora's part in the Battle from half a world away."

More information: Matthew J. Genge, Electrostatic levitation of volcanic ash into the ionosphere and its abrupt effect on climate, *Geology* (2018). [DOI: 10.1130/G45092.1](https://doi.org/10.1130/G45092.1)

Provided by Imperial College London

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