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Artificial Intelligence Detects Volcanic Fingerprints in Historical Climate Records

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Deciphering past climate variations, especially distinguishing between externally forced and inherent changes, is a major challenge. While proxy data from tree rings or ice cores can validate the occurrence of significant volcanic eruptions, linking the resulting temperature patterns to specific events or their geographic sources proves difficult. In this study, we present a neural network classifier capable of identifying the presence and hemispheric location of volcanic events. Trained on summer temperature anomalies from numerical climate simulations influenced by volcanoes, our classifier shows excellent accuracy over different magnitudes and locations of volcanic activity (hit rate >92%). The shift towards using an ensemble of observational (re-)analyses successfully detects volcanic eruptions in recent decades, showing a strong correlation between the neural network predictions and the observed aerosol optical depth field. Furthermore, our analysis uncovers traces of volcanic eruptions in 19th century climate data, identifying major events such as Tambora (1815) and Krakatau (1883), as well as smaller eruptions, thereby highlighting relevant climate signals. In addition, we identify a signature indicative of a northern extratropical eruption in 1809, establishing a link with the previously unidentified event of that year, despite continuing uncertainty about its exact location.