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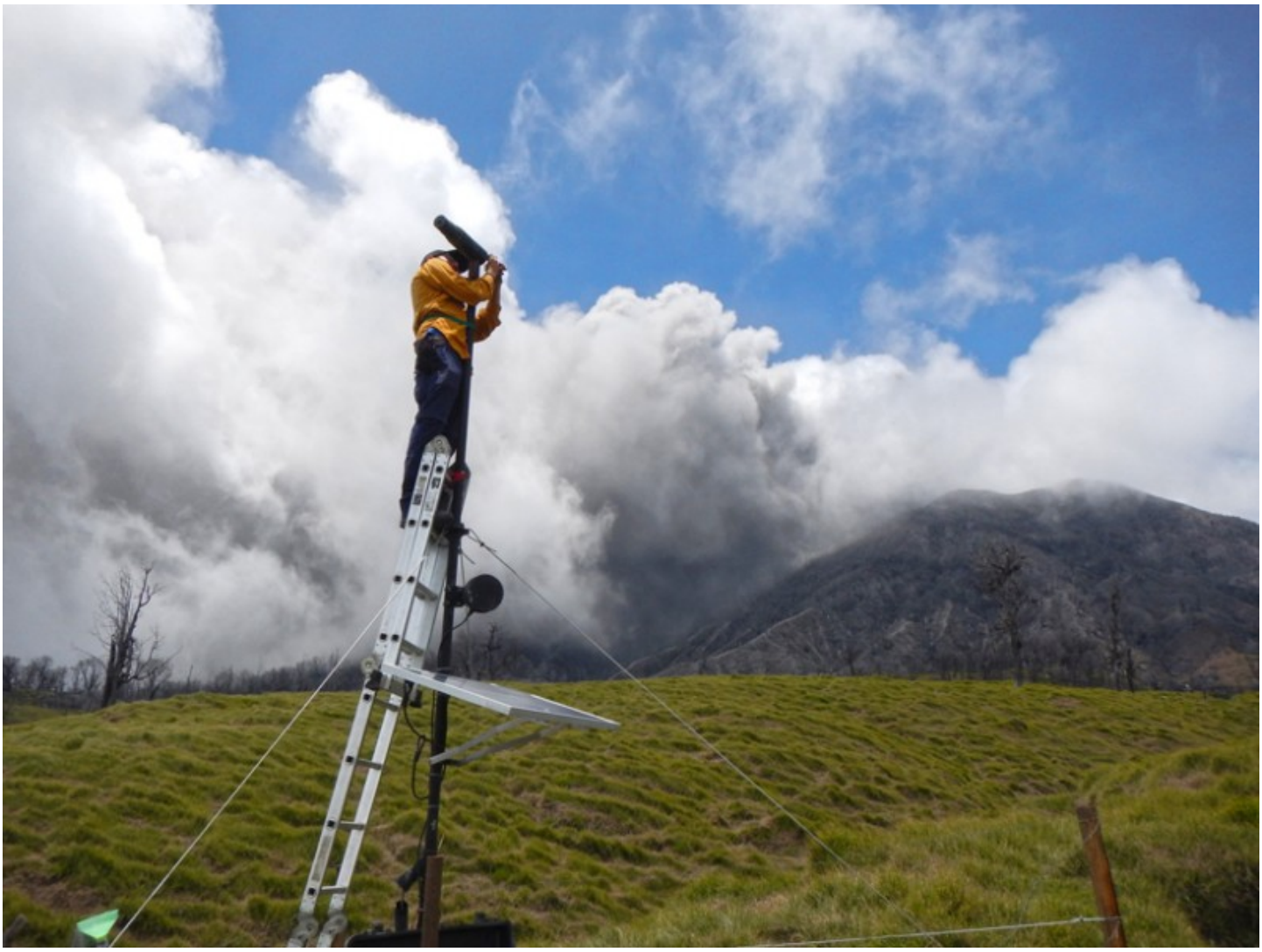
Monitoring Gas Emissions Can Help Forecast Volcanic Eruptions

5th Meeting of the Network for Observation of Volcanic and Atmospheric Change; Turrialba Volcano, Costa Rica, 27 April to 1 May 2015



Maarten de Moor adjusts a scanning differential optical absorption spectroscopy instrument, mounted 2 kilometers from Costa Rica's smoldering Turrialba Volcano. The Observatorio Vulcanológico y Sismológico de Costa Rica maintains instruments like this one to continuously monitor sulfur dioxide emissions from the country's active volcanoes. Credit: Geoffroy Avard, OVSICORI

By Christoph Kern, J. Maarten de Moor, and Bo Galle 12 August 2015

As magma ascends in active volcanoes, dissolved volatiles partition from melt into a gas phase, rise, and are released into the atmosphere from volcanic vents. The major components of high-temperature volcanic gas are typically water vapor, carbon dioxide, and sulfur dioxide.

Continuous monitoring of gas emissions has been difficult because of the remote locations of many active volcanoes and the harsh environmental conditions at these sites.

Volcanologists have long recognized (http://volcanoes.usgs.gov/activity/methods/gas.php) that measuring the chemical composition and emission rates of these discharged volatiles can help them understand the physical and chemical processes occurring within volcanic systems. However, in the past, continuous monitoring of gas emissions has been difficult because of the remote locations of many active volcanoes and the harsh environmental conditions at these sites.

In late April, 40 scientists collaborating in the Network for Observation of Volcanic and Atmospheric Change (NOVAC (http://www.novac-project.eu)) gathered for the first time in 5 years. The meeting, held on Turrialba Volcano (http://volcano.si.edu/volcano.cfm?vn=345070) in Costa Rica, was intended to provide a platform for the exchange of experiences with NOVAC instrumentation, spectral evaluation, and data interpretation.

NOVAC Activities

NOVAC is currently the only international network of volcanic geochemical monitoring. Founded in 2005 by a European Union science project, the network's volcano observatories and university partners use scanning differential optical absorption spectroscopy instruments to continuously monitor volcanic sulfur dioxide emission rates.

To date, the consortium has installed 80 such instruments at 33 (~20%) of the world's most active volcanoes. The spectrometers measure the absorption of scattered solar ultraviolet radiation by sulfur dioxide in volcanic plumes. By scanning across the plume cross section, the instruments are able to measure the volcanic emission rate of sulfur dioxide from a safe distance from the vent.

What Limits Data Accuracy?

Meeting participants identified two main constraints on data accuracy: the availability of accurate wind speed information at the altitude of the volcanic plume and the ability to derive accurate light path distributions in cases where clouds or aerosols scatter radiation into and out of the instrument field of view.

Solutions suggested at the meeting include using mesoscale wind modeling in regions surrounding the monitored volcanoes, implementing methods to retrieve wind speed from the spectroscopy data themselves, and applying sophisticated spectral analysis techniques to correct scattering effects.

The Value of Gas Emission Data

Despite the challenges, meeting participants unanimously agreed that the collected sulfur dioxide emission data greatly improved situational awareness of volcanic activity.

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Case studies presented at sessions showed that emission rates were often correlated with explosive activity, in some cases preceding it by days or weeks. Information on magmatic processes could also be derived from the short-term variability of gas emissions, as well as their correlation with other measured geophysical parameters, such as seismicity or ground deformation.

The value of the NOVAC data for eruption forecasting and improving estimates of the global volcanic gas flux into the atmosphere makes expansion of the network to other high-threat volcanoes highly desirable, and the meeting participants agreed to seek support for this effort wherever possible.

Acknowledgments

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