P64

Statistical Analysis of the Transport and Deposition Patterns of Volcanic Emissions from the Sakurajima Volcano

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Introduction

Volcanic emissions from volcanoes with long eruptive periods can have a direct effect on the atmospheric composition and air quality in the surrounding area. However, there remain significant gaps in the understanding of the long-term behavior of emissions from such volcanoes. Here, we focus on the Sakurajima volcano in Japan as an example of such activity. During a 6-year period from 2009 to 2015 the volcano was erupting at an almost constant rate, with approximately 500kt of ash per month emitted to the atmosphere. Long-term characteristics of the transport and deposition of volcanic emissions are analysed using daily surface observations of suspended particulate matter (SPM) and SO2 at 17 points and monthly ashfall values at 62 point in the Kagoshima prefecture.

Suspended volcanic ash and gases

Concentrations of SO2 show significant variability depending on the bearing from the vent and a strong decrease with distance. On the other hand airborne volcanic ash has a uniform effect, increasing SPM concentrations across the area surrounding the volcano, with a less notable decrease with distance. During the period studied here both SO2 and SPM concentrations are, at times and depending on the season, over recommended daily and yearly exposure limits.

Results for both SO2 and SPM concentrations suggest that during the 6-year period studied here, locations to southeast and west of the volcano had potentially unsafe concentrations of pollutants. No health-related studies have been carried out for this period and the drastic changes in volcanic activity before 2009 and after 2015 allow for further research on the impact of emissions from Sakurajima on the surrounding communities.

Volcanic ash deposition

Long-term ashfall distribution was seen to be highly non-uniform, influenced in part by preferential dispersal due to seasonal winds and topographic effects. Stations in the vicinity of steep topographic features differing up to two orders of magnitude for distances between stations as short as 4 km.

Despite these localised effects, deposition of volcanic ash for accumulation periods between 1–72 months was sufficiently approximated by an inverse power law relationship, however, the fidelity of the approximation was seen to differ depending on the distance: for proximal to intermediate distances from the vent (<20 km), errors decrease with longer accumulation periods, while the opposite was seen for deposition in distal areas (>20 km).

Conclusions

Even though the study focused specifically on the Sakurajima volcano, qualitative results can be applied for other volcanoes with similar activity of long-term volcanic emissions and small but frequent eruptions that lack extensive observations networks.