Operational Implementation of the Tephra Fall Forecast with the JMA Mesoscale Tracer Transport Model

Toshiki Shimbori[*], Yuri Aikawa[†] and Naoko Seino[‡]

[*]*Volcanological Division, Japan Meteorological Agency, Tokyo 100-8122, Japan*

[†]*Numerical Prediction Division, Japan Meteorological Agency, Tokyo 100-8122, Japan*

[‡]*Meteorological Research Institute, Tsukuba, 305-0052, Japan*

The Japan Meteorological Agency (JMA) implemented the tephra fall forecast in Mar. 2008 as one of the forecasts on volcanic phenomena. This is a six-hour forecast of volcanic ash-fall areas, and is disseminated in graphical format when a large eruption occurs in Japan (e.g., if the height of the ash plume is greater than 3,000 m above the crater rim, or if the JMA volcanic alert level is higher than 3). The forecast is based on the outputs of the JMA Mesoscale Tracer Transport Model for volcanic ash. This model, which is based on the JMA Tracer Transport Model (Iwasaki et al., 1998), is applied to volcanic-ash forecasting with meteorological fields predicted by the operational JMA Mesoscale Model (MSM). Another application of the JMA Mesoscale Tracer Transport Model is the oxidant forecast (Takano et al., 2007).

A flowchart of the tephra fall prediction system is shown in Fig. 1. When an eruption occurs in a domestic volcano, we immediately obtain an observation report on the eruption describing the location, event time, plume height and so on. Based on this report and the assumed continuance of eruption, we create a model of an eruption column, which leads to the initial condition of the JMA Mesoscale Tracer Transport Model for volcanic ash. The model of the eruption column is composed of 100,000 tracer volcanic-ash particles with a grain size from about 100 mm to 0.001 mm and virtual mass. Then, these tracer particles are diffused from the eruption column during the continuance of eruption and transported with a time interval of three minutes using the hourly outputs of the MSM for the nearest initial time (00, 06, 12 or 18 UTC) to the event occurrence. In the model, the settling velocities of volcanic ash are considered (Suzuki, 1983). Finally, we count the number of deposited tracer particles per hour and transform their virtual mass into the surface density of ash-fall mass. The tephra fall forecast determines ash-fall areas as those with surface densities exceeding 0.1 g/m^2.

The tephra fall forecast was activated for the eruptions that occurred at Sakurajima Volcano on 27 to 28 Jul. 2008 and at Asama Volcano on 1 Feb. 2009. The results are shown in Figs. 2 and 3, respectively. These forecasts were qualitatively good in comparison with the ash-fall observations. From a quantitative point of view, however, the predicted amounts of ash-fall were underestimated around the foot-level of the volcanoes. For quantitative tephra fall prediction, we will apply a high-resolution local forecast to the tracer transport model.

[*] E-mail: shimbori@met.kishou.go.jp

References

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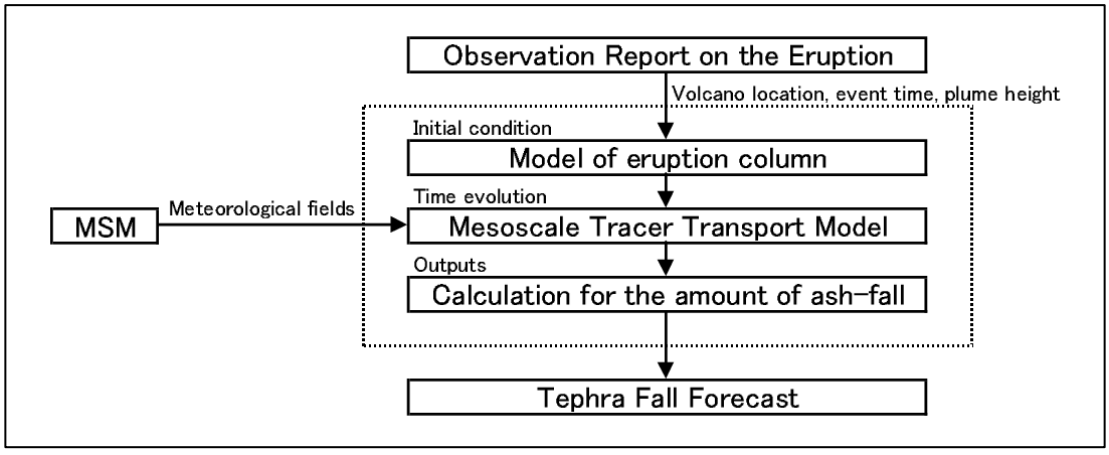

Fig. 1 Flowchart of the tephra fall prediction system

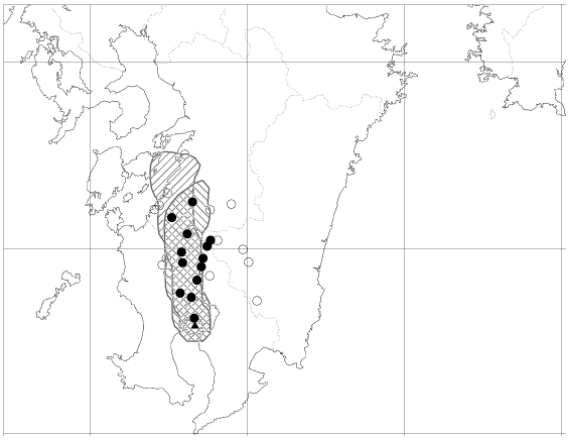

Fig. 2 Six-hour forecast of the two eruptions at Sakurajima Volcano (denoted by ▲) in Jul. 2008. 1st eruption ▨: from the event time at Jul. 27 22:05 UTC to the valid time at Jul. 28 04:00 UTC with a plume height of 3,300 m above the crater; 2nd eruption ▨: from the event time at Jul. 28 01:10 UTC to the valid time at 07:00 UTC with a plume height of 3,200 m. In comparison with ash-fall observations (●: observed; ○: not observed).

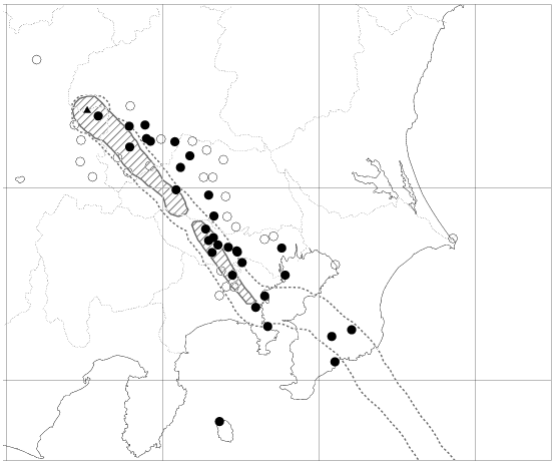

Fig. 3 Six-hour forecast of the eruption at Asama Volcano (denoted by ▲) on 1 Feb. 2009 from the event time at 16:51 UTC to the valid time at 23:00 UTC with a plume height of 2,000 m above the crater. In comparison with ash-fall observations (the notations are the same as those in Fig. 2). For reference, the dotted-line contour indicates 0.01 g/m^2.