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Particle segregation from bent-over plume detected by reconstruction of eruption plume

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Recently, calculation of tephra fall distribution is utilized in forecasting and hazard analysis. On the other hand, such calculation often fails to reconstruct observation.

Such discrepancy could be caused by lack of modeling during transportation (i.e. particle aggregation); however over simplification of the particle source is also attributed to the defect. In fact, recent reconstruction of particle source based on Tephra2 analysis showed that there is a large heterogeneity of particle segregation as a function of column height (particle segregation along the column; PSC: Mannen, 2014; JVGR 284, 61-78). In addition to that, vertical source that is assumed in many tephra fall calculation including Tephra2 could be the source of the large error.

We conducted sampling and sieving for tephra fall deposit of the 2011 eruption of Shinmoe-dake and prepared a dataset of mass loading per unit area for several particle size classes of 1 phi interval. Using this dataset and a mesoscale analysis of Japan Meteorological Agency, we reconstructed PSC based on method of Mannen (2014).

The reconstructed source shows that most of the particles are segregated from the source less than 5 km high. This result is consistent to the column height that is analyzed from satellite images and trajectory models.

However, tephra deposit observed more than 20 km from the source vent was not reconstructed by Tephra2 calculation based on the optimum PSC and wind data. Distribution axis of such deposit is parallel to the wind direction of approximately 4 km high. Thus bent-over plume that drifted approximately 4 km high is implied as a significant source of the tephra deposit. We consider introduction of bent-over plume to the source model is key to improve tephra fall calculation.

Keywords: tephra, Tephra2, Kirishima volcano, Shinmoedake, ash fall forecast