The feasibility study for the estimating the grain-size distribution of volcanic ashes with the wind profiler LIDAR

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There are some earlier studies of the observations of volcanic plume with the Mie LIDAR, such as Sakai et al. (2014), and most of them reported about the altitude of the volcanic-ash cloud, but there are not much studies about estimating the grain-size distribution of the volcanic ashes in troposphere with LIDAR. Doppler LIDARs are used to estimate the wind profile using the spectral analysis of the backscatter by aerosols. Aoki et al. (2015 a,b) demonstrate the estimation of rain drop size distribution using Gaussian Mixture Model (GMM) fitting of Doppler spectra. This suggests the possibility of the estimation of the grain-size distribution of aerosols.
As part of the joint research project by Meteorological Research Institute and Kagoshima Meteorological Office, the observation of wind around Sakurajima volcano using the Wind Profiler LIDAR (Doppler LIDAR, hereafter WPL) was done on March, 2015. The eruptions were observed by 32 times in the observation period, so WPL observed the atmospheric flow including volcanic-ash. In this study, the estimation method of volcanic ashes size distribution using spectral analysis is tested.
At first, the observed spectral power distributions are fitted to GMM, and derived Doppler speed (V_r) for each mode. The falling velocities of ashes (V_F) are derived from Vr and the environmental wind (V_e). The grain-sizes of ashes (D) are estimated using the relationship of D and V_F in Shimbori et al. (2014). In this study, the analysis data of the Japan Meteorological Agency (JMA) Local Forecast Model (LFM) are used as V_e. For the verification, the analyzed distribution is compared with one using the volcanic-ash prediction of the JMA Regional Atmospheric Transport Model (RATM) driven by LFM.
In the case study for the data between 14:50 -15:00 JST on 26th March, the peak of the distribution is about 0.1mm in the both results of WPL analysis and RATM prediction, so they are almost consistent. But the D in WPL analysis is widely distributed, up to 20mm. This ‘unreliable’ D is thought to be caused by the noise in spectra. In addition, some possible reasons to affect the analysis like the fluctuations of wind and the difference between the ‘real’ wind over WPL and the LFM analysis data must be considered. And the observed grain-size distribution data is needed for the further verification.
Although there are some points to be noted like the measures to the accumulation of falling volcanic-ashes on WPL antenna in the observation of the volcanos, there are advantages like the portability and the possibility to observe the lower wind profile. So it is worth to consider the applications WPL to the observation of the volcanic plumes.

Keywords: Volcanic ashes, Doppler LIDAR

