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Estimation of velocity and energy during large pyroclast transport

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Volcanoes emit large pyroclasts (> 10 cm) during the early stage of an explosive eruption. It is important to know the ejection and landing velocity of these pyroclasts because they can kill people if their momentum energy is high enough. We have estimated the ejection and landing velocity in the Ontake 2014 eruption in which more than 50 people were killed by lesions possibly related to being hit by volcanic blocks. A three-dimensional numerical multiparticle ballistic model adapted to account for topographic effect was used to estimate the ejection and landing energy. Comparing the distribution of observed impact craters on the ground with the numerical simulation results, the ejection velocity was estimated to be between 145 and 185 m/s. As in this case, large pyroclasts are often modelled as ballistic projectiles. Ballistic projectiles in a volcanic setting are pyroclasts travelling in the air decoupled from the gas phase and following independent parabolic trajectories. On the contrary, large pyroclasts often travel with the gas flow released when the explosion occurs. This effect should be evaluated in order to estimate more plausible values of the ejection and landing velocity. The trajectories of pyroclasts are expected to change if gas flow interacts with these particles. Therefore, pyroclast trajectories were observed to study how gas flow influences the transport of large pyroclasts. We obtained images from the video footage of the Aso 2015 stromblian eruption, and these images were used to estimate the gas flow velocity. We would like to discuss the method to estimate the gas flow velocity based on observations and theory.