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Lidar depolarization measurement of fresh volcanic ash from Mt. Etna, Italy

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HIGHLIGHTS

- Ash emission from Mt Etna was followed by a polarization lidar.
- Particle depolarization of fresh volcanic ash was measured near the source.
- Depolarization and lidar ratio values of two plumes components were determined.
- Estimation of volcanic ash mass concentration at source was performed.

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ABSTRACT

A small, portable, polarization lidar system with scanning capability was used to perform range resolved measurements of fresh erupted volcanic plume from Mount Etna in Italy. Measurements were carried out on November 15, 2010 during a volcanic plume emission event by placing the lidar very close to volcano summit craters. Depolarization measurements highlighted that aerosol of different shape and optical properties were emitted by the two involved vents, Bocca Nuova and North-East Craters. In the plume emitted from Bocca Nuova Crater the mean value of aerosol linear depolarization ratio resulted near to zero, corresponding to non depolarizing particles or liquid droplets, while values of (16 ± 2)% and (45 ± 3)% were observed in the ash plume emitted from North-East Crater, in the morning and in the afternoon, respectively. The retrieved values of volcanic aerosol depolarization ratio, aerosol backscattering and lidar-ratio allowed distinguishing the changes in the properties of the emitted aerosol. Furthermore, the ash mass concentration at source was estimated, reaching a maximum value of 24,000 ± 6000 μg m^{-3}, with an additional systematic uncertainty of 50% related to the assumption of an effective radius of 10 μm for ash particles.

1. Introduction

The aerosol produced during volcanic activities has a huge impact on the global environment. In fact, major eruptions strongly influence the Earth's radiative balance by injecting in the atmosphere a great amount of particles and gases which produce secondary aerosols (Mather et al., 2003).

The interest in the study of volcanic ash plumes comes also from their large dispersion scale and long residence times, since these ashes represent a serious hazard to aircraft engines. Recently, the Eyjafjallajokull volcano eruption in Iceland (March 20, 2010) raised this problem, demonstrating the high vulnerability of the human flight transport system. During this eruption, near-real time observations of the volcanic cloud evolution were performed by ground-based lidar stations of EARLINET network (Ansmann et al., 2010; Gasteiger et al., 2011), demonstrating the ability of lidar networks to detect and monitor the evolution of volcanic aerosol plumes.

During the last years, lidar systems were widely used to study volcanic aerosol clouds produced by major volcanic eruptions (Chazette et al., 1995; Langford et al., 1995; Di Girolamo et al., 1996; Ansmann et al., 2010). In particular, the polarization lidar technique was used to distinguish the shape and thermodynamic phase of

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