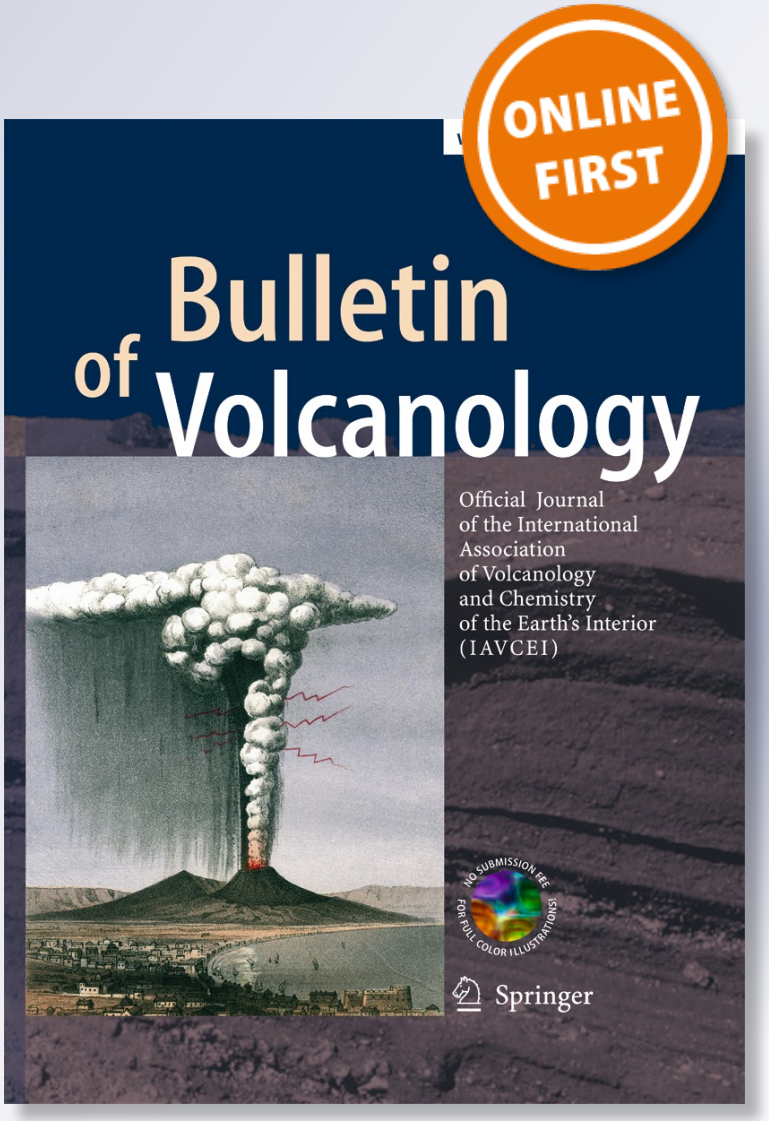
Monitoring Etna volcanic plumes using a scanning LiDAR

Simona Scollo, Antonella Boselli, Mauro Coltelli, Giuseppe Leto, Gianluca Pisani, Nicola Spinelli & Xuan Wang

Bulletin of Volcanology
Official Journal of the International Association of Volcanology and Chemistry of the Earth`s Interior (IAVCEI)

ISSN 0258-8900

Bull Volcanol
DOI 10.1007/s00445-012-0669-y



Springer

Bull Volcanol
DOI 10.1007/s00445-012-0669-y

RESEARCH ARTICLE

Monitoring Etna volcanic plumes using a scanning LiDAR

Simona Scollo · Antonella Boselli · Mauro Coltelli · Giuseppe Leto · Gianluca Pisani · Nicola Spinelli · Xuan Wang

Received: 5 April 2012 / Accepted: 24 September 2012

Abstract In this paper, we use data obtained from LiDAR measurements during an ash emission event on 15 November 2010 at Mt. Etna, in Italy, in order to evaluate the spatial distribution of volcanic ash in the atmosphere. A scanning LiDAR system, located at 7 km distance from the summit craters, was directed toward the volcanic vents and moved in azimuth and elevation to analyse different volcanic plume sections. During the measurements, ash emission from the North East Crater and high degassing from the Bocca Nuova Crater were clearly visible. From our analysis we were able to: (1) evaluate the region affected by the volcanic plume presence; (2) distinguish volcanic plumes containing spherical aerosols from those having non-spherical ones; and (3) estimate the frequency of volcanic ash emissions. Moreover, the spatial distribution of ash mass concentration was evaluated with an uncertainty of about 50 %. We found that, even during ash emission episodes characterised by low intensity like the 15 November 2010 event, the region in proximity of the summit craters should be avoided by air traffic operations, the ash concentration being greater than 4×10^{-3} g/m^3. The use of a scanning permanent LiDAR station may usefully monitor the volcanic activity and help to drastically reduce the risks to aviation operations during the frequent Etna eruptions.

Keywords Volcanic plume · Scanning LiDAR measurements · Etna · Ash emission episodes

Editorial responsibility: J. Taddeucci

S. Scollo (✉) · M. Coltelli
Istituto Nazionale di Geofisica e Vulcanologia,
Osservatorio Etneo, Sezione di Catania,
Piazza Roma 2, 95123 Catania, Italy
e-mail: simona.scollo@ct.ingv.it

A. Boselli
CNISM and IMAA-CNR,
C.da S. Loja, 85050 Tito Scalo, Potenza, Italy

G. Leto
Osservatorio Astrofisico di Catania, INAF,
Via Santa Sofia 78, I-95123 Catania, Italy

G. Pisani · N. Spinelli
CNISM and Dipartimento di Scienze Fisiche,
Università di Napoli "Federico II",
via Cintia 21, 80126 Napoli, Italy

X. Wang
CNISM and CNR-SPIN, Dipartimento di Scienze Fisiche,
Università di Napoli "Federico II",
via Cintia 21, 80126 Napoli, Italy

Published online: 09 November 2012

Introduction

During explosive activity, volcanoes release a large amount of silicate particles and gases mainly composed of water vapour, carbon and sulphur dioxides (Sparks et al. 1997). This emission represents the most important natural source of pollutants in the atmosphere (Oppenheimer 2003), affects terrestrial ecosystems and human health on local to regional scales (e.g. Mather et al. 2003) and influences microphysical processes in clouds and climate (Durant et al. 2010). Silicate particles, in particular, cause respiratory problems, eye injuries and skin irritations (e.g. Horwell and Baxter 2006), damage to crops, roads and infrastructures (e.g. Blong 1984), whereas sulphur dioxide leads to acid rain, lowers the surface temperatures and, if the stratosphere is reached, promotes depletion of the Earth's ozone layer (e.g. Robock 2000). An accurate monitoring of the amount of volcanic aerosol ejected in atmosphere is, hence, necessary.

Etna is one of the most active volcanoes in the world and is considered among those volcanoes frequently causing damage to airport operations (Guffanti et al. 2008), especially due to the high frequency of explosive activity (e.g.