Detection of volcanic ash from the Eyjafjallajoekull eruption with a Raman lidar over Thessaloniki, Greece

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Introduction

Eyjafjallajökull is one of the smallest glacier in Iceland. After seismic activity recorded during December 2009, a first eruption started on March 20, between 22:30 and 23:30 UT.
The transport of aerosol in the troposphere during the Eyjafjallajokul eruption is presented with the use of lidar observations, model simuations and sunphotometer measurements. The case study concentrates on the period between 16 April and 21st of April.

Lidar Measurements

Lidar measurements were performed with a lidar system located at the Laboratory of Atmospheric Physics (LAP) in Aristotle University of Thessaloniki (AUTH) during the event. LAP-AUTH lidar system is a 355 nm Raman/elastic lidar system operational since May 2000. The LAP-AUTH lidar is based on the second and third harmonic frequency of a compact, pulsed Nd:YAG laser, which emits pulses of 300 and 120 mJ at 532 nm and 355 nm, respectively, with a 10 Hz repetition rate. Elastically backscatter signals at both 355 and 532 nm and N2 Raman shifted signal at 387 nm are collected with a Newtonian telescope of 500mm diameter with 0.73 mrad adjustable field-of-view.

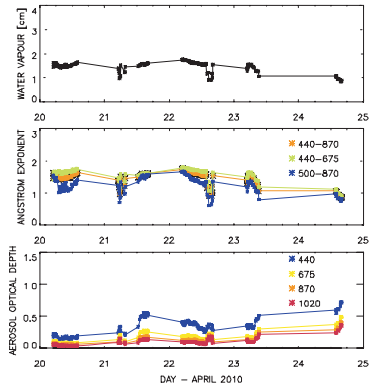
EURAD Model

The EURopean Air Pollution Dispersion (EURAD) model system simulates the physical, chemical and dynamical processes which control emission, production, transport and deposition of atmospheric trace species. As a result EURAD provides concentrations of these trace species in the troposphere over Europe and their removal from the atmosphere by wet and dry deposition. The model system has permanently been evaluated using chemical and meteorological data from the atmospheric boundary layer, the free troposphere and the lower stratosphere.

Cimel Sunphotometer

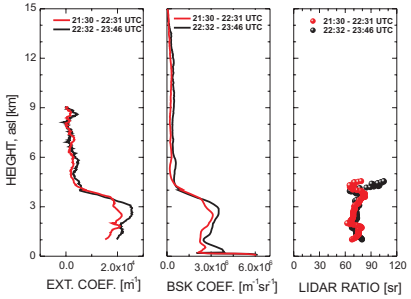
The sunphotometer observations reported in this study were performed by a CIMEL sun-sky radiometer, which is part of the AERONET Global Network. The CIMEL was installed at Thessaloniki in June 2003. The CIMEL is an automatic Sun-sky scanning filter radiometer allowing the measurements of the direct solar irradiance and sky radiance at 440, 670, 870, and 1020 nm.

Figure 1: Sunphotometer Parameters



The aerosol optical depth starts to increase in the morning of 21st of April due to transport of volcanic ash in Thessaloniki as seen by cimel sunphotometer. This increase is not due to the presence of clouds. The Angstrom exponent values for the period under study shows slightly larger particles.

Figure 2: Raman Lidar Parameters



In figure 2 we present profiles of extinction, backscatter and lidar ratio for the time periods between 21:30 - 22:31 UTC and 22:32 - 23:46 UTC. Aerosol optical depth from 1.0 to 9 km for the first period is 0.65 while an increase of optical depth is observed next hour. Mean values of lidar ratio are of about 80 sr.

Conclusions

During the 21st of April volcanic ash is observed in Thessaloniki coming from the region of Eyjafjallajokul in Iceland. Specificaly, two layers of volcanic ash were presented one around 2.5 and one around 4 km , just below a persistent visible thin cloud at 4 km The first layer is persistent but with variable thickness, while the thin layer at 5km seems to disappear after some hours. According to EURADs simulation these two layers should be volcanic ash. Later on and in higher altitudes thin layers are observed between 5 and 8 km, that are directly associated with Vocanic erruption. The first layers seems to be transported from West Europe according to trajectory analysis. In these regions EURAD model shows high concentration of particles that are resulting from Volcanic erruption. On the other hand the descending layers that are observed in higher altitudes seems to directly assocciated with the volcanic erruption and transport to Thessaloniki as EURAD model predicts. On 22nd of April a layer between 3 and 4 km are observed. A second layer at 5km is also observed.

References

Amiridis, et al., 2005: Four years aerosol observations with a Raman lidar at Thessaloniki, Greece, in the framework of European Aerosol Research Lidar Network (EARLINET), J. Geophys. Res., 110, D21203
EURAD model: http://www.eurad.uni-koeln.de
Trajectories: http://ready.arl.noaa.gov/HYSPLIT.php
AERONET: http://aeronet.gsfc.nasa.gov/

Acknowledjments

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Figure 3: Timeseries of RCS on 21st

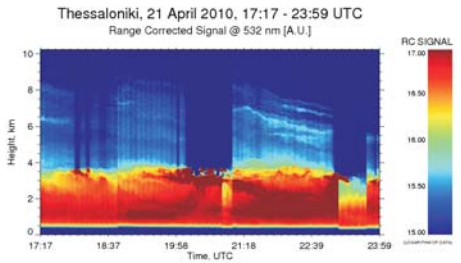

Figure 4: Timeseries of RCS on 22nd

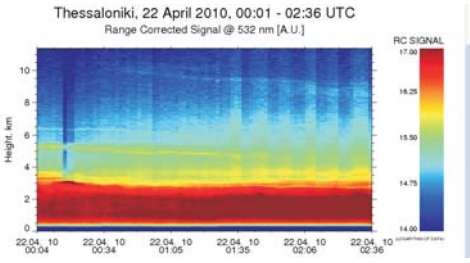

Figure 5: Back-Trajectory on 21st

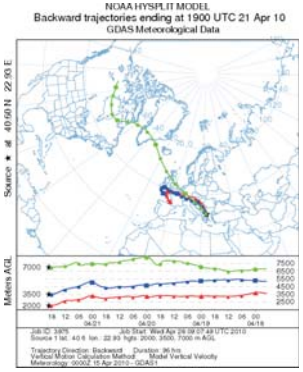

Figure 6: EURAD on 17th

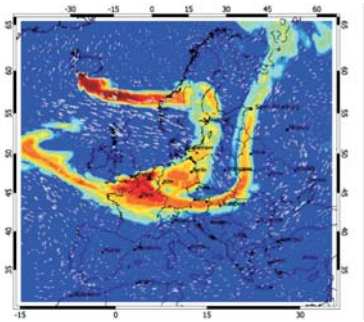

Figure 7: EURAD on 21st