Aerosol transport studies using lidar data and a transport model

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CNR-IMAA –Potenza

CNR-ISAC – Bologna

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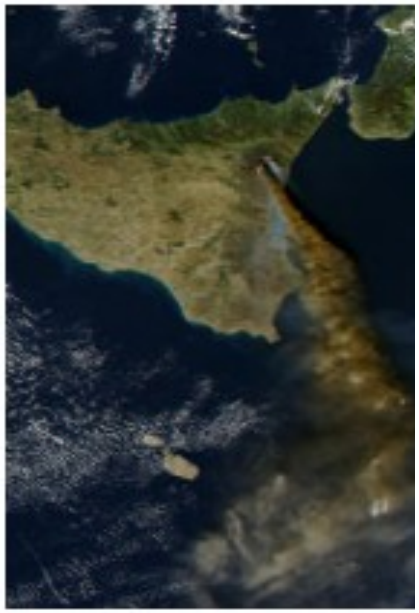
First case study



October – November 2002 Etna volcanic eruptions

Motivations

- ✓ **Geophysical interest**
- ✓ **Well defined and localized source**
- ✓ **High-quality lidar observations in Potenza**
- ✓ **Aerosol climatology available for observational site**

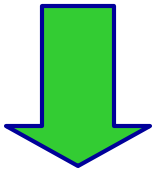
BOLAM model

(Bologna Limited Area Model) developed by CNR-ISAC

Meteorological driver based on primitive hydrostatic equation for wind components, potential temperature, pressure and specific humidity.

BOLAM good performances demonstrated during devoted campaign like Mesoscale Alpine Programme Special Observing Period (MAP-SOP)

Meteorological driver for transport phenomena in regional domains with resolution that ranges between those typical for general circulation models to about 5 km



Wind fields

Particles trajectories are computed run time using forward Lagrangian model named ARTURO

Transport model parameters

Selected domain: 6800 x 5600 km covering also Sahara region

Time coverage: 27 October 0000UT – 04 November 0000UT

Spatial Resolution: 20 km

Temporal Resolution: 150 s

Initialization of the model: ECMWF 0.5° x 0.5°

Point-source / point receptor problems needs high accuracy in wind fields

BOLAM reinitialization each 24h

Source difinition: a column of initial points over the volcano

Plume vertical extent plume is a critical point

Check with satellite images

Fluid Particles Trajectories

Particles trajectories movie

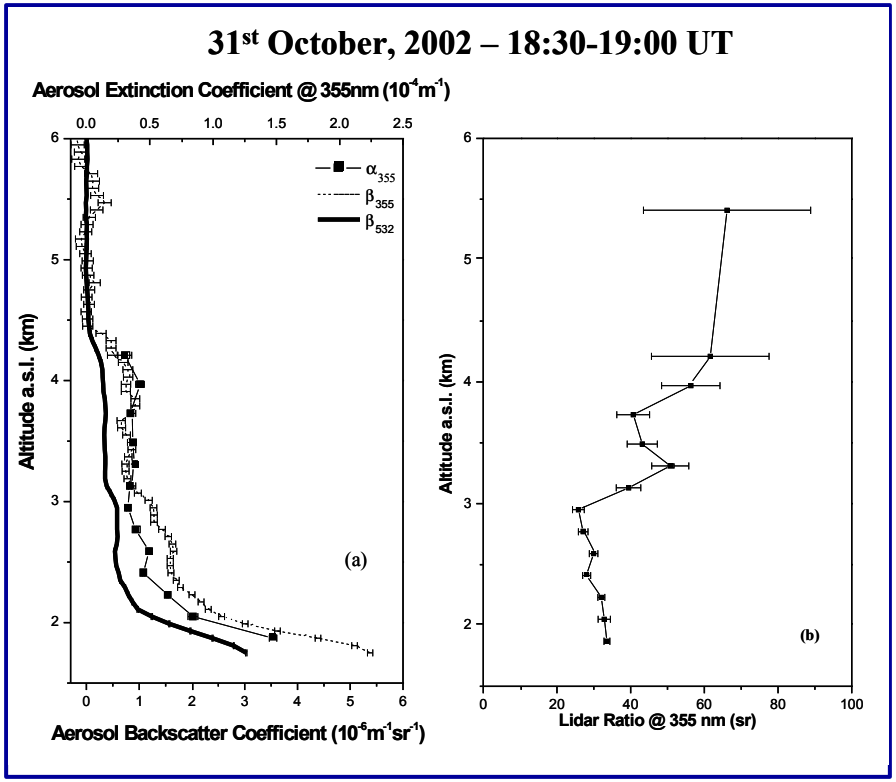
CNR-IMAA Observations

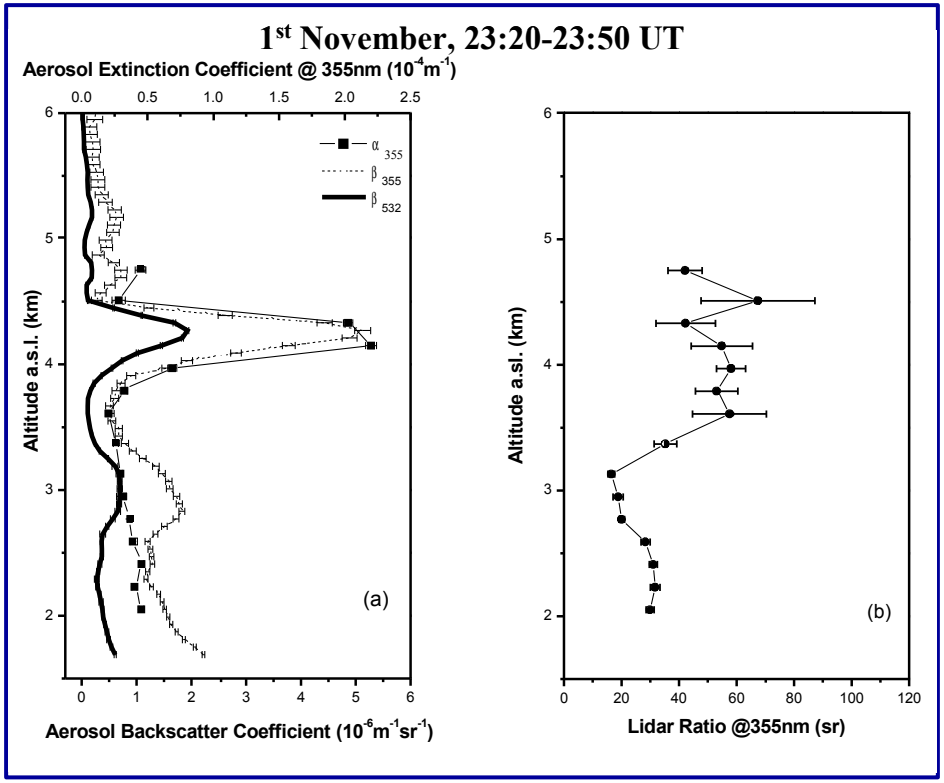
28 October –30 October : no volcanic aerosol layer is observed

31 October: feeble aerosol layer appears at noon

and becomes more intense in the evening

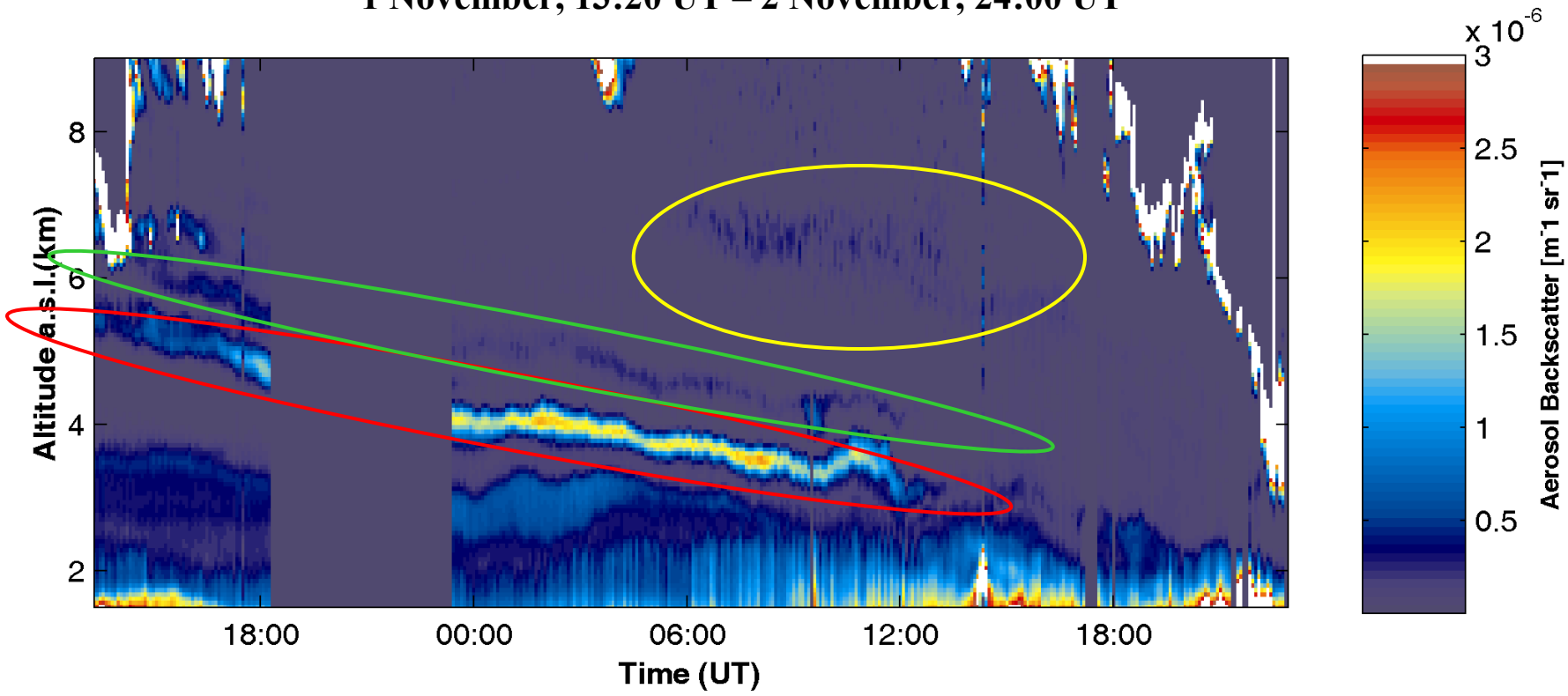
1-2 November: intense volcanic aerosol layer at about 4 km a.s.l.



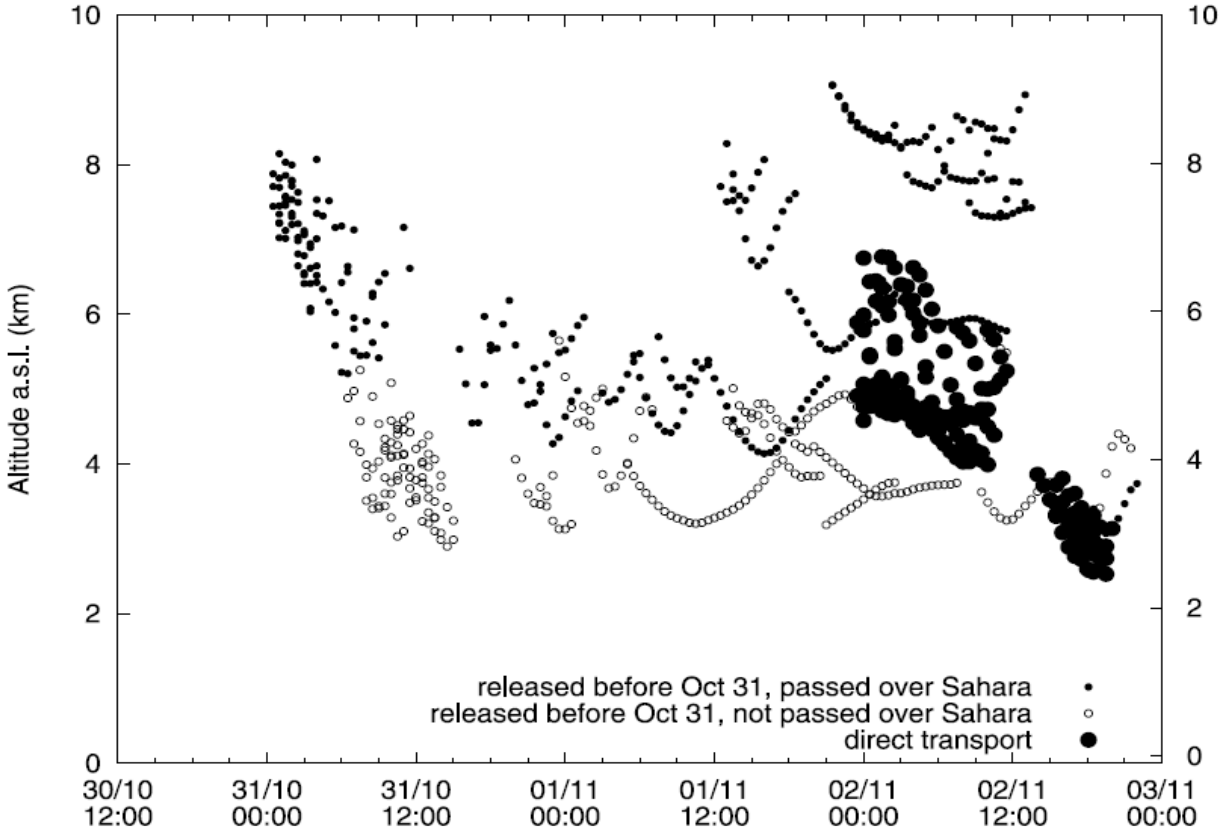


CNR-IMAA Observations

1 November, 13:20 UT – 2 November, 24:00 UT



Modeled transported particles over Potenza area



Transport model /Observations Comparison

Volcanic aerosol particles reached Potenza on 31 October.

A larger quantity arrived on 1-2 November.

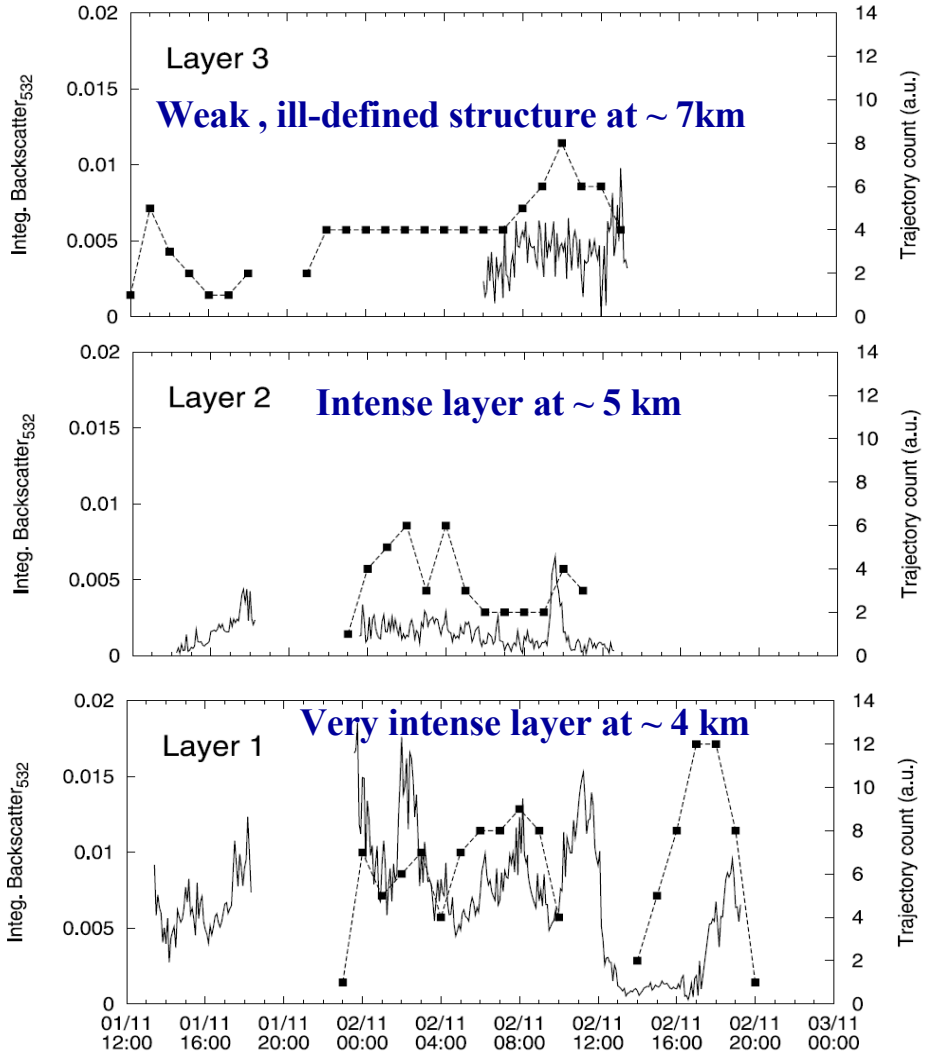
Particles reaching Potenza on 31 October experienced a long-path travel

Lidar Ratio variability inside the volcanic aerosol layer

Direct and fast transport from Etna to Potenza on 1-2 November

Lidar Ratio almost constant within the volcanic aerosol layer

Transport model /Observations Comparison



Layer 1 - 2 consist of particles released within few hours delay separated vertically because of large wind shear at source.

(Model)

Layer 3 particles that reached Potenza after long-path.

(Model)

Falling speed: **2.1 cm·s^{-1} and 2.7 cm·s^{-1} for Layer 1 and 2 (Lidar) – 2.5 cm·s^{-1} in 4-5 km range (Model)**

Transport model /Observations Comparison

Fair agreement between the simulated and observed presence of particles over Potenza.

Vertical structure of the aerosol layers and downward vertical velocity in good agreement.

Altitude shift between observed aerosol layers and modeled fluid particles because of difficulties in source modeling as strength and altitude.