Aerosol monitoring over Vipava valley using Raman polarization lidar

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Valley regions with dense population can usually be considered as air pollution hot-spots. **Our aim was to investigate:**

- local air pollution dispersion processes
- long range aerosol transport

in a hot spot location, using the case of Vipava valley.

**Key issues:**

- aerosol spatial distributions
- identification of different aerosol types and their optical properties (depends on mixing types and aging characteristics)
Vipava valley

Location: 45.87° N, 13.90° E, a part of the Mediterranean region

Location features:
- Stable atmospheric conditions, strong downslope winds
- Mixture of long-range transport aerosols (mineral dust and marine) and local emissions (biomass burning and traffic sources)
Vipava valley

Location: 45.87° N, 13.90° E, a part of the Mediterranean region

http://modis.gsfc.nasa.gov

**Location features:**

- Stable atmospheric conditions, strong downslope winds
- Mixture of long-range transport aerosols (mineral dust and marine) and local emissions (biomass burning and traffic sources)
Measurement sites and instruments

- Instruments: two lidars, two aethalometers (absorption coefficients and black carbon (BC) concentration), optical particle counter (size distributions 0.25 to 32 $\mu$m and mass concentration PM$_{10}$)

- Measurement sites:

![North-South terrain profile of Vipava valley](image)
Two-wavelength polarization Raman lidar

- Backscatter coefficient (355 and 1064 nm)
- Extinction coefficient (355 nm)
- Depolarization ratio at 355 nm
- Lidar ratio at 355 nm
- Backscatter Ångström exponents

Temporal variation of aerosol layers on 5/6 April 2016. Aerosols in the elevated layers are predominantly mineral dust.

Lidar measurements from Ajdovščina
Aerosol distribution

Temporal variation of aerosol layers on 5/6 April 2016. Aerosols in the elevated layers are predominantly mineral dust.

In-situ measurements from Otlica and Ajdovščina
Mass concentration profiles

![Graphs showing mass concentration profiles at different times.

- 21:00-21:30
- 23:00-23:30
- 01:00-01:30
- 03:00-03:30
- 05:00-05:30

- 08:30-9:30
- 10:30-11:30
- 12:30-13:30
- 14:30-15:30
- 16:30-17:30

The graphs display PM10 concentration over different heights and times.]
Profiles of aerosol properties on 31 August, 23:40 to 00:10 1 September.
Aerosol identification in different atmospheric layers

<table>
<thead>
<tr>
<th>Layer</th>
<th>Height [km]</th>
<th>PDR [%]</th>
<th>LR [sr]</th>
<th>BAE</th>
<th>Aerosol type</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBL</td>
<td>&lt; 0.7</td>
<td>9±2</td>
<td>60±5</td>
<td>0.9±0.2</td>
<td>BB</td>
</tr>
<tr>
<td>RL</td>
<td>0.7 – 1.4</td>
<td>7±2</td>
<td>35±13</td>
<td>1.2±0.2</td>
<td>marine &amp; BB</td>
</tr>
<tr>
<td>EAL</td>
<td>1.4 – 3.5</td>
<td>3±1</td>
<td>20±3</td>
<td>0.7±0.2</td>
<td>marine</td>
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## Aerosol identification in different atmospheric layers

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**Graph:**
- **Y-axis:** Lidar ratio [sr]
- **X-axis:** Particle depolarization ratio [%]
- **Legend:**
  - BB in this study
  - Marine in this study
  - Marine mixture in this study
  - BB in references
  - Marine in references
Occurrence number of characterization observables

<table>
<thead>
<tr>
<th>Aerosol type</th>
<th>Presence [%]</th>
<th>Predominance [%]</th>
<th>Absence [%]</th>
</tr>
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<tr>
<td>Marine</td>
<td>63</td>
<td>17</td>
<td>37</td>
</tr>
<tr>
<td>Combustion</td>
<td>100</td>
<td>74</td>
<td>0</td>
</tr>
<tr>
<td>Mineral Dust</td>
<td>34</td>
<td>9</td>
<td>66</td>
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Graphs showing distribution of aerosol characteristics with respect to height and various coefficients.
Occurrence number of characterization observables

The mean occurrence frequency of presence, predominance and absence in total aerosol

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Conclusion

1. **Vertical aerosol mass concentration profiles** can be extracted from elastic lidar data with additional use of aerosol properties information at the surface.

2. **Aerosol types in different atmospheric structures** can be identified using Raman lidar data. They were found to be mixtures of mineral dust, traffic emissions, particles from biomass burning and marine aerosols.

3. **The contribution of individual aerosol types** to light attenuation (air pollution) can be separated, which provides information on the dispersion of specific aerosols and allows effective control of air quality in the valley.
Thank you for your attention!