The COMTESSA project: Tomography of artificial SO₂ plumes with multiple SO₂ cameras for improving our understanding of plume dispersion and turbulence

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SO₂ cameras deliver SO₂ column density images based on measurements of backscattered sunlight at different wavelengths. A set of 9 SO₂ cameras was developed to meet the requirements of COMTESSA in respect of spatial and temporal resolution.

**Camera Observations and Modelling of 4D Tracer Dispersion in the Atmosphere**
Andreas Stohl (ast@nilu.no)
1/11/2015 – 31/10/2020
Experiments: every year in spring & summer
Military facilities in Norway
High-resolution 4D tracer concentration field

**Goals**
- **SO₂ Camera technique**
  - Validation of SO₂ retrieval
  - Comparison of UV and IR imaging
- **Tomography**
  - 3D reconstruction of SO₂ plume
  - 3D optical flow analysis
- **Turbulent dispersion**
  - Richardson-Obukhov constant
  - Parameterizations for Lagrangian models

**Atmospheric boundary layer**
- Test of Richardson-Obukhov law
- Relative dispersion and meandering of plume and puffs
- Statistics of velocity vector field and scalar concentration field
- Two-point concentration structure function

**Further Reading**
Radiative Transfer: Emde et al. 2016 Geosci. Model Dev., 9, 1647–1672, 30

**Acknowledgment**
This project has received funding from the European Research Council (ERC) under the European Union’s Horizon 2020 research and innovation programme under grant agreement No 670462.

**Modelling**
Large Eddy Simulations
LES are used to examine the characteristics of the scalar field dispersing from a localized small source under a wide range of atmospheric boundary layer conditions

Radiative Transfer Simulations
Wavelength-selective intensity images as seen by the SO₂ cameras of the above concentration field are simulated using libRadtran and MYSTIC.

Tomographic 3D reconstruction
Poster X5.492 Thu 17:30-19:00: Tomographic iterative reconstruction of a passive scalar in a 3D turbulent flow

**Experiment**
Controlled release of trace gas SO₂ from tower
- Observation of SO₂ column densities from multiple viewing directions using SO₂ cameras (both UV and IR)
- Observation of atmospheric conditions on towers and tethered balloon
- Boundary layer structure (PTU sonde)
- High-speed cameras (both UV and IR)

**SO₂ Cameras**
- SO₂ cameras deliver SO₂ column density images based on measurements of backscattered sunlight at different wavelengths.
- A set of 9 SO₂ cameras was developed to meet the requirements of COMTESSA in respect of spatial and temporal resolution.

**Dimensions**
<table>
<thead>
<tr>
<th>Camera Model</th>
<th>6 x UV</th>
<th>3 x IR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camera Model</td>
<td>PCO ultraviolet (dual camera)</td>
<td>Xenics Gobi-384 (triple camera)</td>
</tr>
<tr>
<td>Wavelength Bands</td>
<td>310 &amp; 330 nm</td>
<td>8.6, 10 &amp; 11 µm</td>
</tr>
<tr>
<td>Max. frame rate [Hz]</td>
<td>7.3</td>
<td>84</td>
</tr>
<tr>
<td>FOV [°]</td>
<td>14.7 x 11.1</td>
<td>13.7 x 10.3</td>
</tr>
<tr>
<td>Resolution [pixel]</td>
<td>1392 x 1040</td>
<td>384 x 288</td>
</tr>
<tr>
<td>Focal Length [mm]</td>
<td>25</td>
<td>40</td>
</tr>
<tr>
<td>Weight [kg]</td>
<td>8.3 x 11.6</td>
<td>7.5 x 11.7</td>
</tr>
<tr>
<td>Dimensions [cm]</td>
<td>21.5 x 23.5 x 29</td>
<td>21.5 x 23 x 26</td>
</tr>
</tbody>
</table>

**Further Information**
Don’t hesitate contacting us asd@nilu.no