

SO₂ Plumes Observation with LMOL: Theory, Modeling, and Validation

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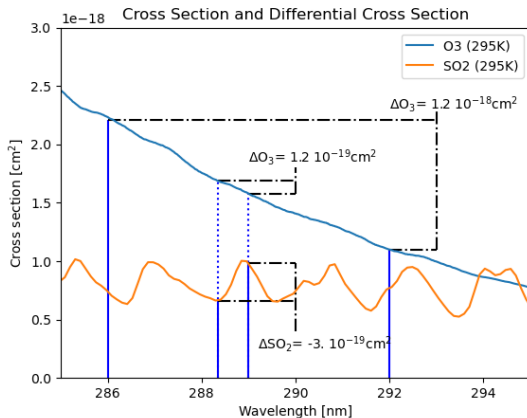
The Langley Mobile Ozone Lidar (LMOL)

LMOL

- Mobile Lidar for Aerosols and O_3 measurements, part of the TOLNet network.
- Inputs parameters, outputs parameters, uncertainty validation, etc, validated by the network.
- Adapted to study evolution of O_3 .
- Available to support calibration/validation of satellites (TROPOMI, TEMPO)
- Typical resolution: 5 min, 20 m – 1000 m (vertical).
- Capabilities: 100m – 6/7 km altitude (day), 10 km (night)...and improving!
- Smallest TOLNet Lidar / most mobile.
- **TUNABLE LASER**

Adaptation to SO₂

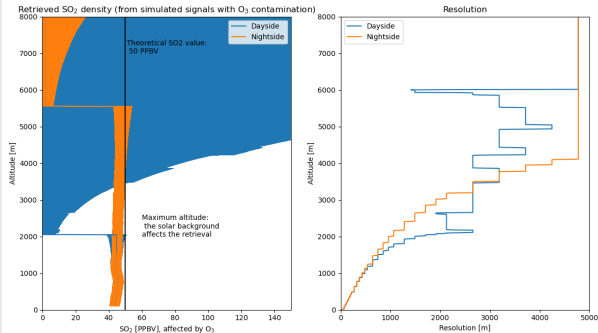
Wavelength selection to observe SO₂ with minimal contribution from O₃



- Density retrieval sensitive to $\Delta\sigma$
- Wavelength dedicated to lower O₃ sensitivity relative to SO₂
- Wavelength selection so that high O₃ would appear as negative SO₂ value

Validation of SO₂ capabilities

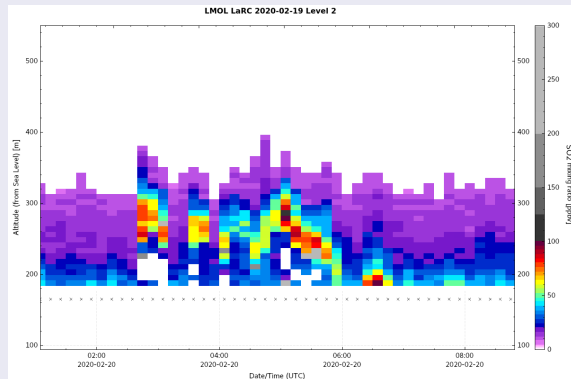
Retrieval of modeled lidar signals



- Lidar signals were modeled with fixed SO₂
- Daylight contribution was added based on LMOL observation
- LMOL standard retrieval algorithm was applied to modeled signals
- Validates the capabilities of LMOL to retrieve and estimate the uncertainty

Observation of SO₂ from the Hampton Steam Plant

Steam Plant Plume observation



- LMOL observed a SO₂ plume that is coming from the nearby steamplant
- 90 PPBV is observed over a 50 m height.
- Windspeed was 0.5m/s, if we approximate the plume by a 50 m diameter “tube” this gives 10 tons of SO₂ emitted per year, to be compared with the 8 tons reported.
- (Large uncertainties exist in the variation of the emissions and the shape of the plume, which means we are way inside the errorbars)

Discussion / Conclusions

Conclusions

- Adaptation of LMOL to SO_2 observations was validated by modeling.
- The current system works if O_3 density is small /not varying.
- Observation of SO_2 plume of the nearby steamplant is consistent with the official exhaust numbers.
- Future development of LMOL involve using 3 wavelengths to retrieve both O_3 and SO_2 without interference.