

# SO<sub>2</sub> Plumes Observation with LMOL: Theory, Modeling, and Validation

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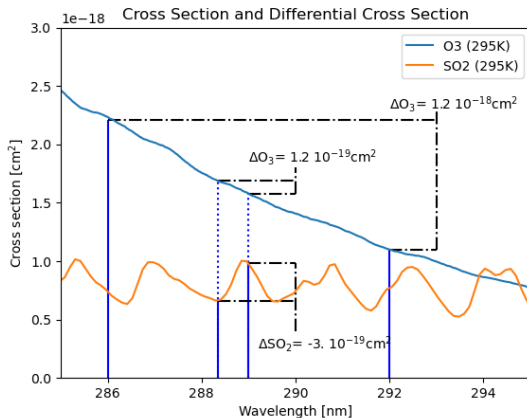
# The Langley Mobile Ozone Lidar (LMOL)

## 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 SO<sub>2</sub>

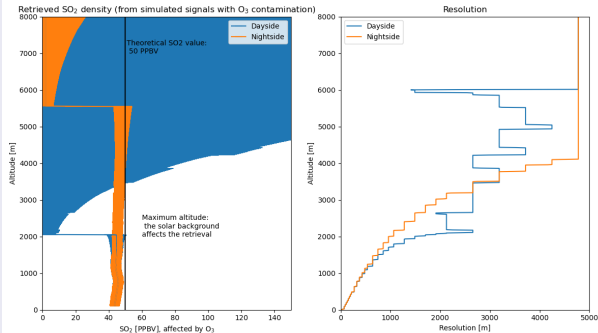
## Wavelength selection to observe SO<sub>2</sub> with minimal contribution from O<sub>3</sub>



- Density retrieval sensitive to  $\Delta\sigma$
- Wavelength dedicated to lower O<sub>3</sub> sensitivity relative to SO<sub>2</sub>
- Wavelength selection so that high O<sub>3</sub> would appear as negative SO<sub>2</sub> value

# Validation of SO<sub>2</sub> capabilities

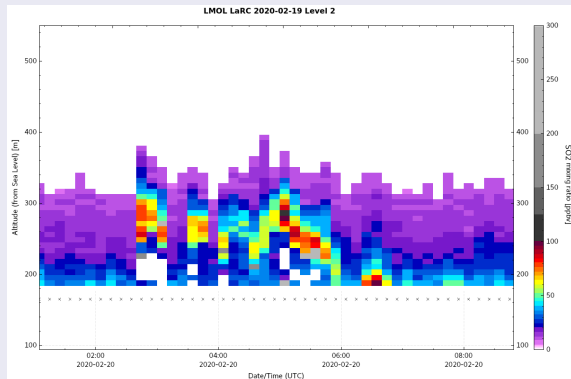
## Retrieval of modeled lidar signals



- Lidar signals were modeled with fixed SO<sub>2</sub>
- 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 SO<sub>2</sub> from the Hampton Steam Plant

## Steam Plant Plume observation



- LMOL observed a SO<sub>2</sub> 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 SO<sub>2</sub> 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)

## Conclusions

- Adaptation of LMOL to  $\text{SO}_2$  observations was validated by modeling.
- The current system works if  $\text{O}_3$  density is small /not varying.
- Observation of  $\text{SO}_2$  plume of the nearby steamplant is consistent with the official exhaust numbers.
- Future development of LMOL involve using 3 wavelengths to retrieve both  $\text{O}_3$  and  $\text{SO}_2$  without interference.