Ozone vertical profiles over Bucharest

Introduction to the Ozone Lidar system from Magurele-Bucharest

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Outline

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Introduction

The Differential Absorption Lidar Technique - (DIAL) offers a way to perform measurements for the retrieval of ozone vertical profiles (ppb) (up to 12 km for our system)

This paper presents the DIAL system at Magurele and shows some preliminary results of ozone vertical profiles obtained over Magurele, Romania

- this are the first profiles of this type measured and process at our site-

-the results are promising, but lot of work is still needed-

DIAL technique

- DIAL – Differential Absorption Lidar

The DIAL system is based on the differential absorption of light. Basically the DIAL transmits two wavelengths: an "on-line" wavelength that is absorbed by the gas of interest (in our case ozone) and an off-line wavelength that is not absorbed. The differential absorption between the two wavelengths gives a measure of the concentration of gas as a function of range.

The system used in ozone retrievals has three of this ”on”-”off” pairs

- 266-289 nm for lower part of the profile – up to 2 km

- 289-299 nm for the mid part of the profile – between 2 and 6 km

- 299-316 nm above 6 km

Pairs chosen in accordance with the ozone absorption cross section for that specific wavelength.

The DIAL system

- Three blocks
  - Emission block
    - Quanta Ray laser @ 266nm @ 10hz @ 120mJ
    - Two Raman Cells (D2, H2, N2) for 289, 299, 316nm
  - Reciving block
    - Newtonian telescope
    - 400mm, f=4m, D=6mm
  - Aquisition block
    - Licel 4 x an+pc TR 20

Case study

- 9 th of june 2010-

- the only profile that gave relevant results -

- day measurement with 1h of averaging-

- ozone rerieval with no beta and alpha corrections -

Case study
-data processing-

Concentration retrieval

$$N_a = \frac{1}{2(R_2 - R_1)(\sigma_{on} - \sigma_{off})} \ln \frac{P_{on}(R_1) \cdot P_{off}(R_2)}{P_{off}(R_1) \cdot P_{on}(R_2)} - \frac{1}{2(R_2 - R_1)(\sigma_{on} - \sigma_{off})} \ln \frac{\beta_{on}(R_1) \cdot \beta_{off}(R_2)}{\beta_{off}(R_1) \cdot \beta_{on}(R_2)} - \frac{1}{\sigma_{on} - \sigma_{off}} (\alpha_{on} - \alpha_{off})$$

-first term = concentration, second and third are corrections for beta and alpha

Error propagation

$$\varepsilon_s = \frac{1}{2n\Delta\sigma_{onoff} \cdot \Delta Z N^{1/2}} \sqrt{\frac{2}{SNR_1^2} + \frac{2}{SNR_2^2}}$$

Statistical error

(no systematic errors used in this study)

where: $SNR_i = P_i/(P_i + P_{bi})^{1/2}$

P_i = number of photons at channel i (i=ON or OFF wavelength)

P_{bi} is the background noise at channel i

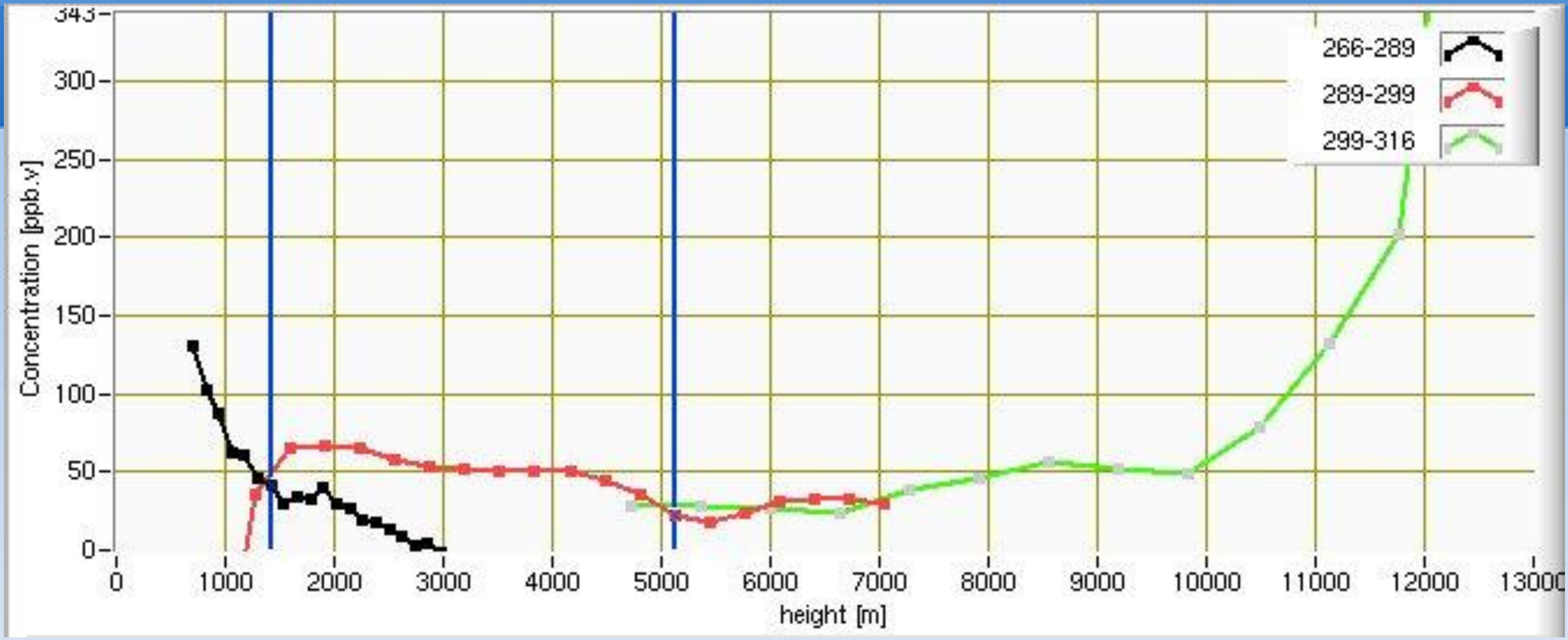
Δz = range resolution

$\Delta\sigma_i = \sigma(\lambda_{ON}) - \sigma(\lambda_{OFF})$ for ozone

n = ozone concentration at range z

N = number of laser shots (related to the integration time)

Case study



-overlap of first part of profile – different overlap for each pair, corrections

-second and third pair – good agreement

-promising results-

Future work

- beta and alpha corrections
- extended error analysis (systematic error calculus to be implemented)
- MORE MEASUREMENTS – one is not conclusive
- correlations with ground measurements, airborne measurements (low probability)

Conclusions

- this paper presents the system and the first ozone profile over Bucharest – PRELIMINARY RESULTS

- pairs 289-299nm and 299-316nm are in good agreement

- more measurements are needed for conclusive results

- for the first sector of the profile, the overlap differences between channels are not negligible (slope and values are not reliable) - good alignment is crucial. Corrections are also very important

- a good practice is to know the overlap function for all channels- helps in the retrieval of ozone for the low part of the profile (up to 1,5 km)

- for dial measurements, long averaging is needed (bad retrievals for low averaging)

Thank you!!

Comments and questions are welcomed!!