NRC·CNRC

Spectrometer calibration with UAV-BORNE LED

Ivănescu, L.[1], Marseille, C.[2], O'Neill, N.T.[2], Albert, J.E.[3]

[1]NRC-CNRC, Ottawa, CANADA
[2]Université de Sherbrooke, Sherbrooke, CANADA
[3]University of Victoria, Victoria, CANADA

CORM/CIE joint conference
06 Nov 2023

Motivation

Part of

- “Flights for Precision Calibration for Dark Energy, Microwave Astronomy, and Atmospheric Physics” project (CSA).
- “Airborne Laser for Telescopic Atmospheric Interference Reduction”, or ALTAIR project (CSA).

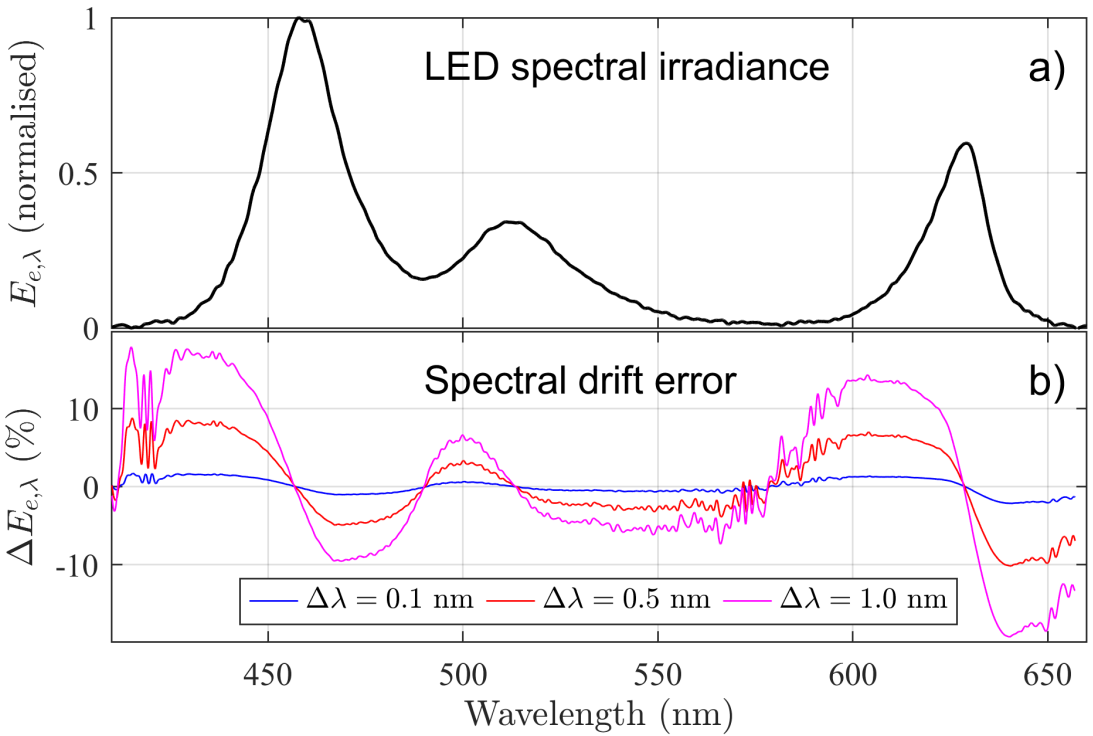
Scope

- Investigate feasibility and the limitations of using an UAV-borne (Unmanned Aerial Vehicle) light source for calibrating a spectroradiometer.
- Investigate limitations in using an LED light source for calibration.
- Proof-of-concept experiment for future use of satellite- and balloon-borne calibration light sources.

Outline

- Laboratory spectral irradiance measurement
- Starphotometer-UAV calibration set-up
- Langley calibration results

Laboratory LED spectral irradiance measurement



$M_0 = -2{,}5 \log E_{e,\lambda}$, magnitude of spectral irradiance

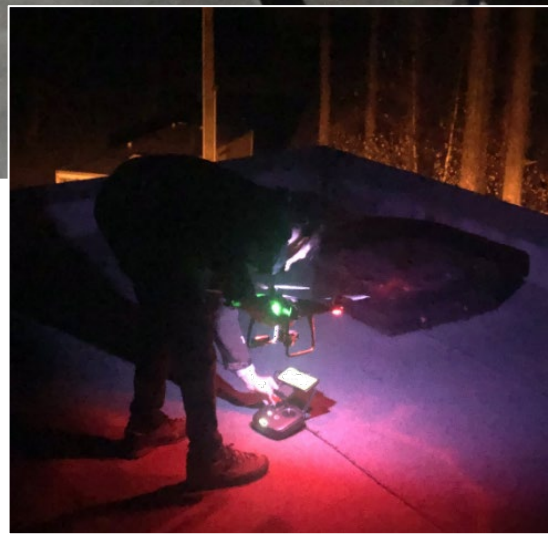
Calibration set-up

$S = -2{,}5 \log F$, starphotometer magnitude of measured signal F (counts/s)

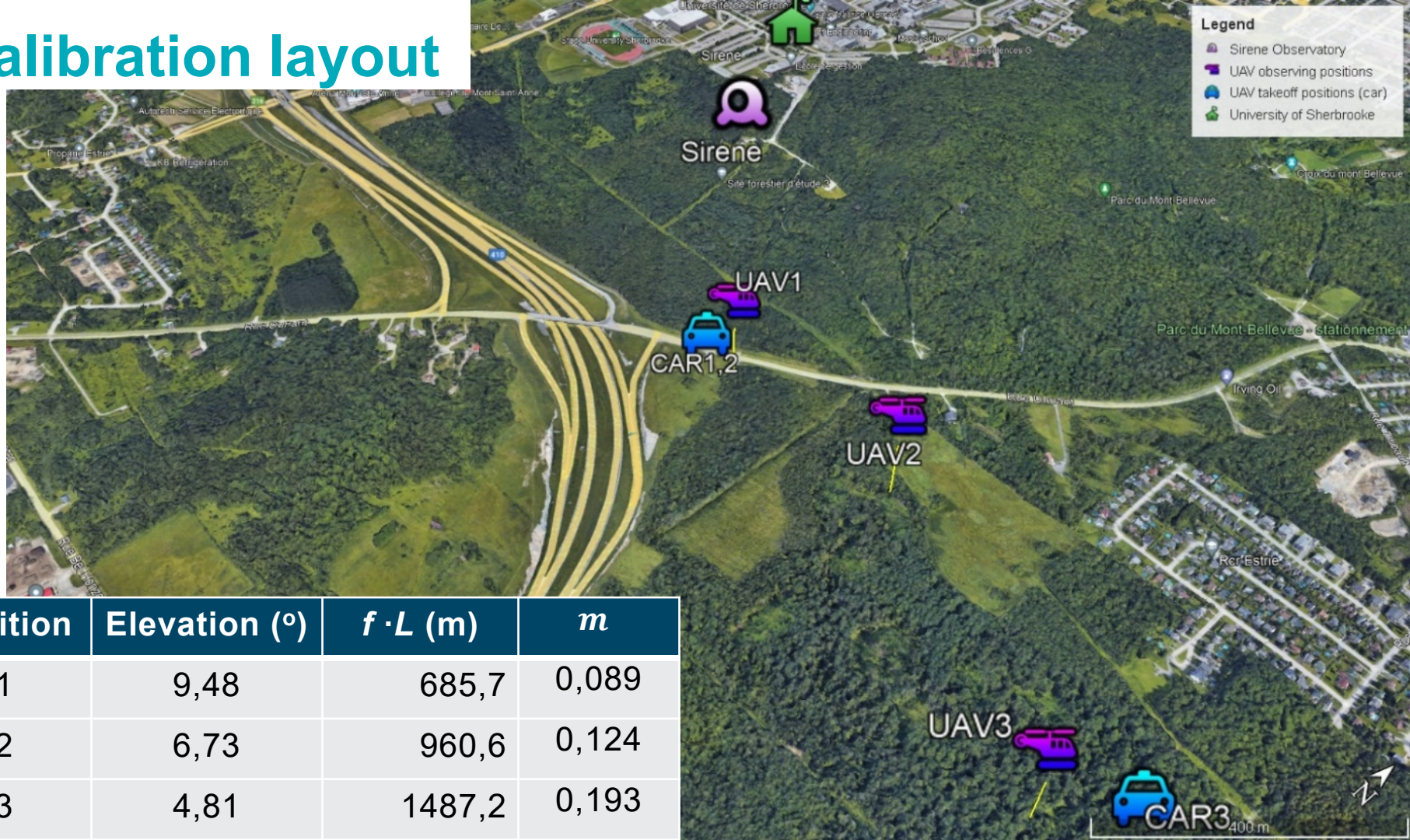
$S = \tau x + S_0$, Langley calibration to retrieve S_0 (unattenuated S) and τ (optical depth) where $x = m/0{,}921$, with m the airmass.

$C = M_0 - S_0$, retrieval of the calibration C

C factor accounts for the optical and electronic throughput of the starphotometer, as well as the photometric system transformation between the instrument signal magnitude and the laboratory absolute units-based magnitude

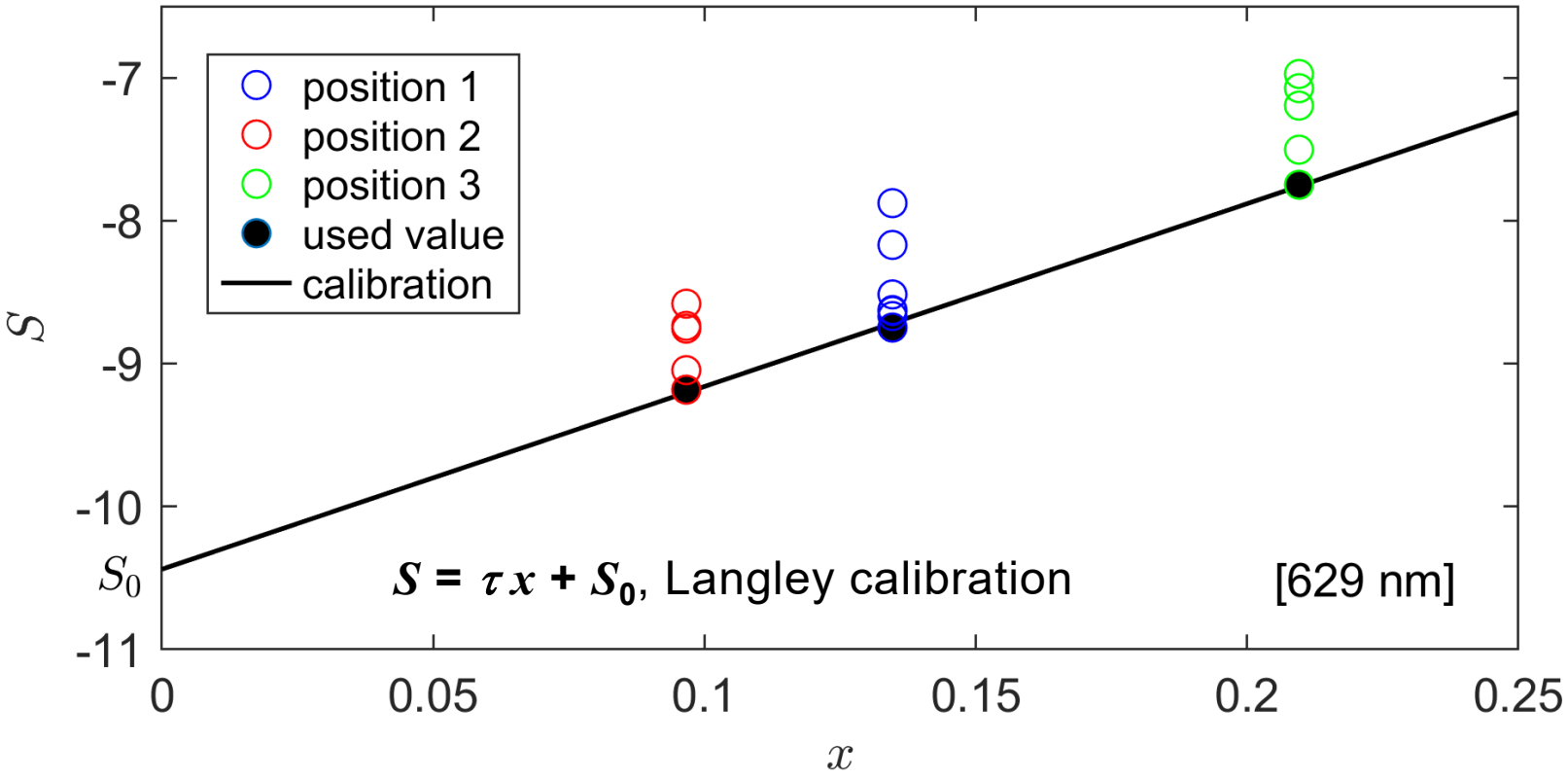


Calibration layout



Position	Elevation (°)	$f \cdot L$ (m)	m
1	9,48	685,7	0,089
2	6,73	960,6	0,124
3	4,81	1487,2	0,193

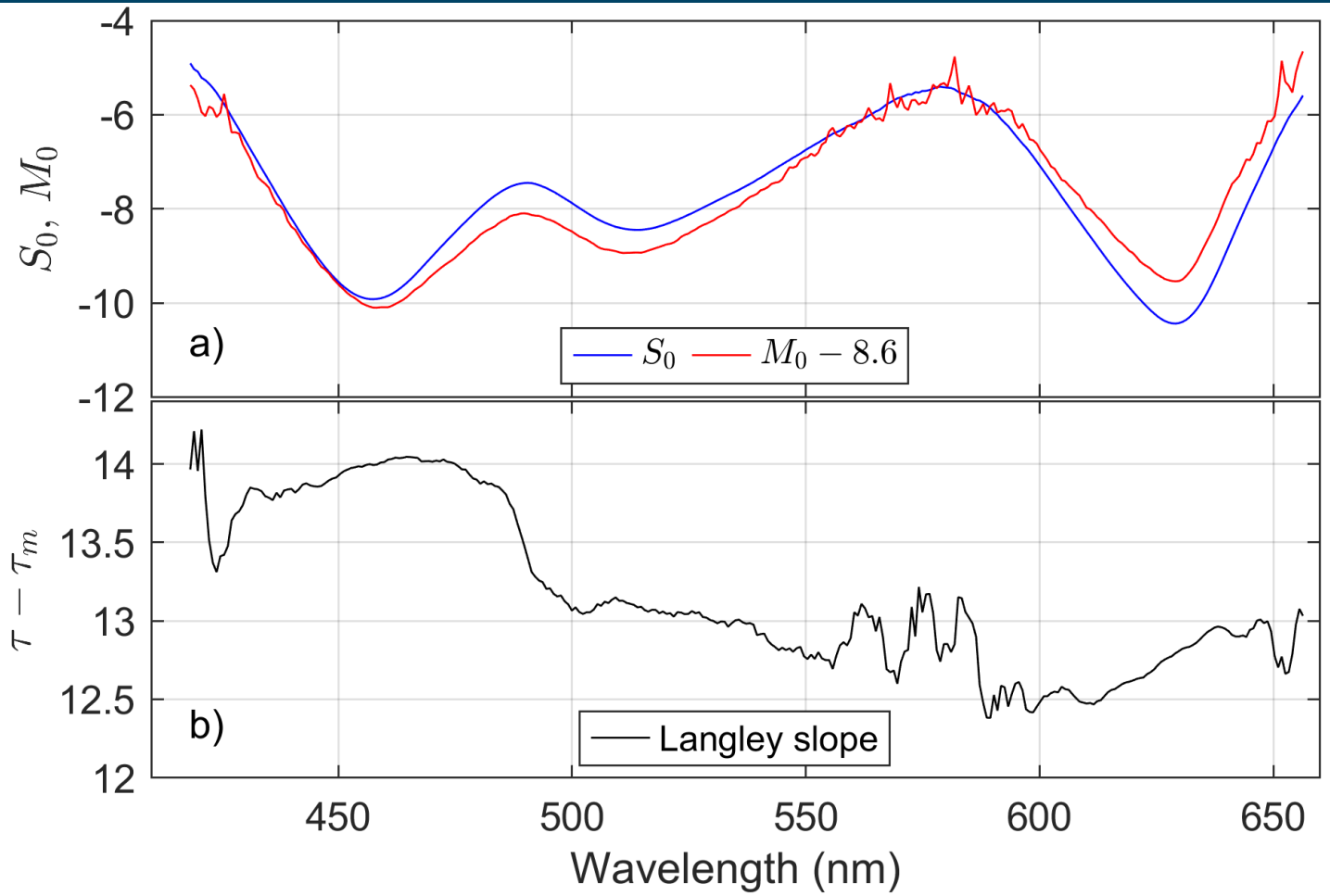
Spectroradiometer Langley calibration



$S = -2{,}5 \log F$

$x = m/0{,}921$

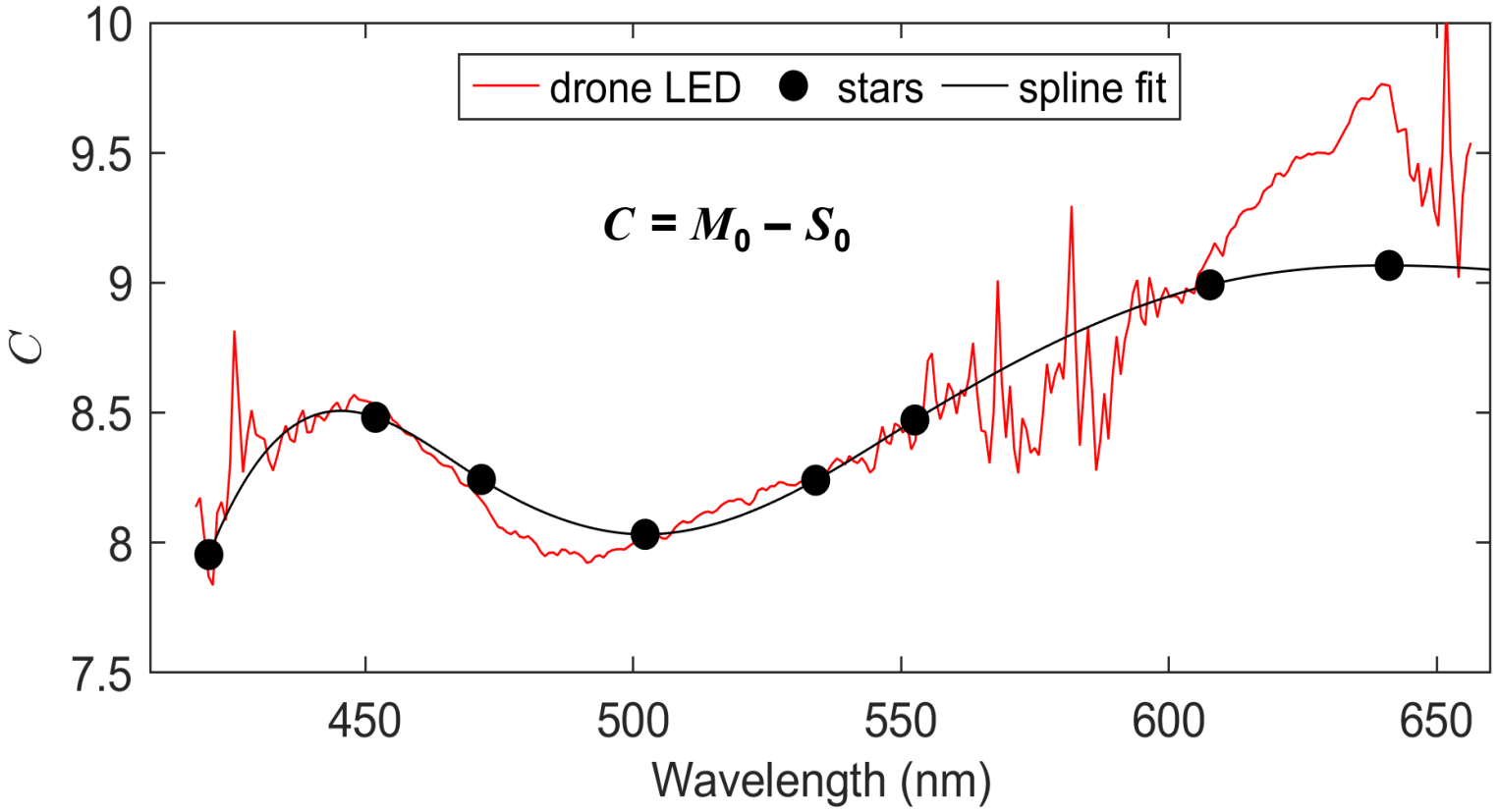
Calibration byproducts



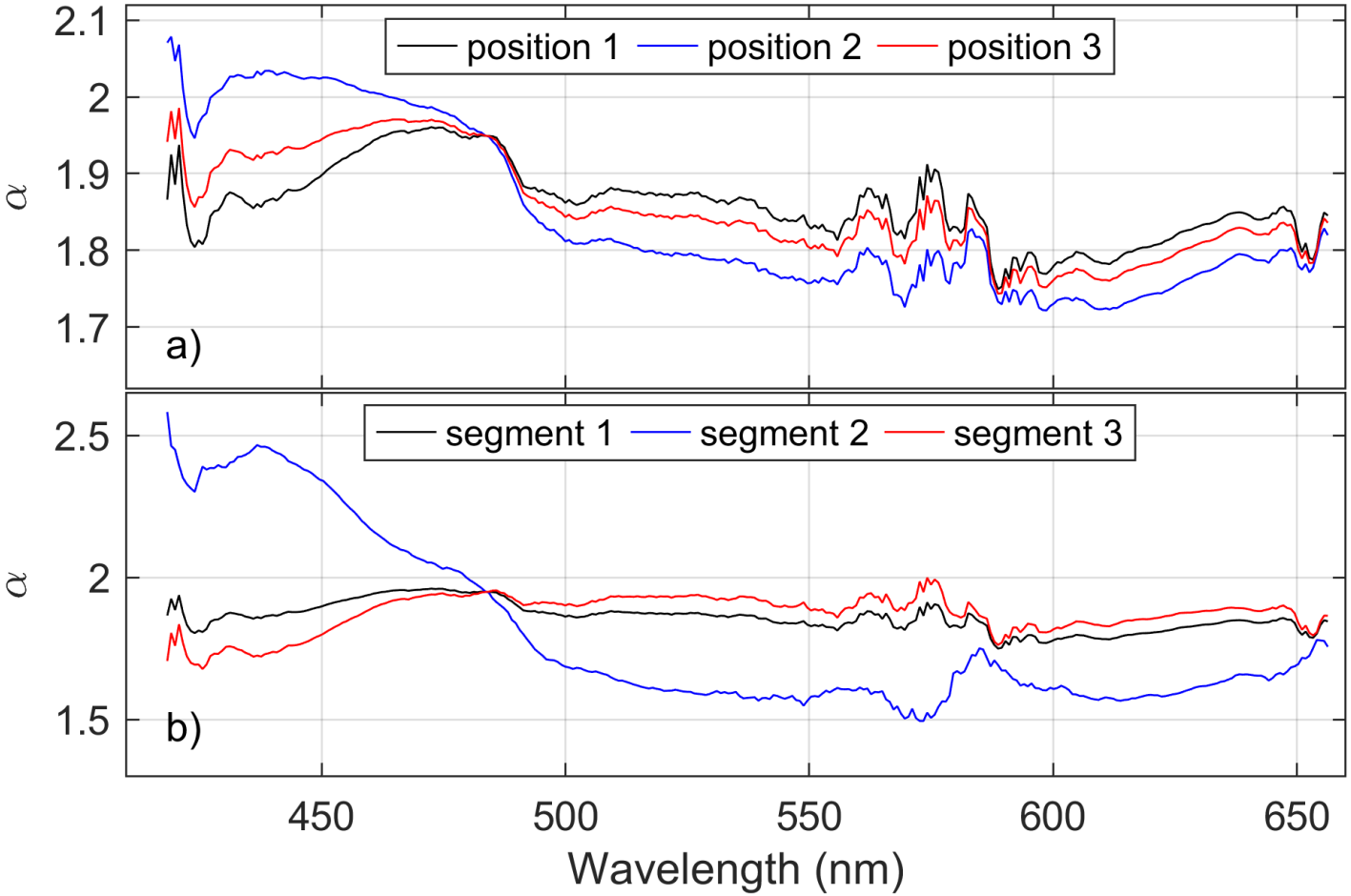
$S = \tau x + S_0$

Langley calibration

Calibration retrieval



Extinction retrieval



$S = \tau x + S_0$

Langley calibration

Conclusions

Managed to retrieve encouraging calibration values, while developing an innovative way of retrieving particulate extinction profiles along the line of sight, but:

- Very challenging to stabilise the UAV light acquisition at close–range
- Not able, at this stage, to test the tracking of the angular drift levels expected from a radiosonde-balloon
- Potential solutions: larger FOV and/or real-time tracking system, like active or adaptive optics
- Narrow-band LED references are problematic

Thank you

Liviu Ivanescu • Research Officer • Liviu.Ivanescu@nrc-cnrc.gc.ca