1. Introduction

The CANDAC Rayleigh-Mie-Raman Lidar (CRL) is stationed in the Canadian Arctic in Eureka, Nunavut (80N, 86W). It measures various physical properties of the atmosphere from the ground up to the mid-stratosphere. At low altitudes the CRL has a reduction in photon counts due to an incomplete transmitter-receiver overlap and therefore an altitude dependent correction, known as the overlap function, is used. The observed overlap is modeled using a simple thin-lens model. Agreement between the observed and modeled overlap functions allow the instrument’s characteristics to be better understood and improve its performance at low altitudes.

Goal: Model the overlap profile and improve the CRL’s performance at low altitudes.

2. The Overlap

The beam steering mirror and support (at B) block a fraction of the incoming signal from being recorded by the telescope below. Overlap profiles while varying the field of view (FOV) and beam’s zenith angle are used to determine how well the overlap can be modeled and thus characterize the CRL better.

Data Collection:
- Aligned the beam vertically
- Collected photon signals at FOV’s: 1.0 mrad, 1.5 mrad and 2.0 mrad
- Collected photon signal at 1.5 mrad FOV again (vertically aligned)
- Then misaligned the zenith angle by +50 steps in the y-direction
- Converted photon signal count to overlap values using the Lidar equation (C. Weitkamp)

Overlap Model:
- Thin-lens model of the receiver (ray tracing)
- Telescope is represented as a single lens with a field stop
- Main adjustable variables:
  - FOV of the telescope
  - δ displacement of the field stop from the focal length of the telescope
  - Beam divergence
  - Zenith angle of the beam

3. Results of the Model fits

- The photon signal count increases with increasing FOV and decreases with altitude.
- The sharp drop in signal near the ground is due to the overlap effect.
- The overlap affects the signal up to several kilometers in altitude, however it is most noticeable between the ground and 1km.

Varying the FOV parameter settings:
- Scaling factor (green) = 38%
- Scaling factor (red) = 66%
- Scaling factor (blue) = 90%
- δ = -0.079 m
- Beam divergence = 0.99 mrad
- Zenith angle = 0.42 mrad
  - Corresponds to a 107 step offset!

Varying the zenith angle parameter settings:
- FOV = 1.40 mrad
- δ = -0.016 m
- Beam divergence = 0.59 mrad
- Zenith angle (pink) = 0.41 mrad
- Zenith angle (yellow) = 0.29 mrad
  - Corresponds to a 31 step difference!

4. Conclusion and Future Work

- Designated measurements of the overlap profile to characterize the CRL:
  - varied the FOV
  - zenith angle was purposely misaligned
- Optimized the model overlap for the best fit
- The models had similar parameter values for both of the above experiments
- The model indicates that the instrument pointing system misaligns the ‘vertical’ beam – an error in zenith angle (and possibly azimuth) positioning.
We need to...
- Analyze the instrument pointing system to fix misalignment issues.
- Double check conversion calculations of the zenith angle.
- Make adjustments to the setup as the optimized parameters suggest to improve the overlap profile of the CRL.

References and Acknowledgements