Contamination of Ground Spectral Measurements Due to Operator Proximity

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Ground Spectral or Field Spectrometry Measurements

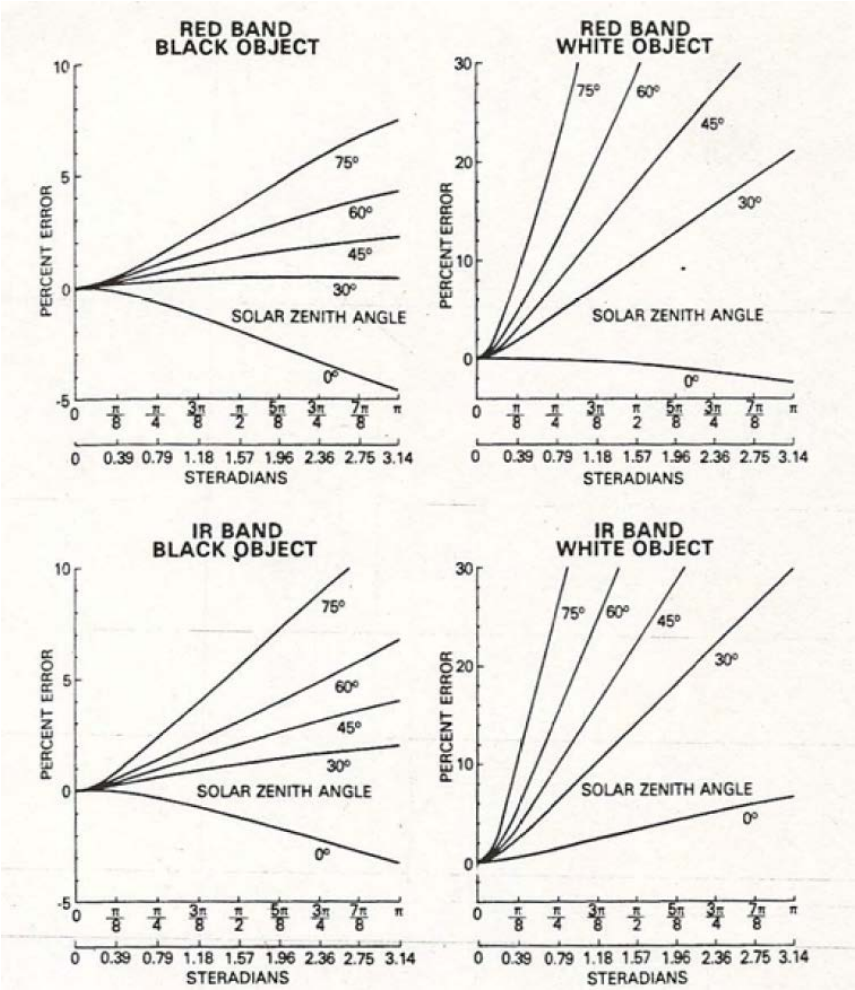
- Plays an important role in many remote sensing campaigns
  - Vicarious or Scene-based calibration
  - Ground validation studies
  - Used in support of airborne and spaceborne acquired imagery

Ground Spectral or Field Spectrometry Measurements

- Accuracy requirements
  - varies depending on application
  - can be significantly influenced by the methodology used to make the ground measurements.
  - operator proximity to either the reflectance reference panel or the target of interest is one such issue that can have an impact the quality of the results.

- Question - How significant and what is the nature of the errors induced by operator proximity?

- Although the issue of scattering of incident light off nearby objects is commonly referred to, only one published article was found attempting to quantify the effect.
  - Kimes, D.S., Kirchner, J.A., and Newcomb, W.W.(1982). “Spectral radiance errors in remote sensing ground studies due to nearby objects”, Applied Optics, Vol. 22, No. 1, February 1982.
- The reported results were simulated and for two channels, a broad red and a broad near IR band, for a black and white object.
- Wanted to get a handle on what the impact is on the quality of ground spectrometer measurements.



From Kimes et al. 1982

Panel Substitution Methodology (PSM)

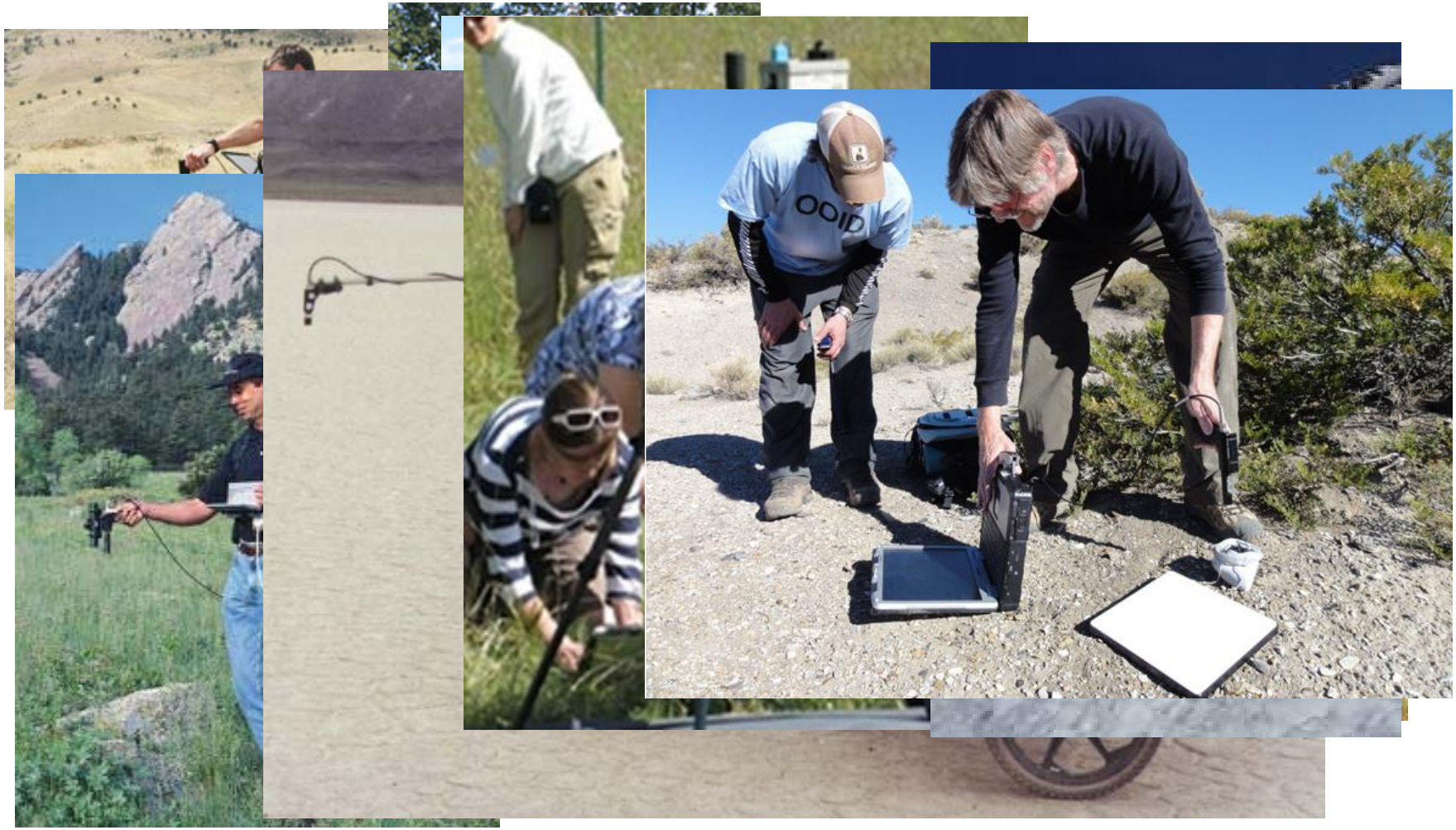
$$R_T(\lambda) = \frac{S_T(\lambda)}{S_R(\lambda)} \times R_R(\lambda)$$

where

- $R_T(\lambda)$ = Target Reflectance
- $R_R(\lambda)$ = Reference Panel Reflectance
- $S_T(\lambda)$ = Target Signal
- $S_R(\lambda)$ = Reference Panel Signal

- Radiometric System Linearity
- Instrument Stability
- Stability of Illumination conditions between reference and target measurements.
- Spectral reflectance of the reference
- Field-of-View (Target homogeneity)

Field Spectrometer Deployment Photos From Google Images



Data Acquisition

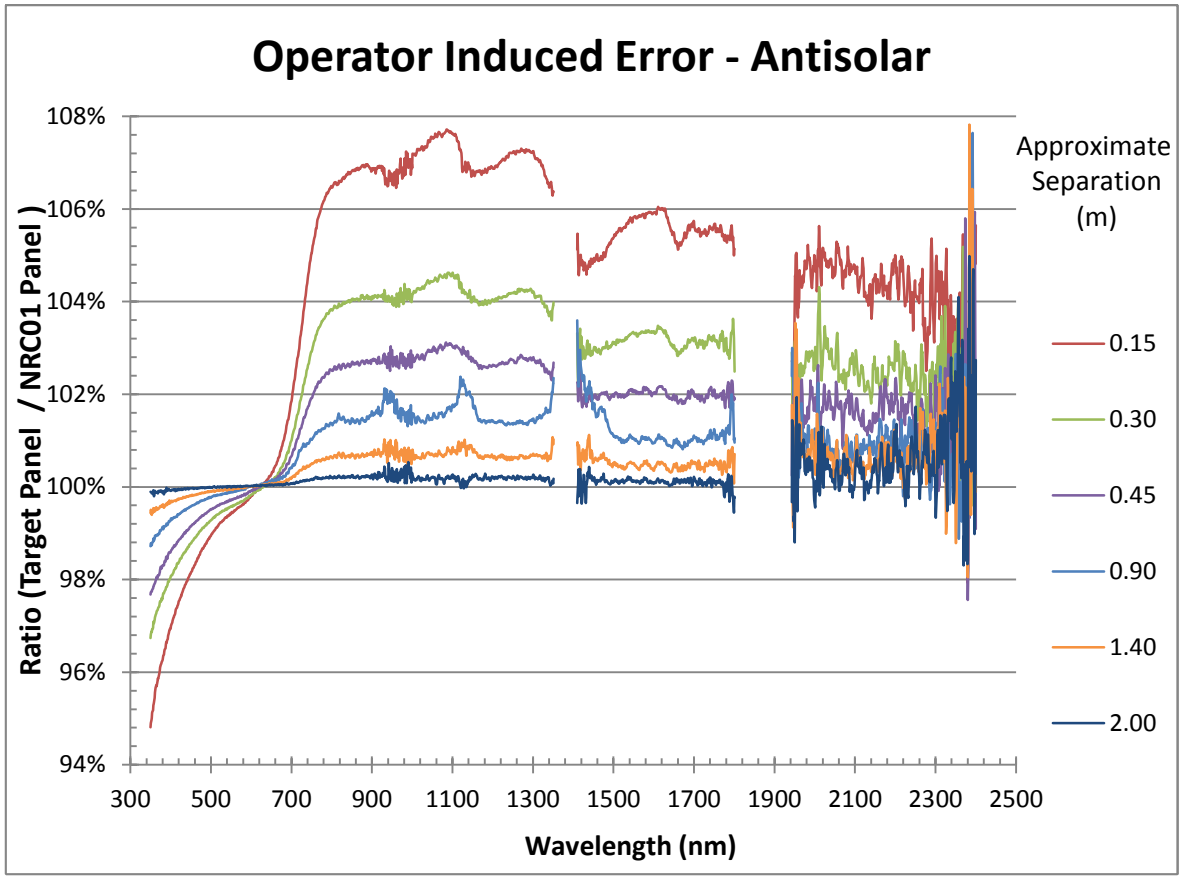
- Tripod mounted ASD Field Spec3 with 1° FOV at 1.4 m AGL
- Spectralon reference panel at 0.9 m AGL
- 1.89 m Operator
- Cloudless sky
- Open field (low horizons)
- 31° Solar Zenith Angle
- Quick data acquisition sequence (2 minutes) to minimize fluctuations in the downwelling irradiance
- Measurements of Spectralon Panel acquired with operator separation of +10m (reference), 0.15, 0.30, 0.45, 0.90, 1.40, 2.00, and +10 m (alternate reference)

Operator Induced Error - Definition

Operator induce error is define as the **ratio** of **signal acquired with obscuration of the diffuse light** by the operator (the reference measurement) to the **signal acquired without operator** obscuration (the target measurement).

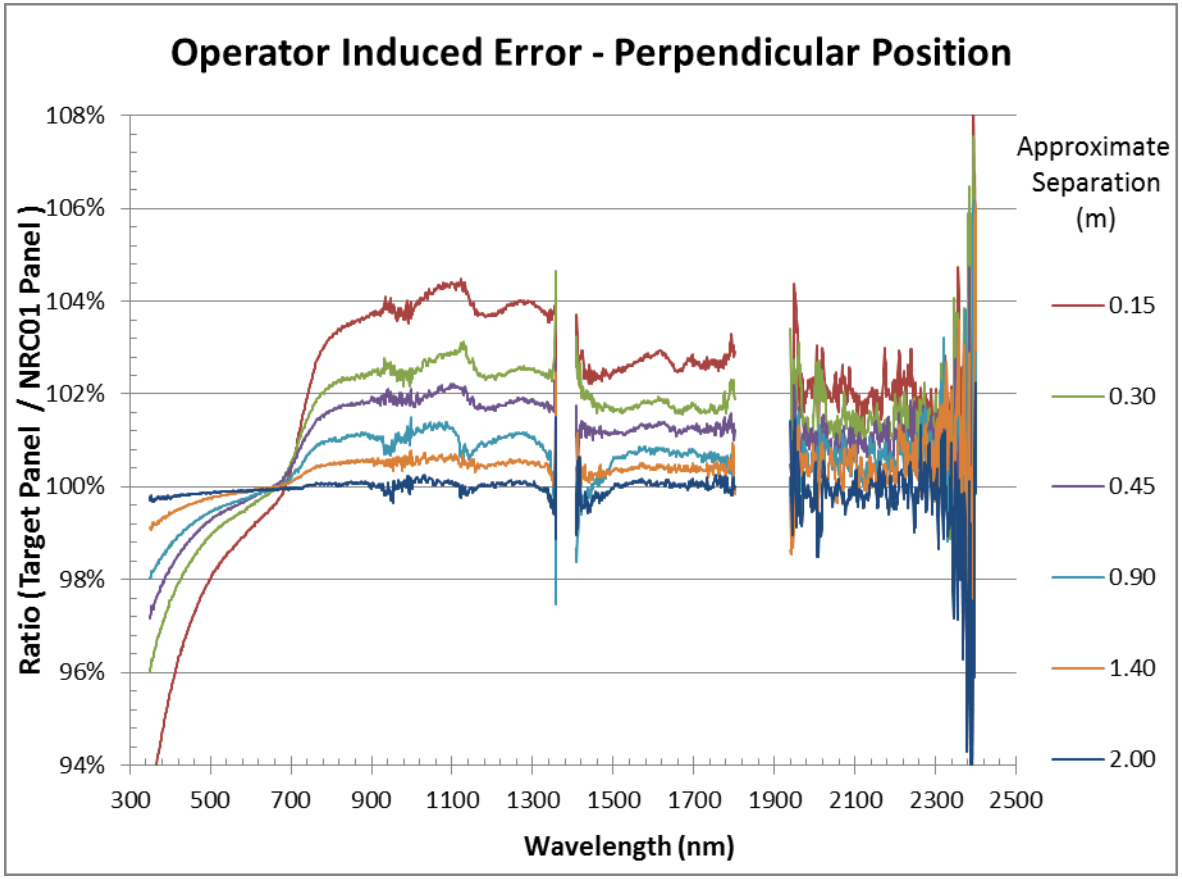
Operator Proximity: Antisolar Position

Operator separation: 10+ m
(alternate reference)

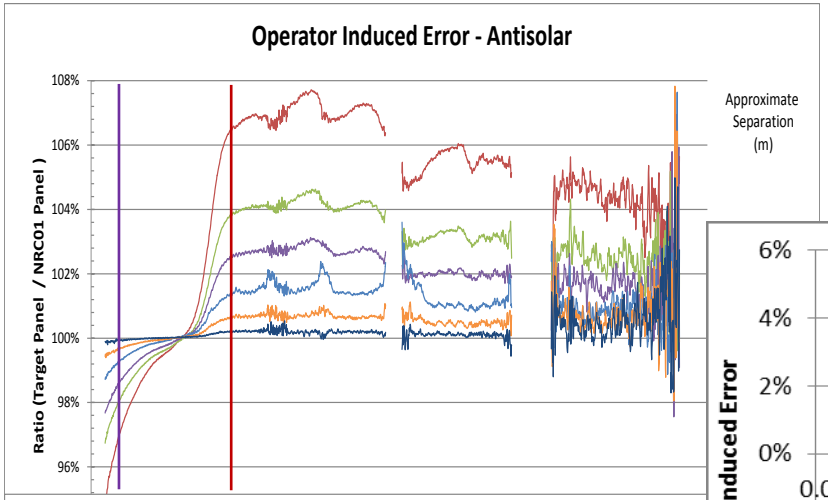


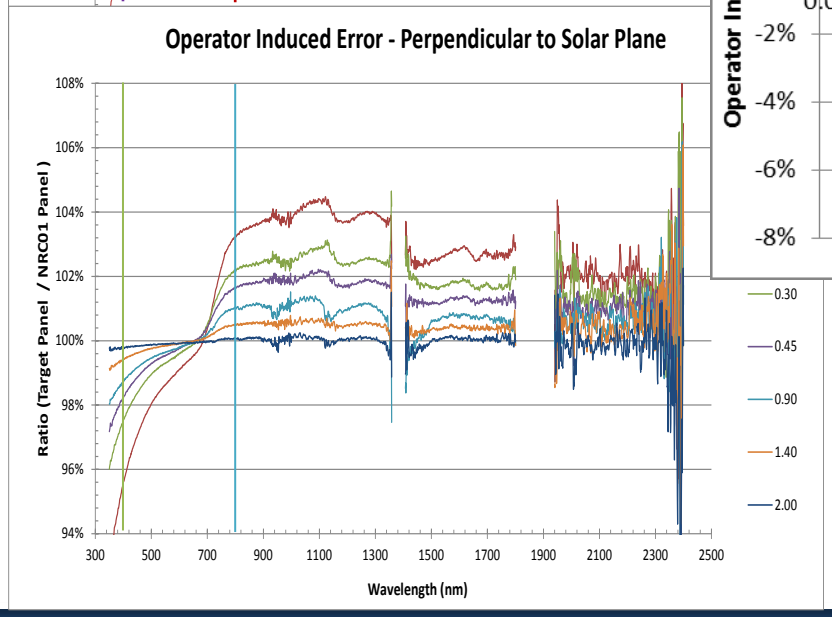
Operator Proximity: Perpendicular Position

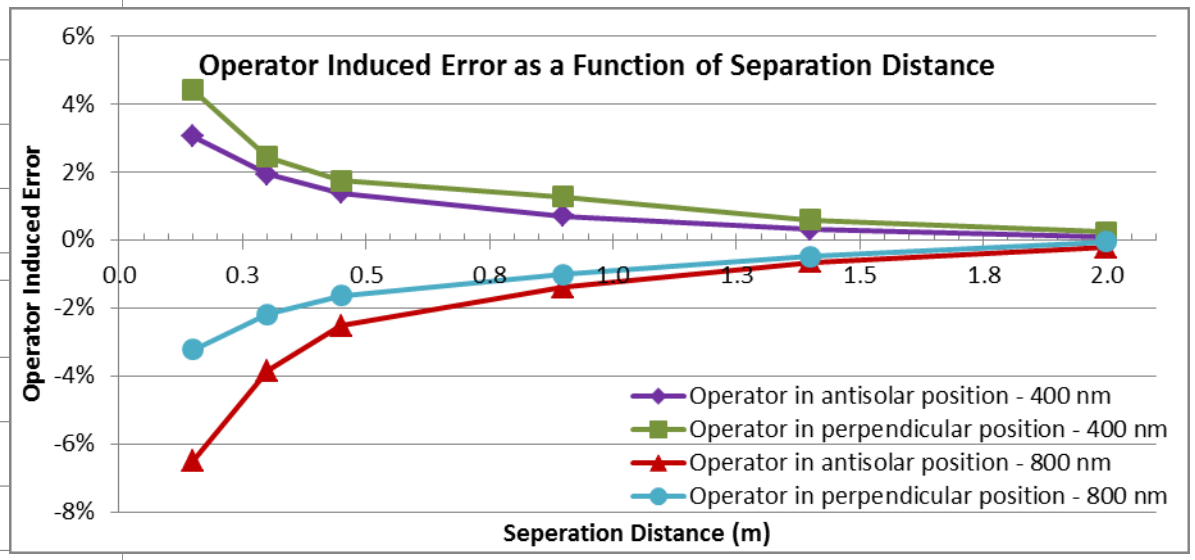
Operator separation: 10+ m (alternate reference)



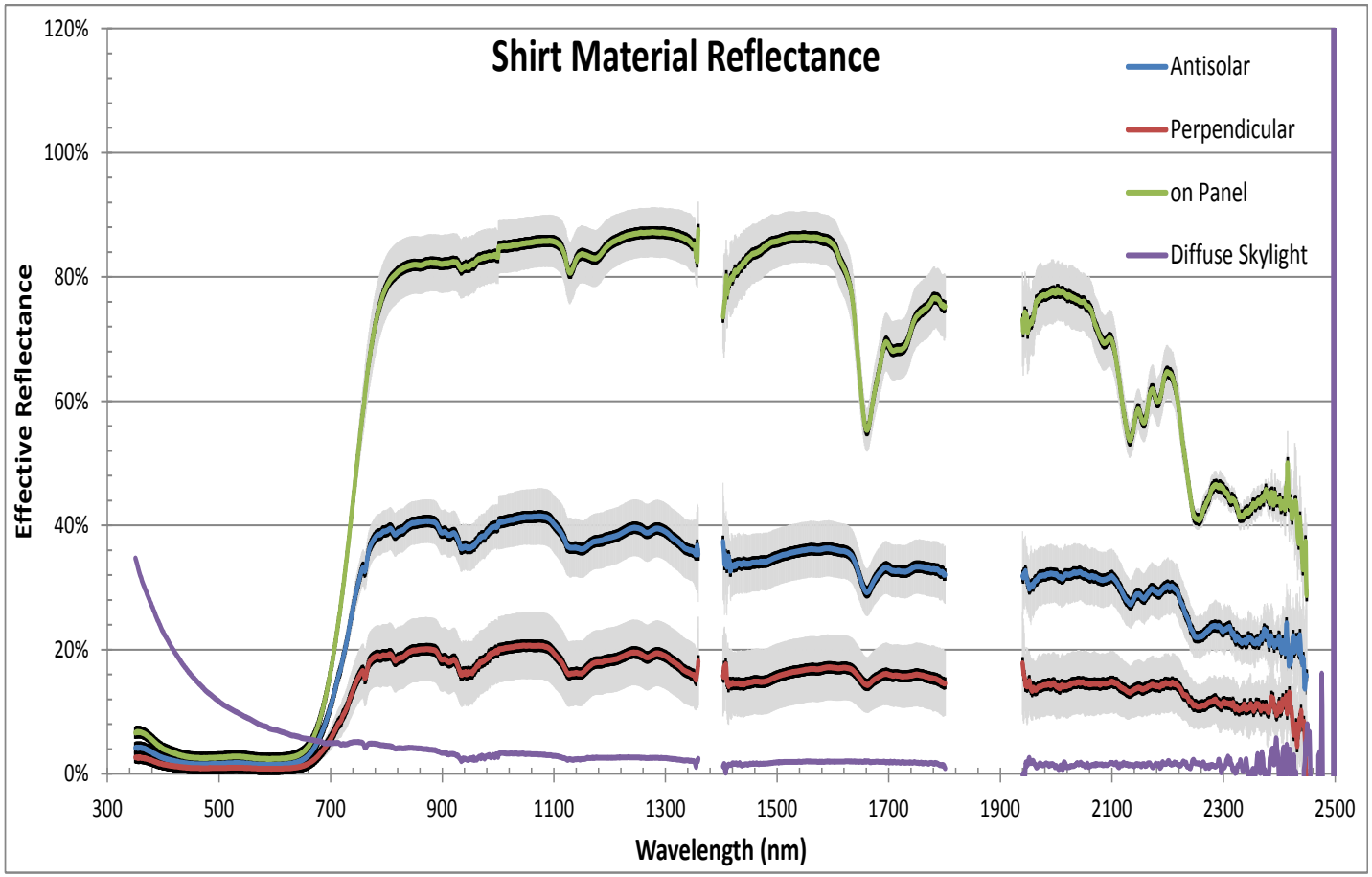
Operator Induced Error as a Function of Separation Distance



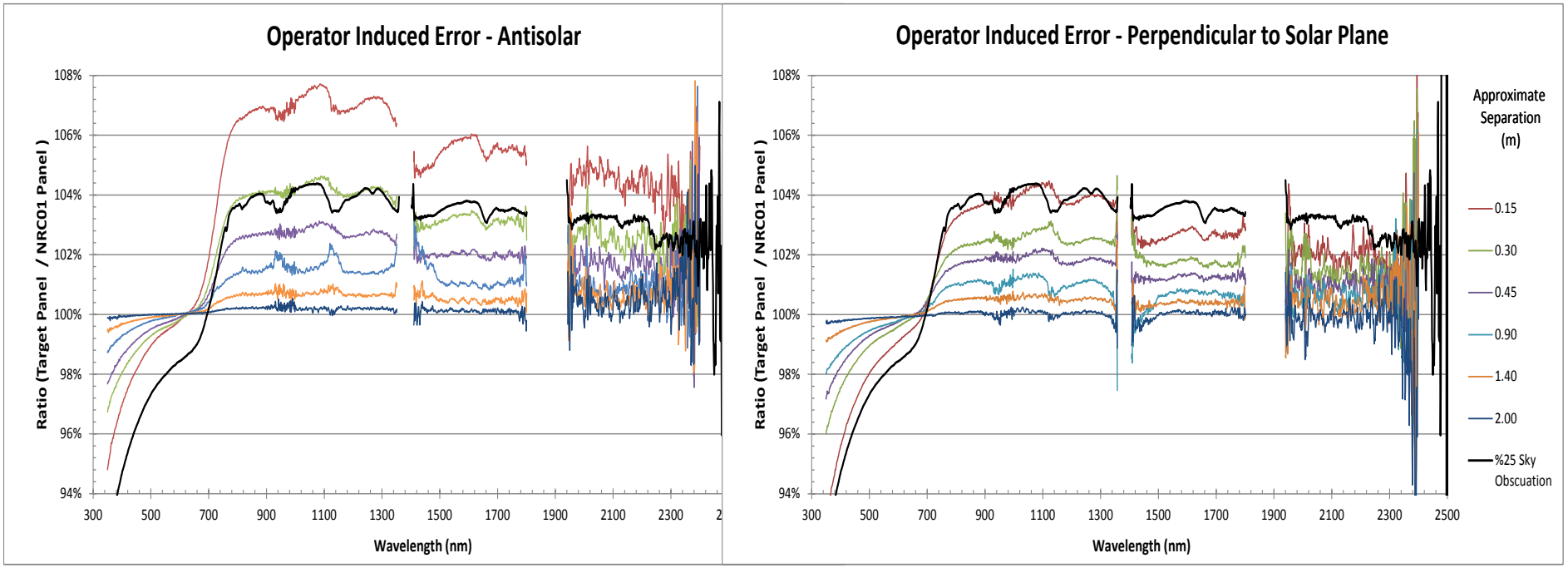




Shirt Reflectance

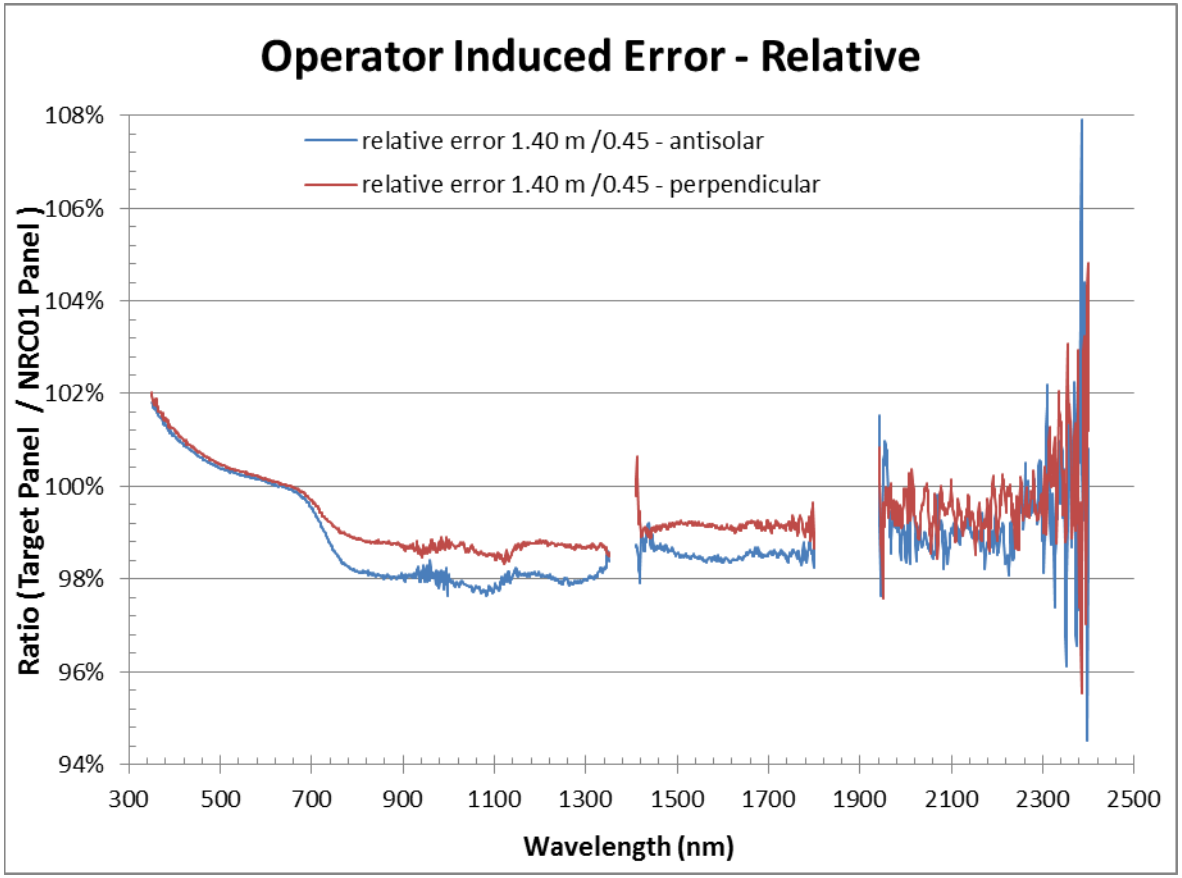


Modeling impact of operator as function of % obstructed skylight

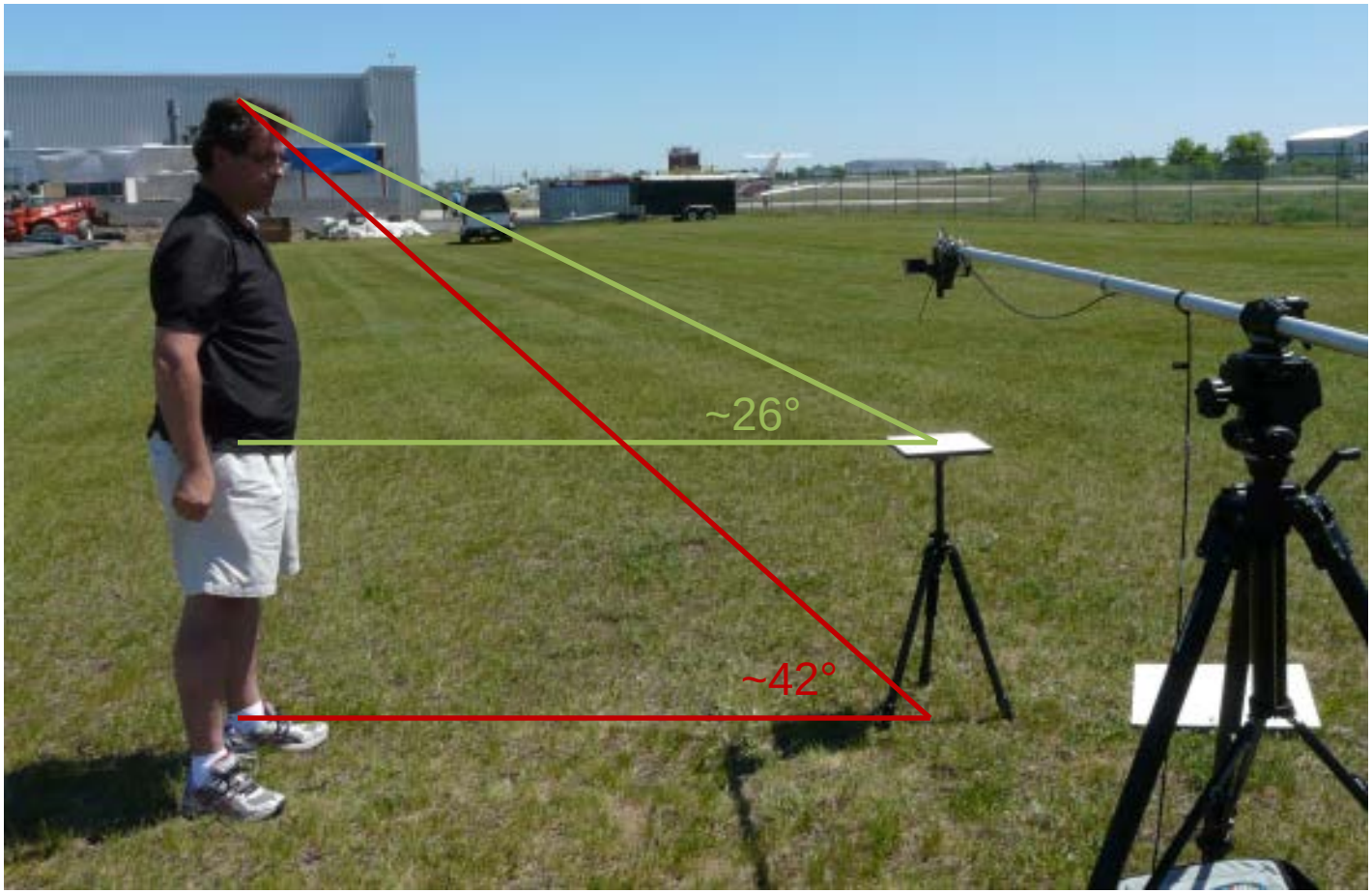


25% sky obstruction

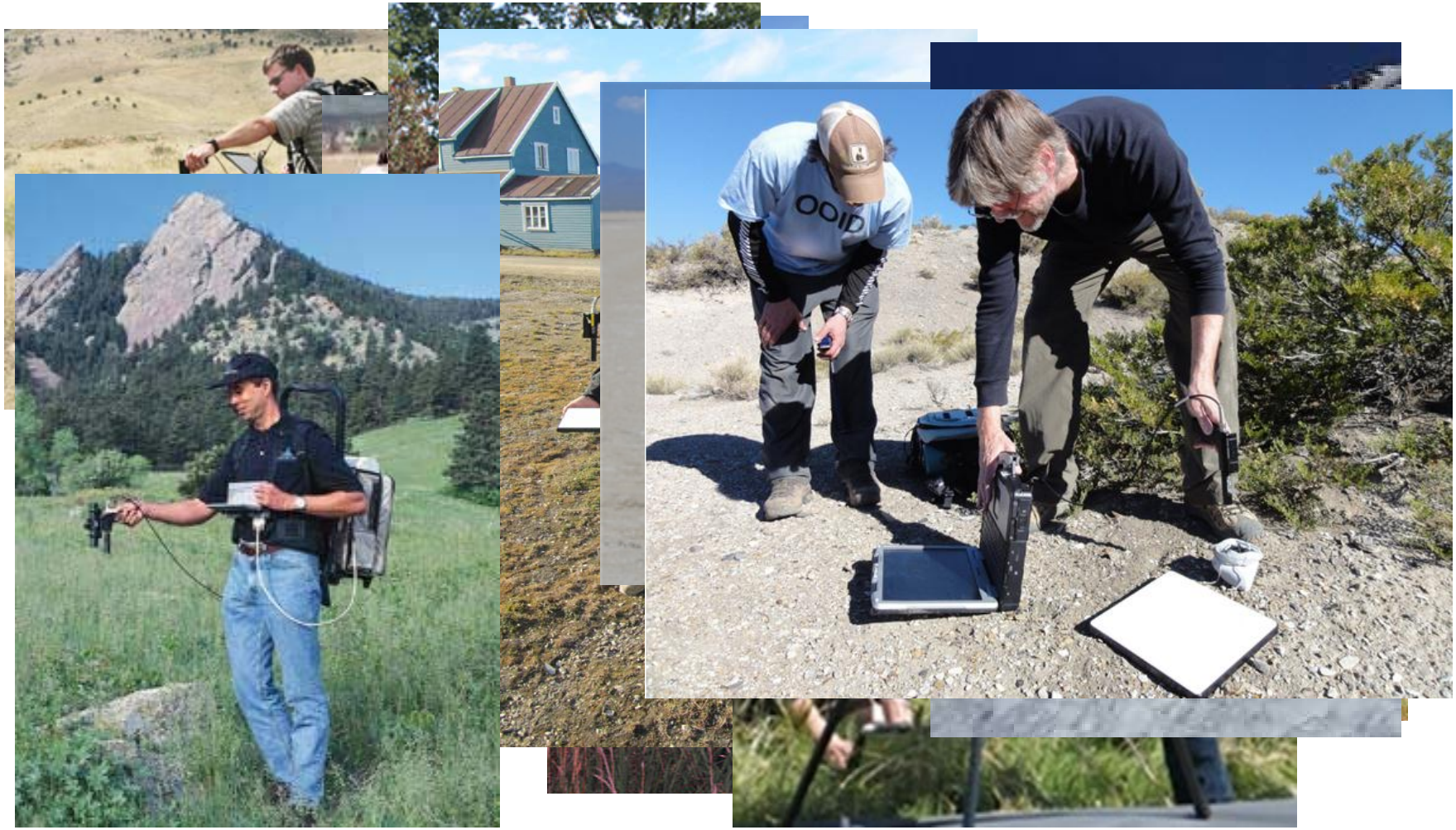
Relative Error



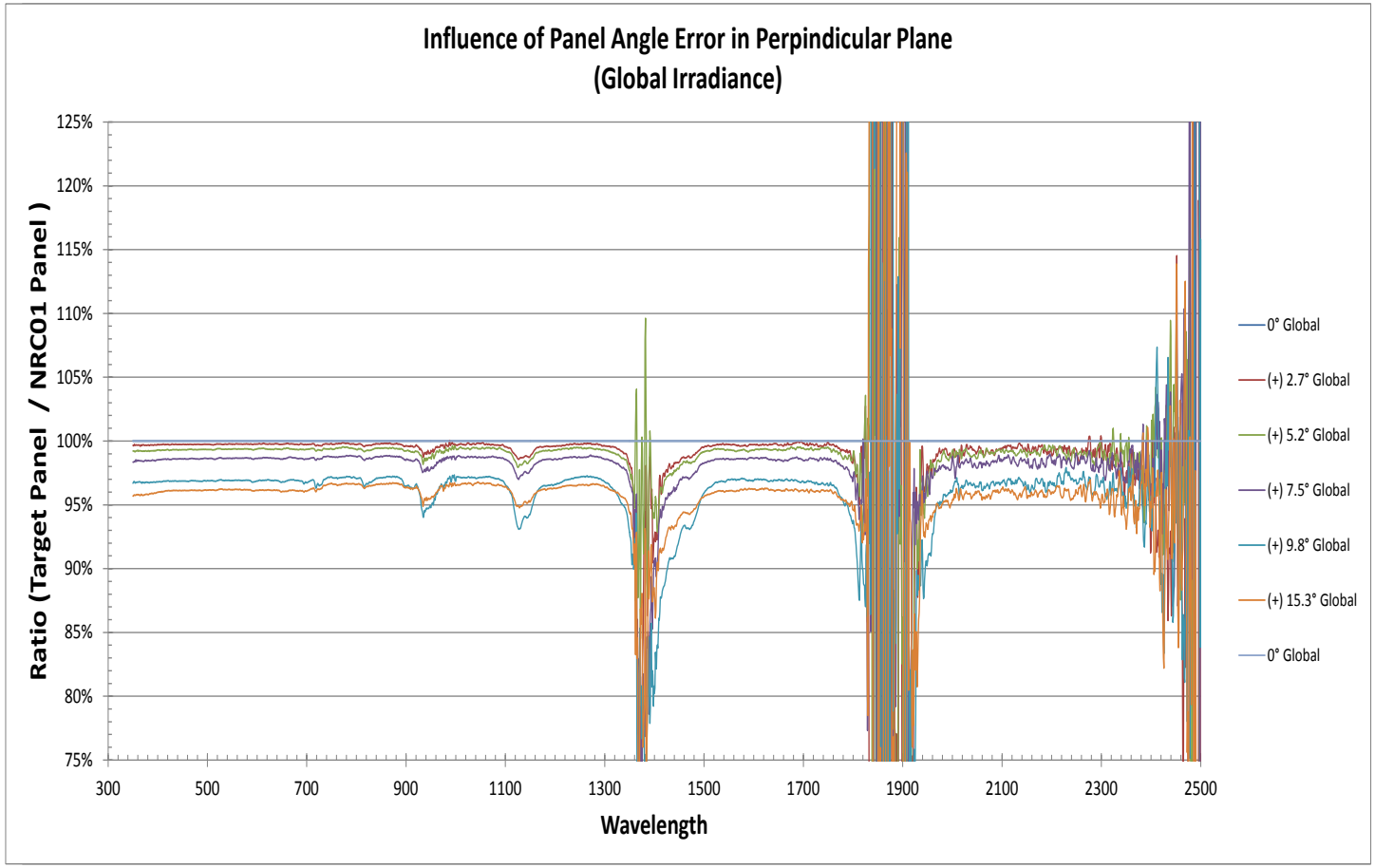
Same separation distance, different reference/panel heights



Field Spectrometer Deployment Photos From Google Images



Measurement error due to panel tilt



Discussion

- the error introduce by a nearby operator or other object can be minimized by attempting to ensure that the obscured background irradiance field remains consistent for both the reference and target measurement.
- using black/dark clothing does not necessarily reduce the error.
- elevated objects, clouds, or haze on the horizon would complicate the situation.
- hemispherical photos from the position of the reference/target would have allowed for a more detailed analysis.
- what, if any, is the impact of the nearby object on the spectral reference reflectance applied to the to the PSM equation?

Conclusions

- The impact of operator proximity on field spectroscopy measurements can be understood, at least in broad terms.

- The estimated “errors” identified in this work represent a worst case scenario
  - the operator non-existent in one measurement then introduced into the downwelling irradiance path in the other.
- The information can, however, be extended to estimate the error in less significant scenarios.

- Errors approached 0% at 2 m separation for the test scenario.

- Knowledge gained here also applies to nearby structures and objects that impact the downwelling irradiance on either the reference or target measurement or both.

- To minimize signal contamination when operator proximity cannot be avoided, it may be possible to determine:
  - an optimal operator material in terms of spectral composition
  - the least obstructive position of for an operator
  - a first order correction????

Thank you - Questions?

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