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Cornell University
Office of Sponsored Programs
373 Pine Tree Road
Ithaca, NY 14850 -2820

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The views, opinions and/or findings contained in this report are those of the author(s) and should not contrued as an official Department of the Army position, policy or decision, unless so designated by other documentation.

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UU	UU	UU	UU		19b. TELEPHONE NUMBER 607-255-0801

RPPR Final Report
as of 04-Sep-2018

Agency Code:

Proposal Number: 68405EVRIP **Agreement Number: W911NF-16-1-0243**
INVESTIGATOR(S):

Name: William Philpot
Email: wdp2@cornell.edu
Phone Number: 6072550801
Principal: Y

Organization: **Cornell University**
Address: Office of Sponsored Programs, Ithaca, NY 148502820
Country: USA
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Report Date: 31-Jul-2017 Date Received: 14-Aug-2017
Final Report for Period Beginning 01-May-2016 and Ending 30-Apr-2017
Title: Acquisition of a field-portable, laboratory-grade spectroradiometer
Begin Performance Period: 01-May-2016 **End Performance Period:** 30-Apr-2017
Report Term: 0-Other

Submitted By: William Philpot Email: wdp2@cornell.edu
Phone: (607) 255-0801

Distribution Statement: 1-Approved for public release; distribution is unlimited.

STEM Degrees: **STEM Participants:**

Major Goals: The major goal of this project was to acquire a laboratory grade field spectrometer in order to complete the experiments required to support the ARO-funded research into modeling the spectral reflectance of wetted soils. The spectroradiometer in use at the time of the request was fast approaching the end of its useful life. After 12 years of nearly constant use, the instrument remained fully operational, but was showing serious signs of wear. We requested funds to replace the instrument with a newer model: a FieldSpec4 with accessories. Given the excellent reliability of the original instrument, we sought to replace it with a newer, more sensitive model from the same company.

The research, funded by the Army Research Office (W911NF-15-1-0071; PI: W. Philpot), is directed toward gaining a better understanding of the physical interactions of light with the soil. Such an understanding will necessarily underlie any general, effective proximal or remote sensing technique for soil analysis that relies on spectral reflectance. The objective is to develop a physically-based model of reflection that will be useful both as a tool for understanding the effect on reflectance of the wetting and drying processes, and for determining the limits of remote sensing for characterizing the properties of an unknown soil. It is essential that the model take the optical and structural soil characteristics into account and that it functionally describe the effect of wetting on soil reflectance.

Model development is intimately tied to observations of spectral reflectance in experiments designed to tease out soil characteristics (e.g., particle size and pore size distribution) that would be expected to alter the reflectance in characteristic ways. The eventual goal is to be able to invert the model in order to predict soil properties from reflectance measurements. A field spectroradiometer is essential to this work. The instrument requested in this proposal will insure the continuity of the experimental work.

Accomplishments: An ASD FieldSpec 4, a laboratory grade spectrometer that is specifically designed for use in the field was acquired along with a set of accessories that have extended the capacity of the instrument. The FIeldSpec4 has been in nearly constant use in support of the ARO project W911NF-15-1-0071. It is rugged, maintains calibration, and has the spectral range (350-2500 nm) and spectral resolution (3 nm from 350-1000 nm; 10 nm from 1000-2500 nm) to meet the requirements of the research.

Training Opportunities: Nothing to Report

Results Dissemination: Nothing to Report

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Honors and Awards: Nothing to Report

Protocol Activity Status:

Technology Transfer: Nothing to Report

PARTICIPANTS:

Participant Type: PD/PI
Participant: William Philpot
Person Months Worked: 1.00
Project Contribution:
International Collaboration:
International Travel:
National Academy Member: N
Other Collaborators:

Funding Support:

Instrument and Accessories

The requested instrument, an ASD FieldSpec 4, is both a replacement and an upgrade of the current instrument. As with the current instrument, the FieldSpec 4 is a laboratory grade spectrometer that is specifically designed for use in the field. It is rugged, maintains calibration, and has the spectral range (350-2500 nm) and spectral resolution (3 nm from 350-1000 nm; 10 nm from 1000-2500 nm) to meet the requirements of the research.

Accessories were also acquired in order to enhance the calibration and broaden the range of experiments that could be undertaken. The additional accessories are:

1. **Spectralon Reference Panels.** Three reference panels are requested: 50% and 99%. The 99% panel is standard for calibration. The 50% reflectance panel will be useful for optimizing the reflectance measurements from darker targets.
2. **Ruggedized Fiber Optic Cable**. Since the instrument will be used in the field, the ruggedized cable will be essential to help prevent the cable from stretching when it is pulled lengthwise.
3. **Illuminator Reflectance Lamp**. The lamp currently in use is also aging. This would be a simple replacement of the existing lamp in order to insure long-term stability.
4. **Fiber Optic Illuminator** and **Bifurcated fiber optic reflectance probe**. The opposition effect is an important characteristic of directional reflectance, but is impossible to measure when the detector obscures the illumination. The bifurcated reflectance probe permits observation in the opposition direction.
5. **Fiber Checker magnifiers.** With this tool the user can reverse illuminate the VNIR, SWIR 1 and SWIR 2 regions individually or all together and count the illuminated fibers in order to confirm that there are no broken fibers internally on the fiber optic cable. Cables with broken fibers need recalibration or replacement.
6. **Shipping case.** The FieldSpec is frequently used in the field, and sometimes requires shipping to the field site. It will also need to be shipped back to the company once per year for recalibration and maintenance.
7. **Ergonomic Pro-Pack Backpack**. The backpack is essential for field work. It makes it possible to carry the instrument safely to the sites at which we commonly need to work (agricultural fields, beaches, lakes, marshes, …)
8. **Integrating Sphere.** The integrating sphere makes it possible to measure several quantities not otherwise possible, in particular, the total hemispherical reflectance (including or excluding specular reflectance).
9. **Diffuse Transmission Cosine receptor**. This foreoptic allows one to measure the full sky downwelling irradiance.
10. **Turntable**. This device will facilitate measurement of soil samples in order to eliminate the effect of any inhomogeneity of the surface.
11. **Spare batteries (2)**: Spare batteries will be required for extended field operations.