A Field Portable Hyperspectral Goniometer for Coastal Characterization

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Extended Abstract- During an airborne multi-sensor remote sensing experiment at the Virginia Coast Reserve (VCR) Long Term Ecological Research (LTER) site in June 2011 (VCR'11), first measurements were taken with the new NRL Goniometer for Outdoor Portable Hyperspectral Earth Reflectance (GOPHER). GOPHER measures the angular distribution of hyperspectral reflectance. GOPHER was constructed for NRL by Spectra Vista Corporation (SVC) and the University of Lethbridge through a capital equipment purchase in 2010. The GOPHER spectrometer is an SVC HR-1024, which measures hyperspectral reflectance over the range from 350-2500 nm, the visible, near infrared, and short-wave infrared. During measurements, the spectrometer travels along a zenith quarter-arc track that can rotate in azimuth, allowing for measurement of the bi-directional reflectance distribution function (BRDF) over the whole hemisphere. The zenith arc has a radius of approximately

2m, and the spectrometer scan pattern can be programmed on the fly during calibration and validation efforts. The spectrometer and zenith arc assembly can be raised and lowered along a mast to allow for measurement of uneven terrain or vegetation canopies of moderate height. Hydraulics on the chassis allow for leveling of the instrument in the field. At just over 400 lbs, GOPHER is a field portable instrument and can be transformed into a compact trailer assembly for movement over long distances in the field (Figure 1). At NRL improvements to the chassis have been made to allow for increased maneuverability over challenging terrain.

Figure 1. (Top,left) NRL GOPHER at the VCR'11 experiment during a measurement cycle; (top,right) the zenith arc can be adjusted to different heights to accommodate variable terrain or vegetation canopy heights (bottom, right). (Bottom, left) the GOPHER chassis converts to a compact form for transport across Hog Island during VCR'11.

During VCR'11, primary measurements focused on beach, sediments, and vegetation on Hog Island, VA, one of the barrier islands in the VCR LTER. GOPHER measurements were conducted in tandem with geotechnical measurements of beach and sediment properties, including moisture level, grain size distribution, field density, shear strength, dynamic deflection modulus, and cone index. A

number of these geotechnical measurements were accomplished after the fact in the laboratory from core samples taken along transects at the site during cal/val efforts.

GOPHER provides a more sophisticated means of relating the geotechnical measurements to spectral measurements observed at the surface and builds upon our past work in this area (Bachmann et al, 2010a, 2010b, 2008), wherein ASD measurements were related to geotechnical measurements to develop spectral-geotechnical lookup tables to estimate geotechnical properties such as dynamic deflection modulus directly from hyperspectral imagery. Because GOPHER can measure BRDF over the whole hemisphere, it opens up the possibility of retrievals for properties of the medium that are more difficult to estimate such as sand or sediment density. Density and grain size information appear parametrically in models of BRDF (Hapke, 1993), and measurements of reflectance from a variety of different phase angles provide information that can be used to estimate these important geophysical parameters. During VCR'11, airborne observations by the NRL CASI-1500 were accomplished at a variety of phase angles for any given spot on the ground by varying flight geometry and time of day of the hyperspectral imagery acquisition. Coincident measurements were accomplished on the ground with GOPHER . Our team is relating the airborne measurements from hyperspectral sensors from CASI (flown at the VCR'11 experiment) to GOPHER measurements as well as table-top goniometer measurements conducted on core samples taken at transect sites throughout the study area. BRDF measurements, including the opposition effect, allow for analysis and potentially the retrieval of intrinsic parameters such as density, which are known to parameterize BRDF (Hapke, 1993).

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