Potential calibration targets in support of the TERN AusCover intensive survey sites

Introduction

- Vicarious calibration refers to the process by which a calibration is established using a method independent of that which was used for primary calibration of the sensor (Milton et al. 2009). The method has become widely adopted as the means to provide independent assurance of the quality of remotely sensed data from both spaceborne sensors and aircraft (e.g. CEOS WGCV documents, Smith and Milton 1999, Karpouzli and Malthus 2003, Brook and Ben Dor 2011).
- For satellites the method largely involves the use of natural earth surfaces which are assumed to be homogeneous over space and stable over time (so-called 'pseudo-invariant' targets). As an alternative to natural targets, artificial targets can be deployed such as calibrated canvas tarpaulins or sheets (e.g. example refs).
- As part of its validation activities, TERN AusCover will undertake a series of combined hyperspectral and lidar campaigns using airborne sensors over a number of key sites around Australia. Fundamental to these campaigns will be the need to deploy vicarious calibration targets at these sites, as an independent check on atmospheric correction methods. It will be necessary to deploy artificial calibration targets at these sites because of the general lack of sufficient natural sites of relevant size and of a range of brightnesses.

The general rules for application of vicarious calibration include:

- Targets should cover a range of reflectance brightnesses from dark targets to bright targets, ideally covering the full dynamic range of the sensor being calibrated.
- Ideally, targets should have a reasonably flat reflectance across the spectral range of interest
- Ideally, targets should be Lambertian in their reflectance properties.
- The targets should be homogeneous in reflectance properties and stable over time.
- In general it is recommended that the target area is at least 5 x 5 pixels in size to allow for uncertainty in geometric correction and the point spread function of the detector (Smith and Milton 1999).
- The targets are laid with the longest axis in the direction of the flightline, as close to the nadir pathline as possible (i.e. centre of the flightline).
- The measurement of target reflectance should be performed coincident with the overflight of the sensor with spectroradiometers traceably calibrated to known reference standards (e.g. NIST, NPL)
- The targest should have their position accurately recorded for subsequent identification on the imagery.

Target materials

- A number of **artificial 'opaque' target materials** have been used for measuring calibration properties of targets. Generally, these have consisted of sheeting or canvas like materials of sufficient thickness to prevent signals from the underlying surface causing interference. Sufficient lengths of the material are sewn together to achieve a target of sufficient size. Key issues with these surfaces are:
  - Transparency, particularly of brighter materials, such that if laid out on grass for example, a residual red-edge signal can be observed through it. This can be overcome by laying the bright transparent target material on top of an opaque one.
  - The surface can have non-Lambertian reflectance properties, particularly if the material is of a shiny nature.
  - The lack of spectral flatness across the wavelength range of interest, dependent on the make up of the material.
  - Size and weight. They can be heavy when sewn to desired large sizes.

Recently, others have proposed the use of **semi-transparent netting** of a range of densities as an alternative in their Smart Vicarious Calibration method proposed in Brook and Ben Dor (2011).

- The materials used in this study were manufactured by Exxon Mobil, and were a metallocene-based polyethylene resin netting, manufactured in different densities (13%, 17% and 25%). The nets were dark and spectrally flat, with no absorption features across VIS-NIR-SWIR. Laying several nets is together is used to achieve different densities, in an albedo sequence to 100%, covering the response function of the sensor. Targets are very light (~0.001 kg/m2) and are easy to fold and transport. They are also fairly low cost (about US$0.15/m2).
- Potential Australian sources of such materials include: 70% shade factor (light blockage), 50m roll x 183 centimetres wide at $254.20 from bigsafety.com.au (dark green only though) or potentially from: http://www.alibaba.com/product-gs/454123424/Black_Knitted_polyethylene_Nets_Agricultural_Nets.html
- Issues with these targets are:
  - To lay the target out needs a flat bright homogeneous background surface area on which the nets are

laid singly or in combinations to achieve the range of desnsities required (e.g. bare soil carpark or beach - see photo below). Suitable homogeneous background sites might potentially be very difficult to find at the planned TERN AusCover sites.

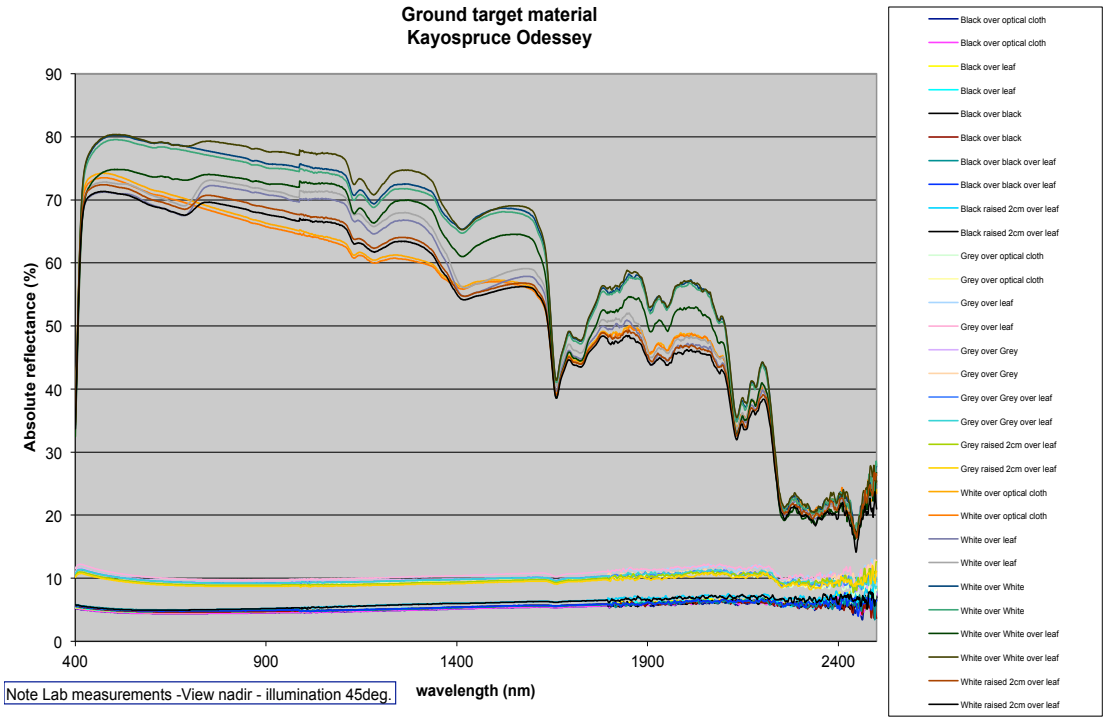
- Bulky - although lightweight, the targets can take up quite a lot of space. particularly at the lengths deployed in the Brook and Ben Dor study.

Recommendations for TERN AusCover:

- That we go for opaque ground targets given the difficulties of finding bright bare homogeneous sites at many of the TERN intensive validation sites.
- The minimum size of the targets should be 8 x 8 m in size (please advise if this is not ideal)
- Ideally, the Odyssey would be most suitable, but a suitable alternative may have to be found.

NERC Field Spectroscopy survey of target materials

- In 2007 the NERC Field Spectroscopy Facility did a fairly thorough survey of a range of artificial and natural targets (canvases, linens, PVC coated canvas). To summarise, the best optical properties they found was of an 'Odyssey' trademark material (a PVC coated canvas material, used for boat covers), which was sourced from Kayospruce Ltd. in the UK. The PVC coating also has the benefit of making the material more hard wearing, and easier to wipe/clean after use.
- Three shades (black, grey and white) now form the basis of sets of targets deployed to support the NERC Airborne Research and Survey Facility (UK). Reflectances of the target materials are shown below over a range of different coloured backgrounds. The black (5% reflecance) and grey (10% reflectance) are both flat and insensitive to background materials. The white target shows transparency (sensitivity to different background targets) and is typically deployed in the field laid over a black target. The white target also demonstrates a lack of spectral flatness, particularly in middle infrared wavelengths but this was a typical feature in all the white potential target materials measured.



NERC FSF Calibration Targets in Use

References:

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