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Characterisation Campaign at the Gobabeb RadCalNet Site in Support of Satellite Calibration and Validation Activities

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RadCalNet

esa
European Space Agency

Metrology for Earth Observation and Climate

RadCalNet (Radiometric Calibration Network)

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- Provides automated surface and atmospheric in-situ data as part of a network including multiple sites for the purpose of optical imager radiometric calibration in the visible to shortwave infrared spectral range

- The key goals of RadCalNet:
  - To standardise protocols for collecting data
  - To process site data to top-of-atmosphere reflectance
  - To provide uncertainty budgets for automated sites traceable to the international system of units
  - 4 current international locations: *La Crau*, France, *Railroad Valley*, Nevada, *Baotou*, China, *Gobabeb*, Namibia

- Working under the guidance of Committee on Earth Observation Satellites (CEOS) Working Group of Calibration and Validation (WGCV) and the Infrared Visible Optical Sensors (IVOS)

RadCalNet (Radiometric Calibration Network)

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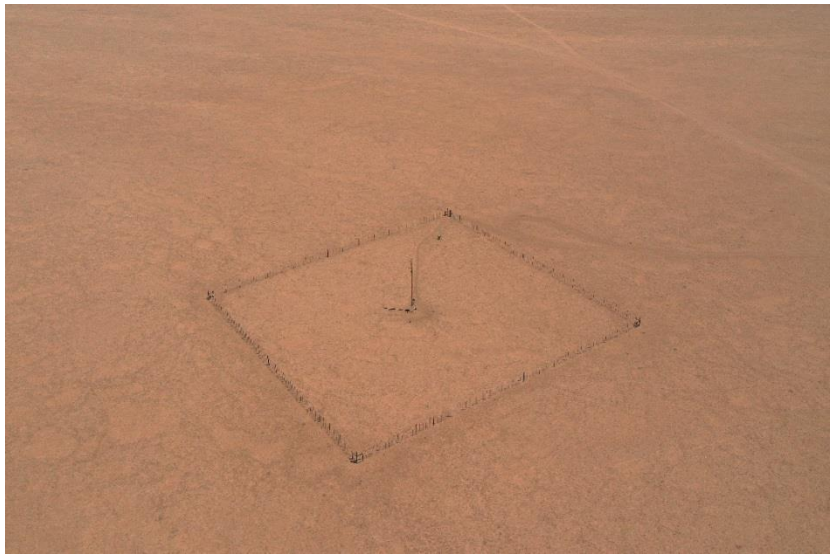
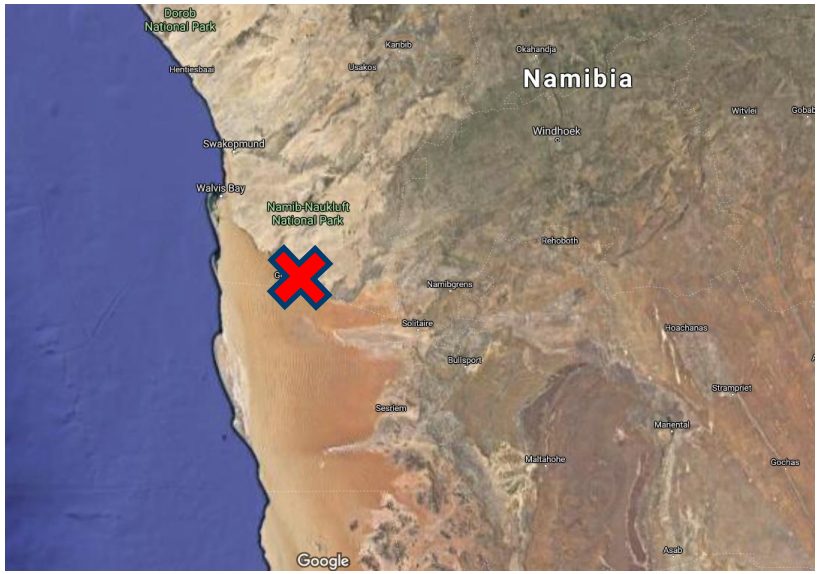


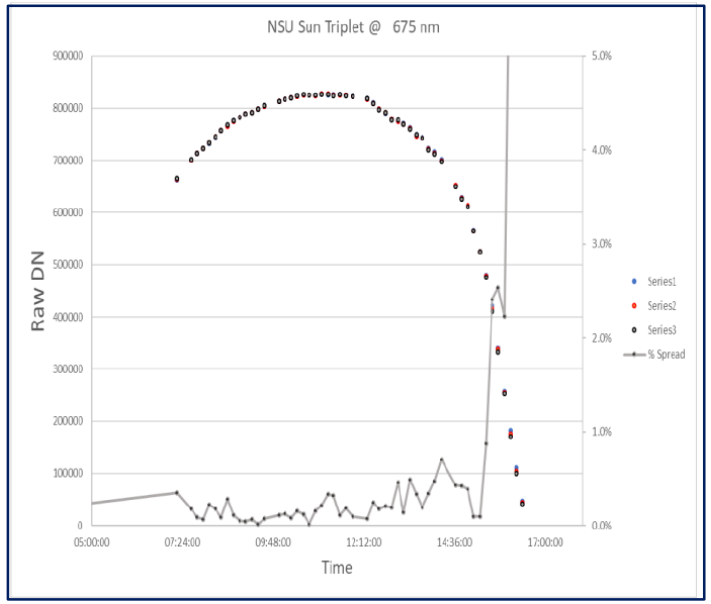

- All RadCalNet sites run automated instrumentation (Gobabeb mast pictured)
- Upwelling radiance is retrieved near ground level and is converted to nadir-viewing Bottom-of-Atmosphere reflectance
- The downwelling irradiance is typically derived through radiative transfer modelling
- This is then processed and supplied through the RadCalNet web-portal for use in vicarious satellite calibration
- Product: SI-traceable, spectrally resolved TOA reflectance for a nadir view at 30 min intervals from 9 am to 3 pm

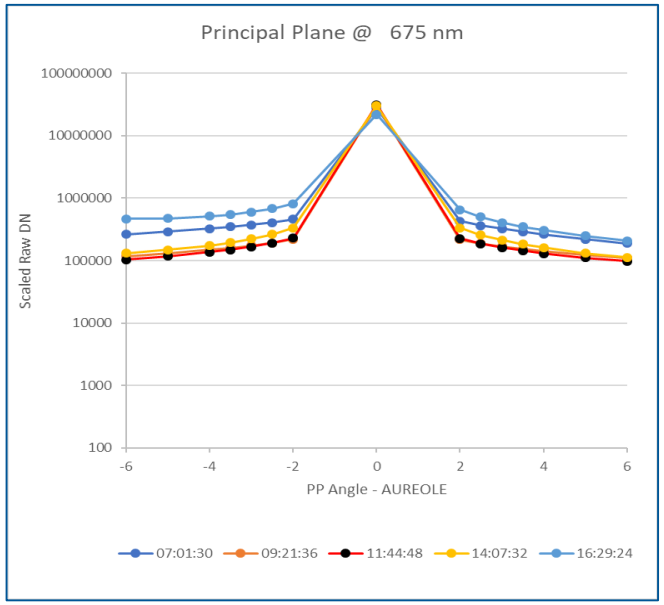
Gobabeb, Namibia, Africa

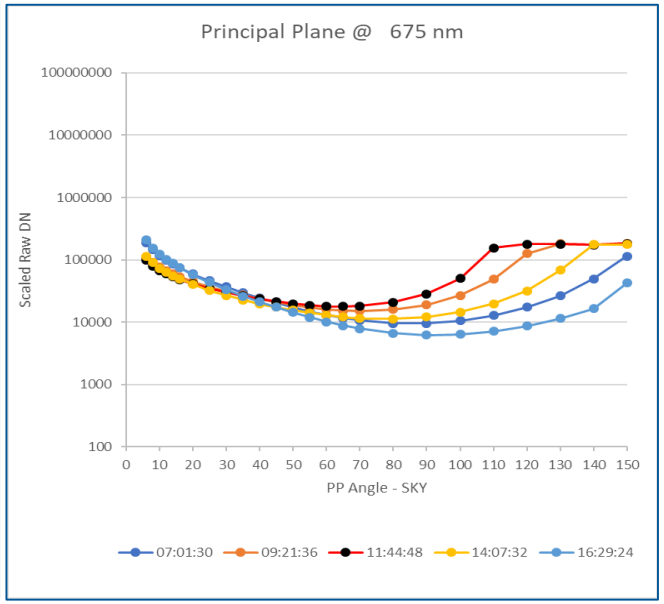


- Providing data since July 2017
- Selected through a global search with assessment of spectral characteristics, spatial uniformity and probability of clear skies

Permanent Instrumentation







- CIMEL CE 318 12-filter BRDF sun photometer
- Measures 12 spectral bands, from 414 nm to 1640 nm
- Continuous CIMEL and weather station measurements:
  - Principle plane, almucantar, sun radiance, ground radiance
  - Surface pressure and temperature, column water vapor and ozone
- View of weather/cloud conditions from SkyCam

Field Measurement Preparation

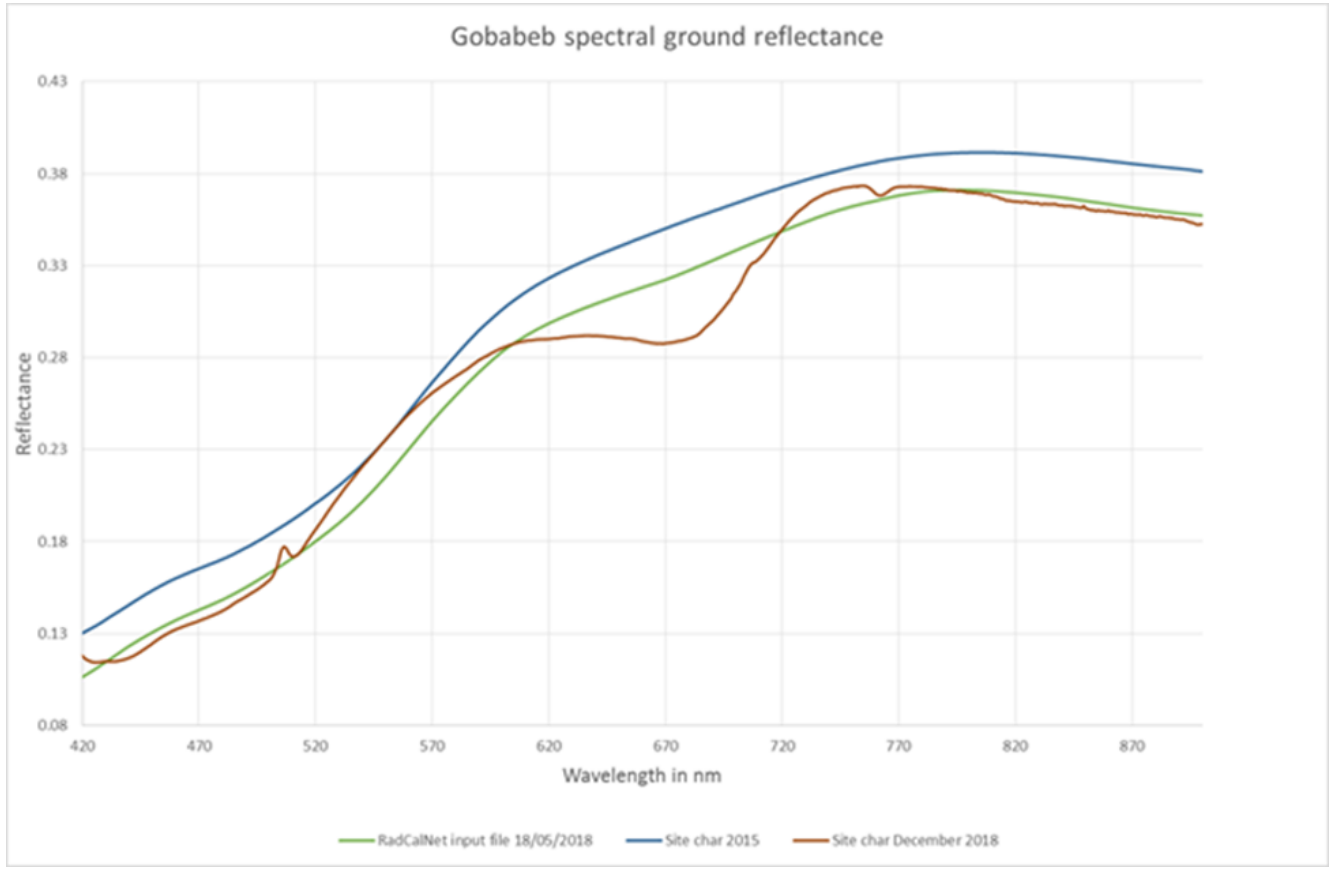
- Regular site visits and field maintenance carried out by NPL and staff at Gobabeb Research and Training Centre
- Opportunity to undertake ground surface characterisation measurements to ensure quality and consistency of site data
- Also completed initial ground characterisation investigation into a new site for similar instrumentation
- March 2020 field campaign:
  - Ongoing data analysis
  - Field considerations and corrections, along with preliminary ASD results are displayed in later slides

Previous Site Characterisation
Ground Reflectance

- 2017
  - Site homogeneity
  - Nadir ground reflectance (ASD)
  - Hyperspectral BRDF (GRASS)

- 2020
  - New site homogeneity
  - Nadir ground reflectance (ASD)
  - Multi-band imaging survey (MAIA)
  - Drone imaging

Previous Site Characterisation Ground Reflectance



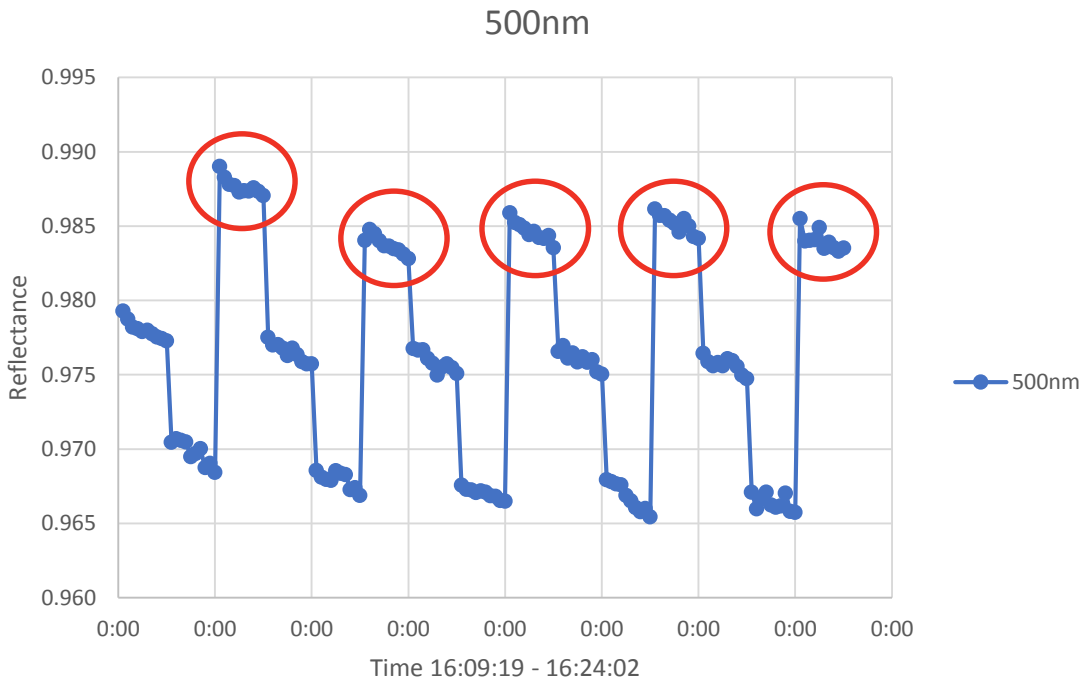
- Important to consider field of view (FOV) when comparing data
- Large discrepancy in data depending on grain size and vegetation distribution within target FOV
- ‘Scene size’ important for optimum FOV and representative data

- Regular ground reflectance characterisation has been completed since the site was developed
- Necessary to maintain data quality

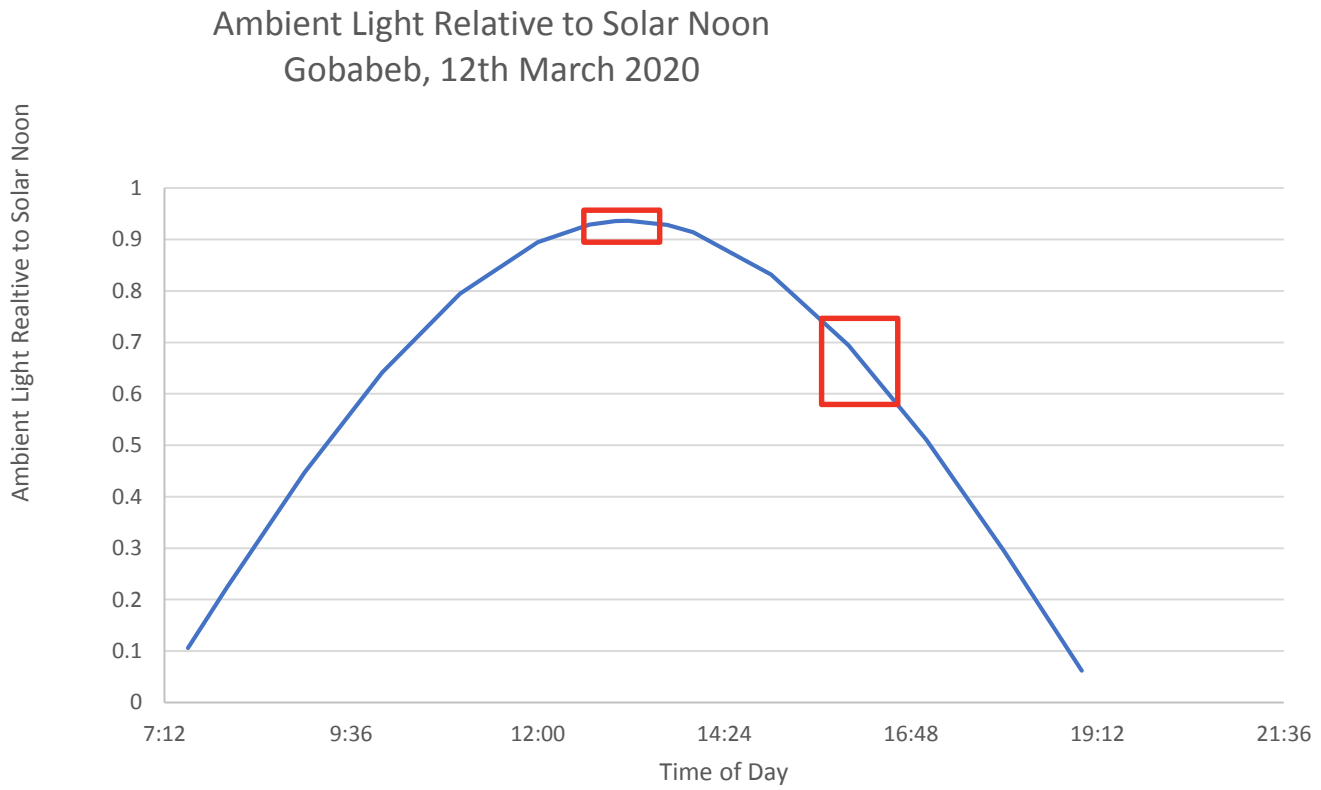
Preliminary Panel Testing

- To ensure quality and reproducibility of measurement data, preliminary testing was carried out on calibrated reference panels on location under natural light conditions

- Notable that ambient light is changing significantly over the 15 minute test period

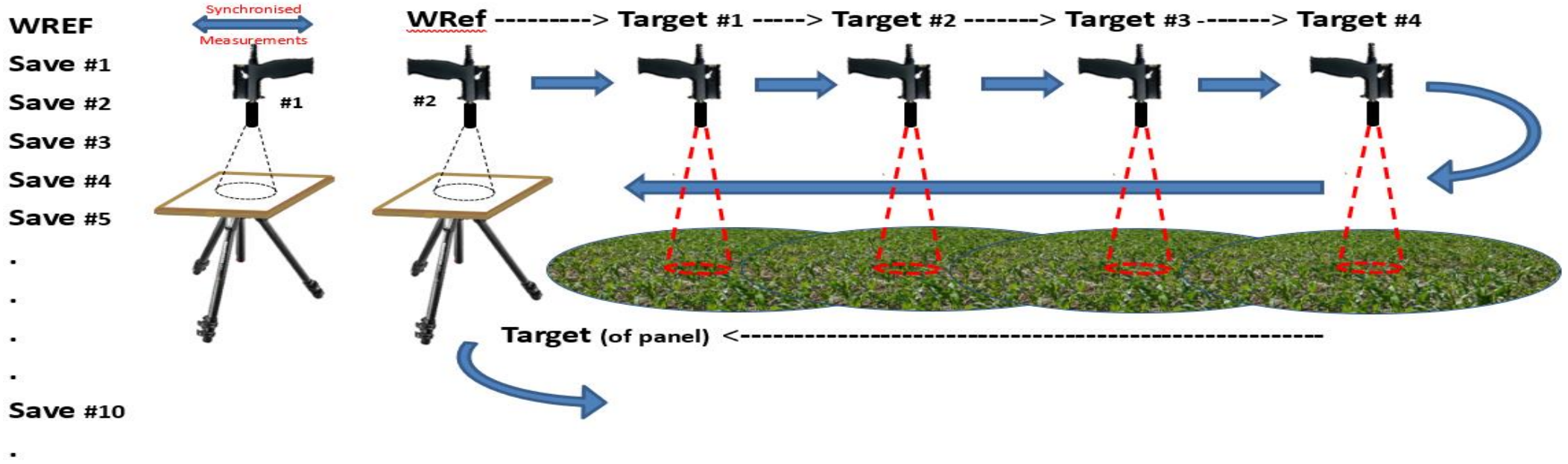


SZA Gobabeb



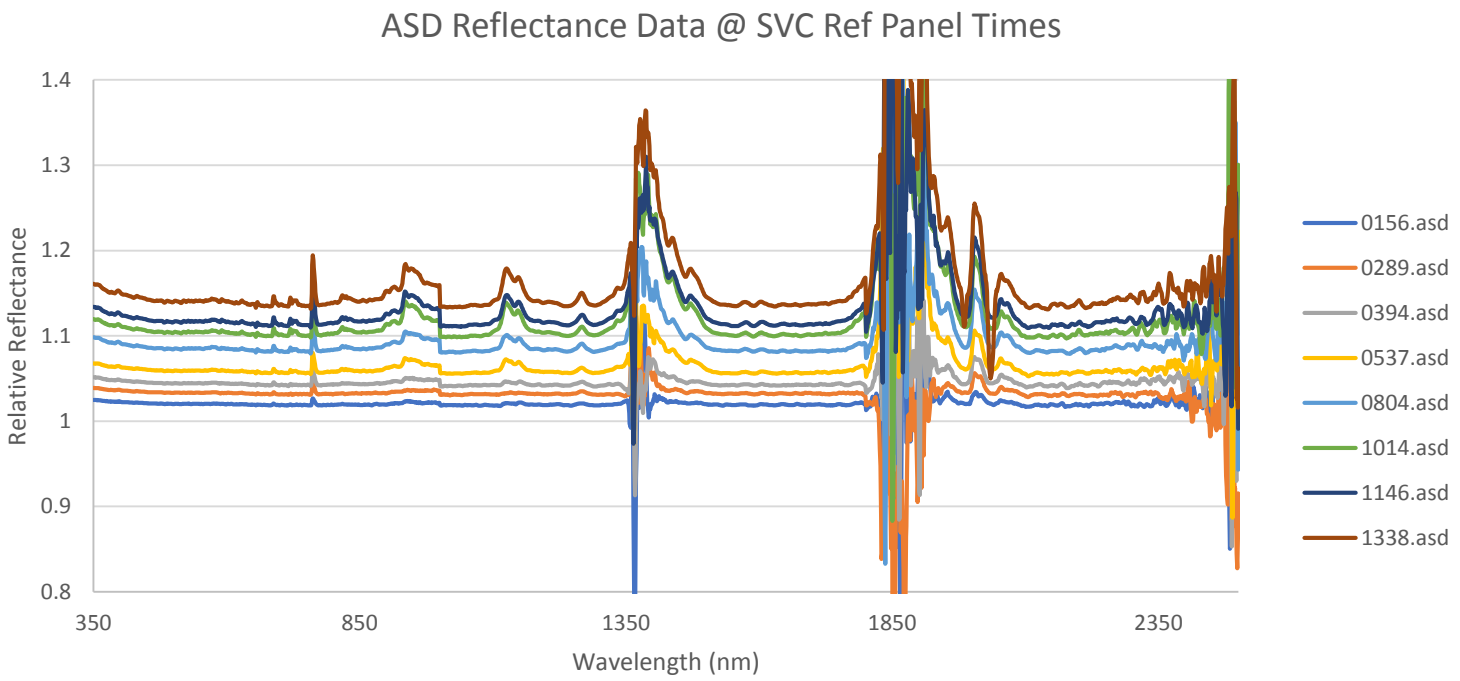
- Ambient light stability follows the change in the cosine of the solar zenith angle
- The same 1hr period at midday provides a longer period of stable light than 1hr at 3pm
- The faster change in light stability will affect measurements taken in the late morning/late afternoon
- Shadows also become an issue when working with reference panels at solar noon

The Dual Field of View Technique (DFOV)



- To ensure we can account for this change in ambient light during the target testing period we use the DFOV method
- Simultaneous acquisition of reference panel and ground measurements
  - One static spectroradiometer constantly recording the 18” panel
  - One roaming spectroradiometer conducting the survey with regular scans of the 10” panel between targets
  - Comparable measurements taken within seconds of each other

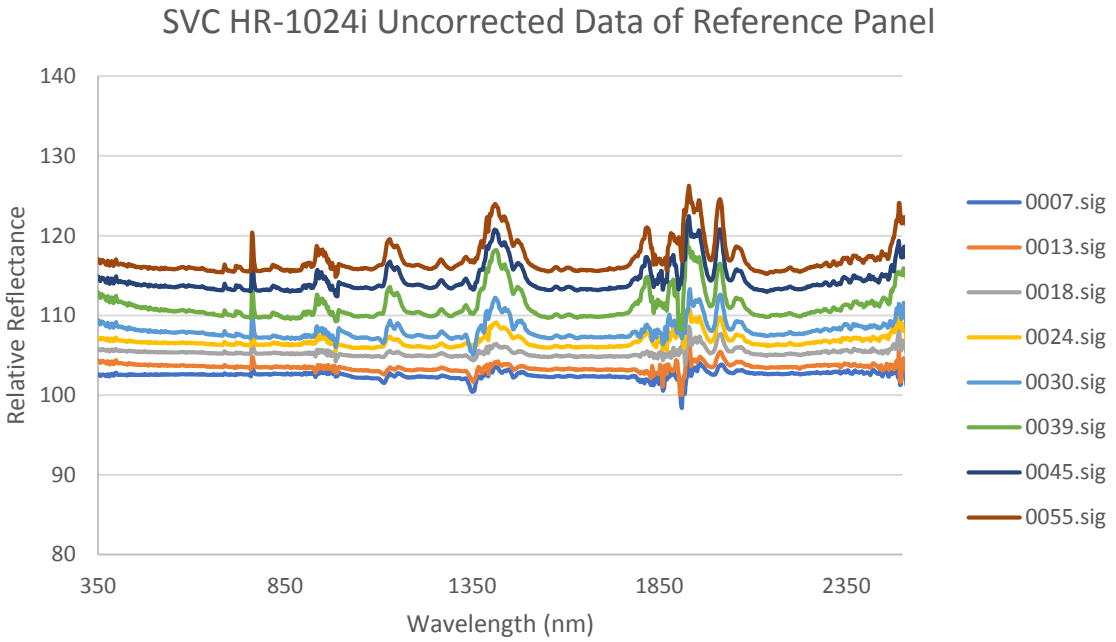
Simultaneous ASD Measurements (Reference Panel)

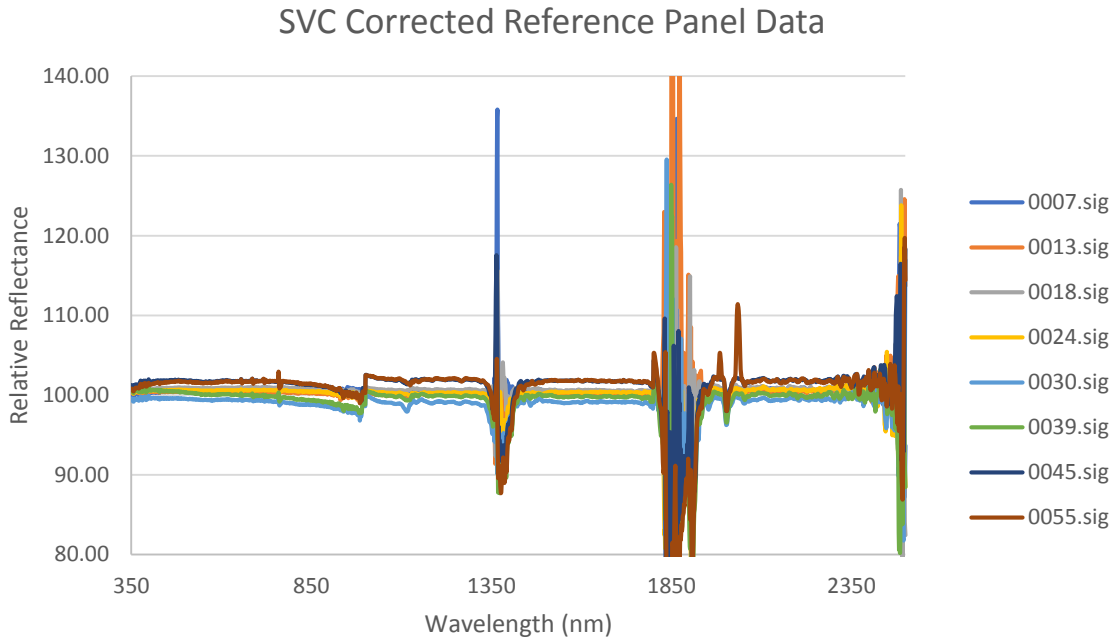


- ~47 minutes between first and last reference measurement
- 15% variation in white panel over this time period

- Static ASD spectroradiometer continuously running measurements on 18” Spectralon panel
- Monitoring the change in ambient light

SVC Uncorrected and Corrected Reference Panel Data (During Survey)

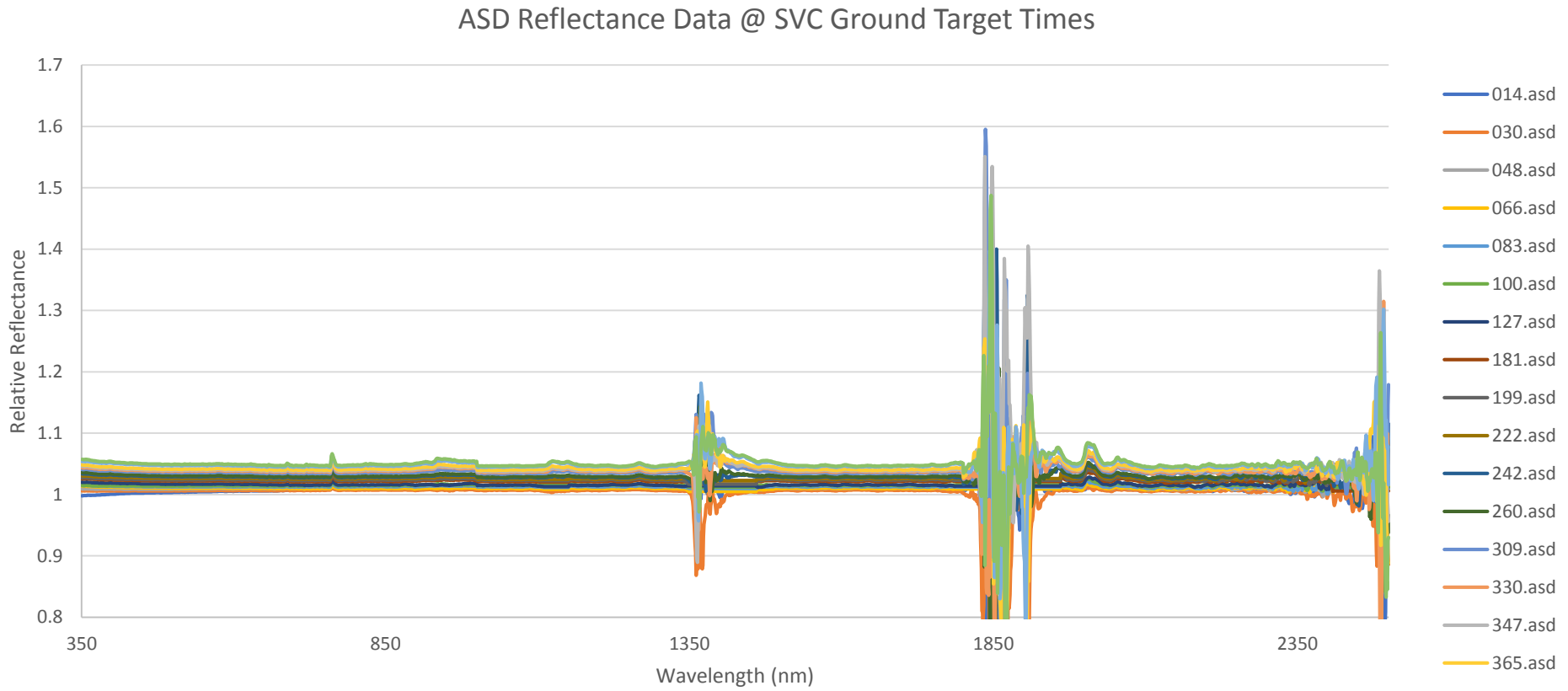




- SVC spectroradiometer moving down survey line
- Measurement of mobile 10” Spectralon reference panel between every 3 target ground reflectance measurements

- SVC spectroradiometer panel data corrected for change in ambient light during test period against the static ASD reference data
- Confidence to then apply the same method to the ground reflectance measurements

Initial Results of Field Reflectance Survey



- Static ASD reference panel data synchronised to ground target measurements
- Only the first 20 measurements are shown in this example, covering a ~10min test period
- Less change in ambient light over this shorter period

SVC Uncorrected and Corrected Survey Data

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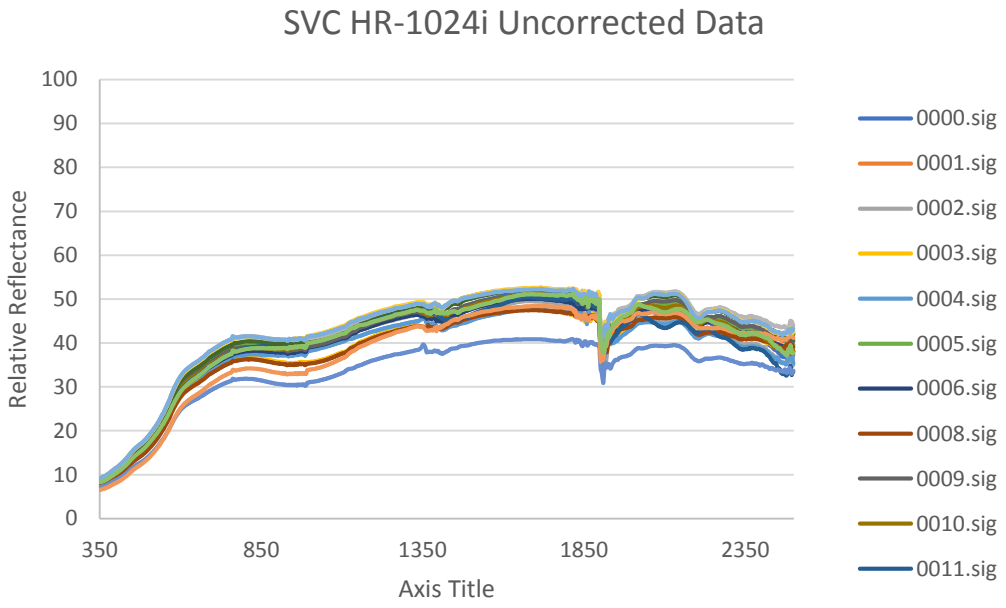
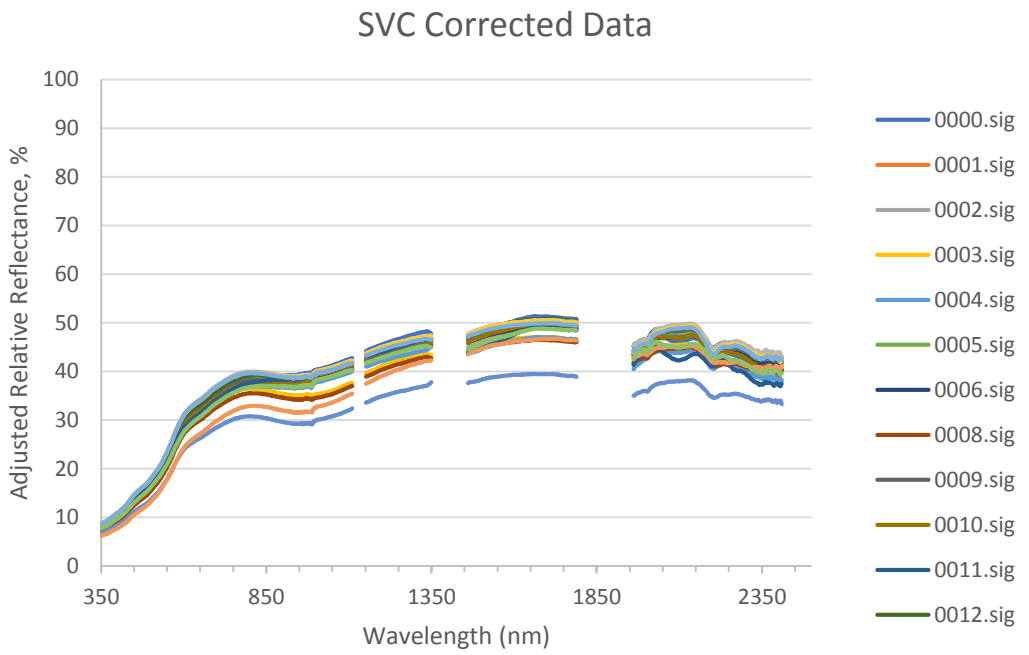




- SVC spectroradiometer moving down survey line
- Target ground reflectance measurements over same 10min time period

- SVC survey data corrected with the static ASD data
- Homogeneity/heterogeneity considerations of FOV during each target scan
- Variations in measurements may be explained by differing target FOVs

Continuing Analysis

- DFOV hyperspectral imaging survey
  - Continued processing
- Drone image and terrain model
  - Overview of potential new instrumentation site
- Multi-band MAIA imaging survey
  - Continued processing with the Field Spectroscopy Facility, NERC, Edinburgh
  - Matching wavelength intervals with Sentinel-2
  - Multi-scale detail

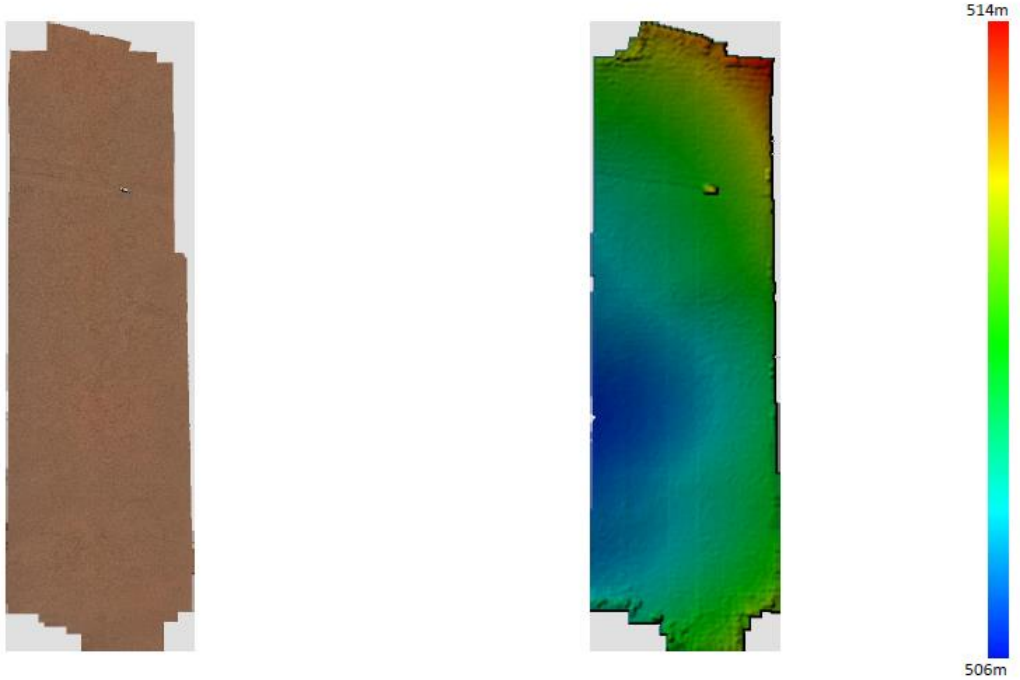
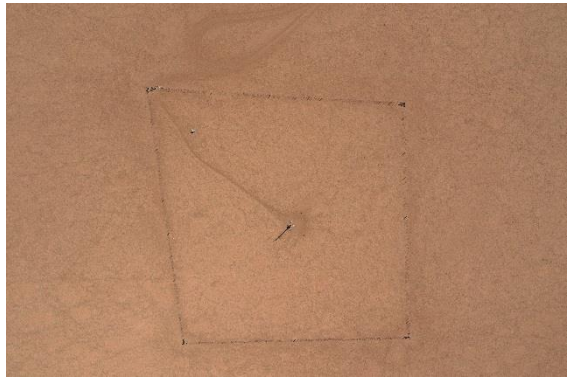


Figure-1 Final Orthomosaic and Terrain Model



- Importance of regular field measurements in vicarious calibration projects
- Potential to further analyse level and importance of surface homogeneity on various scales

Acknowledgements

NERC Field Spectroscopy Facility DFOV processing

- Bouvet M, Thome K, Berthelot B, Bialek A, Czapla-Myers J, P. Fox N, Goryl P, Henry P, Ma L, RadCalNet: A Radiometric Calibration Network for Earth Observing Imagers Operating in the Visible to Shortwave Infrared Spectral Range, Remote Sens. 2019, 11, 2401;
- https://www.radcalnet.org/#!/