

QA4EO Perspective from NCAVEO

Network for Calibration and Validation in EO

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NCAVEO 2004 -2007

- Funded by NERC Knowledge Exchange scheme;
- Initial group of 12 partners, grew to 26 by 2007;
- Academia, industry and government;
- Emphasis on practical, hands-on learning.

Field Spectroscopy Facility
NATIONAL ENVIRONMENT RESEARCH COUNCIL

NERC

infoterra
an EADS company

Environment Agency

Centre for Ecology & Hydrology
NATIONAL ENVIRONMENT RESEARCH COUNCIL

Newcastle University

UNIVERSITY OF
SOUTHAMPTON
School of Geography

NATIONAL ENVIRONMENT
RESEARCH COUNCIL
CLASSIC

Science & Technology
Facilities Council

UNIVERSITY OF
EXETER

CTCD

JOINT NATURE
CONSERVATION
COMMITTEE

University of
Salford

NATIONAL ENVIRONMENT
RESEARCH COUNCIL

Ordnance Survey

PML
Plymouth Marine Laboratory

defra
Department for Environment, Food and Rural Affairs

NPL
National Physical Laboratory

SURREY
SATELLITE TECHNOLOGY LTD

The University of
Nottingham

ITT

RSAC

UCL

NCAVEO Year 1 Outputs

NCAVEO

Spectral Profile

Spectral Profile

Website and tutorials on atmospheric correction

Website and tutorials on atmospheric correction

NCAVEO Field Campaign 2006

- Involved 50 scientists from 22 organisations;
- Community-led campaign with clear science aims:
 - cal/val basic products (radiance, reflectance);
 - validation of leaf area index;
 - create a high quality database.
- Funded by partners;
- Logistic hub: STFC Chilbolton.



Scientific context

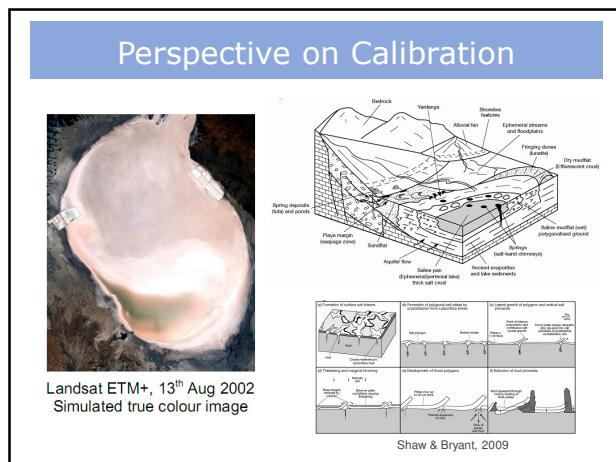
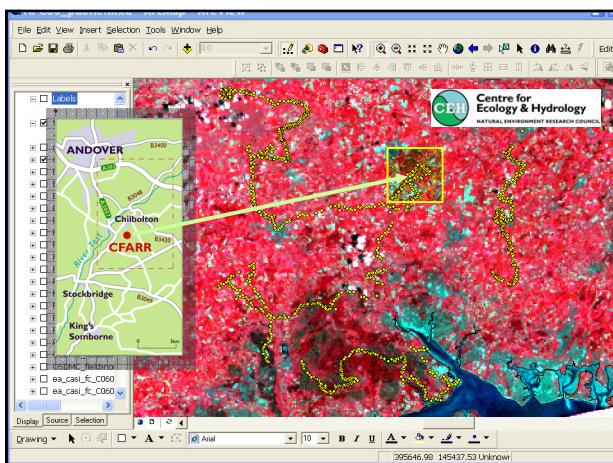
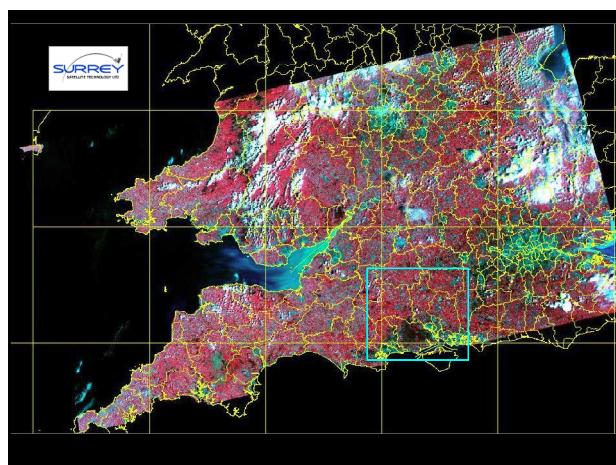
- Measurements and Models
 - Requirements for assimilation and for validation.
 - Land surface process models.
 - Specifically, carbon, water vapour & energy exchange.
- Ranging from statistical approaches (classification) to quantitative approaches (traceable to SI).
- 'Known unknowns'
 - Atmospheric correction uncertainty.
 - Upscaling data / information.

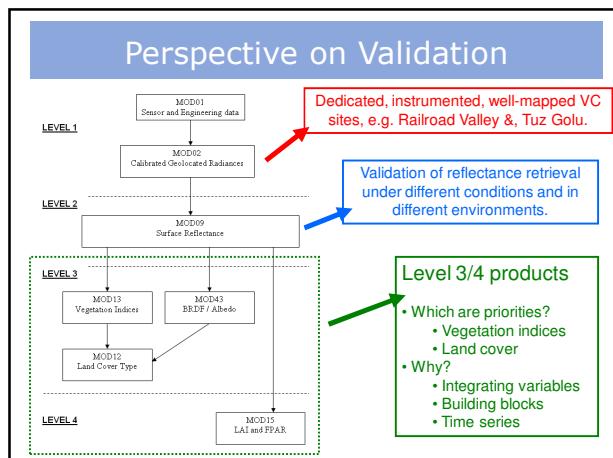
| | Sensor | Date acquired | Operator | Spectral region No. of bands / Pixel size | Summary of data and pre-processing |
|----|---|---------------|----------|---|--|
| 1 | CHRIS/Proba | 17/06/06 | SSTL/ESA | VNIR 62 bands / 34 m | Multiple view angle hyperspectral data. Registered to the British National Grid using ground control points. |
| 2 | UK-DMC | 17/06/06 | SSTL | VNIR 3 bands / 32 m | Wide swath multi-spectral data. UK-DMC has an estimated radiometric accuracy of 4.8%. AISA and Nigeria-Sat have been cross-calibrated with UK-DMC using an image-based method. |
| 3 | AlSat | 14/07/06 | SSTL | VNIR 3 bands / 32 m | |
| 4 | Nigeria-Sat | 13/06/06 | SSTL | VNIR 3 bands / 32 m | |
| 5 | SPOT-5 HRG | 10/06/06 | CNES | VNIR/SWIR 4 bands / 10 m/20 m | Registered to the British National Grid using ground control points. |
| 6 | CASI-2™ | 17/06/06 | NERC | VNIR 15 bands / 2.5 m | Nine flights acquired using an Ires Instruments Compact Airborne Spectrographic Imager. Registered to the British National Grid using data from on-board sensors. |
| 7 | CASI-3™ | 17/06/06 | EA | VNIR 32 bands / 1 m | Nine flights acquired using an Ires Instruments Compact Airborne Spectrographic Imager. Registered to the British National Grid using data from on-board sensors. |
| 8 | Specim AISA Eagle™ | 17/06/06 | NERC | VNIR 244 bands / 1 m | Nine flights acquired. Registered to the British National Grid using data from on-board sensors. |
| 9 | Remote AC Marinell L3™ digital camera | 17/06/06 | EA | RGB 3 bands / 1 m | Nine flights acquired. Registered to the British National Grid using data from on-board sensors. |
| 10 | Intergraph Z/I Imaging DMCI™ | 09/06/06 | OS | VNIR 4 bands / 60 cm | Digital Mapping Camera. Orthorectified to the British National Grid using photogrammetric methods. 84 images acquired with 60% overlap along track. |
| 11 | Optech ALTM 2033™ LiDAR | 17/06/06 | EA | 1064 nm 1 m | 2km x 2km tiles of digital terrain model and digital surface model. First and last pulse returns were recorded, using an approximate pulse spacing of 1-2 metres. |

■ Dates are expressed as DD/MM/YY

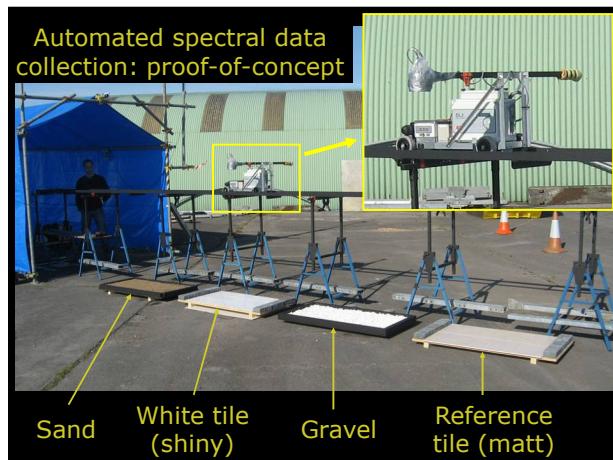
■ VNIR = Visible & Near IR; SWIR = Short-wave IR; RGB = Visible wavelengths only.

| | Sensor | Date acquired ⁱⁱⁱ | Operator | Spectral region No. of bands / Pixel size | Summary of data and pre-processing |
|----|---|------------------------------|----------|--|---|
| 1 | CHRIS/Proba | 17/06/06 | SSTL/ESA | VNIR 62 bands / 34 m | Multiple view angle hyperspectral data. Registered to the British National Grid using ground control points. |
| 2 | UK-DMC | 17/06/06 | SSTL | VNIR 3 bands / 32 m | Wide swath multispectral data. UK-DMC has an estimated radiometric accuracy of 45%, Alsat and Nigeria-Sat have been cross-calibrated with UK-DMC using an image-based method. |
| 3 | AlSat | 14/07/06 | SSTL | VNIR 3 bands / 32 m | |
| 4 | Nigeria-Sat | 13/06/06 | SSTL | VNIR 3 bands / 32 m | |
| 5 | SPOT-5 HRG | 10/06/06 | CNES | VNIR/SWIR 4 bands / 10 m/20 m | Registered to the British National Grid using ground control points. |
| 6 | CASI-21M | 17/06/06 | NERC | VNIR 15 bands / 2.5 m | Nine flightlines acquired using a kris Instruments Compact Airborne Spectrographic Imager. Registered to the British National Grid using data from on-board sensors. |
| 7 | CASI-31M | 17/06/06 | EA | VNIR 32 bands / 1 m | Nine flightlines acquired using a kris Instruments Compact Airborne Spectrographic Imager. Registered to the British National Grid using data from on-board sensors. |
| 8 | Specim AISA Eagle TM | 17/06/06 | NERC | VNIR 244 bands / 1 m | Nine flightlines acquired. Registered to the British National Grid using data from on-board sensors. |
| 9 | Refel AIC- Modular LST TM digital camera | 17/06/06 | EA | RGB 3 bands / 1 m | Nine flightlines required. Registered to the British National Grid using data from on-board sensors. |
| 10 | Interspek ZII Imaging DMCT TM | 09/06/06 | OS | VNIR 4 bands / 60 m | Digital Mapping Camera. Orthorectified to the British National Grid using photogrammetric methods. 84 images acquired with 60% overlap along track. |
| 11 | OpSpec ALTM 2035+ LIDAR | 17/06/06 | EA | 1054 nm 1 m | 2km x 2km tiles of digital terrain model and digital surface model. First and last pulse returns were recorded, using an approximate pulse spacing of 1-2 metres. |





- Why the UK?
 - QA starts at home;
 - Training / professional development role;
 - UK contribution to international activity.
- Criteria for site selection (say 3-5 sites)
 - Continuous atmospheric measurements;
 - Flux tower on-site;
 - Local logistic support;
 - Uncontrolled air space (ARSF);
 - Ground measurements:
 - Automated (spectra) and campaign-specific (biophysical & spectra).



A network of validation sites for the UK?

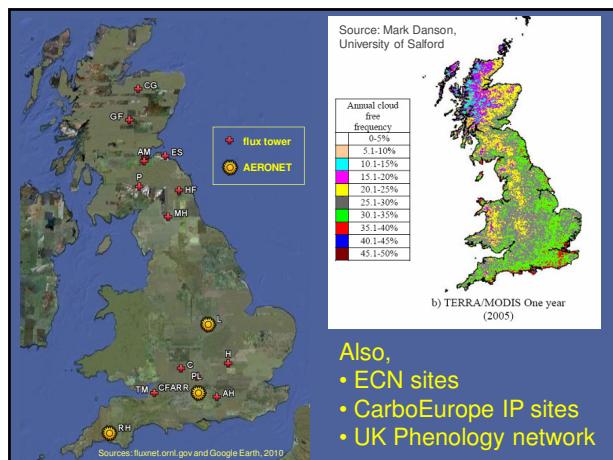
each ~ 50 km², centred on secure site with:

- flux tower
- automated spectrometer
- image stacks
- specific campaigns
- standardised instruments, protocols & algorithms.

EA CASI : Gross near CFARR

| Wavelength [nm] | Reflectance (%) |
|-----------------|-----------------|
| 350 | 1000 |
| 400 | 1500 |
| 450 | 2000 |
| 500 | 2500 |
| 550 | 3000 |
| 600 | 3500 |
| 650 | 4000 |
| 700 | 4500 |
| 750 | 5000 |
| 800 | 5500 |
| 850 | 6000 |
| 900 | 6500 |
| 950 | 7000 |
| 1000 | 7500 |
| 1050 | 8000 |
| 1100 | 8500 |
| 1150 | 9000 |
| 1200 | 9500 |
| 1250 | 10000 |
| 1300 | 10000 |

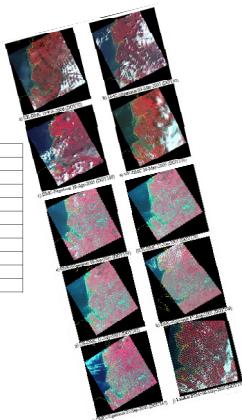
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DMC time series

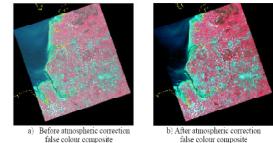
| Satellite sensor | Date | DOY |
|------------------|--------------|-----|
| UK-DMC | 19-Feb-2006 | 50 |
| DMC-Nigeriasat | 03-Mar-2005 | 62 |
| DMC-Nigeriasat | 19-Apr-2005 | 109 |
| UK-DMC 150 | 30-May-2005 | 150 |
| Landsat ETM+ | 30-May-2005 | 150 |
| DMC-Nigeriasat | 08-Jun-2005 | 159 |
| UK-DMC | 27-Jun-2005 | 178 |
| UK-DMC | 11-July-2005 | 192 |
| DMC-Nigeriasat | 17-Aug-2005 | 226 |
| DMC-Nigeriasat | 02-Sep-2005 | 245 |

Source: Mark Danson, University of Salford



Data analysis

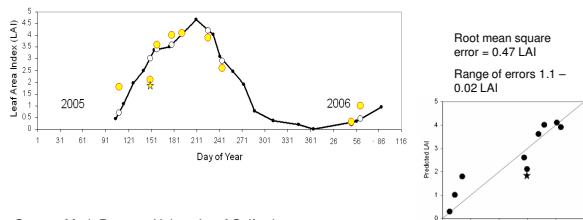
- Geometric correction to BNG
- Atmospheric correction for DMC DOY 150 using image COST method (Chavez, 1996)
- Identification of common spectrally invariant targets
- Cross-calibration of all images to DMC DOY 150 reflectance for around 10 targets
- Correction of all images to G, R, NIR reflectance
- Compute vegetation indices



Source: Mark Danson, University of Salford

Results

| Vegetation index | Equation | R ² |
|------------------|----------------|----------------|
| SAVI | 0.1014x+0.2165 | 0.85 |
| DVI | 0.0697x+0.99 | 0.85 |
| IPVI | 0.523x+0.7442 | 0.74 |
| NDVI | 0.1044x+0.488 | 0.73 |



Conclusion

- NCAVEO as a model for community engagement and knowledge exchange about QA:
 - organisations
 - individuals
 wide range of interests, expectations and remits.
- KE in NCAVEO was facilitated by joint activities – workshops & projects with a clearly defined outcome, for example the Field Campaign.
- Belief that multidisciplinary collaborative experiments are a highly effective use of the UK's EO assets. Involve all the community, not just a few groups.