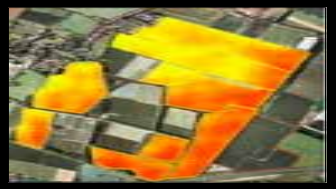
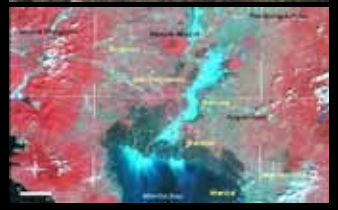
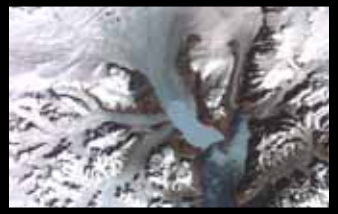
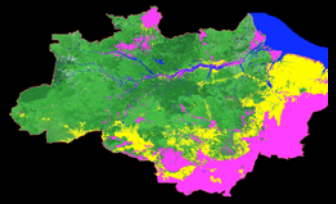








CEOS WGCV 29
DMCii / SSTL Report

Stephen Mackin

Chief Scientist

DMC International Imaging Ltd

Presentation Outline

- Calibration
  - Cross-calibration
  - Uncertainty quantification
- QA/QC development
  - Calibration module
  - Standard Modules
- ESA Requirements
- Summary and Conclusions

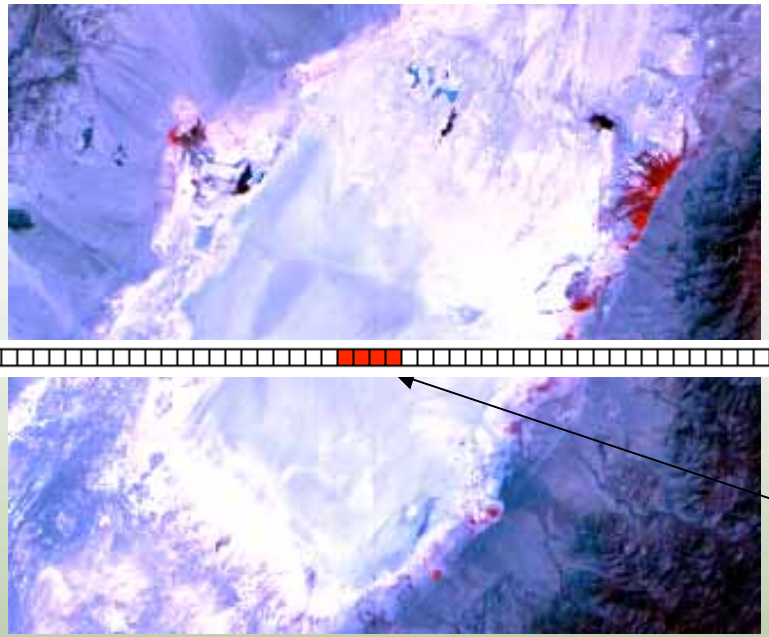
Calibration

- 2003-2008
  - Dark images (Pacific Ocean)
  - Vicarious calibration (RRV)
  - White images (DOME-C)

- Major Issues
  - Management of large constellation to acquire absolute calibration images (with view zenith less than 13 degrees to reduce RRV BRDF effects)
  - Costs as the constellation increases in size. With 4-6 images per satellite and soon perhaps 8 satellites, collecting and processing 48 images can be a costly exercise.
  - Small differences seen between satellites in constellation. Strong requirement for consistent results for same target for high temporal vegetation studies. ALL satellites need to give same result (even with an absolute bias)

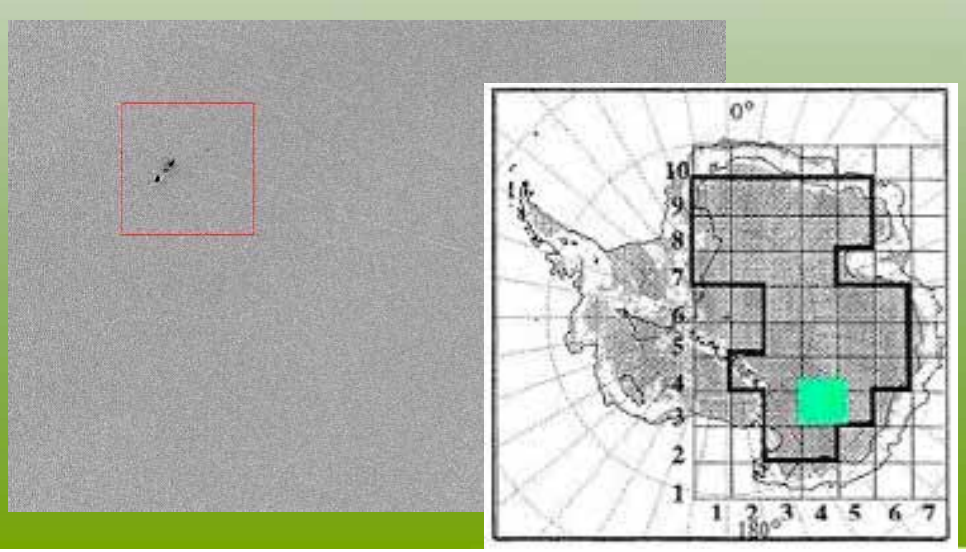
Calibration Process

- Large linear arrays of which nine pixels calibrated over RRV
- Use DOME-C in Antarctica to transfer absolute of nine pixels to rest of array
- Lots of overpasses, flat and stable target
- Use Pacific at Night as dark reference



Absolute Calibration
Railroad Valley Nevada

Calibrated
Pixels (9)



Vicarious Calibration Uncertainties

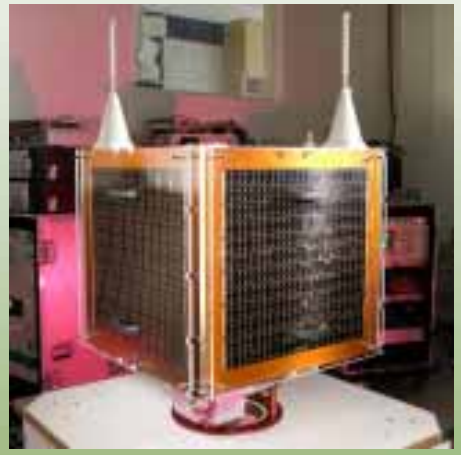
- Stated nominally by University of Arizona at approximately 3%
- Additionally since we sample 9 pixels from our 20,000 detector array and only two rows, there is a variability which includes,
  - Surface variability at RRV
  - System noise
  - Surface variability at DOME-C
  - Produces a 2.75% (1σ) additional uncertainty component.

Vicarious Calibration Uncertainties

- The overall level of uncertainty will be of the order of 5%
- However, processing each individual satellite in this manner can lead to small but detectable differences between satellites when used in vegetation studies
- Absolute can not be improved unless we improve technologies (SNR, spatial resolution)
- Relative can be improved by the cross-calibration process.

Cross-Calibration

- Same data sets, dark, vicarious and white transfer images
  - Vicarious only for one satellite (“Gold” standard. Currently Nigeriasat-1, campaign just finished in Nevada.



  - Transfer between end October and February using intersections between satellites over DOME-C

Cross-Calibration

- Transfer uses overlapping images with time separation of less than one minute
  - Use mean of image (minimises noise contribution)
  - Correction for solar elevation at scene centres
  - Small uncertainty due to pointing knowledge of sensor (0.3% radiance change 1σ) for typical solar elevation

Cross-Calibration - Validation

- To evaluate the uncertainty in the cross-calibration process, multiple joint acquisitions will be made with the two most stable satellites
- Assuming one is “fixed” from a first cross-calibration, the variation in the cross-calibration will be assessed for the other acquisitions
- The contributions in this case will be from
  - Pointing knowledge (0.3%)
  - Surface variability in the overlapping images
  - Rapid atmospheric changes (unlikely)

Cross-Calibration – Variability of surface

- It has been noted in previous studies that the DOME-C site is not perfectly uniform in response. This obviously has impacts on the calibration.

- As part of the procedure, we use a 50 x 50 pixel moving window to determine the mean and standard deviation of the Antarctic surface to assess homogeneity and exclude observations that show too much variability.

- Note that when imaging in ascending node we can see the increase in radiance as we move from south to north across the area.

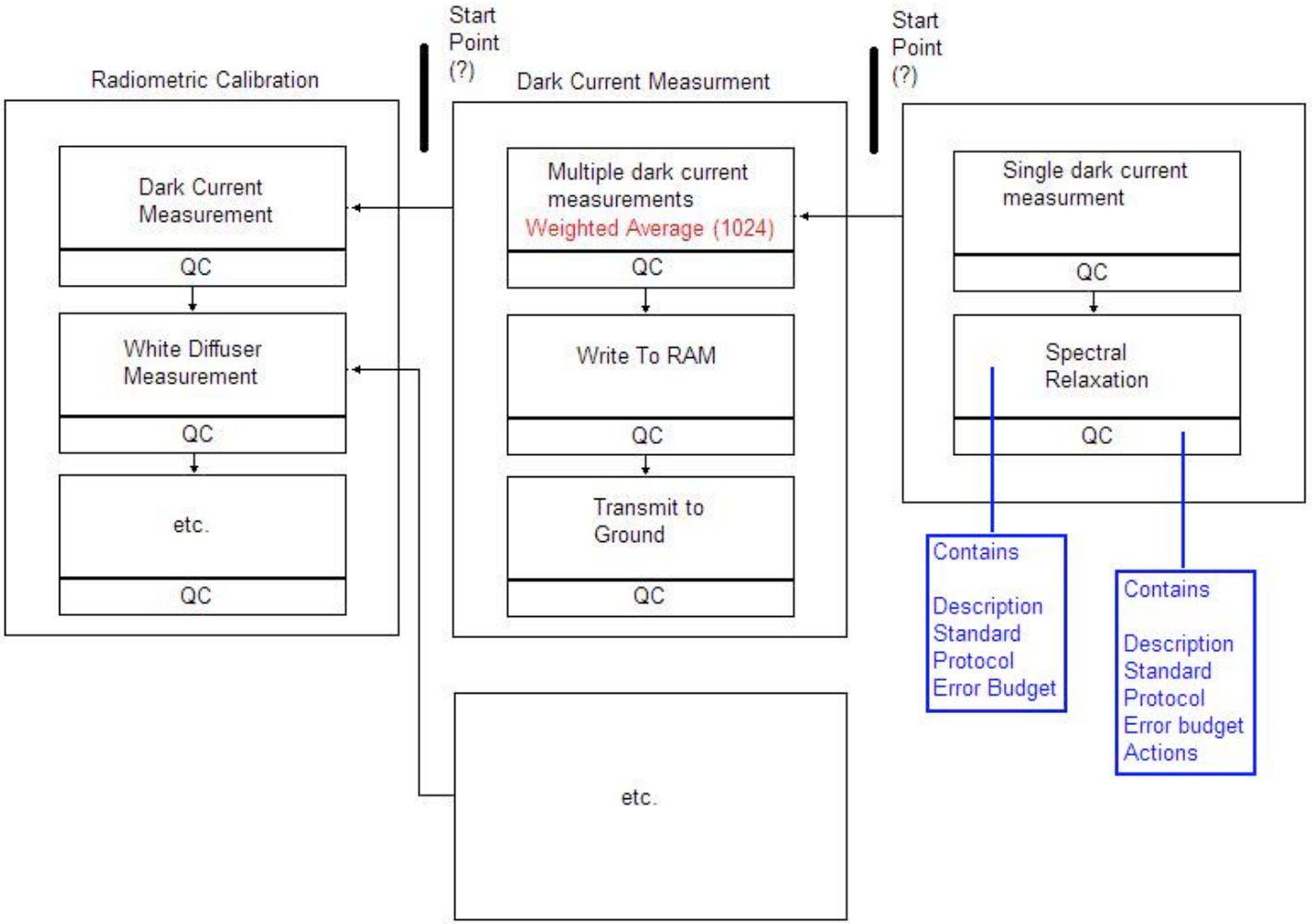
Cross-Calibration – Advantages

- We expect
  - Reduced inter-satellite variability
  - Provides basis for long term archive stability
  - Allows detailed analysis for new satellites which change rapidly in early months of life

QA / QC - Calibration

- Work has started on a modular QA/QC system at SSTL/DMCii
- Initially focused on the calibration area writing procedural modules
- Already some physical modules created. Some difficulties of integrating it into single structure (complex relationships)
- Decided to write individual modules with simple interface and link later

QA / QC - Calibration



QA / QC - Products

- First product algorithms based around modular QA/QC routines have been developed.
- Standalone, so no real traceability outside of module
- Once connected should provide full traceability.
- Only a small proportion under development (26 modules in total) out of hundreds (potentially)

QA / QC - Benefits

- Immediate benefit of seeing the areas for which we have NO uncertainty estimates
- Identification of areas where QC has not been applied rigorously (more areas than imagined).
- More confidence in the previous calibration work as uncertainties in some cases lower than expected

QA / QC - Problems

- Interfacing the QA/QC modules to current processor software
- Lack of suitable feedback mechanisms for automated QC of data processing
- Many uncertainty estimates relate to processes being carried out by third parties (Arizona – Vicarious; Spacemetric – Geometric).
- No proper connection to best practice, as current QA4EO is too high in level for implementation in some cases.

ESA Requirements

- Good to see that TPM mission requirements include data on system performance and collection of calibration data
- A lot based on one paper, would prefer to see them based on CEOS best practice guidelines
- Would like to know how this data is to be used, as in its basic form it is not a quality index

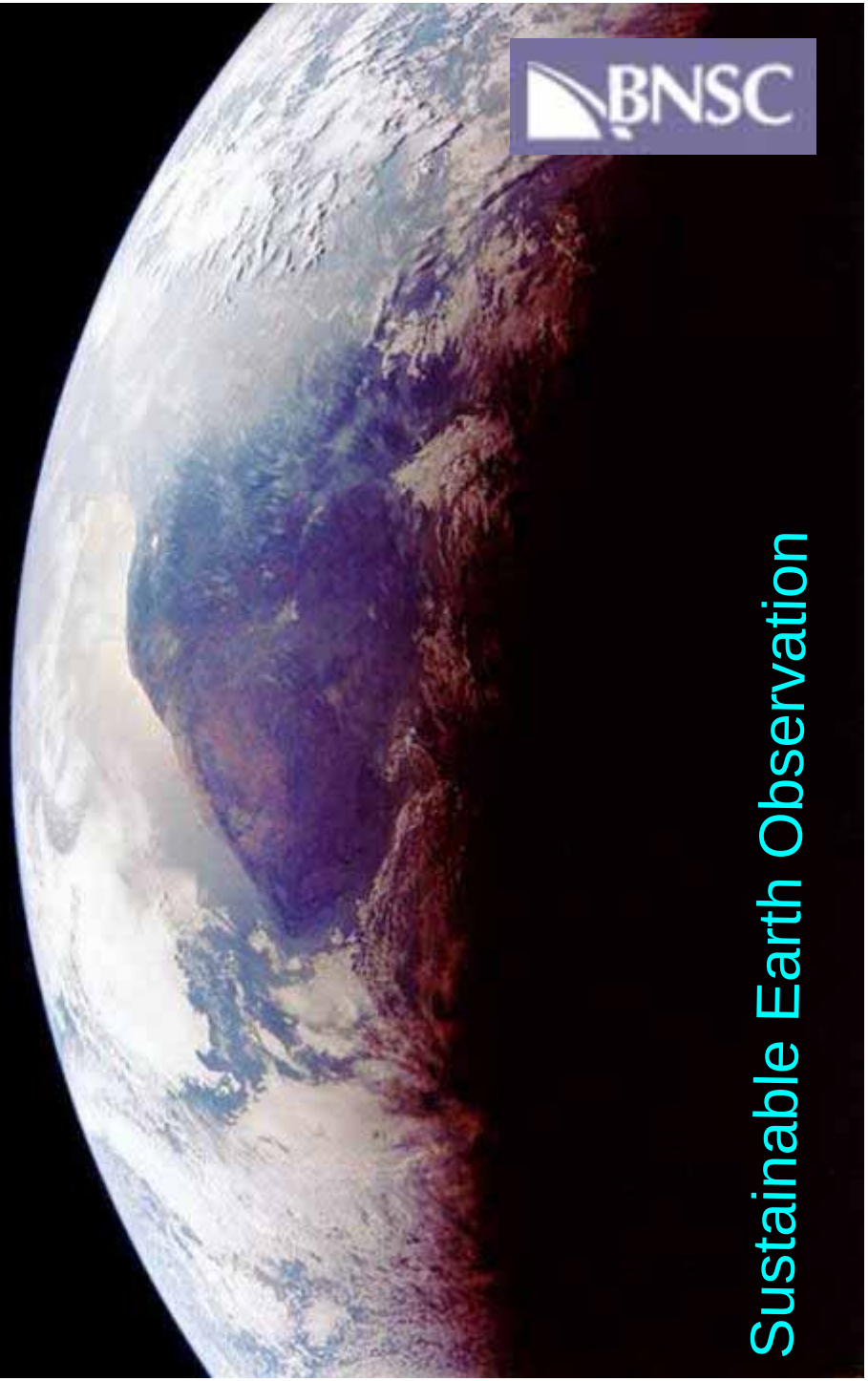
Summary and Conclusions

- Change from normal vicarious calibration to cross-calibration based on a “gold” standard to reduce costs, management and satellite to satellite variability. Results to be posted after Xmas.
- QA/QC progressing, slow process as no clear structure to use. Therefore developing own implementation structure (Best efforts - in spare time).

Questions ?

- **www.sstl.co.uk**
- **www.dmcii.com**

S.Mackin@dmcii.com



Sustainable Earth Observation