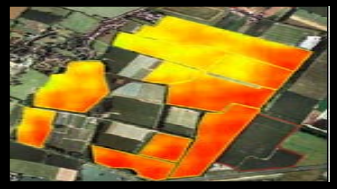
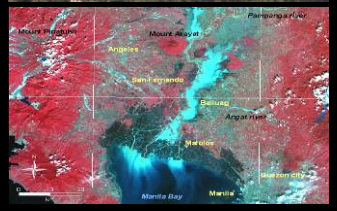


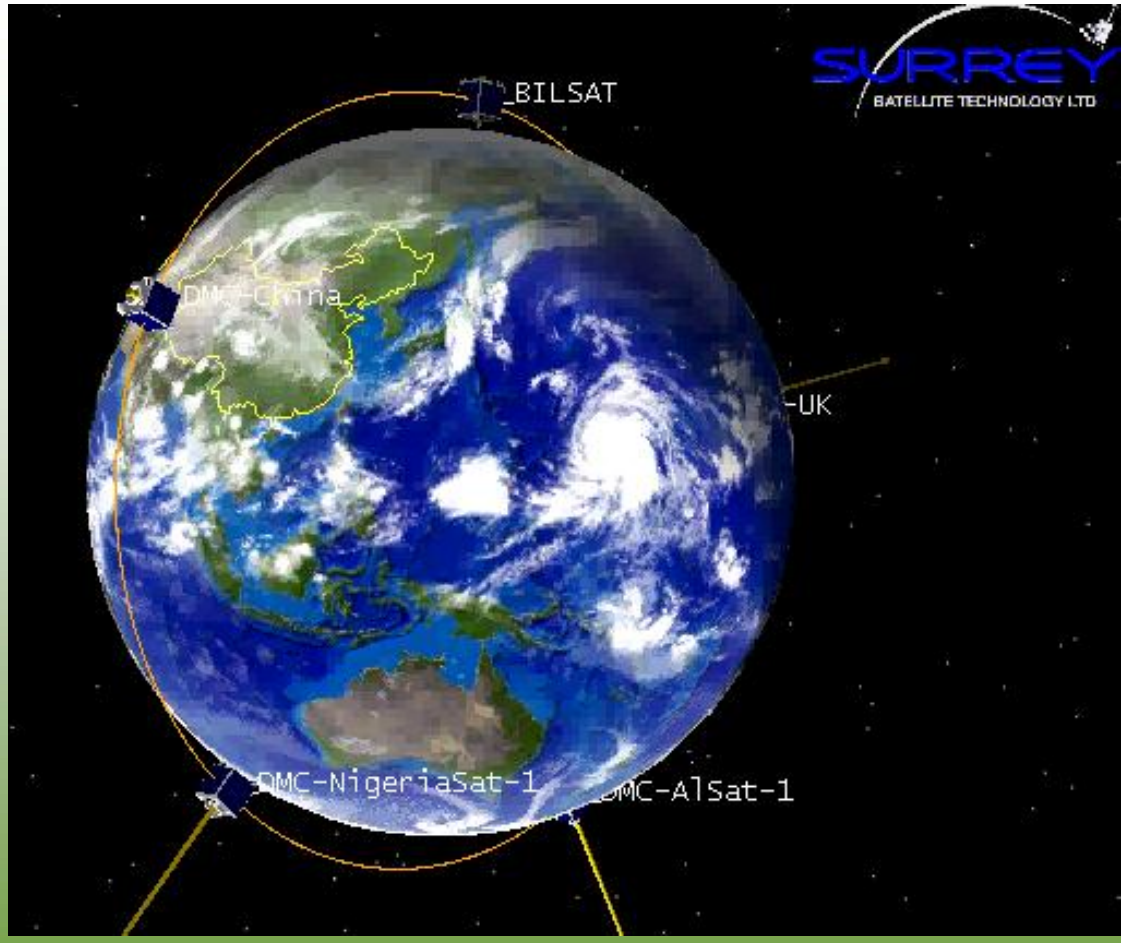


DMCii / SSTL Report
WGCV 30

Steve Mackin
Chief Scientist
DMC International Imaging Ltd

Need for Calibration

- Currently four satellites in constellation
- Three more in 2009
- Need good absolute calibration
- More important the relative calibration for high temporal applications



Problems of Vicarious Calibration

- Logistics and costs
  - Many satellites each requiring several acquisitions
    - Organisational issues (timing, availability)
    - Costs (ground teams and processing)
  - Growing number of satellites each year
- Technically
  - Variable number of acquisitions gives variable quality
  - Larger than desired relative (satellite to satellite) calibration variability
    - Affects customer applications (precision farming using the whole constellation)

Calibration Activities

- In 2008-2009 changed over from individual satellite vicarious calibration to “Gold Standard” and cross-calibration
- Overview of procedure and results, plus uncertainties (where possible) are given

Approach Outline

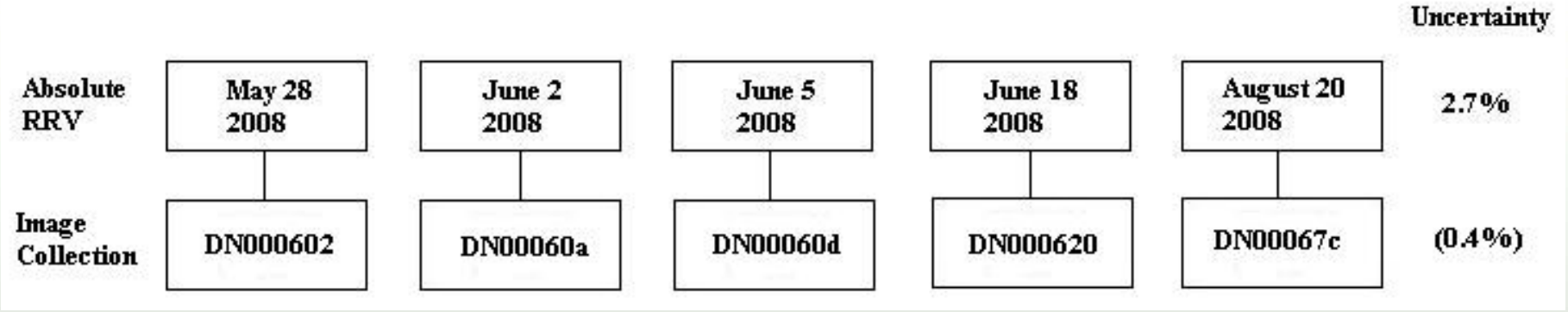
- Three elements
  - Absolute calibration
    - Uses a single satellite “Gold” standard
    - More acquisitions (more confidence)
    - Lower costs as single satellite
  - Transfer calibration
    - Uses Dome-C in Antarctica to transfer from a few detectors to whole array
  - Cross-calibration
    - Intersections over Dome-C (half an image overlap – 320km) time separation of 30 minutes to one hour with stable atmosphere

Step 1 – Absolute (Ground)

						Uncertainty
Absolute RRV	May 28 2008	June 2 2008	June 5 2008	June 18 2008	August 20 2008	2.7%

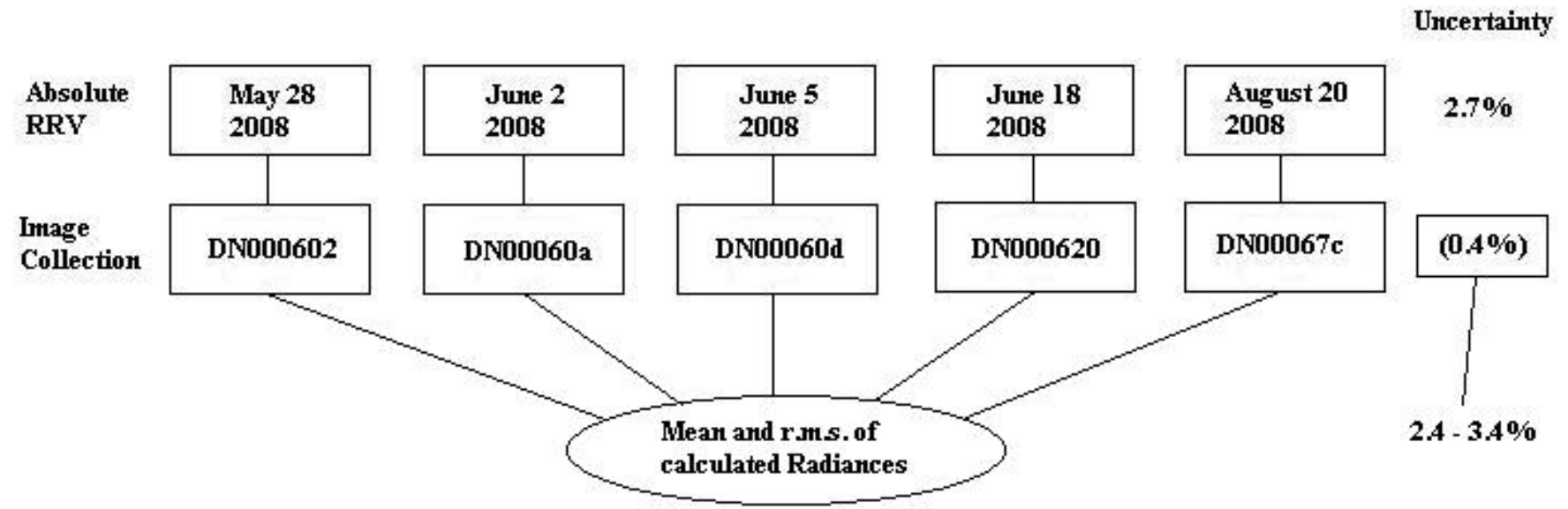
- Uncertainty based on traceability to standards
- Absolute accuracy
- Generates five TOA radiance values

Step 2 – Absolute (Space)



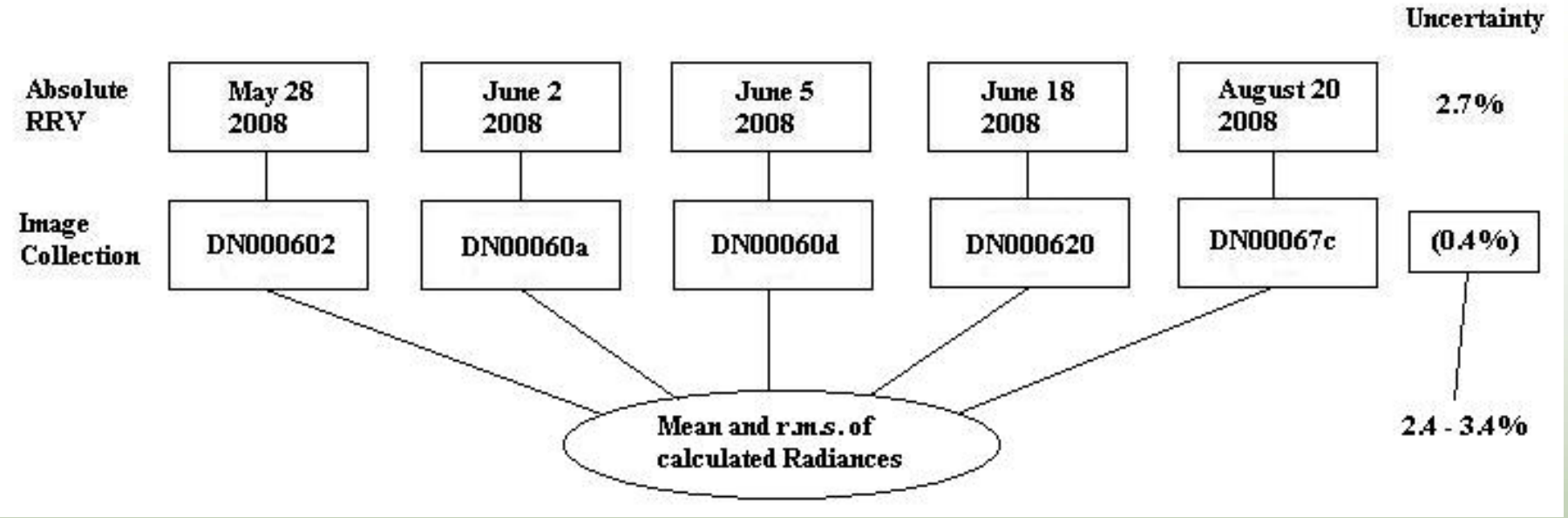
- Surface Variability RRV and system noise in imagery over test site at RRV
- Nine pixels for each image show a variability of 0.4% r.m.s. (NIR band)

Step 3 – Transfer Calibration



- Each image generates calibration coefficients.
- Apply to same DOME-C white image gives five different radiances.
- Variability is the uncertainty due to the repeatability of the RRV Absolute, plus sensor noise and surface variation of DOME-C and RRV.

Step 4 – Final Calibration

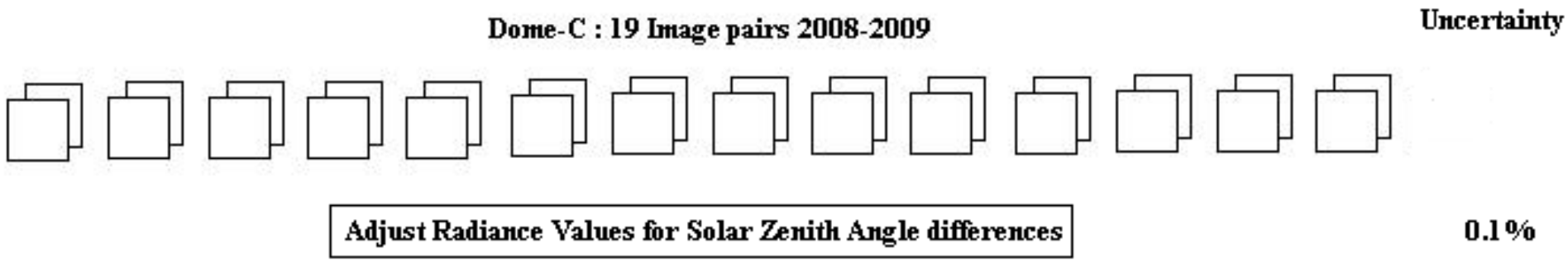


- Combine the absolute accuracy term (2.7%) with the variability term (2.4% to 3.4%) to give the final absolute values
- **Green : 3.6%, Red : 3.9%, NIR : 4.3%**

Cross-Calibration

- Uses Dome-C site. Images have between one half and full overlap.
- Time separation of 30 minutes to one hour, yawed across principal plane.
- Preparation Steps include
  - Identification of image pairs (UK-DMC-1 and Nigeriasat-1 had 19 image pairs)
  - Cloud screening to select best for final cross calibration
  - Correction for solar zenith differences
  - Variability determination by ratioing values using new Nigeriasat-1 calibration and old UK-DMC-1 calibration.

Cross-Calibration – Step 1

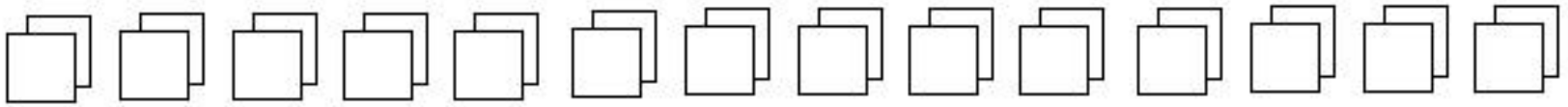


- 19 image pairs (Nigeriasat-1 against UK-DMC-1)
- Large proportion are cloudy
- Radiances of Nigeriasat-1 calculated with new coefficients
- Radiances of UK-DMC-1 calculated with old coefficients.
- Small uncertainty due to pointing accuracy (0.1%)
- Correction for solar zenith angle differences between image pairs

Cross-Calibration – Step 2

Dome-C : 19 Image pairs 2008-2009

Uncertainty

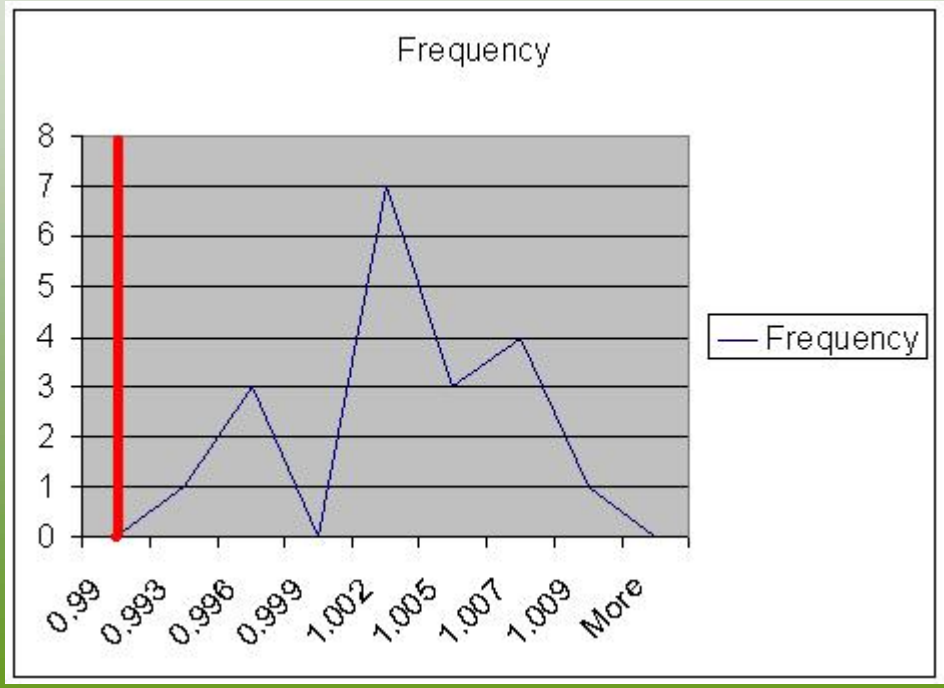


Adjust Radiance Values for Solar Zenith Angle differences

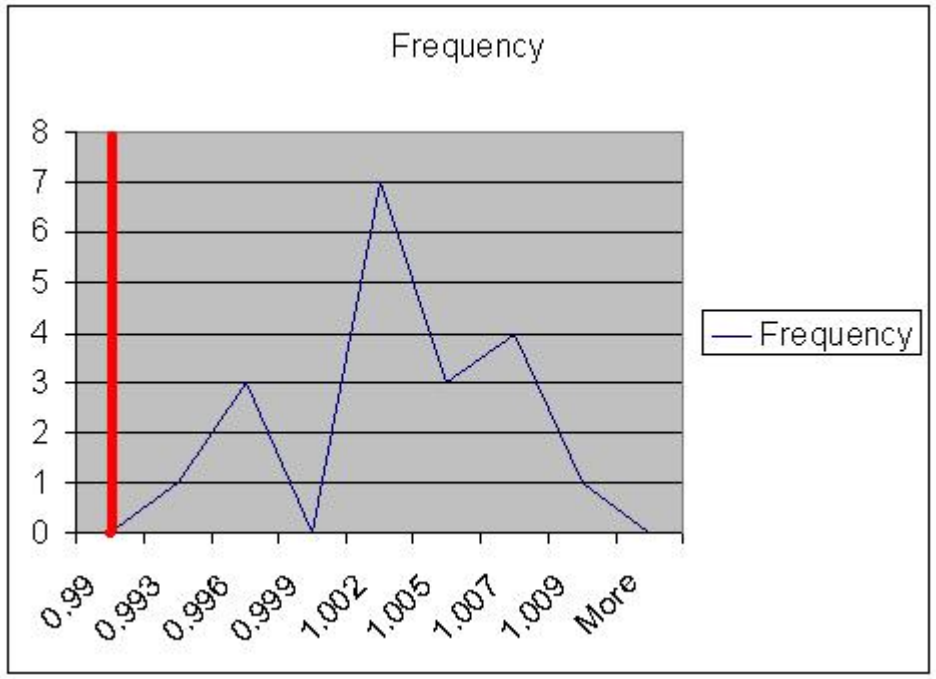
0.1%

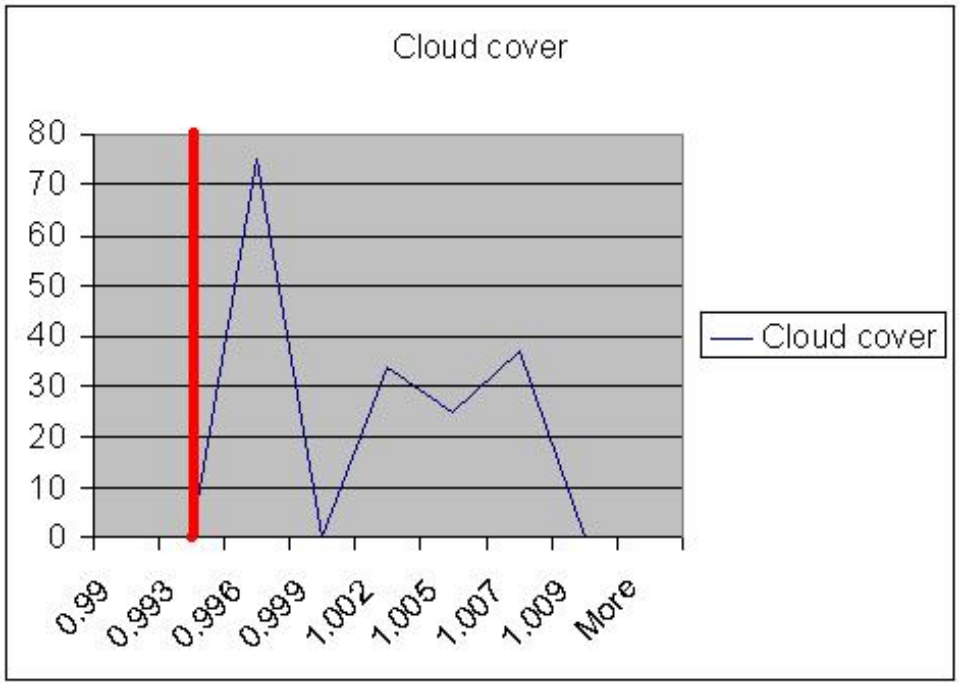
Ratio Nigeriasat-1 / UK-DMC-1 radiances to get average correction factor

- Ratio varies
- Applicable to both cloudy and clear images
- Half image overlap used to generate statistics



Cross-Calibration – Step 2



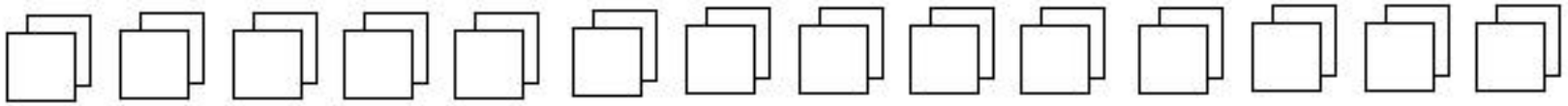


- No relationship between variation in cloud cover and change in ratio value.
- Clear image pairs were found across all ratio values

Cross-Calibration – Step 3

Dome-C : 19 Image pairs 2008-2009

Uncertainty



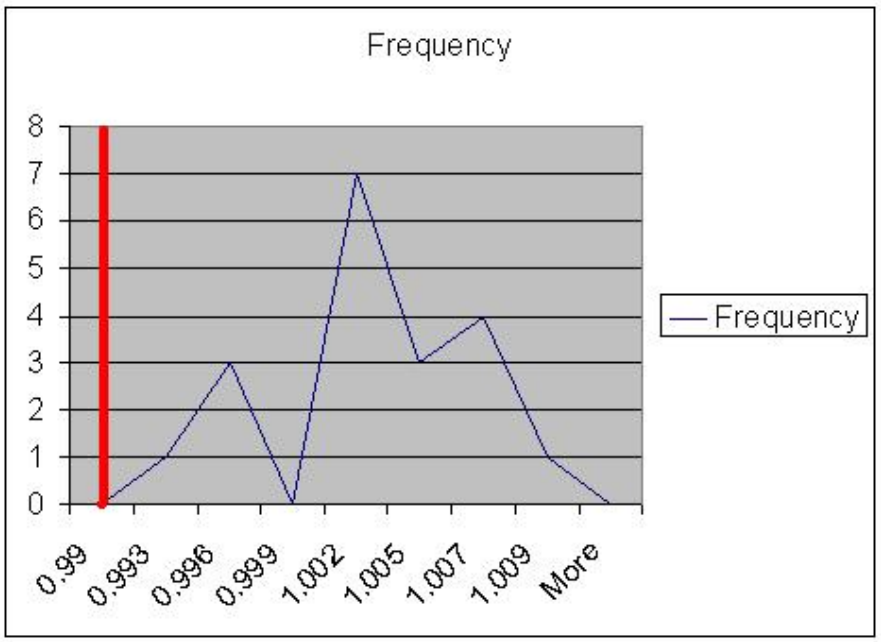
Adjust Radiance Values for Solar Zenith Angle differences

0.1%

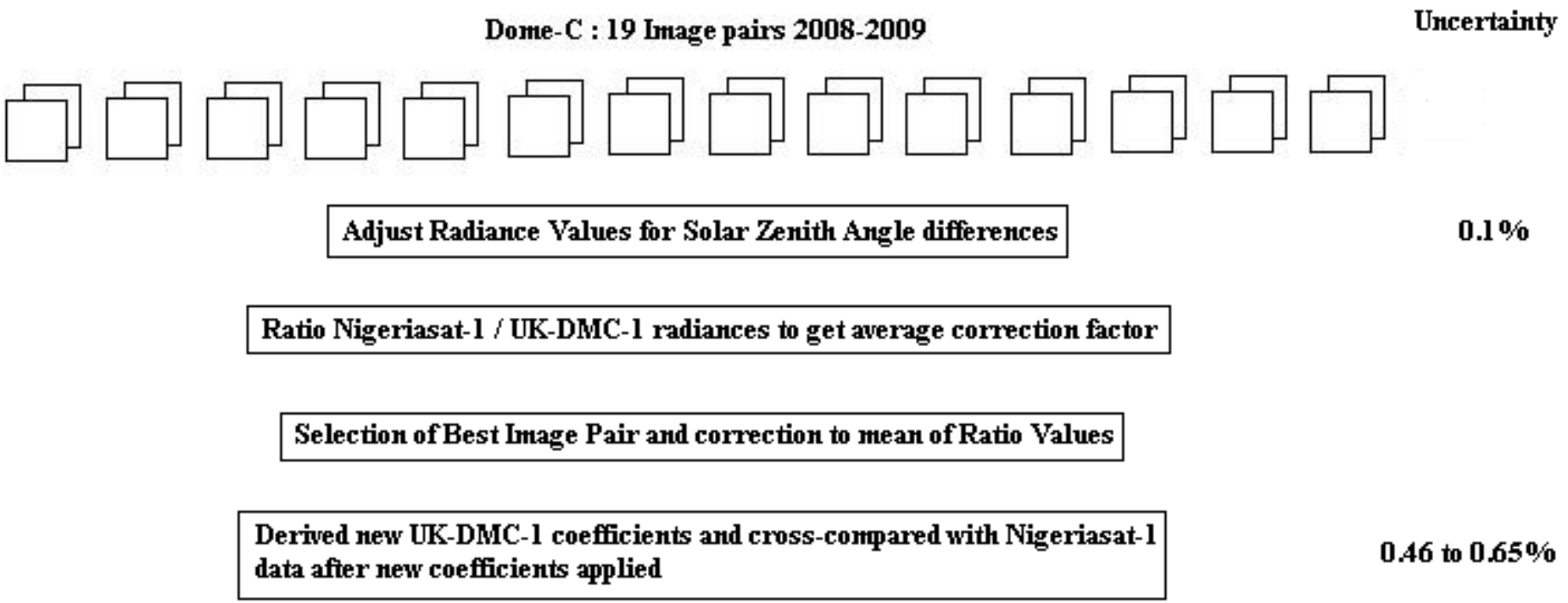
Ratio Nigeriasat-1 / UK-DMC-1 radiances to get average correction factor

Selection of Best Image Pair and correction to mean of Ratio Values

- Selected image pair had no cloud
- Dome-C visible in both images
- Corrected radiance to be in centre of ratio distribution



Cross-Calibration 4



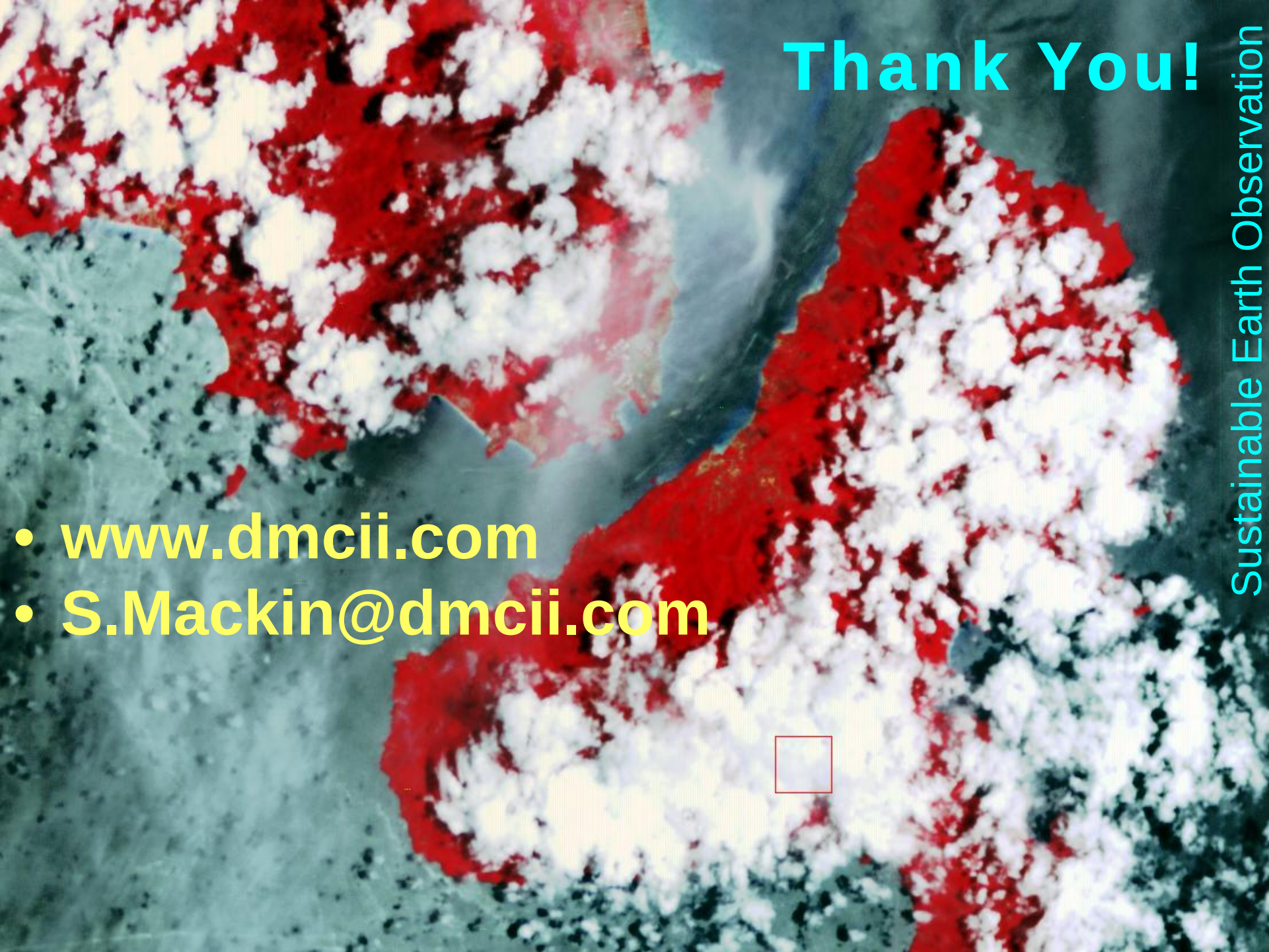
- The uncertainties of this process can then be combined with the absolute from Nigeriasat-1 to give the following for UK-DMC-1
  - Green : 3.7%, Red : 4%, NIR : 4.4%

Cross-Calibration 5

- Repeated for Beijing-1
- Validation between Beijing-1 and UK-DMC-1 intersections with r.m.s. of these less than 0.2%
- Absolute less than 5% for all satellites in constellation
- Relative satellite to satellite less than 1% (1 sigma)

Modular QA/QC

- Still under development
- Some examples to be shown later this week
- Initial results are unearthing many areas of uncertainty previously ignored (electronics stability)
- Some of areas shown in this calibration exercise


Thank You!
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