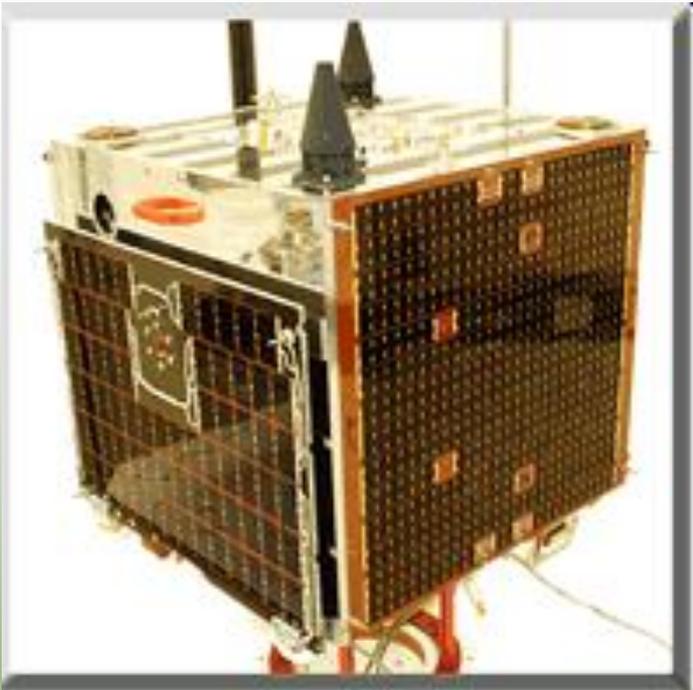




# Presentation

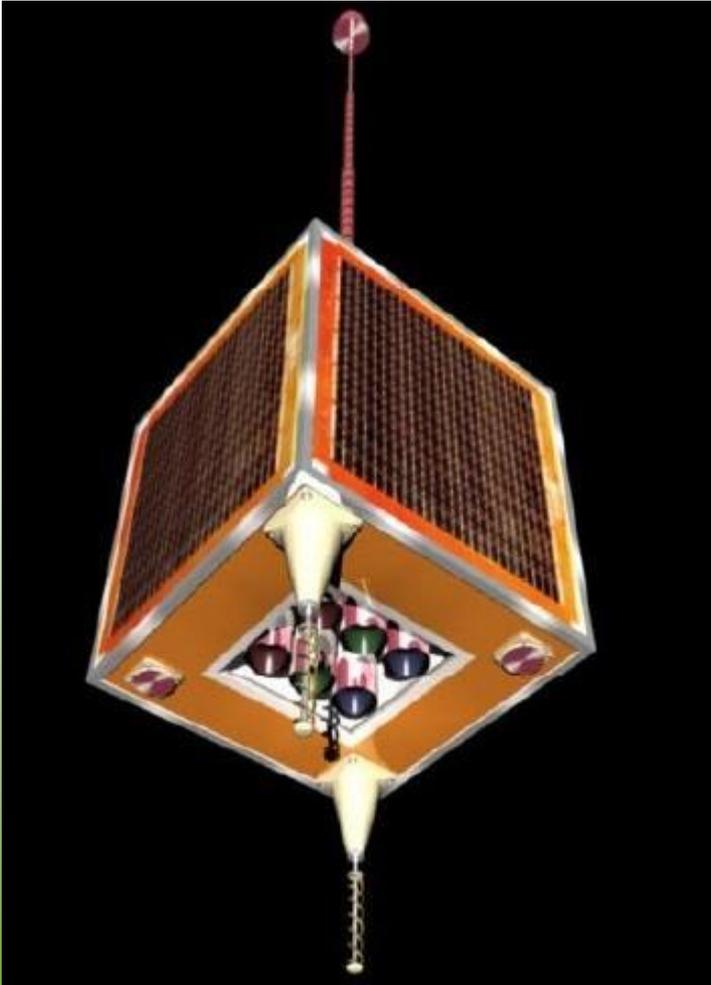
- DMC Constellation introduction
- Comparison – MTF / Spatial Resolution
- Comparison – Noise characteristics
- Comparison – CCD and electronics stability
- Calibration
  - Absolute (Tuz Golu)
  - Cross-calibration
  - Future Calibration (Landsat “Gold” standard)
- UK-DMC-2 where are we now ?

# DMC Constellation



- Currently three 32m GSD imagers (NigeriaSat-1, Beijing-1, UK-DMC-1)
- Two new 22m GSD imagers (Deimos-1 and UK-DMC-2)
- Two to be launched in late 2010, one 22m GSD imager and one 5m GSD imager (NX and NigeriaSat-2)

# DMC Constellation

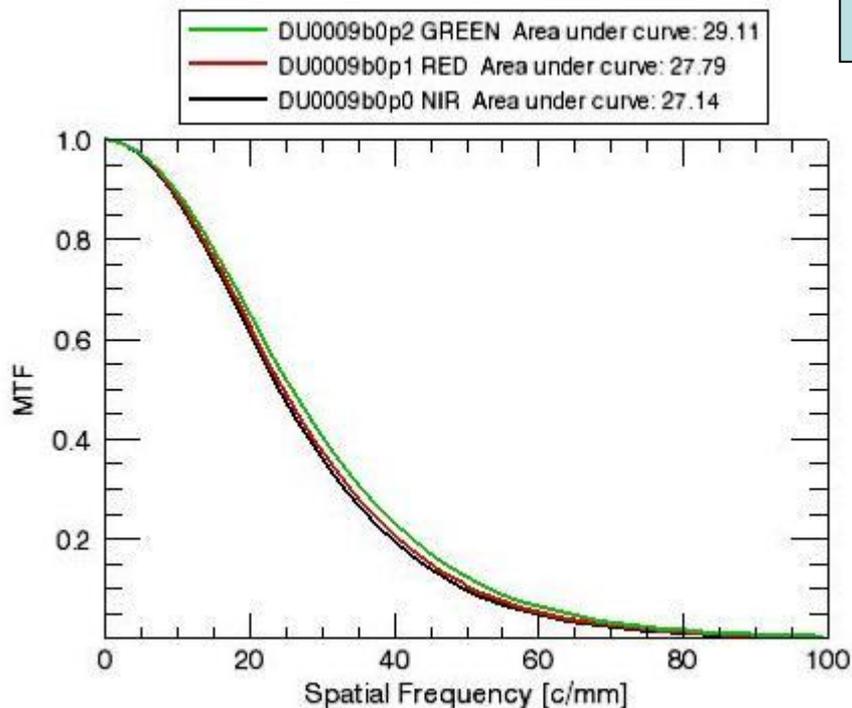


- Three spectral bands (Green, Red and NIR)
- Two imager banks, so six imagers in total
- Wide Field of View with a 640 km swath for the 32m and 22m instruments
- 8 bit data (22m imagers also have 10 bit option)

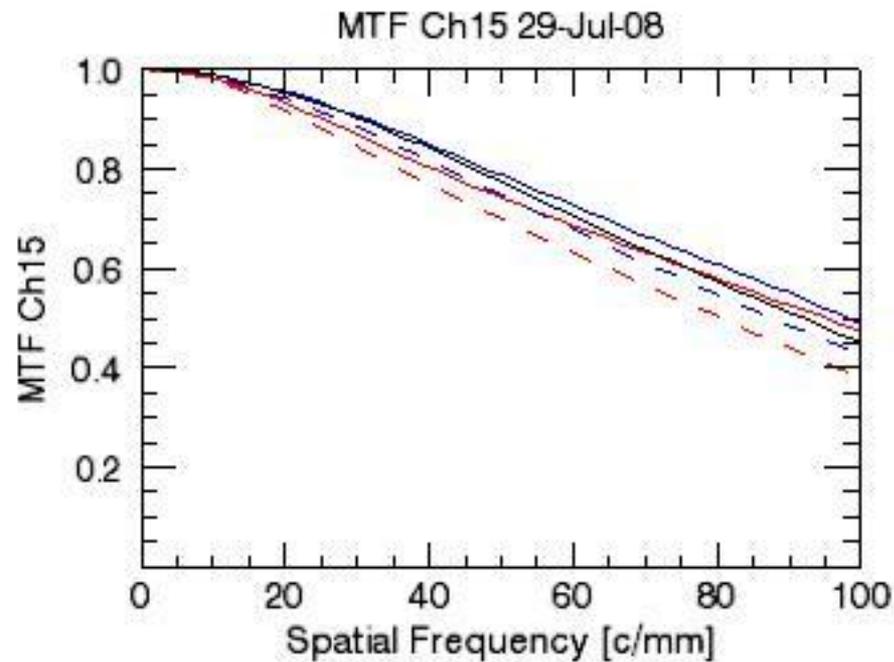
# MTF / Spatial Resolution

All values are quoted for on axis field positions and at the nyquist frequency for the sensor, 100 cycles/mm. In the across track direction (worst case).

	Bank 0	Bank 1
Green channels	42%	31%
Red channels	25%	24%
NIR channels	10%	10%



1<sup>st</sup> Generation (32m)



2<sup>nd</sup> Generation (22m)

# MTF / Spatial Resolution

UK-DMC-1

RED RAW  
DATA



# MTF / Spatial Resolution

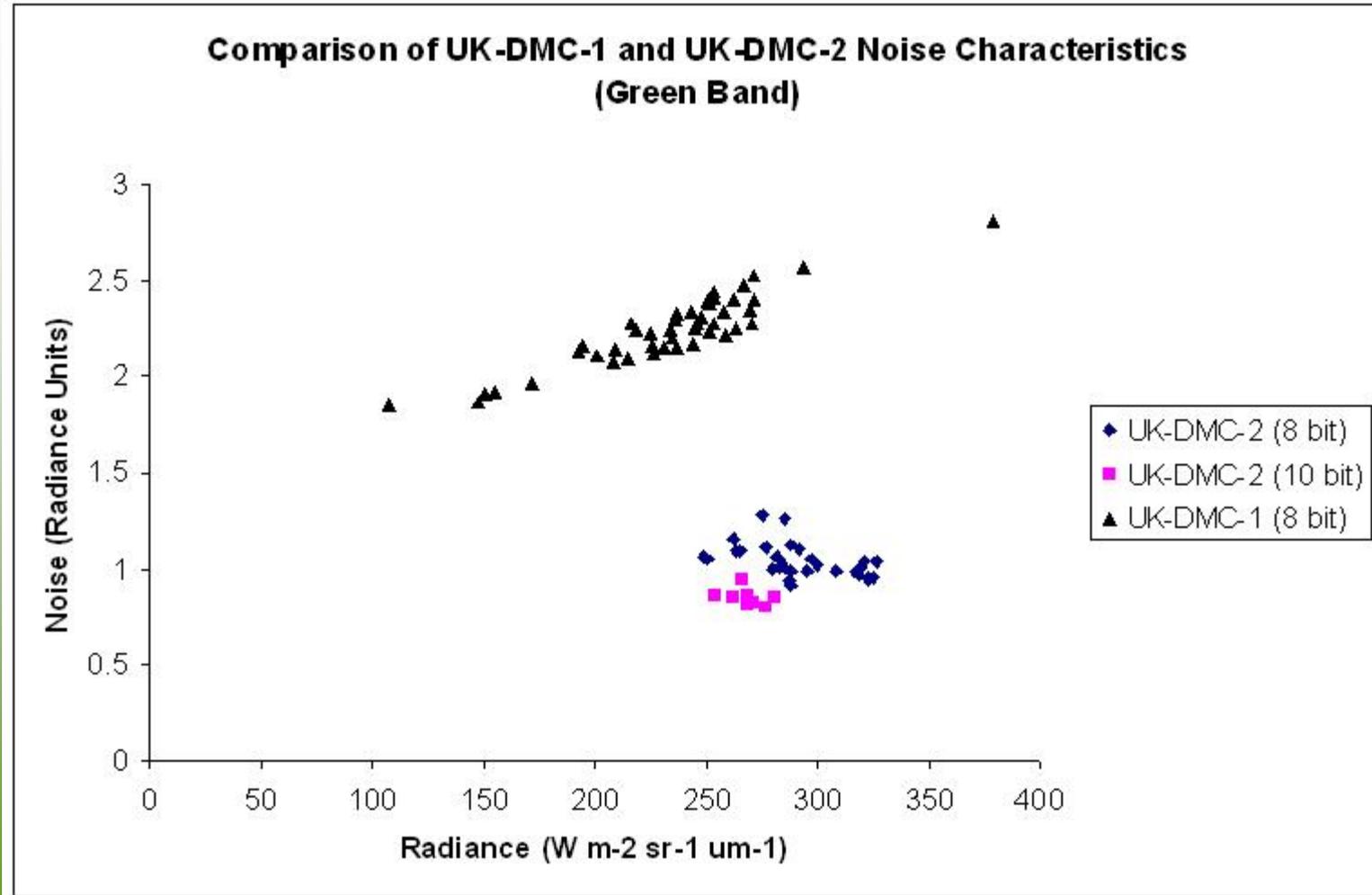
UK-DMC-2

RED RAW  
DATA



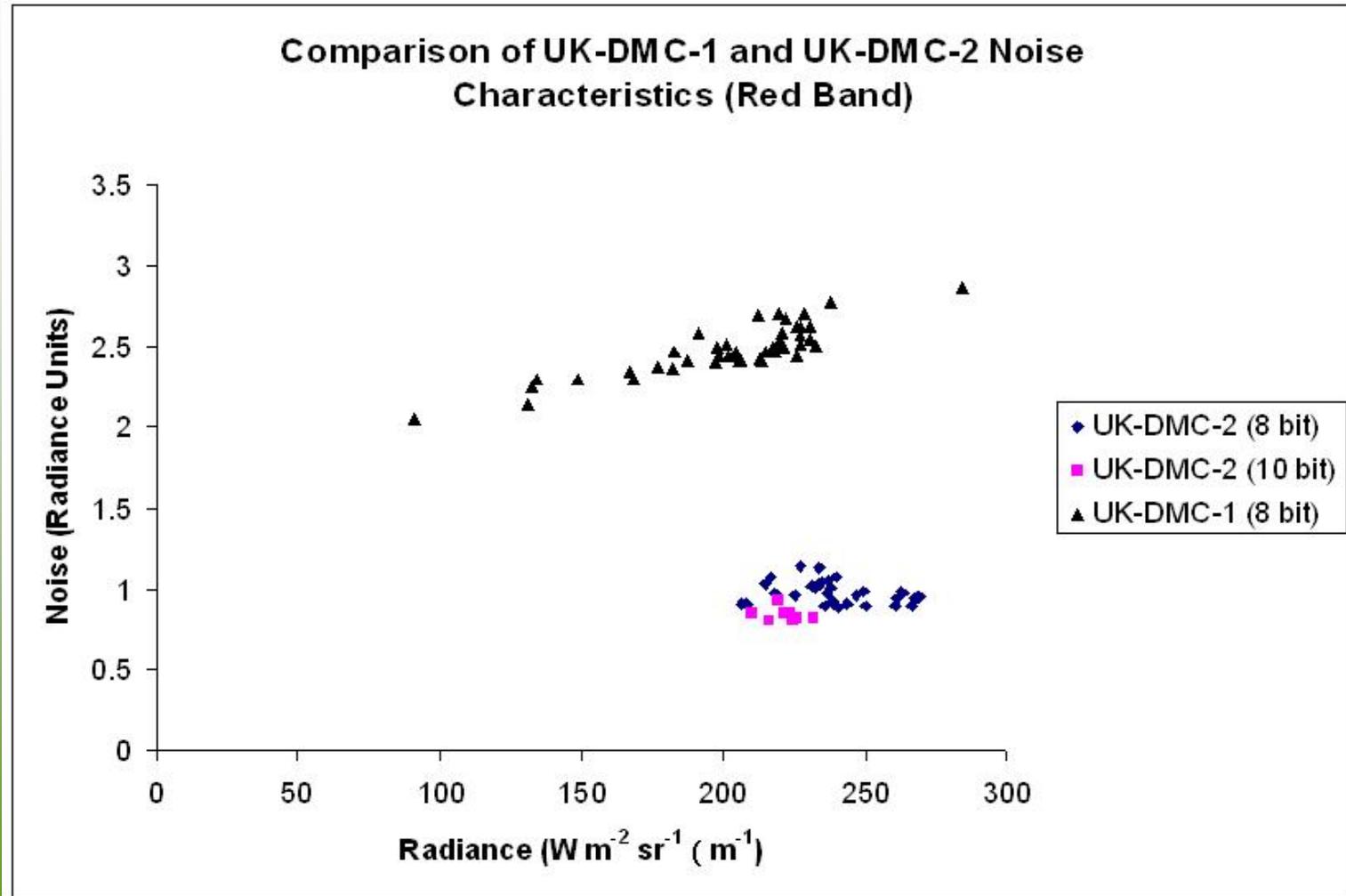
# Noise Characteristics

- Green Band



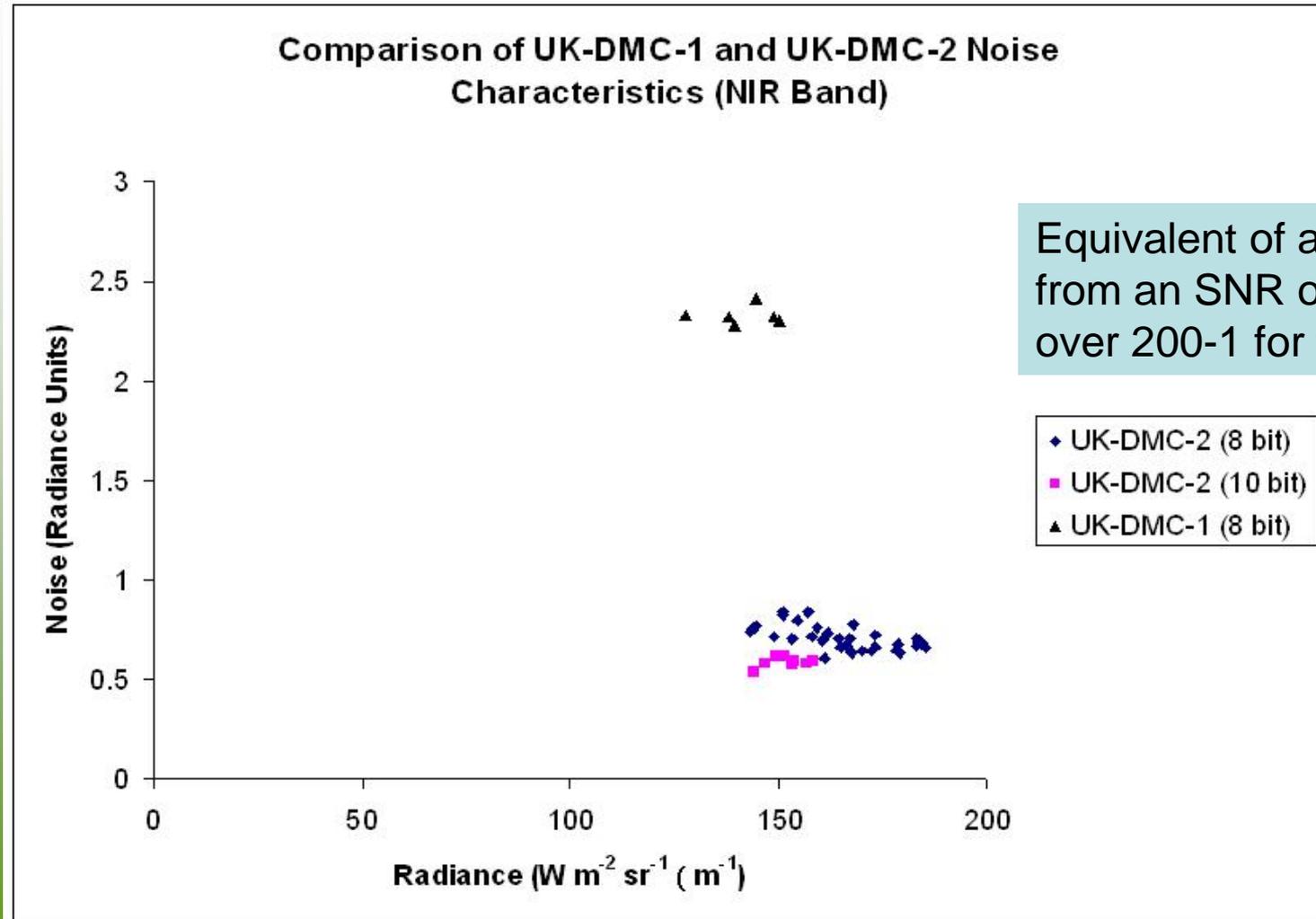
# Noise Characteristics

- Red Band



# Noise Characteristics

- NIR Band



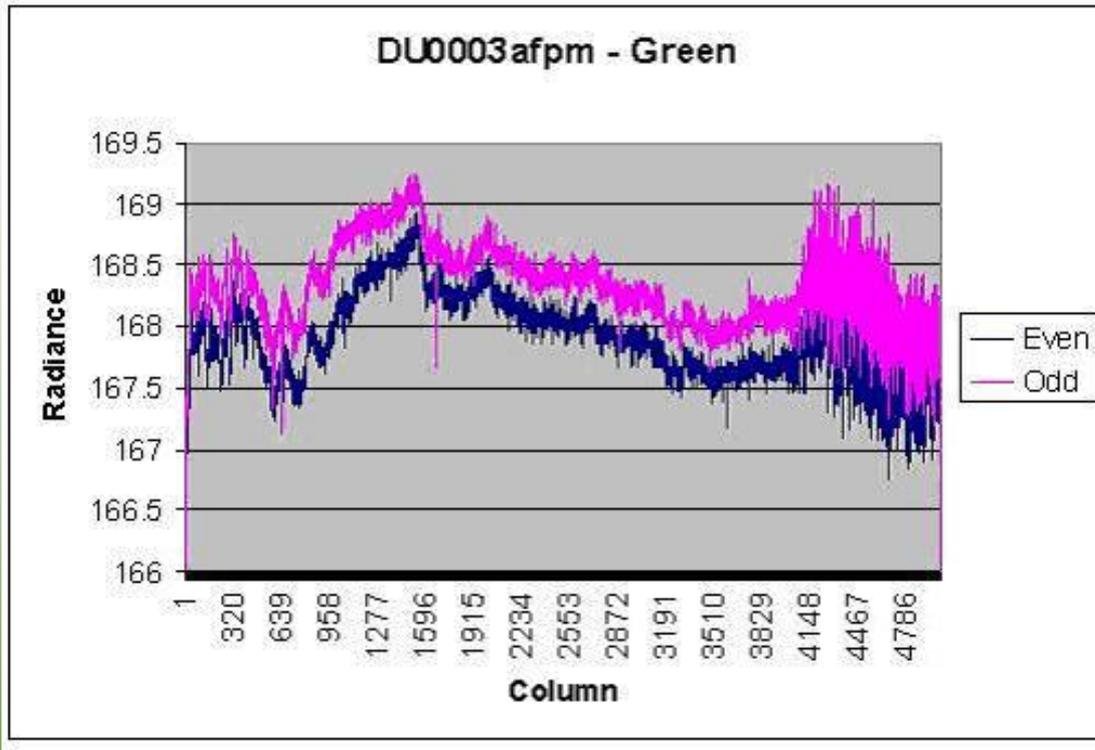
Equivalent of a change from an SNR of 65-1 to over 200-1 for this band

# CCD and Electronics Stability

- The 1<sup>st</sup> Generation DMC satellites have shown small data artefacts in the past
  - Low level horizontal banding on one bank of imagers (still present and noticeable over dark targets such as water bodies)
  - Low level residual vertical striping (now post-processed to remove CCD odd/even detector variability effects)
- 2<sup>nd</sup> Generation imagers have been redesigned not to show these artefacts

# CCD and Electronics Stability

- Vertical Striping – 1<sup>st</sup> Generation Systems

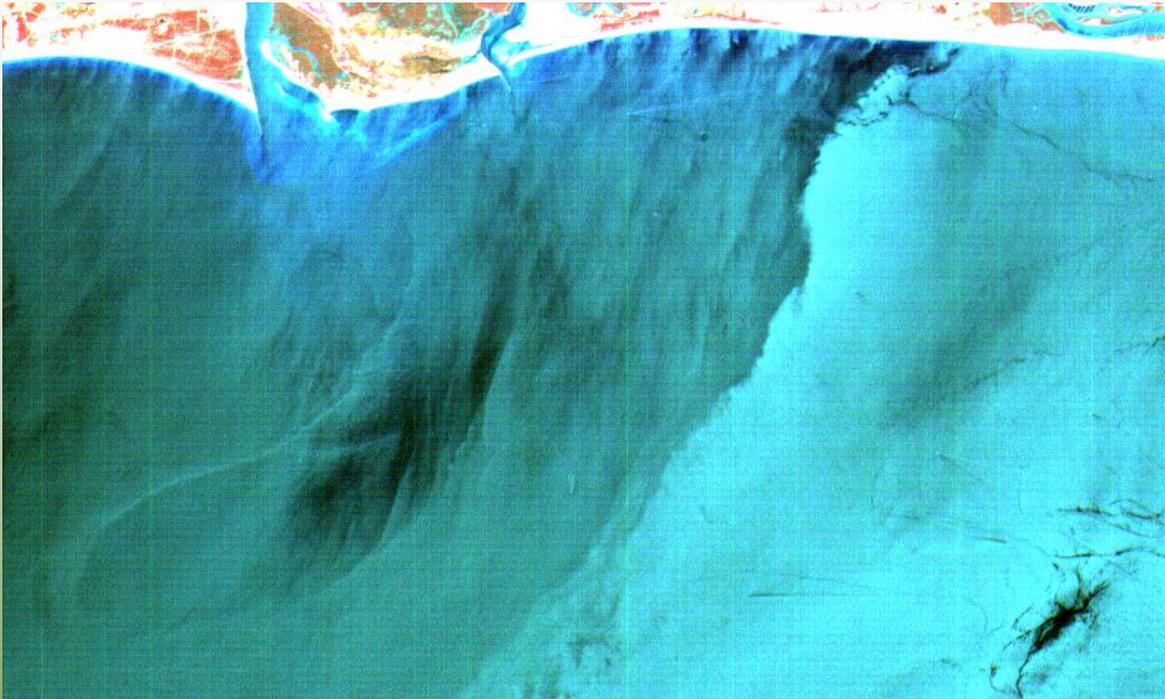


1<sup>st</sup> Generation DMC shows variations of a magnitude of 0.3 W with some variability across the CCD array. Can be removed by post-processing without undue impact on radiometry.

2<sup>nd</sup> Generation DMC's show no discernible variability across the CCD

# CCD and Electronics Stability

- Horizontal banding – 1<sup>st</sup> Generation Systems



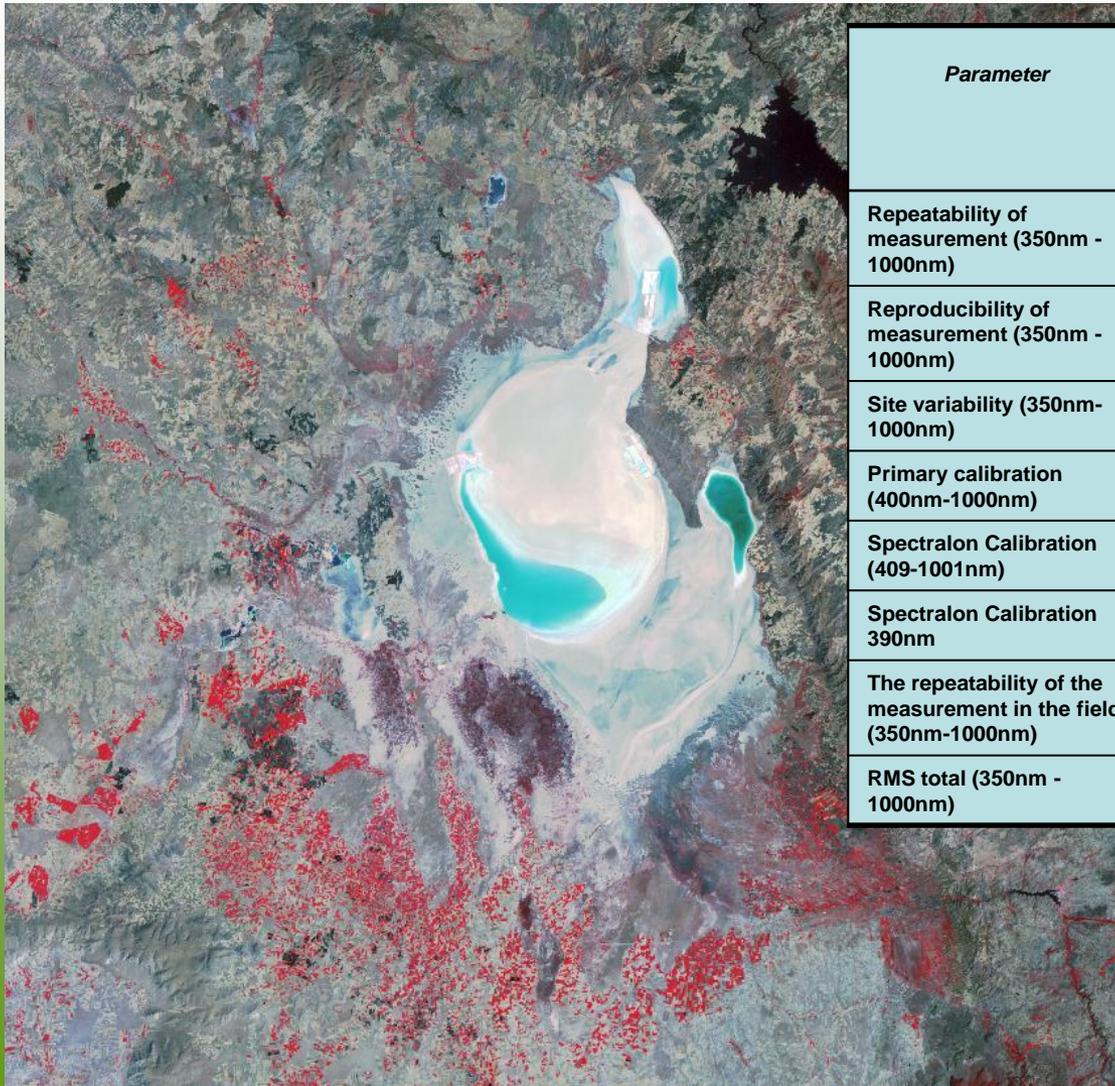
UK-DMC-1 Image

Evident on one bank of the 1<sup>st</sup> Generation DMC's with a magnitude that varies between 0.5 DN to 2 DN in the raw data. Main impact is over dark targets.

2<sup>nd</sup> Generation DMC's have shown no evidence of horizontal striping on either bank.

# Calibration

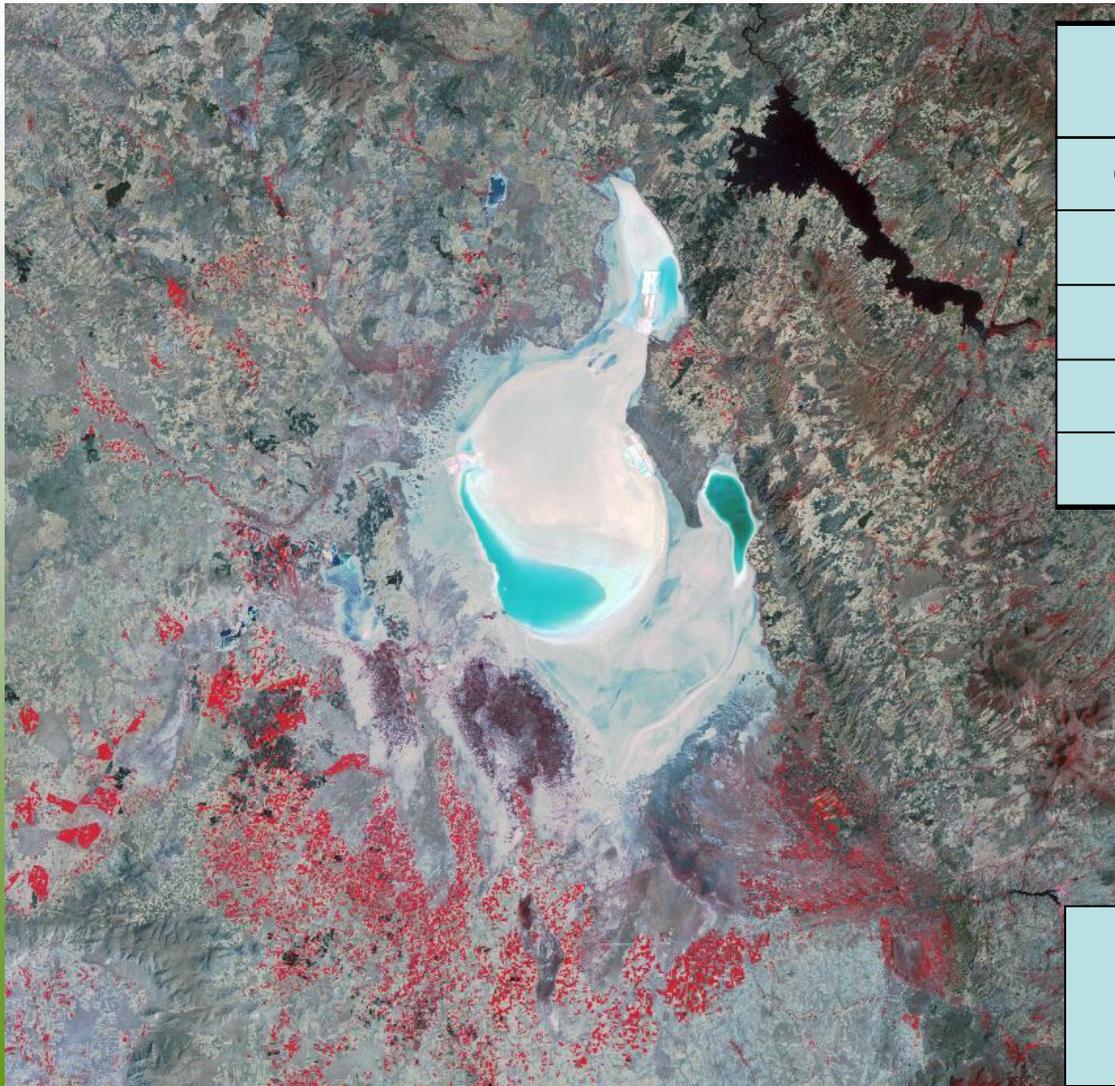
- Absolute – Tuz Golu, Turkey



<i>Parameter</i>	<i>Type A</i>	<i>Type B</i>	<i>Uncertainty in radiance/reflectance</i>
	Uncertainty in Value / %	Uncertainty in Value / (appropriate units)	
Repeatability of measurement (350nm - 1000nm)	0,03%		0,03%
Reproducibility of measurement (350nm - 1000nm)	0,04%		0,04%
Site variability (350nm-1000nm)		2,47%	2,47%
Primary calibration (400nm-1000nm)		1,04%	1,04%
Spectralon Calibration (409-1001nm)		0,3%	0,30%
Spectralon Calibration 390nm		0,5%	0,50%
The repeatability of the measurement in the field (350nm-1000nm)		0,07%	0,07%
RMS total (350nm - 1000nm)	0,05%	2,71%	2,7%

# Calibration

- Absolute – Tuz Golu, Turkey



<i>Source</i>	<i>TOA Uncertainty (1<math>\sigma</math>)</i>
Ground Reflectance Measurement	2,7%
Atmospheric Model	<1%
Lambertian Assumption	1%
Other	1%
RSS	< 3,21%

There are additional uncertainties, including

- System noise of imager
- System instabilities in transfer process

Overall still better than 5% absolute.

# Calibration

- Cross-Calibration – Dome C

Dome-C has been used since 2003 for

- (1) Transfer of the absolute calibration to all the detectors in the array
- (2) Cross-calibration using a DMC constellation member as a “Gold” standard
- (3) Inter-comparison with Landsat 7



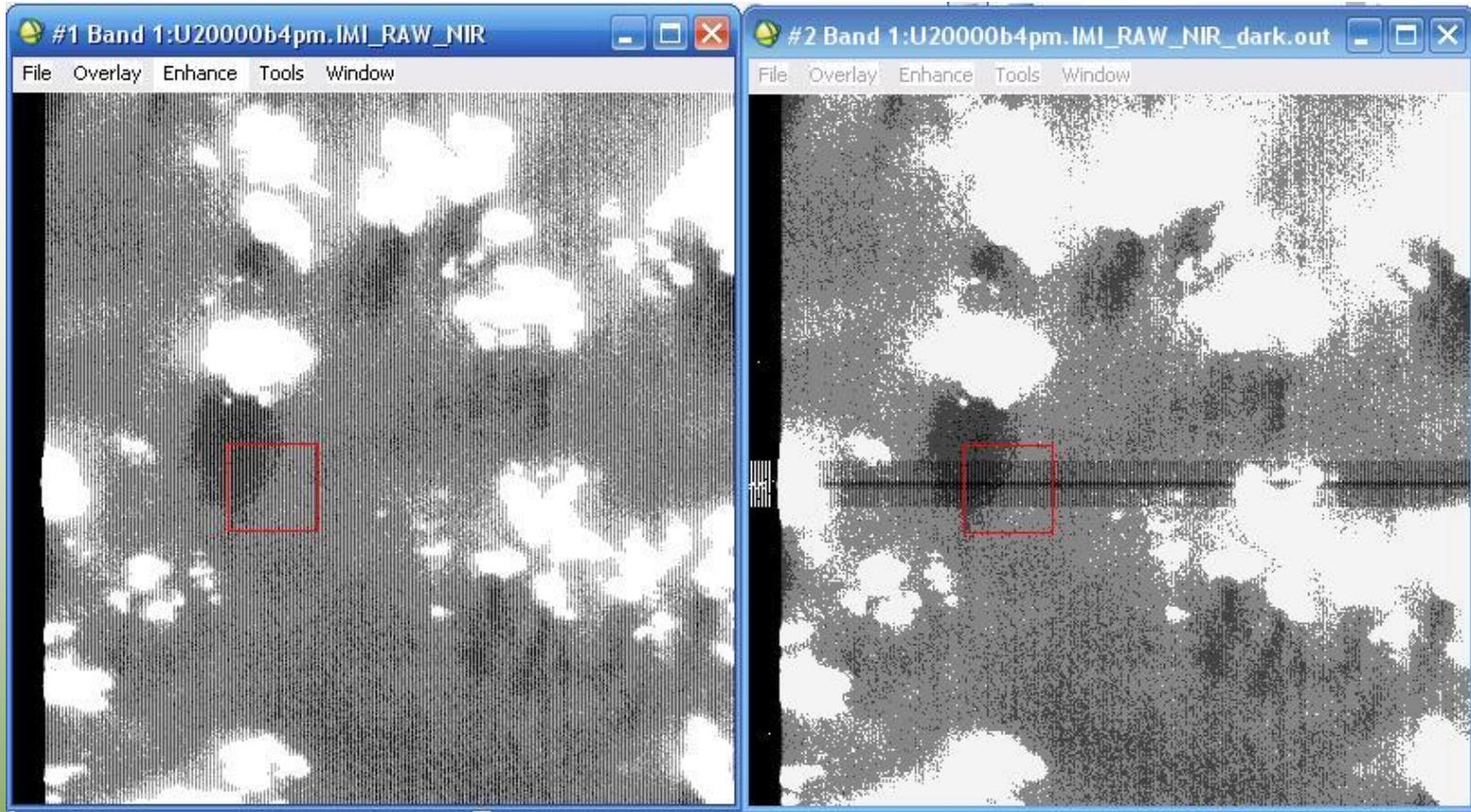
# Calibration

- Future – Landsat 7 “Gold” Standard
  - In the past one member of constellation chosen with near-simultaneous overpasses
  - Using methodology developed during the CEOS intercomparison over Dome-C. Should provide the means to be within 2% of Landsat 7 (target is < 1%)
  - Track all year with all satellites
  - Continue with internal “Gold” standard using vicarious calibration

## UK-DMC-2 where are we now ?

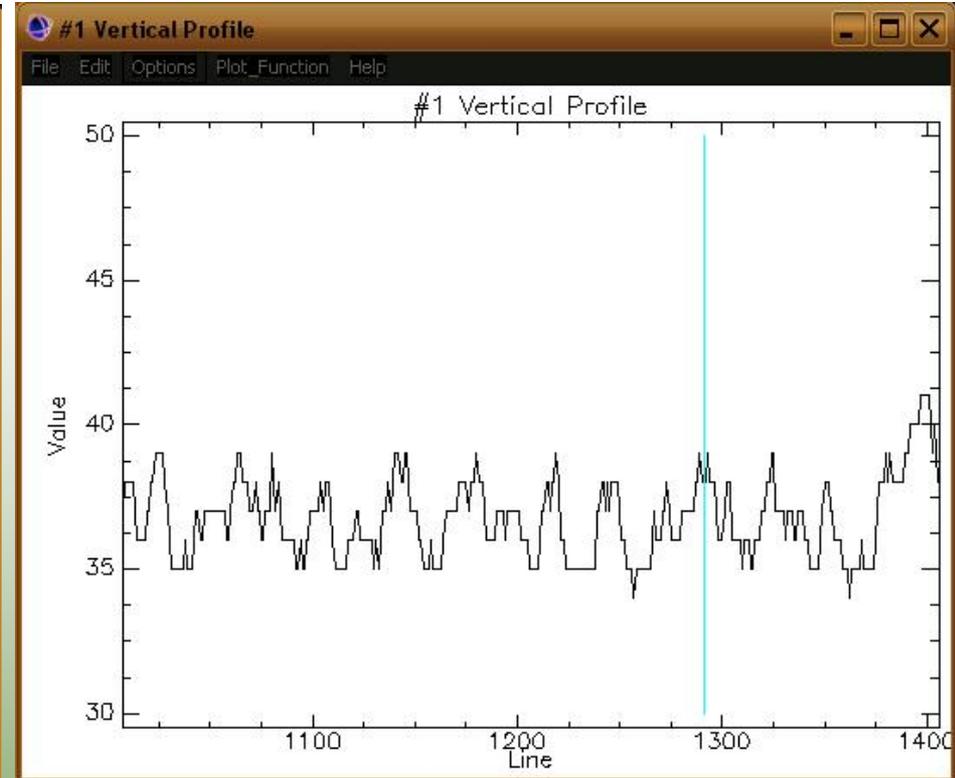
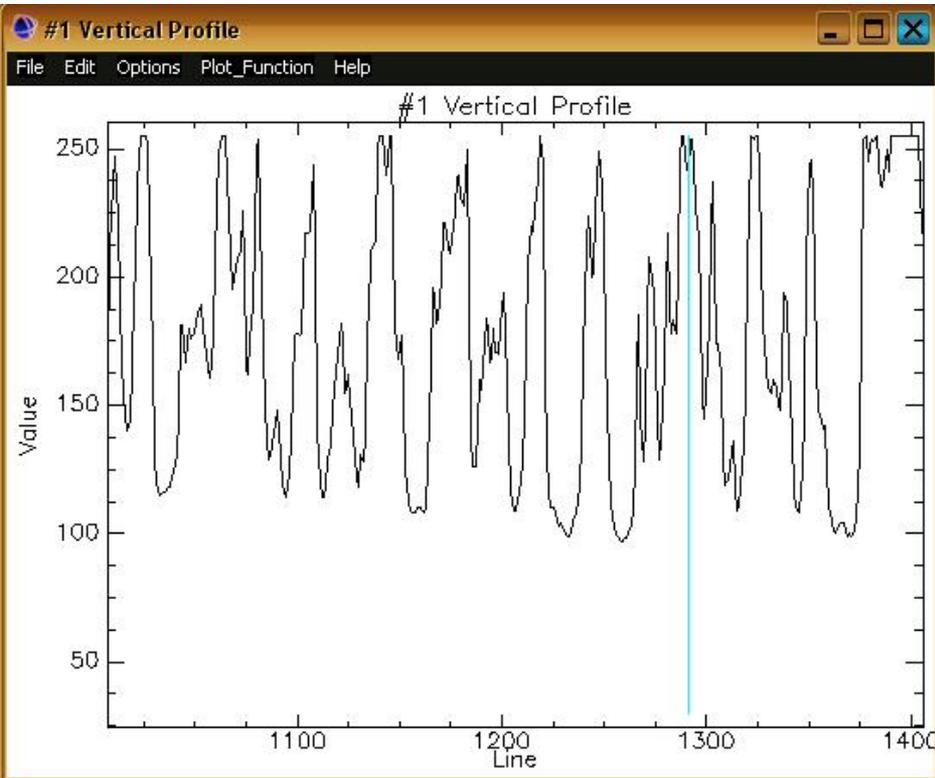
- Fully operational with optimal settings using target driven radiometry model
  - Fully calibrated (better than 5% absolute)
  - QA/QC system operational (end February)
- Do we have any outstanding issues or data artefacts now ?
  - **No**
- Did we have artefacts originally after launch
  - **Yes**

## UK-DMC-2 Artefacts (Aug. 2009 – Jan. 2010)



- Left is the raw image with dark correction off. Right is the same image when the dark current correction is applied. The very bright cloud has modified the average response (of the reference pixels due to charge diffusion) so much that it produces a stripy well defined band.

## UK-DMC-2 Artefacts (Aug. 2009 – Jan. 2010)



- Comparison of data pixel 18 (left) and reference pixel 16 in a dark correction OFF 8 bit image over the United States. Caused banding, effective drift in odd and even pixel calibration (hence striping). **Correction process is completed and hence this will no longer be a problem.**

## Final Conclusions

- The second generation imagers are showing a marked improvement on the 1<sup>st</sup> Generation imagers with
  - Better SNR
  - Better MTF and spatial resolution
  - No imager artefacts
- Early life artefacts were detected, the cause identified and were eliminated by changes in operational procedures.

# Thank You!

- [www.dmccii.com](http://www.dmccii.com)
- [www.sstl.co.uk](http://www.sstl.co.uk)

