An analysis of the Radiometry and Data Quality of the Disaster Monitoring Constellation (DMC) satellite systems.

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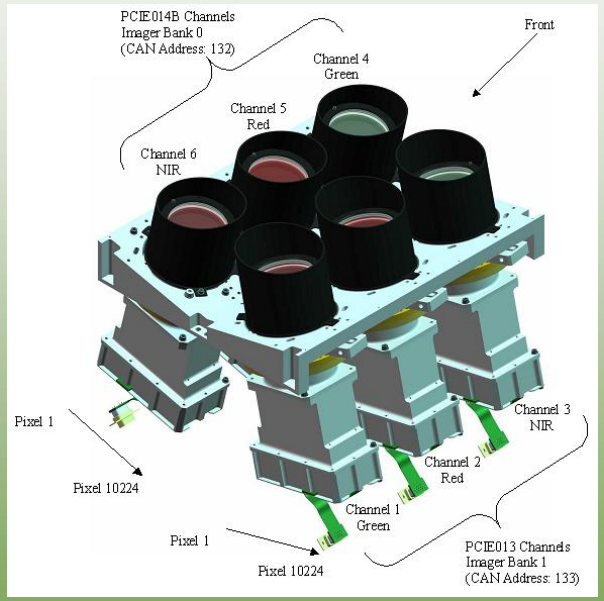
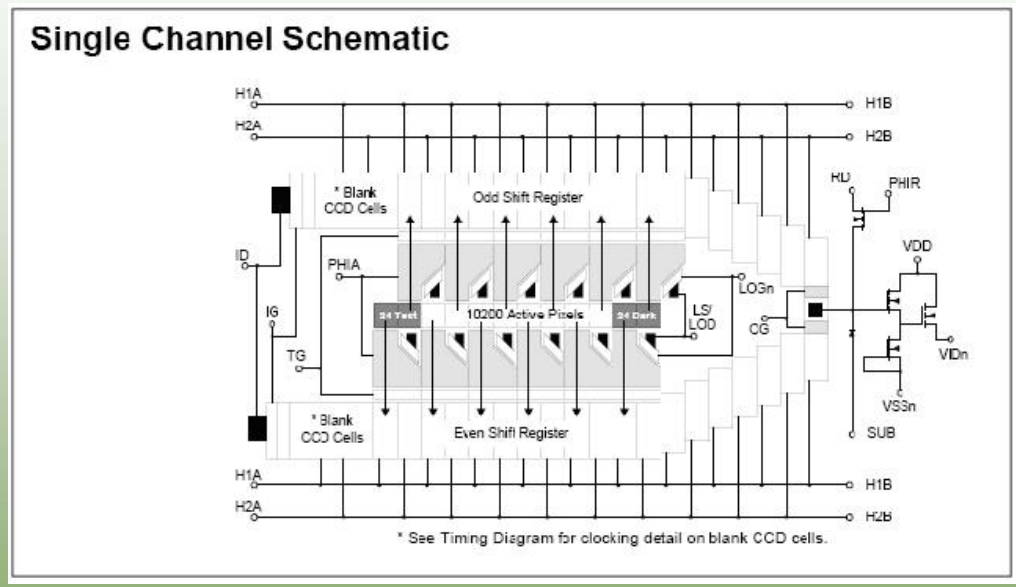
DMC Sensor

- Three band Imager (Green, Red and NIR)
- Two Image banks
- 20,000 detectors
- Pushbroom
- 660 km swath
- 32m GSD
- Variable gain and integration times



DMC Detectors

- Odd and even detectors go through separate shift registers
- Dark current subtracted on chip using 16 shielded pixels
- Residual pattern noise present



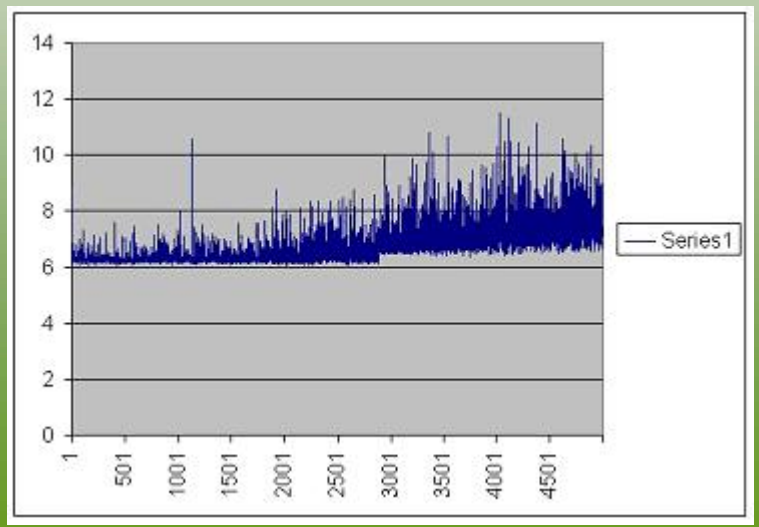
DMC Calibration

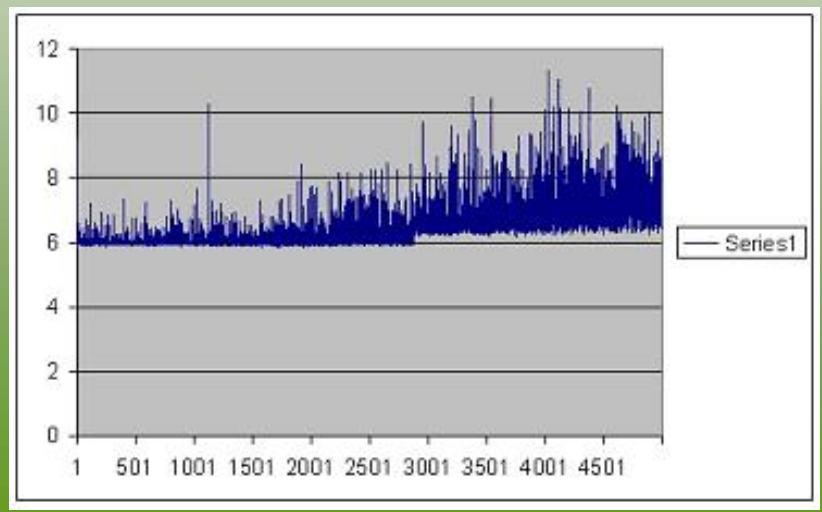
There are three stages in the process,

- Quantification of dark image pattern residuals
- Absolute Calibration
- “Transfer” Calibration

Quantification of dark image pattern residuals

- Deep space images acquired (left)
- Pacific at night images (right) identical
- Pattern values independent of integration time





Absolute Calibration (1)

- Uses RRV site and Ivanpah site and collaboration with RSG in Arizona
- Small test sites, so only 9 detectors calibrated
- TOA Radiances calculated (W m^{-2} sr^{-1} μm^{-1})
- Range of view zenith angles to target

	2004-1	2004-2	2004-3	2005-1	2005-2	2005-3	2005-4
NIR	105.08	113.55	108.67	115.65	95.24	94.94	97.17
Red	142.47	155.9	151.39	144.77	126.46	120.85	123.39
Green	152.03	163.31	159.66	136.29	120.36	125.57	127.27
View Zenith	Port-R 23.08	Stbd-R 24.89	Port-R 13.88	Port-I 14.57	Port-I 6.303	Port-R 17.5	Stbd-R 6.36

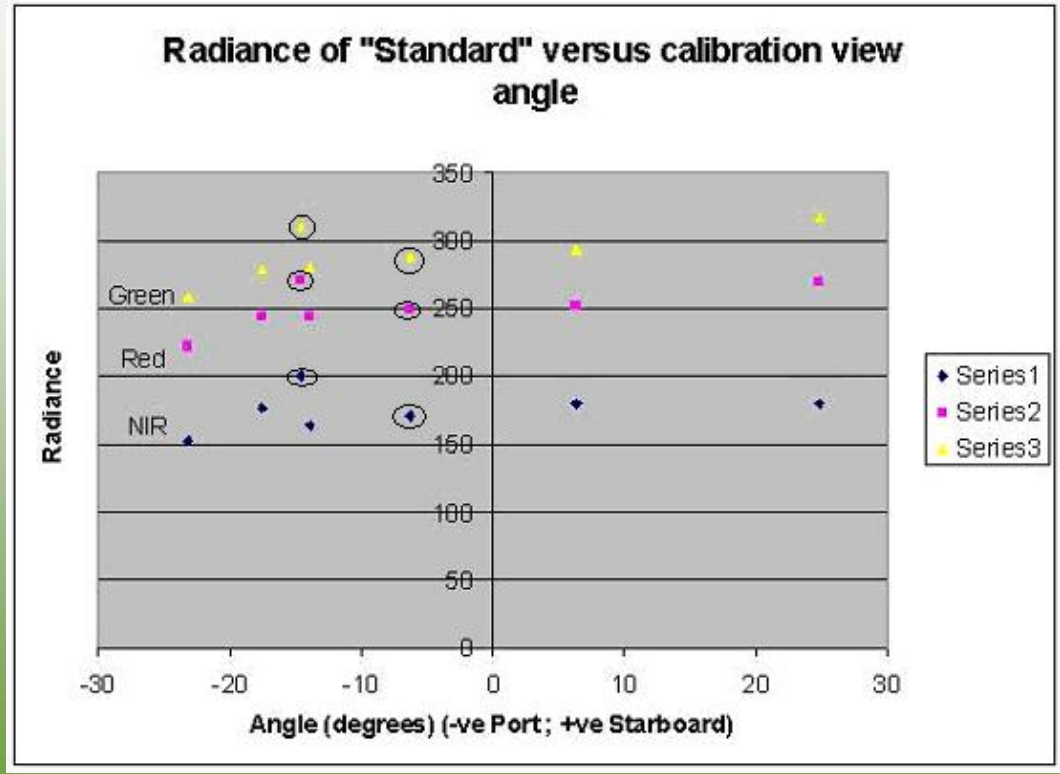
Absolute Calibration (2)

- Data “normalised” by applying derived gains from each absolute calibration to same “white” homogeneous scene.
- Results varied more than expected

	2004-1	2004-2	2004-3	2005-1	2005-2	2005-3	2005-4
NIR	152.453	179.98	164.686	200.8584	170.475	176.944	180.389
Red	221.88	269.52	244.883	270.8654	249.3177	244.803	252.539
Green	259.494	318.03	280.033	311.4267	289.3919	278.9659	293.536
View Zenith	Port-R 23.08	Stbd-R 24.89	Port-R 13.88	Port-I 14.57	Port-I 6.303	Port-R 17.5	Stbd-R 6.36

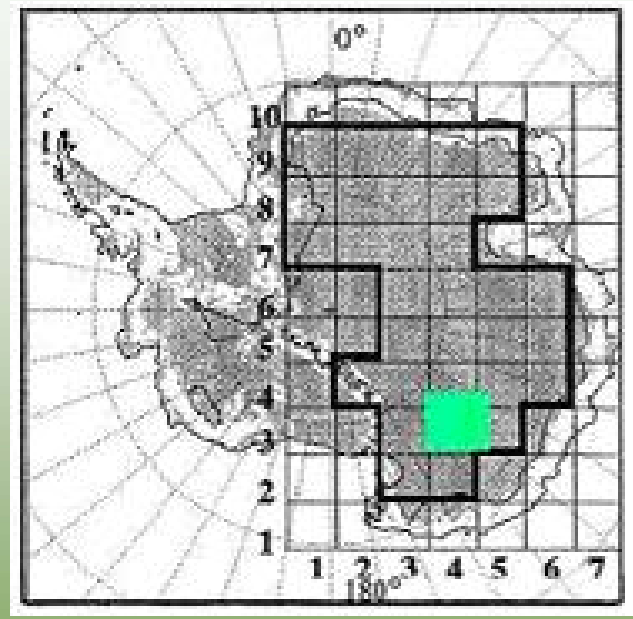
Absolute Calibration (3)

- Values plotted against view zenith
- Showed distinct relationship (BRDF ?)
- Excluding data from extremes of view the differences 2004-2005 were at the 1% to 4% level (very stable).



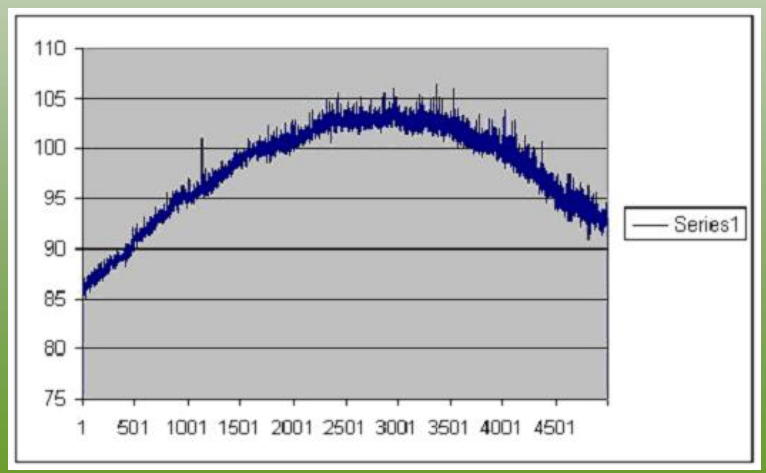
“Transfer” Calibration (1)

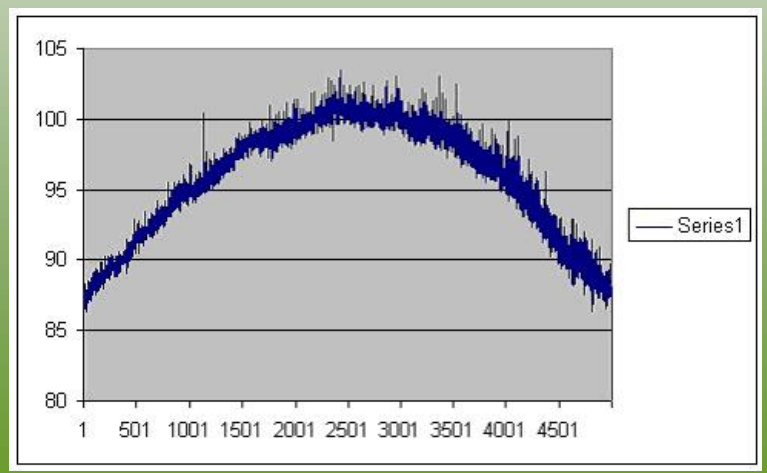
- Only nine pixels calibrated absolutely
- Need homogeneous scene with 640 km swath with good temporal stability
- DOME-C site in Antarctica used
- Very flat, high (so limited recrystallisation)
- Instrumented year round, some BRDF studies
- Used by AVHRR, SPOT-Veg



“Transfer” Calibration (2)

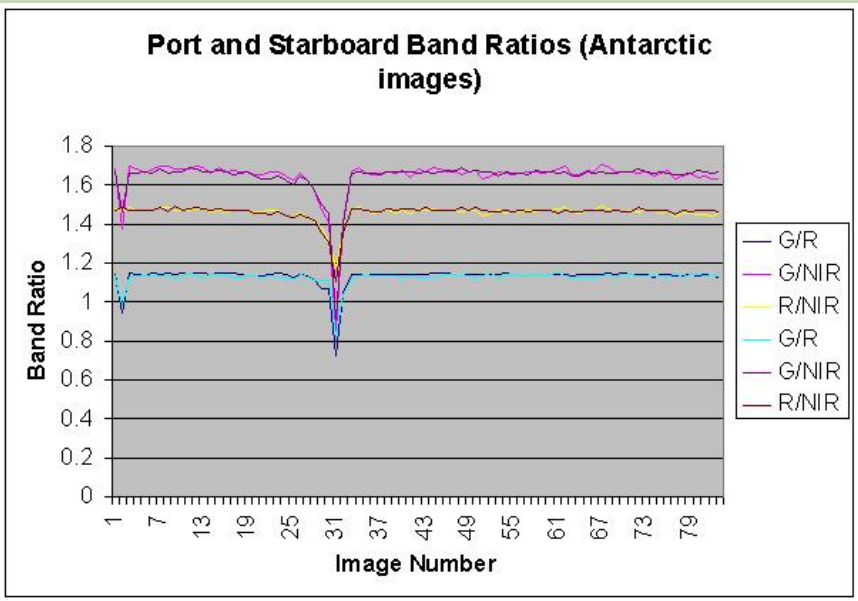
- Original images (left) showed cross-track asymmetry due to sun-target-sensor geometry
- Yawed spacecraft to produce equal-illumination image (right)





Relative band-to-band stability

- Over 100 Antarctic scenes over three years
- Monitored band ratios (G/R, G/NIR)
- r.m.s. variation less than 0.34% (very stable)



Odd feature around image 31. Start of season with very low solar elevation angle and with unusually large snowfall event registered at DOME-C

Lasted for less than one week

Noise Analysis (1)

- Used homogeneous scenes (Antarctica)
- Different illumination conditions hence range of values
- Calculations based on those used by Landsat

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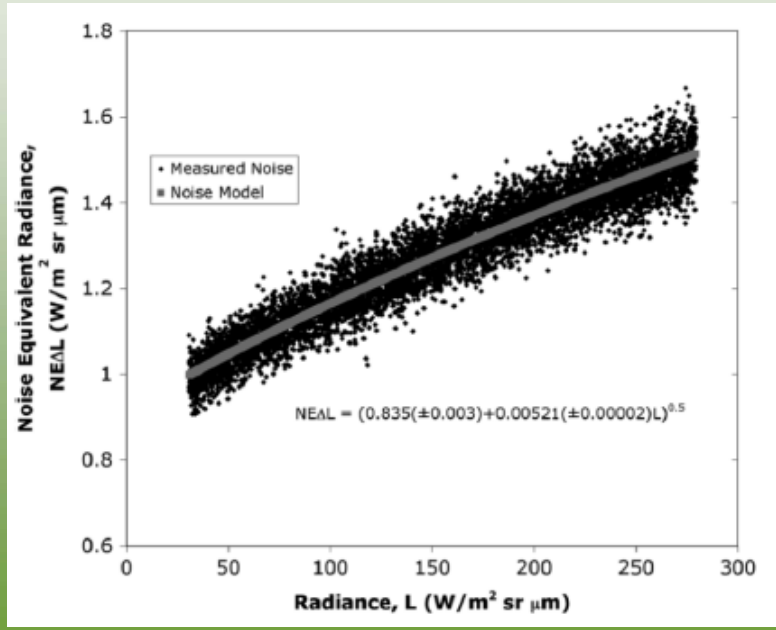
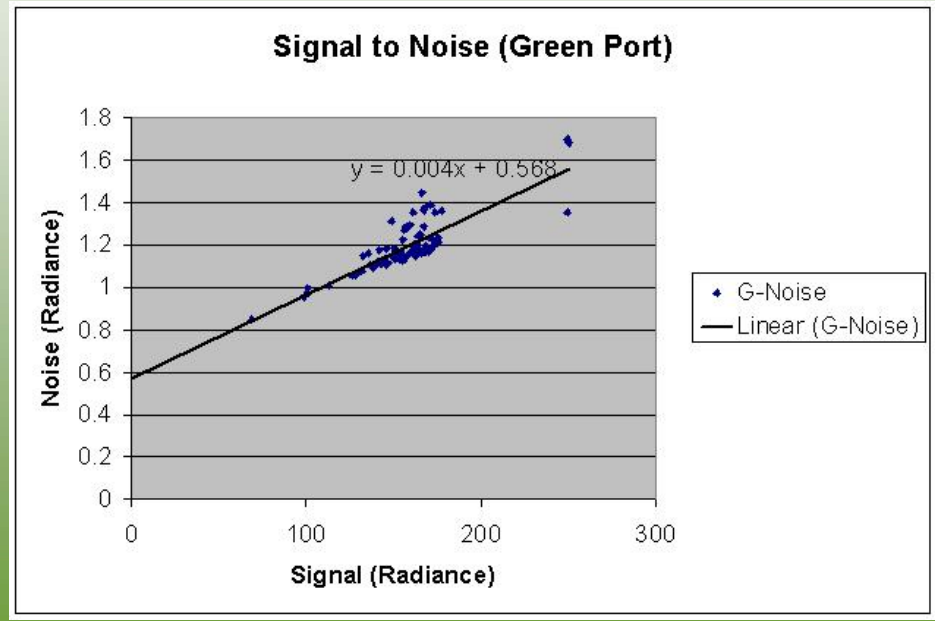
Landsat-7 ETM+ On-Orbit Reflective-Band Radiometric Characterization

Pat L. Scaramuzza, Brian L. Markham, *Member, IEEE*, Julia A. Barsi, and Ed Kaita

Noise Analysis (2)

- Plots of standard deviation against signal with Landsat 7 (blue) and UK-DMC (green)





Noise Analysis (3)

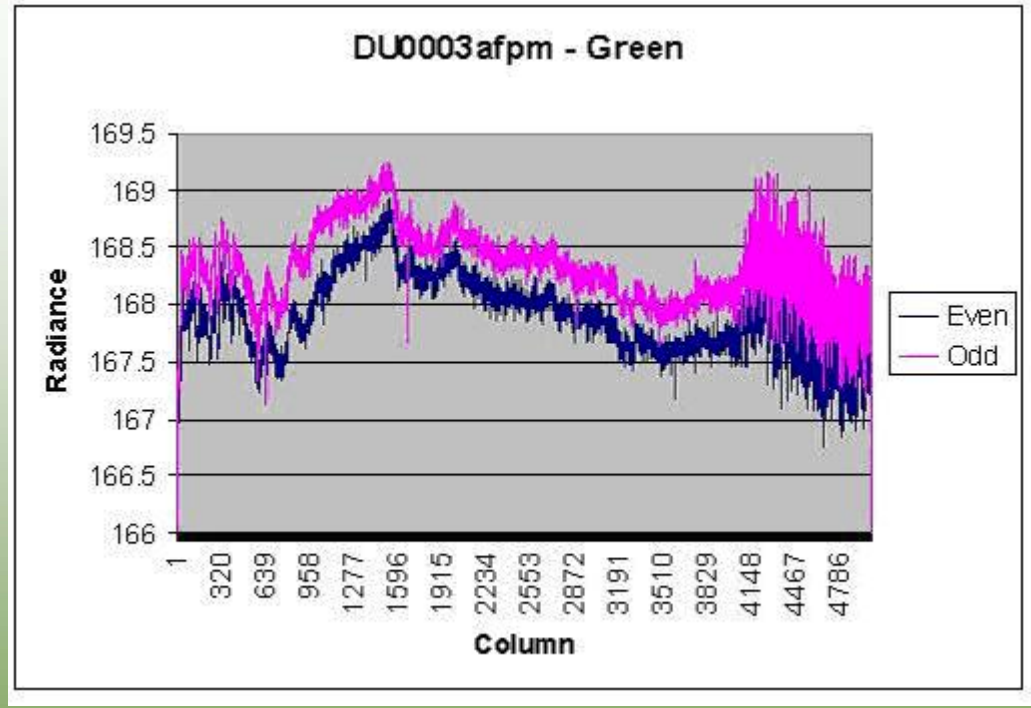
- The results gave intercepts at zero signal radiance of 0.6, 0.75 and 0.72 W m^{-2} sr^{-1} μm^{-1} for the green, red and NIR bands of the DMC (equivalent to bands 2, 3 and 4 of Landsat).
- This gives NEdL values of 0.77, 0.87 and 0.85.

TABLE III
BAND-AVERAGED DARK-NOISE LEVELS NEΔL (WATTS PER SQUARE METER STERADIAN MICRON)

Band	Landsat-5 TM	Landsat-7 ETM+ High Gain
1	0.7	0.90
2	0.6	0.69
3	0.7	0.75
4	0.4	0.37
5	0.1	0.10
7	0.06	0.056
8 (pan)	N/A	1.4

Noise Analysis (4)

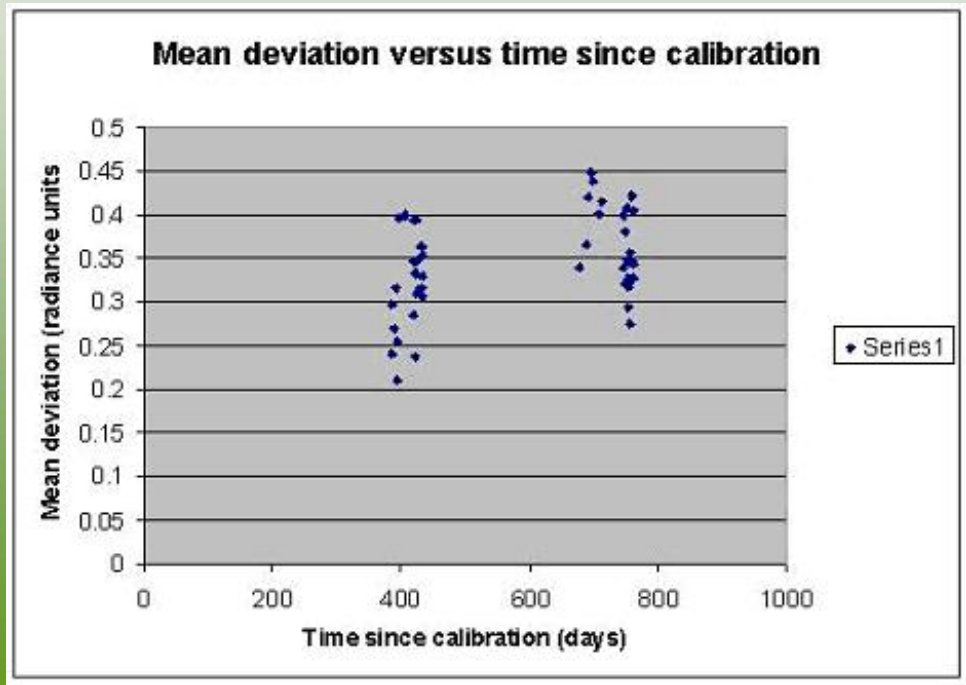
- Results approach those of Landsat, except in NIR.
- Higher noise due to odd/even dark values drifting
- Drift has increased over two years. No signal dependency



Drift between odd and even pixels.
Separation is of the order of 0.4 W m^{-2} sr^{-1} um^{-1} in this example.

Noise Analysis (5)

- Results show a large scatter for the odd/even pixel mean separation
- Increase from 0.3 to 0.35 W m^{-2} sr^{-1} μm^{-1} over two years.



Conclusions

- Radiometric procedure well established, achieving less than 5% error in precision.
- Improvements planned (more acquisitions and examination of potential BRDF effects)
- Relative band-to-band ratios very stable over three years (less than 0.34% r.m.s error).
- Noise Equivalent Radiance (NER) currently higher than Landsat, but approaching it.
- Odd/even pixel correction will bring NER into Landsat range

Final Comments

- The DMC satellites have shown both remarkable radiometric stability and noise characteristics that approach Landsat
- They provide continuity over the critical bands used for vegetation studies at similar GSD to Landsat.
- Improvements in processing (noise reduction, more extensive calibration and also including the possibility of MTF sharpening) are part of the plan to enhance the data quality for the end-user.