



MODIS On-Orbit Spectral Calibration for the Reflective Solar Bands

MODIS Characterization Support Team (MCST)

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Introduction

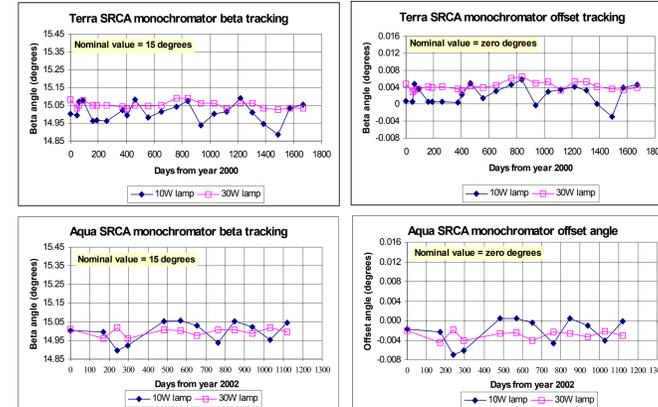
- The MODIS 36 bands cover spectral range from 0.41 to 14.2 μm.
- Its spectral characterization was measured prelaunch using a Spectral Measurement Assembly (SpMA) at SBRS.
- On-orbit spectral characterization is performed using an on-orbit calibrator: Spectro-Radiometric Calibration Assembly (SRCA) for the reflective solar bands (RSB).
- The SRCA has the capability of wavelength self-calibration.
- The SRCA tracks the MODIS spectral characterization over MODIS lifetime.

SRCA operation on-orbit

Terra						Aqua					
Op. No.	Year	Day									
1	2000	49	13	2002	109	1	2002	171	7	2003	287
2	2000	61	14	2002	206	2	2002	241	8	2004	31
3	2000	161	15	2002	297	3	2002	295	9	2004	118
4	2000	189	16	2003	23	4	2003	28	10	2004	209
5	2000	262	17	2003	125	5	2003	118	11	2004	300
6	2000	329	18	2003	209	6	2003	203	12	2005	25
7	2001	9	19	2003	287						
8	2001	40	20	2004	28						
9	2001	99	21	2004	112						
10	2001	193	22	2004	209						
11	2001	284	23	2004	301						
12	2002	31	24	2005	26						

The SRCA spectral mode is operated quarterly on-orbit

SRCA monochromator parameter trending



Band center wavelength and bandwidth (nm)

Band	Specification		Tolerance		Diff. measured by SpMA		Diff. measured on-orbit (2005)		Diff. orbit (2005) to SpMA	
	Center wln	Bandwidth	Center wln	Bandwidth	Center wln	Bandwidth	Center wln	Bandwidth	Center wln	Bandwidth
	λ _c	λ _{BW}	Δλ _c	Δλ _{BW}	Δλ _c SpMA	Δλ _{BW} SpMA	Δλ _c Orbit	Δλ _{BW} Orbit	Δλ _c	Δλ _{BW}
1	645	50	±4	4	1.3	-2.5	1.5	-2.6	0.2	-0.1
2	858	35	±2.2	4.3	-1.6	2.8	-1.5	N/A	0.1	N/A
3	469	20	±4	2.8	-3.3	-1.3	-3.3	-1.5	0.0	-0.2
4	555	20	±4	3.3	-1.3	-0.4	-1.3	-0.5	0.0	-0.1
5	1240	20	±5	7.4	2.1	3.2	N/A	N/A	N/A	N/A
6	1640	24.6	±7	9.8	-10.6	3.1	N/A	N/A	N/A	N/A
7	2130	50	±8	12.8	-15	2.4	N/A	N/A	N/A	N/A
8	412	15	±2	1.5	-0.1	-0.5	-0.7	-0.7	-0.6	-0.2
9	443	10	±1.1	1.6	-0.8	-0.4	-1.2	-0.9	-0.4	-0.5
10	488	10	±1.2	1.7	-1	0.6	-1.4	0.5	-0.4	0.0
11	531	10	±2	1.9	-1.2	1.9	-1.4	1.5	-0.2	-0.4
12	551	10	±5	1.4	-4.1	0.3	-4.2	0.0	-0.1	-0.3
13	667	10	-2,+1	1.7	-1.3	-0.1	-1.5	-0.5	-0.2	-0.4
14	678	10	±1	1.7	-2	1.3	-2.0	1.7	0.0	0.5
15	748	10	±2	1.9	-1.7	-0.2	-1.9	-0.3	-0.2	-0.2
16	869	15	±5	4.3	-3.1	0.5	-3.4	0.6	-0.3	0.1
17	905	30	±2.3	5.4	-0.8	4.7	-0.8	4.5	0.0	-0.2
18	936	10	±2.3	5.6	-0.9	3.5	-1.2	3.2	-0.3	-0.3
19	940	50	±2.4	5.6	-4.2	-4.1	-4.4	-5.0	-0.2	-0.9
26	1375	30	±6	8	5.4	5.5	N/A	N/A	N/A	N/A

MODIS at launch



TERRA (EOS-AM):
Launched on 12/18/99

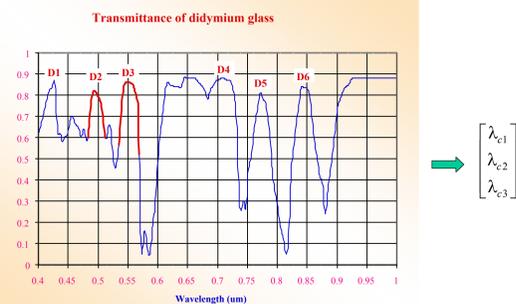
AQUA (EOS-PM):
Launched on 05/04/02

Algorithm for wavelength scale

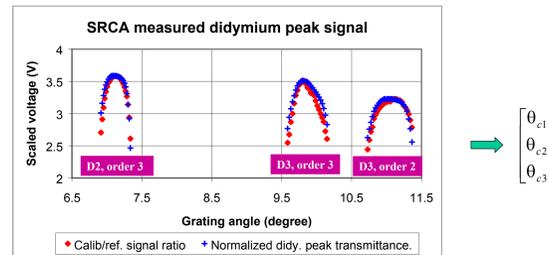
The centroid value of the ratio of calibration SiPD signal to reference SiPD signal is

$$\theta_c = \frac{\sum_{i=0}^{\theta_2} \frac{dn_{calibration_SiPD}(\theta + \Delta)}{dn_{reference_SiPD}(\theta)} \cdot \theta \cdot d\theta}{\sum_{i=0}^{\theta_2} \frac{dn_{calibration_SiPD}(\theta + \Delta)}{dn_{reference_SiPD}(\theta)} \cdot d\theta}$$

Δ-- angular difference between the main slit and didymium slit



Peaks @ 0.496 μm and 0.551 μm (two orders) are utilized.



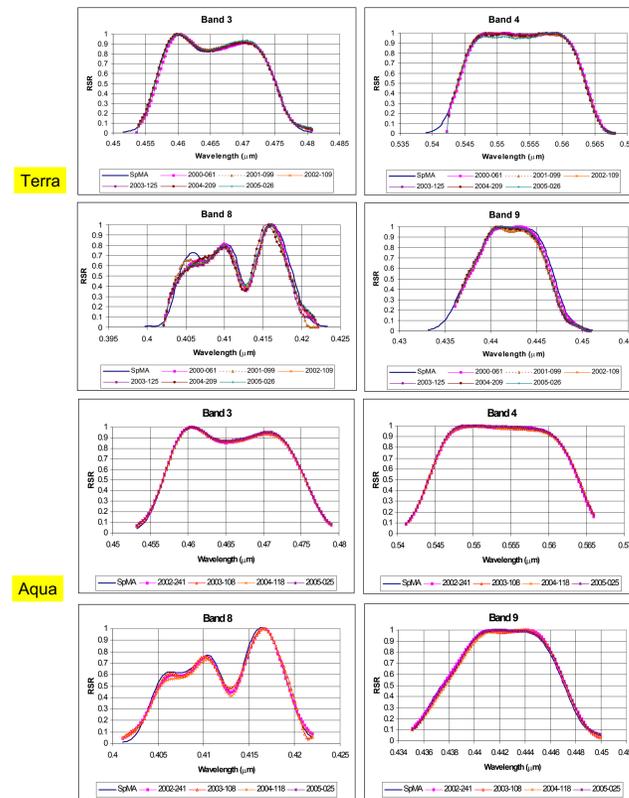
Determine monochromator parameters, β and θ_{off}, by knowing three λ_c and θ_c

$$\begin{bmatrix} \lambda_{c1} \\ \lambda_{c2} \\ \lambda_{c3} \end{bmatrix} = 2A \begin{bmatrix} \sin(\theta_{c1} + \theta_{off}) \cdot \cos \beta \\ \sin(\theta_{c2} + \theta_{off}) \cdot \cos \beta \\ \sin(\theta_{c3} + \theta_{off}) \cdot \cos \beta \end{bmatrix}$$

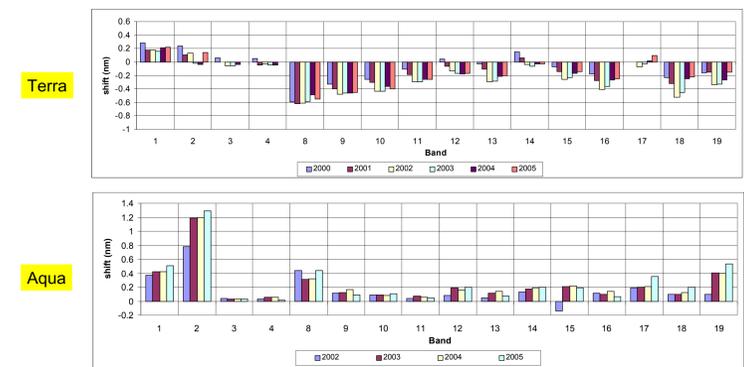
Monochromatic beam wavelength, λ, at any grating angle θ is

$$\lambda(B, \theta_{grating}) = \frac{A}{m(B)} \cdot \sin(\theta_{grating} + \theta_{off}) \cdot \cos \beta$$

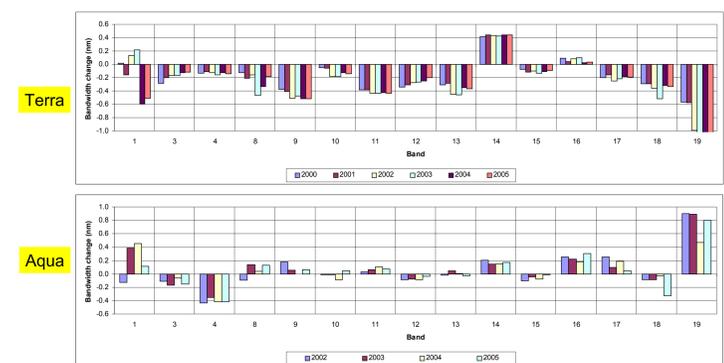
Terra/Aqua band response recovered (bands 3, 4, 8, and 9)



Band center wavelength shift trending (nm)



Bandwidth change trending (nm)



Summary

- The SRCA has successfully tracked the MODIS spectral characterization from prelaunch to on-orbit for λ < 1 μm (limited by the reference SiPD response).
- The trending results demonstrate that the SRCA self-calibration is operated properly.
- Center wavelength shifts were observed after launch and the changes vary slowly over time. All center wavelength shifts are less than 0.5 nm except for Terra MODIS B8 and Aqua MODIS B2. The bandwidth changes are less than 0.5 nm except for Terra MODIS B19.
- The observed center wavelength shift impact on the band radiance is within 0.5%.

Web sites

- MODIS: <http://modis.gsfc.nasa.gov>
 MCST: <http://www.mcst.ssaai.biz/mcstweb/>
 LIB Product: <http://www.mcst.ssaai.biz/mcstweb/LIB/product.html>

Relative Spectral Response (RSR) of MODIS

