

# TERRA MODIS STATUS

MODIS Characterization Support  
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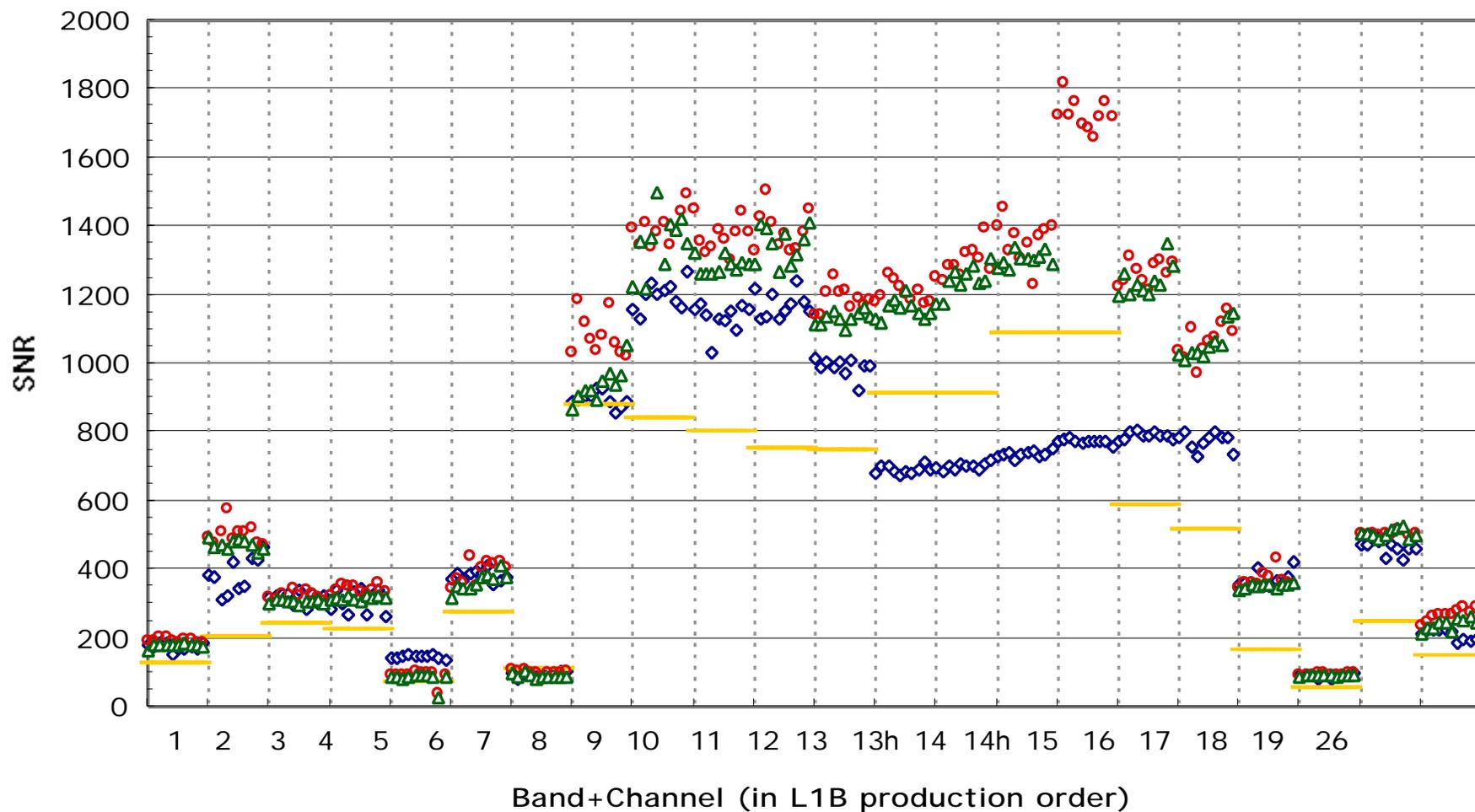
# Terra MODIS Year 1 Highlights

## SENSOR, L1B PRODUCTS AND MCST

- Successful and safe MODIS turn-on, activation and continuing event-free commanding operations
- MODIS L1B data was first Terra data publicly release
- 22.9 terra-bytes of MODIS data in SSR playback in year 2000
- Detected and selected operation configuration to minimize electronic cross-talk
- Transitioned to electronics B-side for best ADC performance
- Initiated long-term trend of calibration in RSB using lunar observations
- Achieved stable operating configuration

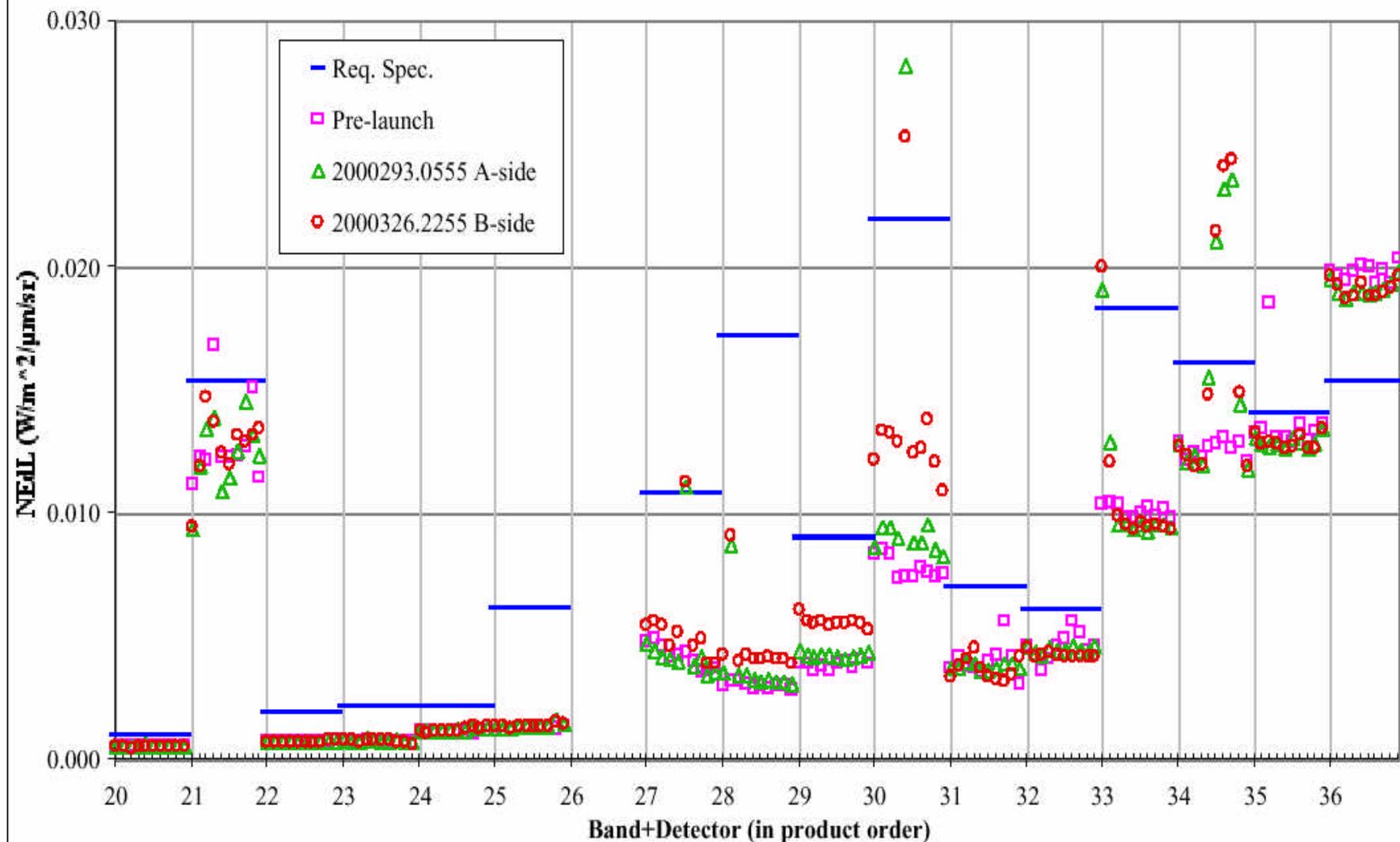
**We are indebted strongly to the support and help of the MODIS Science Team Members for what successes we have had in this work.**

MODIS RSB SNR from Pre-launch, Post-launch and Specification at Ltyp



◆ Pre-launch — Specification ○ Aside-2000294 ▲ Bside-2000305

MODIS PFM TEB On-orbit NEdL (@ Ltyp) vs. Pre-launch and Specification



## SUMMARY OF KEY MODIS OPERATIONAL CONFIGURATIONS

2000	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31														
February	Science Data in Earth View Sector																																												
	SW/MWIR Focal Plane Bias																																												
	Temperature Control of Cold Focal Plane																																												
	A-side (Primary)/B-side (Redundant) Electronics																																												
March	various values																																												
April																																													
May																																													
June																																													
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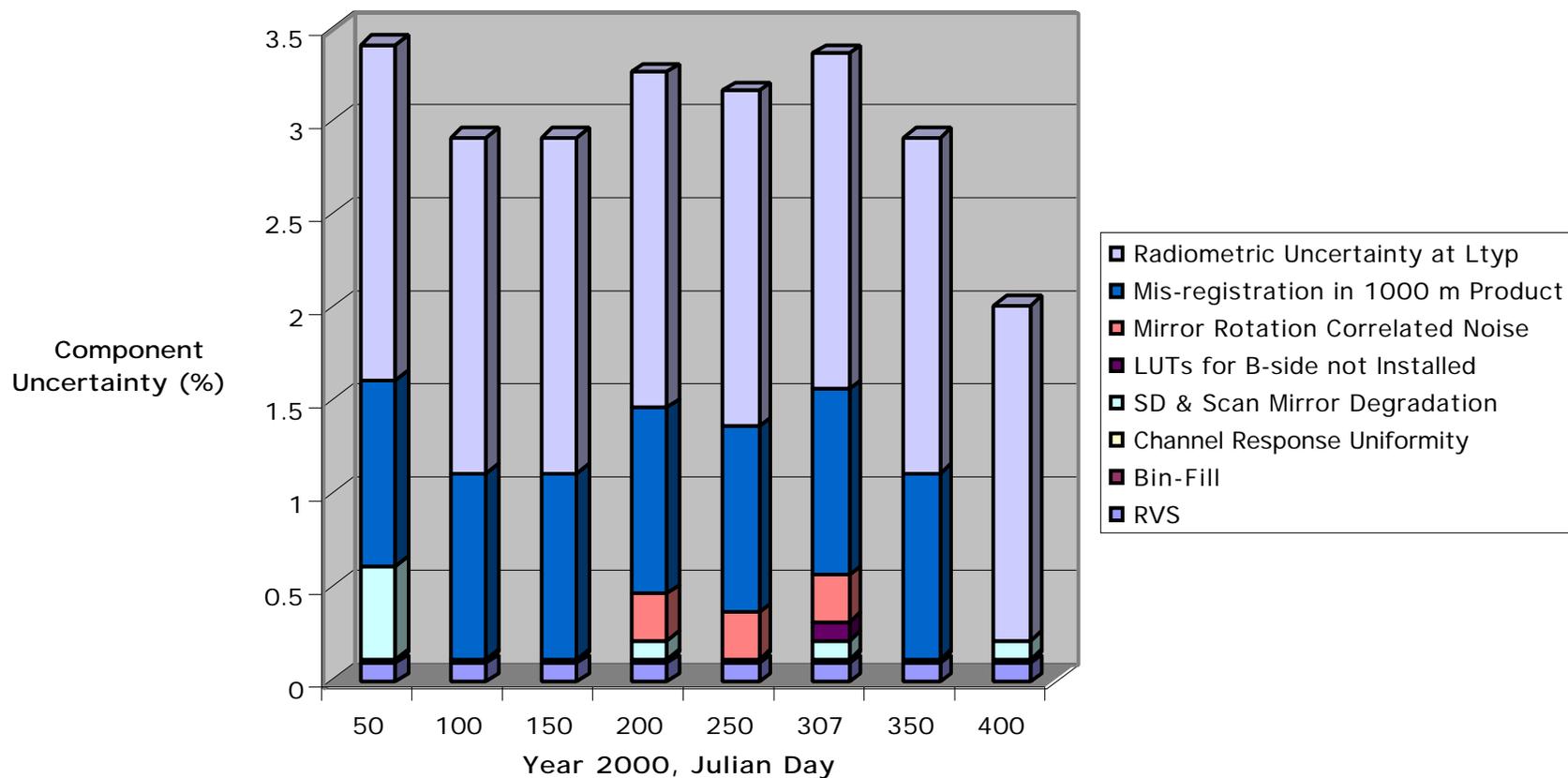
Legend		Yes	No (Nadir Door Closed or Sensor data not to Recorder)
Science Data in Earth View Sector		110	190
SW/MWIR Focal Plane Bias (DN)		218	226
Temperature Control of Cold FPA		Yes	Partial Loss in orbit
A-side /B-side Electronics		A-side	B-side
		Day 2000174, first formatter reset	
		Complete cooler outgas, focal plane control returned	

JD (Yr 2000)

<i>Band 4 (555 nm) uncertainty (%)</i>	50	100	150	200	250	307	350	400
NON-FUNCTIONING DETECTOR								
INCOMPLETE KNOWLEDGE OF SENSOR RESPONSE ACROSS SCAN - THERMAL EMISSIVE BANDS								
INCOMPLETE KNOWLEDGE OF SENSOR RESPONSE ACROSS SCAN - REFLECTED SOLAR BANDS	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
OPTICAL CROSS-TALK FROM BAND 31 INTO BANDS 32 THROUGH 36, SWIR Thermal Leaks								
ELECTRONIC CROSS-TALK AMONG BANDS 5 TO 7, 20 TO 26								
Non-Uniform Digital Count Bin-Fill Factor (bin-width), particularly for the Bands 31 to 36	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Non-Uniform Channel to Channel Response Within a Band	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Band 21, a Fire Band, not yet Calibrated								
Band 27 Anomalous Band Width, Anomalous Gain								
Sensor time-dependent response function for reflected solar bands (1 to 19, plus 26) has not been installed. The change is believed to be about 2% in the blue to nearly nothing in the red and SWIR	0.5	0	0	0.1	0	0.1	0	0.1
L1B data sets produced for data days in November were processed with LUTs corresponding to focal plane bias and electronics sides different than those for which the data were collected.	0	0	0	0	0	0.1	0	0
Mirror Rotation Correlated Noise (departure from noise pattern predominant in pre-launch calibration operations)	0	0	0	0.25	0.25	0.25	0	0
COLD FOCAL PLANE Temperature Uncontrolled								
Sub-1000 m bands mis-registered to 1000 m bands in 1000 m band files (scene dependent)	1	1	1	1	1	1	1	0
Radiometric uncertainty at Scan Angle of SD for Ltyp	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
RSS for the various uncertainty values	2.121	2.062	2.062	2.079	2.077	2.082	2.062	1.806

These uncertainty estimates for the several characteristics identified on the MCST software pages as Caveats refer to the software product currently present in the Goddard DAAC for the Level 1B Product for the identified data day.

## Terra-MODIS Band 4 (555 nm) L1B Product Uncertainty Components



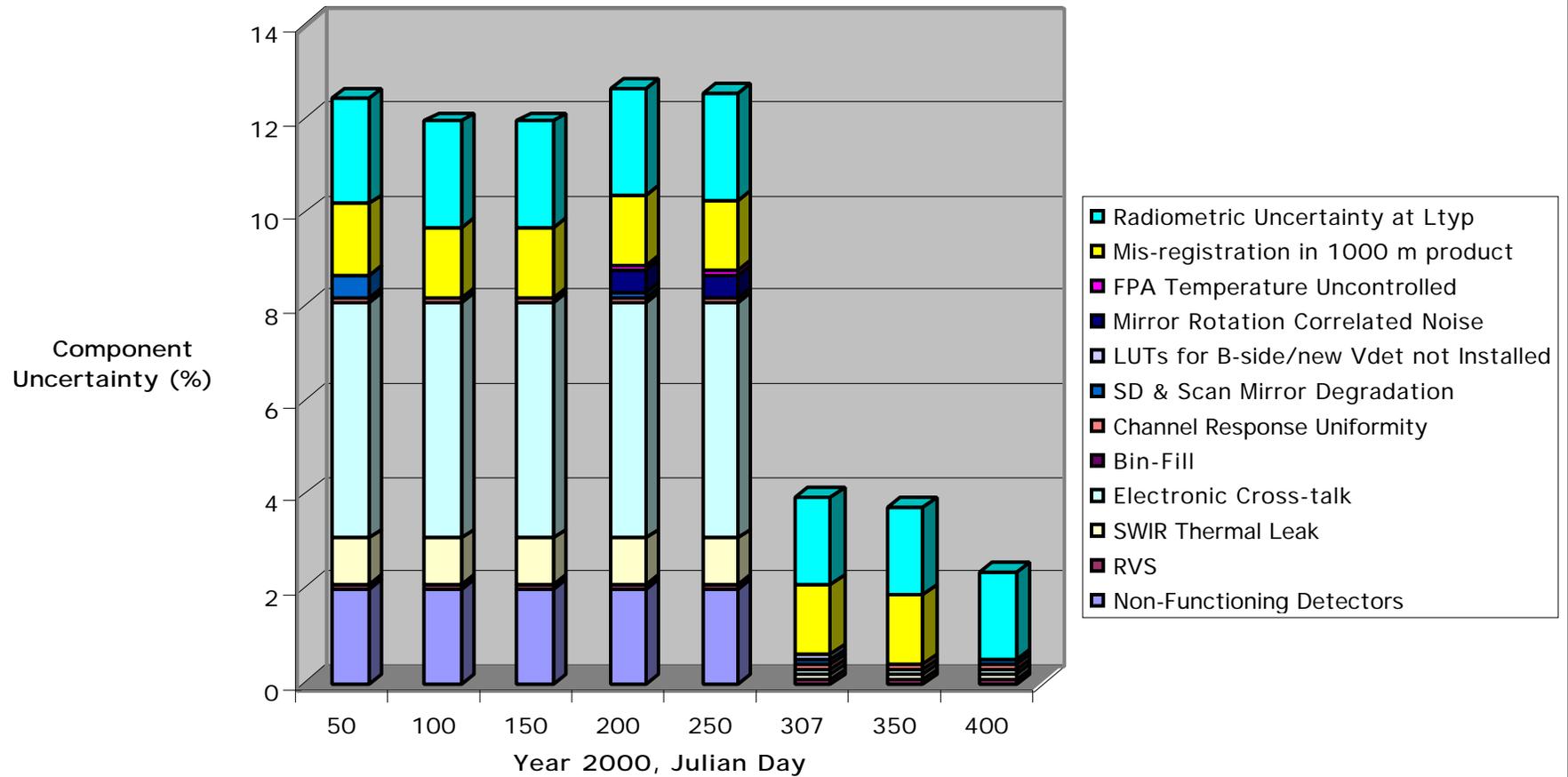
Note: The sum of uncertainties as displayed in this "stacked bar" chart exceeds the total uncertainty for these same uncertainty sources that more properly should be handled in an RSS sense.

JD (Yr 2000)

<i>Band 5 (1240 nm) uncertainty (%)</i>	50	100	150	200	250	307	350	400
NON-FUNCTIONING DETECTOR	2	2	2	2	2	0	0	0
INCOMPLETE KNOWLEDGE OF SENSOR RESPONSE ACROSS SCAN - THERMAL EMISSIVE BANDS								
INCOMPLETE KNOWLEDGE OF SENSOR RESPONSE ACROSS SCAN - REFLECTED SOLAR BANDS	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
OPTICAL CROSS-TALK FROM BAND 31 INTO BANDS 32 THROUGH 36, SWIR Thermal Leaks	1	1	1	1	1	0.1	0.1	0.1
ELECTRONIC CROSS-TALK AMONG BANDS 5 TO 7, 20 TO 26	5	5	5	5	5	0.1	0.1	0.1
Non-Uniform Digital Count Bin-Fill Factor (bin-width), particularly for the Bands 31 to 36	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Non-Uniform Channel to Channel Response Within a Band	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Band 21, a Fire Band, not yet Calibrated								
Band 27 Anomalous Band Width, Anomalous Gain								
Sensor time-dependent response function for reflected solar bands (1 to 19, plus 26) has not been installed. The change is believed to be about 2% in the blue to nearly nothing in the red and SWIR	0.5	0	0	0.1	0	0.1	0	0.1
L1B data sets produced for data days in November were processed with LUTs corresponding to focal plane bias and electronics sides different than those for which the data were collected.	0	0	0	0	0	0.1	0	0
Mirror Rotation Correlated Noise (departure from noise pattern predominant in pre-launch calibration operations)	0	0	0	0.5	0.5	0	0	0
COLD FOCAL PLANE Temperature Uncontrolled				0.1	0.1			
Sub-1000 m bands mis-registered to 1000 m bands in 1000 m band files (scene dependent)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	0
Radiometric uncertainty at Scan Angle of SD for Ltyp	2.25	2.25	2.25	2.25	2.25	1.85	1.85	1.85
RSS for the various uncertainty values	6.130	6.110	6.110	6.132	6.131	2.394	2.390	1.863

These uncertainty estimates for the several characteristics identified on the MCST software pages as Caveats refer to the software product currently present in the Goddard DAAC for the Level 1B Product for the identified data day.

## Terra-MODIS Band 5 (1240 nm) Product Uncertainty Components



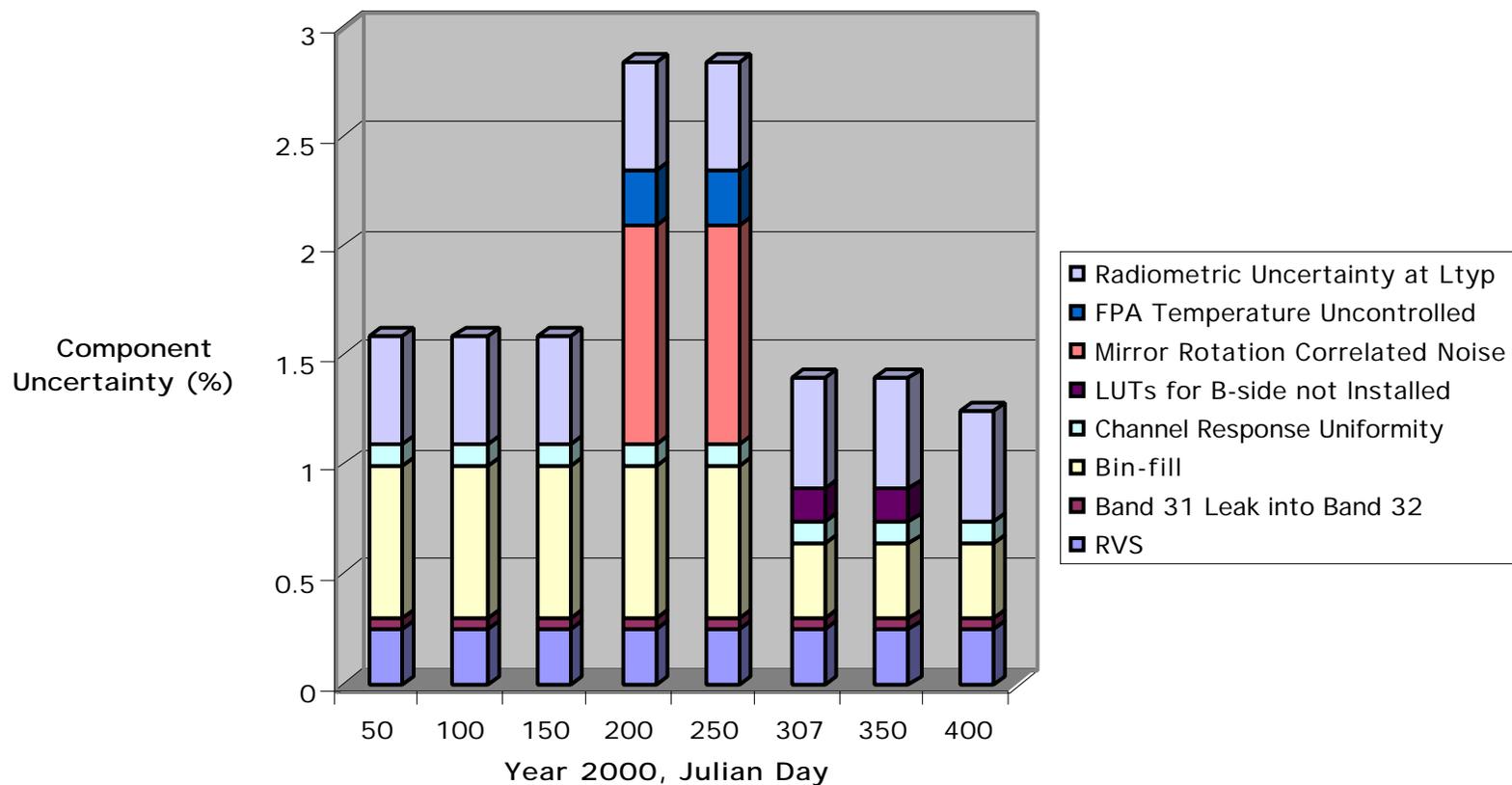
Note: The sum of uncertainties as displayed in this "stacked bar" chart exceeds the total uncertainty for these same uncertainty sources that more properly should be handled in an RSS sense.

JD (Yr 2000)

<i>Band 32 (12000 nm) uncertainty (%)</i>	50	100	150	200	250	307	350	400
NON-FUNCTIONING DETECTOR								
INCOMPLETE KNOWLEDGE OF SENSOR RESPONSE ACROSS SCAN - THERMAL EMISSIVE BANDS	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
INCOMPLETE KNOWLEDGE OF SENSOR RESPONSE ACROSS SCAN - REFLECTED SOLAR BANDS								
OPTICAL CROSS-TALK FROM BAND 31 INTO BANDS 32 THROUGH 36, SWIR Thermal Leaks	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
ELECTRONIC CROSS-TALK AMONG BANDS 5 TO 7, 20 TO 26								
Non-Uniform Digital Count Bin-Fill Factor (bin-width), particularly for the Bands 31 to 36	0.7	0.7	0.7	0.7	0.7	0.35	0.35	0.35
Non-Uniform Channel to Channel Response Within a Band	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Band 21, a Fire Band, not yet Calibrated								
Band 27 Anomalous Band Width, Anomalous Gain								
Sensor time-dependent response function for reflected solar bands (1 to 19, plus 26) has not been installed. The change is believed to be about 2% in the blue to nearly nothing in the red and SWIR								
L1B data sets produced for data days in November were processed with LUTs corresponding to focal plane bias and electronics sides different than those for which the data were collected.	0	0	0	0	0	0.15	0.15	0
Mirror Rotation Correlated Noise (departure from noise pattern predominant in pre-launch calibration operations)	0	0	0	1	1	0	0	0
COLD FOCAL PLANE Temperature Uncontrolled	0	0	0	0.25	0.25	0	0	0
Sub-1000 m bands mis-registered to 1000 m bands in 1000 m band files (scene dependent)								
Radiometric uncertainty at Scan Angle of OBC-BB for Ttyp	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
RSS for the various uncertainty values	0.903	0.903	0.903	1.370	1.370	0.686	0.686	0.669

These uncertainty estimates for the several characteristics identified on the MCST software pages as Caveats refer to the software product currently present in the Goddard DAAC for the Level 1B Product for the identified data day.

## Terra-MODIS and 32 (12000 nm) L1B Product Uncertainty Components



Note: The sum of uncertainties as displayed in this "stacked bar" chart exceeds the total uncertainty for these same uncertainty sources that more properly should be handled in an RSS sense.

## Principal Parameters Requiring On-orbit Determination/ Verification

Principal Parameters Requiring On-orbit Determination/ Verification	Strategy for Determination/ Verification	Comments
Reflected Solar Bands (RSB) Reflectance-factor Calibration	Use literature values for solar spectral irradiance and measured Bidirectional Reflectance Factor (BRF) of solar diffuser (SD)	SD attenuation screen has small ripple due to variation with illumination of screen hole pattern
Thermal Emissive Bands (TEB) non-linear coefficients, all bands	Observe response of sensor to on-board blackbody during cycle of temperature <u>cool down from 315 K to ambient</u>	No pre-launch data for Bands 20-25 and 27-30; best results for measurements over temperature <u>range of flight blackbody (315 K to 274 K)</u>
Electronic cross-talk	Pre-launch improvements not tested; look for Short-wave InfraRed (SWIR) sub-frame differences; direct measurements using high contrast sharp edges such as moon in space view port <u>and rectangular reticle in SRCA</u>	SWIR sub-frame differences misleading, perhaps because pre-launch correction put system into different engineering regime; both moon and SRCA data useful, but thermal bands heavily saturated for moon data, and complex data processing needed <u>to show effect in SRCA data.</u>
Analog to Digital Converter (ADC), differential non-linearity effects	Knew differential non-linearity not in specification, but failed to understand the implications of that situation	Effect seen as fuzzy histograms on virtually all bands; modest improvements in Bands 31 - 36 using redundant electronics; frequent need to truncate data to 11 bits for most demanding analyses
Spectral Leaks, SWIR thermal & Band 31 into Bands 32 - 36	Verification needed for pre-launch characterizations	SWIR data for night (no sun) provide best data set for thermal leak; moon in Space View Port useful for Band 31 leak, further tuned using vicarious data sets looking at ghost images of surface features
Channel to channel and band to band co-registration	Spectro-radiometric Calibration Assembly (SRCA) to be used for these studies	Objectives met through complex data analysis strategies
Response versus Scan Angle (RVS) & Mirror side differences	Best strategy is deep-space calibration maneuver in absence of moon in FOV; remove mirror side differences by looking at inside of closed nadir aperture door (C-NAD)	Deep Space maneuver date TBD; C-NAD data set useful to normalize mirror side differences, but can provide no insight into true RVS for either mirror side
Solar Diffuser Stability Monitor (SDSM) system performance	No system level performance testing accomplished on SD or SDSM	Significant structure in radiance field onto SDSM detectors due to 1.8% transmission screen requires complex modelling analysis for tracking <u>solar diffuser degradation</u>
Band 21 (fire band) calibration above 3.5% full-scale	Specified to 500 K but tested only to 340 K, useful for approximate linear <u>gain term</u>	Literature values at 4 micrometers (400 K) to calibrate linear gain term over larger temperature <u>range; non-linear terms not determined</u>

## Principle MODIS On-Orbit Surprises

Characteristic	Nature of Surprise	Comments
Initial System Turn-on	Y2K and Christmas shut-downs at Goddard and longer time period for ascent to orbit delayed initiation of science and created significant early <u>operations commanding requirements</u>	First Earth-view observations delayed until 22 February 2000
Electronic Cross-talk	Pre-launch resistor change mitigated electronic cross-talk in Bands 27 - 30, but not in Bands 5-7 and 20 - 26. It apparently did change sensor electronic cross-talk in these 10 bands into a different performance regime. The presence of new regime was no	Transition to more negative bias voltage on SW/MWIR focal plane on October 30, 2000 minimized SW/MWIR electronic cross-talk and eliminated the non-functional detector concerns on that focal plane by returning all detectors to a focal plane bias where all
Mirror-side induced banding and channel-to-channel induced striping in data	Ripples in SD transmission screen interferes with channel-to-channel equalization calibrations in ocean color bands; initial OBC-BB observations provided smooth images in IR only at location in scan corresponding to location of BB within scan cavity	May need "develop" more complex radiometric calibration algorithm in ocean color bands; still need deep space calibration maneuver for response versus scan angle in infrared bands
Analog to Digital Converter (ADC), differential non-linearity effects	LSB on many bands noisy; seen in histograms of frequency of occurrence of DN values as "fuzzy" histograms.	Did not recognize importance of miss on differential non-linearity specification; amounts to non-functional LSB in most bands; when taken with Tsat on Bands 31 and 32 leads to significant limit to 12-micron pathfinder SST accuracy; lead to redesign of the
Mirror rotation correlated noise variations in imaging smoothing	Appears to be variations in system noise performance across scan lines; leads to apparent mirror RVS characteristics changing with time frames not related to any sensor optical changes	Transition to B-side (redundant) electronics has eliminated the effect in continuing data acquisitions; electronic effect (?) still TBD, and will have impact on development of optimum look-up tables for reprocessing between 22 June and 31 October 2000.
Polarization		Not started in L1B studies
Scene Restoration due to Scattering Corrections		Not started in L1B studies