MODIS Operations and Systems Overview

MODIS Science Team Meeting
Columbia, MD

January 24, 2001

by
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MODIS Science Team Leader

MODIS GENERAL STATUS

- **MAJOR INSTRUMENT SYSTEMS WORK**
  - **Spatial, spectral, radiometric, quantizing, etc.**

- **PROCESSING SYSTEMS GETTING BETTER AND TENDING TOWARD STEADY STATE (INGEST, PROCESSING, ARCHIVING, DISTRIBUTING)**
  - **Direct Read-out evolution seems quite positive**

- **SCIENCE/TEAM MEMBERS PRODUCING PRODUCTS AND VALIDATION EFFORTS PROCEEDING**

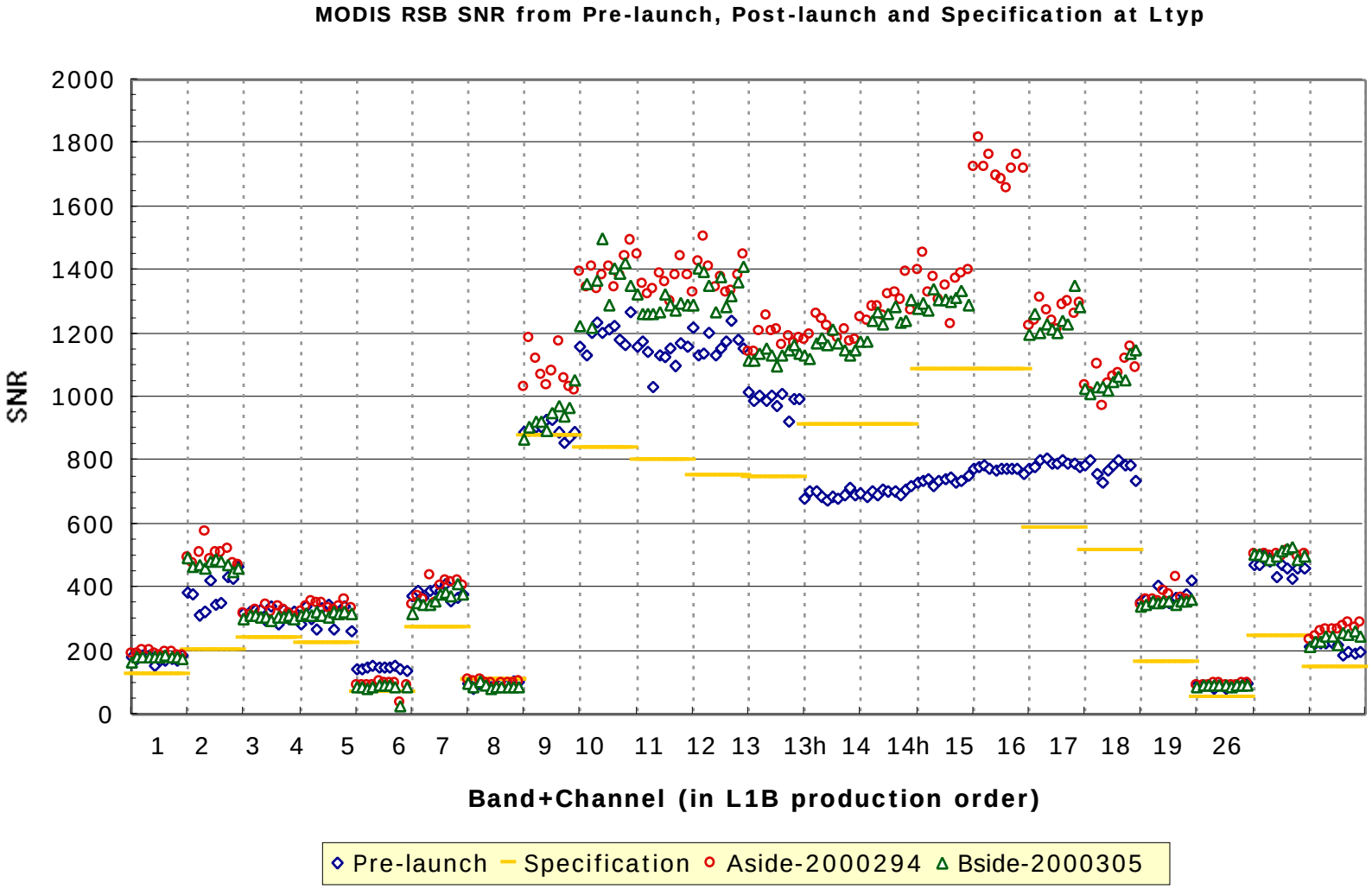
- **OUTPUT OF RESULTS IS PROCEEDING AND IMPROVING**
  - **Material on the Web for MODIS is quite impressive**
  - **Several meetings have or are going to feature MODIS results**
  - **Review on products with HQ went pretty well**

Level 1B IMPROVEMENT STUDY AREAS (January 2001)

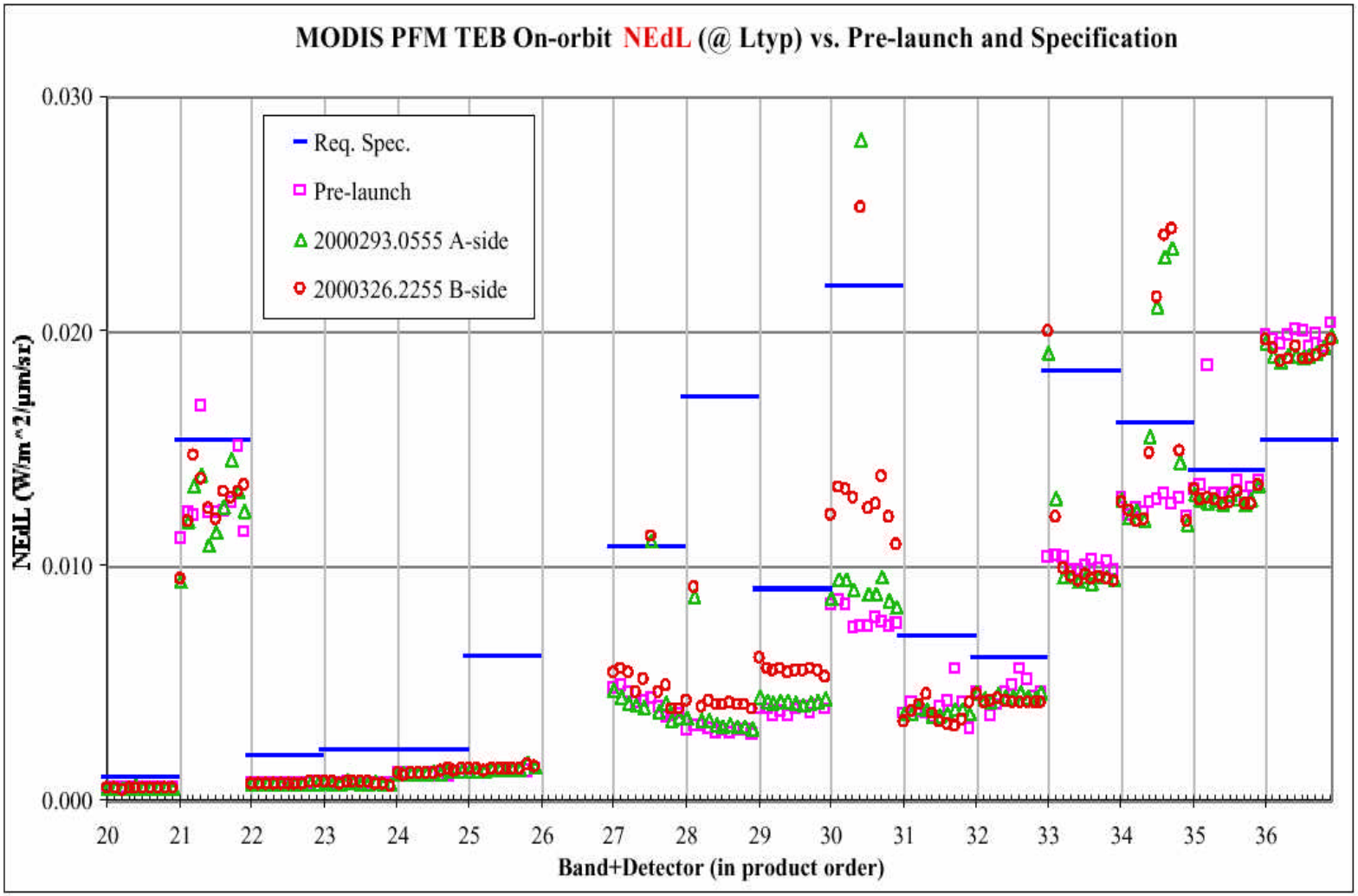
- Non-Functioning Detectors
- * Incomplete knowledge of sensor response across scan Thermal Emissive Bands (TEB)
- Incomplete knowldege of sensor response across scan Reflected Solar Bands (RSB)
- Incomplete knowledge of sensor time-dependent response function for reflected solar bands (RSB-1 to 19, plus 26)—correction not installed. Believed to be ~2% in the blue to zero in the red and SWIR
- *Optical cross-talk from Band 31 into Bands 32 through 36
- *Electronic cross-talk amongst Bands 5 to 7, 20 to 26
- *Non-uniform digital count bin-fill factors (bin-width), particularly for Bands 31 to 36
- Non-uniform channel to channel response within a band
- Band 21, a fire band, not yet calibrated
- Band 27 anomalous band width, anomalous gain
- Level 1B data sets produced for data days in Nov. being processed with LUT's corresponding to focal plane bias and electronic sides different than those for which data was collected
- Scan-dependent Noise (also called mirror-sideness)
- Sub-1000m bands misregistered to 1000m bands in 1000m band files

NOTE: *fixed or improved on Aqua

MODIS Reflected Solar Bands Performance (01/2001, B. Guenther/MCST)

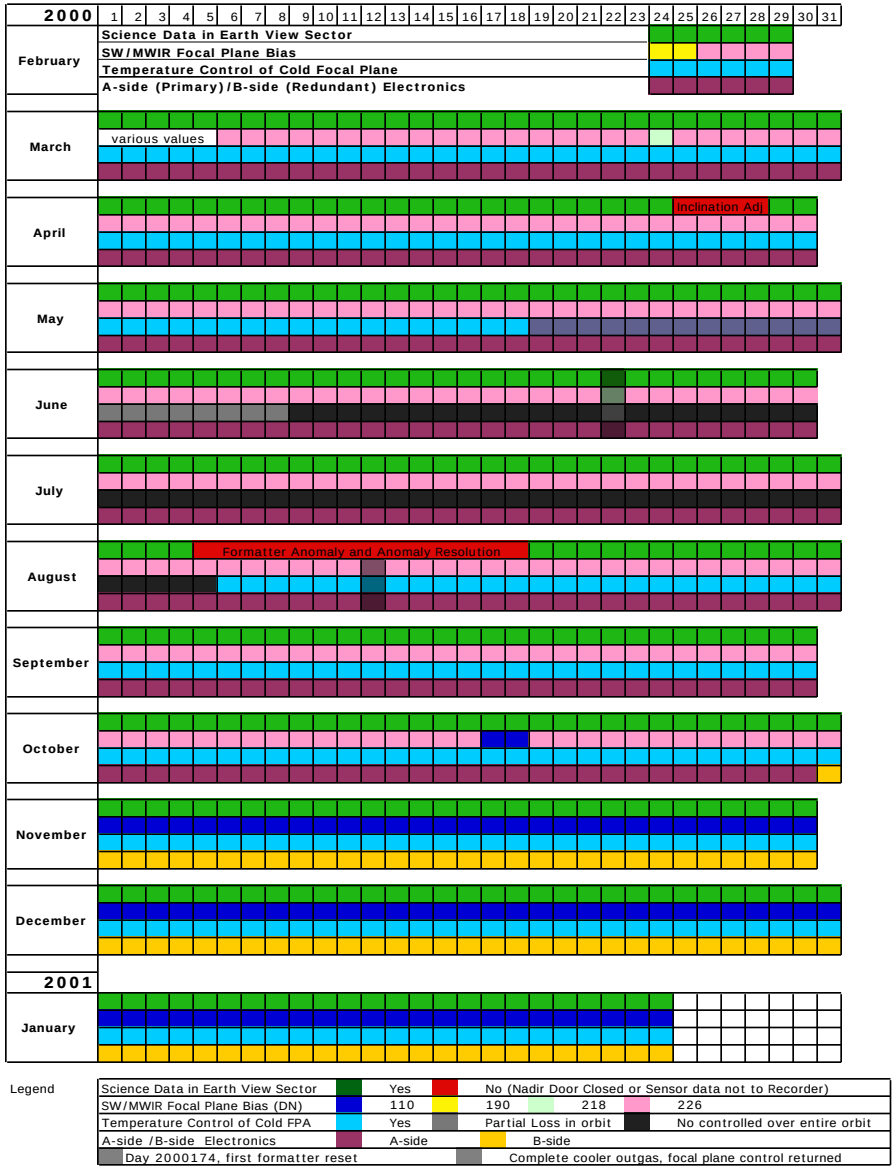


MODIS Thermal Bands NEdL Performance (01/2001, B. Guenther/MCST)

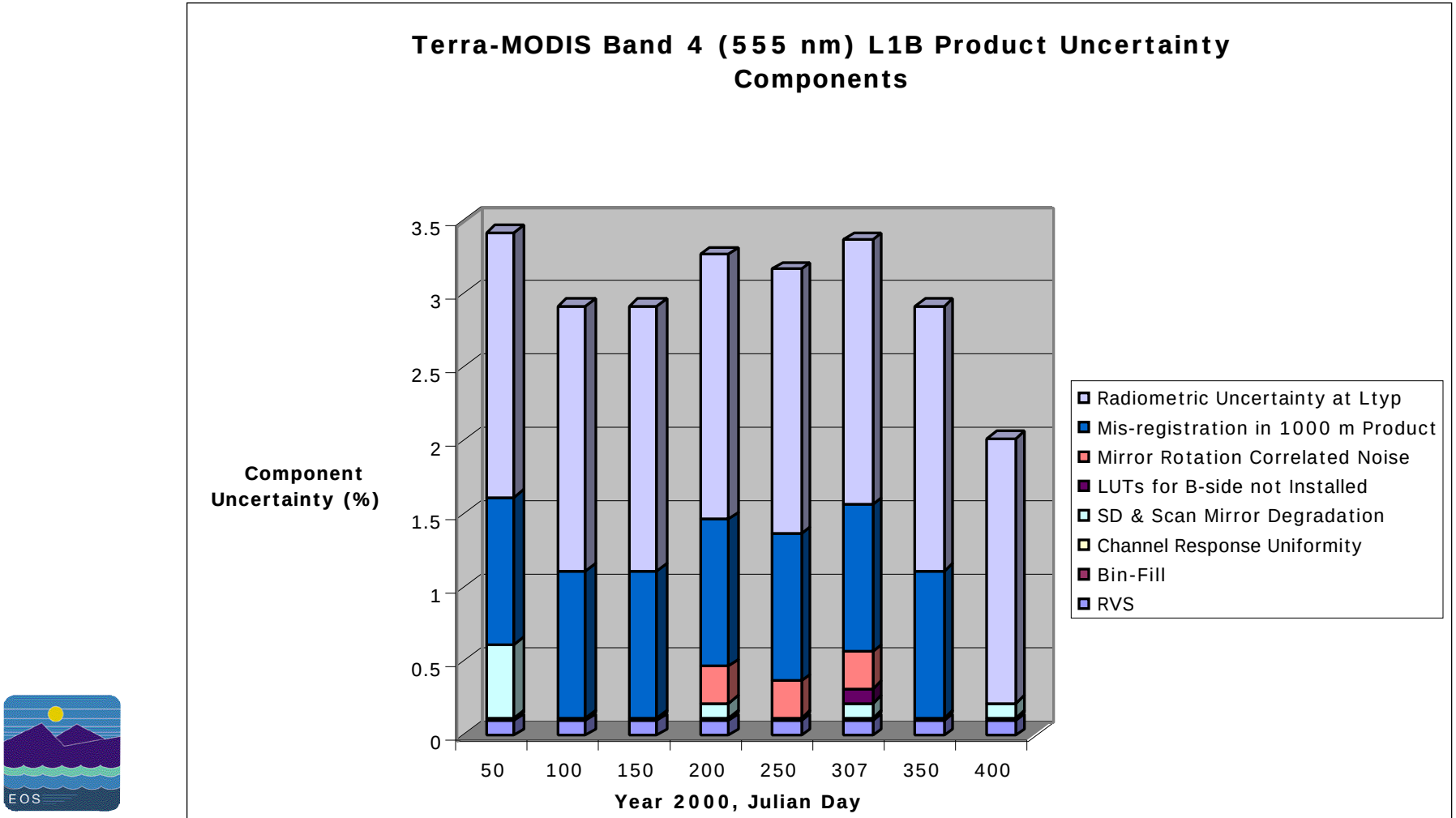


MODIS Operational Configuration Timeline

SUMMARY OF KEY MODIS OPERATIONAL CONFIGURATIONS



MODIS Band 4 Uncertainties (1/2001, B. Guenther/MCST)



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.

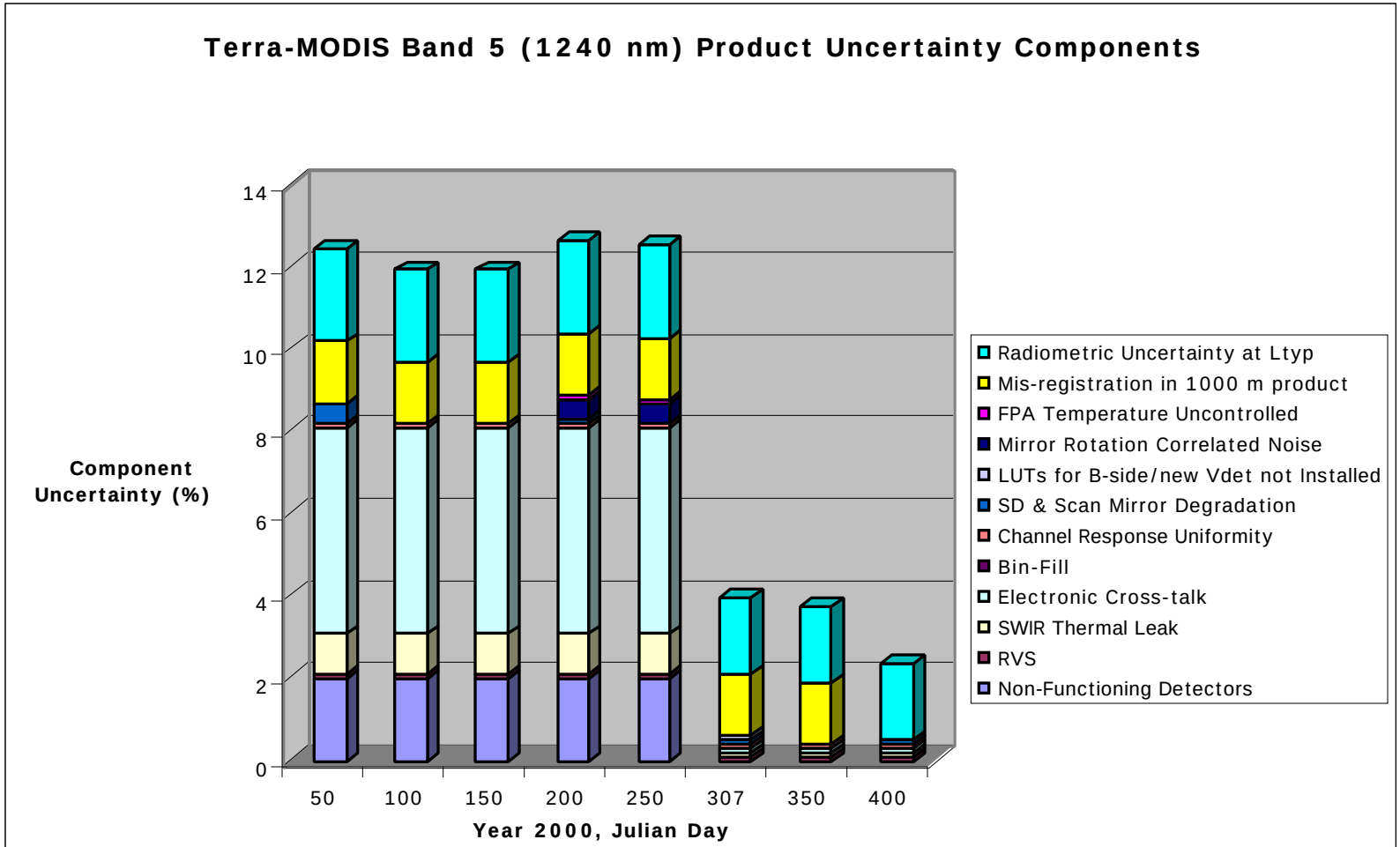
MODIS BAND 4 RSS UNCERTAINTY

JD (Yr 2000)

Band 4 (555 nm) uncertainty (%)	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
Radiometeric 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.

MODIS Band 5 Uncertainties (1/2001, B. Guenther/MCST)



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.

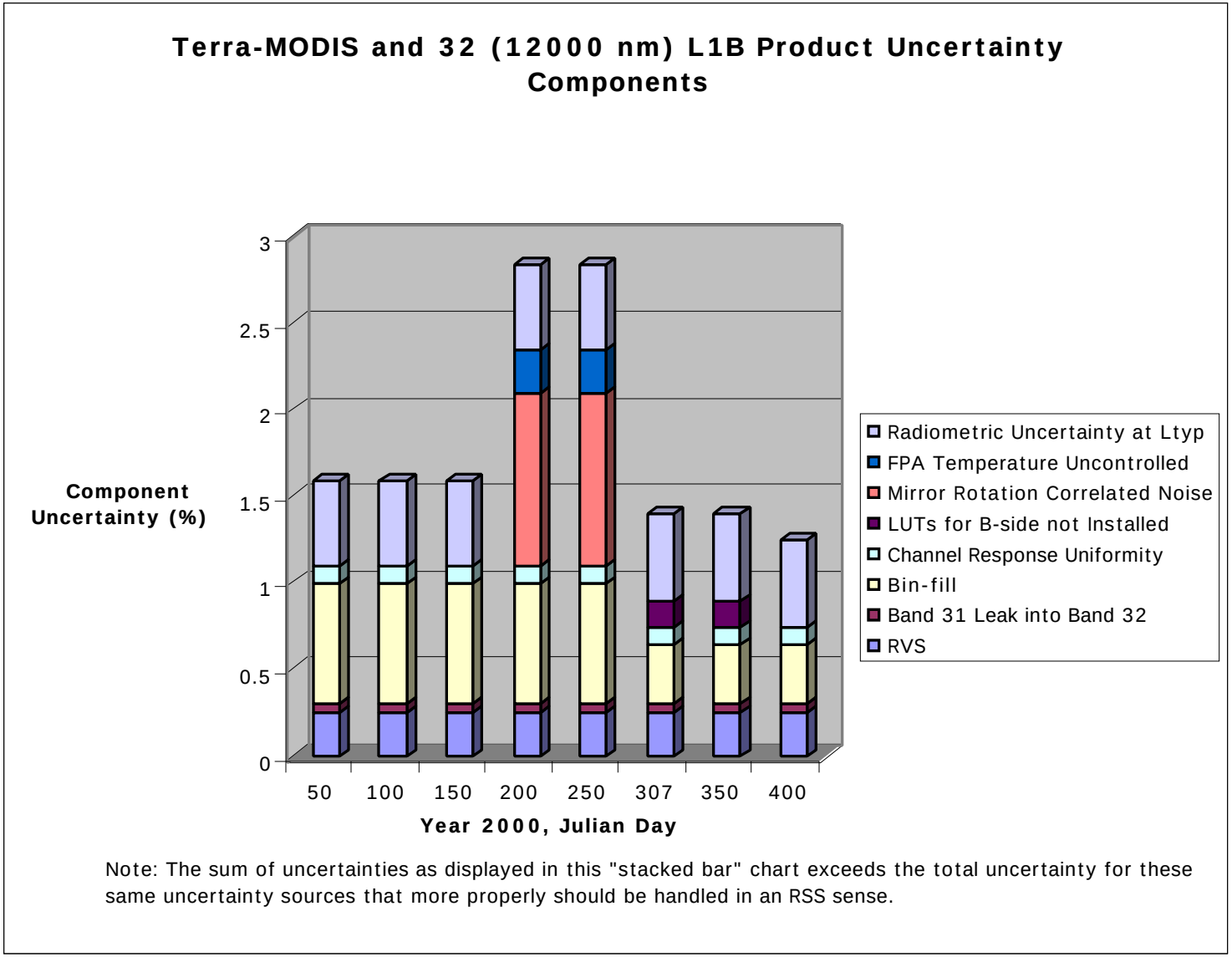
MODIS BAND 5 Uncertainties

JD (Yr 2000)

Band 5 (1240 nm) uncertainty (%)	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
Radiometeric 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.

MODIS Band 32 Uncertainties (1/2001; B. Guenther/MCST)



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.

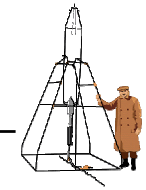
MODIS BAND 32 RSS Uncertainties

JD (Yr 2000)

Band 32 (12000 nm) uncertainty (%)	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)								
Radiometeric 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.

MODIS On-Orbit Verification (01/2001; B. Guenther/MCST



Principal Parameters Requi ring On-oribt Determination/ Verification

[illegible] Parameters Requiring On-orbit Determination/ Verification	Strategy for Determination/ Verification	Comments
Reflective Solar Bands (RSB) Reflectance-factor Calibration [illegible]	Use literature [illegible] ral irradiance and measured [illegible] ional Reflectance Factor [illegible] (SD)	SD attenuat [illegible] o variation [illegible] tern
Thermal Emissive Bands (TEB) [illegible]	[illegible] temperature [illegible] o ambient	[illegible] best results for measurement [illegible] emperature [illegible]
Electronic crosstalk	Prelaunch improvement [illegible] tested [illegible] (SWIR) [illegible] measurement [illegible] rast [illegible] angular [illegible] SRCA	SWIR [illegible] because prelaunch correct [illegible] syst emint o [illegible] SRCA data [illegible] saturation [illegible] a [illegible]
[illegible] (ADC) [illegible] s	[illegible] specification [illegible] and the impact [illegible] hat situation	Effect [illegible] improvement [illegible] elect [illegible] o truncat [illegible] analyses
Spectral leaks, SWIR [illegible] hermal & [illegible]	Verificat [illegible] characterizations	SWIR data [illegible] data set [illegible] useful [illegible] het [illegible] data set [illegible] features
Channel [illegible] o [illegible] ration	Spectro-radiometric Calibration Assembly (SRCA) [illegible] hese studies	Objectives met [illegible] analysis strategies
Response versus Scan Angle (RVS) [illegible]	Best strategy [illegible] deep space [illegible] ion [illegible] by [illegible] aperture door (SVAD)	Deep Space maneuver [illegible] aset useful [illegible] rit o [illegible] her mirror side
Solar Diffuser St ability [illegible] or (SDSM) [illegible] performance	[illegible] es [illegible] accomplished [illegible] SDSM	Significant struct [illegible] SDSM detector [illegible] 8% [illegible] ransmission screen [illegible] racking [illegible] ion
[illegible] ion [illegible]	[illegible] te [illegible] o [illegible] ehear [illegible] erm	Literature [illegible] 4 micrometer [illegible] o calibrat [illegible] emperature [illegible] ermined

MODIS ON-ORBIT SURPRISES (01/2001; B. Guenther/MCST)

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 operations commanding requirements	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 not recognized until the Fall.	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 detectors are operational.
Mirror-side induced banding and channel-to-channel induced striping in data	Ripples in SD transmission screen interfers 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 occurance 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 these Tsat on Aqua.
Mirror-sidedness 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 reprcessing between 22 June and 31 October 2000.
Polarization		Not started in L1B studies
Scene Restoration due to Scattering Corrections		Not started in L1B studies

MODIS TABLE OF PRODUCTS (Page 1)

MODIS Data Products

MODIS Data Products Release Dates
Updated 1/16/01

Product ID	Product Name	Level/Frequency*				Discipline	Planned release after launch on 12/18/99 (Earth Observer 01/99)	Date Released	Status	Start Date of Data Series	Archive Center
MOD01	Level-1A Radiance Counts	1A				—	90-120 (4/16)	4/19/00	Available	3/18/00	GSFC
MOD02	Level-1B Calibrated Geolocated Radiances	1B				—	90-120 (4/16)	4/19/00	Available	3/18/00	GSFC
MOD03	Geolocation Data Set	1B				—		4/19/00	Available	3/18/00	GSFC
MOD04	Aerosol Product		2			Atmos.	120-210 (7/15)	9/29/00	Available	8/20/00	GSFC
MOD05	Total Precipitable Water		2			Atmos.	150-180 (6/15)	9/29/00	Available	8/20/00	GSFC
MOD06	Cloud Product		2			Atmos.	120-180 (6/15)	9/29/00	Available	8/20/00	GSFC
MOD07	Atmospheric profiles		2			Atmos.	150-210 (7/15)	11/27/00	Available	10/21/00	GSFC
MOD08	Gridded Atmospheric Product			3 (1d)		Atmos.		11/27/00	Available	10/21/00	GSFC
				3 (8d)		Atmos.		12/27/00	Available	10/23/00	GSFC
				3 (1m)		Atmos.			1/22/01	11/1/00	GSFC
MOD09	Surface Reflectance		2G			Land	150-210 (7/15)	11/10/00	Available	6/9/00	EDC
				3 (8d)		Land		8/4/00	Available	6/9/00	EDC
MOD10	Snow Cover		2			Cryo.	150-210 (7/15)	10/13/00	Available	9/13/00	NSIDC
				3 (1d)		Cryo.		10/13/00	Available	9/13/00	NSIDC
				3 (8d)		Cryo.		10/13/00	Available	9/13/00	NSIDC
MOD11	Land Surface Temperature & Emissivity		2			Land	150-210 (7/15)	9/1/00	Available	6/25/00	EDC
				3 (1d)		Land		9/1/00	Available	6/25/00	EDC
				3 (8d)		Land		10/13/00	Available	8/28/00	EDC
MOD12	Land Cover/Land Cover Change			3 (96d)		Land	150-210 (7/15)		3/30/01	6/1/00	EDC
MOD13	Gridded Vegetation Indices (Max NDVI & Integrated MVI)			3 (16d)		Land	150-210 (7/15)	8/4/00	Available	6/9/00	EDC
MOD14	Thermal Anomalies, Fires & Biomass Burning		2			Land	150-210 (7/15)		1/19/01	11/1/00	EDC
			2G			Land			1/19/01	11/1/00	EDC
				3 (1d)		Land			2/2/01	11/1/00	EDC
				3 (8d)		Land		10/13/00	Available	8/20/00	EDC
MOD15	Leaf Area Index & FPAR				4 (8d)	Land	210-360 (12/12)	8/4/00	Available	6/9/00	EDC
MOD17	Vegetation Production, Net Primary Productivity				4 (8d)	Land	210-360 (12/12)		2/2/01	10/31/00	EDC
			2			Ocean	150-210 (7/15)	10/13/00	Available	9/15/00	GSFC

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MODIS Data Products

MODIS Data Products Release Dates
Updated 1/16/01

Product ID	Product Name	Level/Frequency*	Discipline	Planned release after launch on 12/18/99 (Earth Observer 01/99)	Date Released	Status	Start Date of Data Series	Archive Center
MOD18	Normalized Water-leaving Radiance	3 (1d)	Ocean	150-210 (7/15)	11/9/00	Available	9/21/00	GSFC
		3 (8d)	Ocean		11/13/00	Available	9/21/00	GSFC
MOD19	Pigment Concentration	2	Ocean	150-210 (7/15)	10/13/00	Available	9/15/00	GSFC
		3 (1d)	Ocean		11/9/00	Available	9/21/00	GSFC
		3 (8d)	Ocean		11/13/00	Available	9/21/00	GSFC
MOD20	Chlorophyll Fluorescence	2	Ocean	150-210 (7/15)	10/13/00	Available	9/15/00	GSFC
		3 (1d)	Ocean		11/9/00	Available	9/21/00	GSFC
		3 (8d)	Ocean		11/13/00	Available	9/21/00	GSFC
MOD21	Chlorophyll_a Pigment Concentration	2	Ocean	150-210 (7/15)	10/13/00	Available	9/15/00	GSFC
		3 (1d)	Ocean		11/9/00	Available	9/21/00	GSFC
		3 (8d)	Ocean		11/13/00	Available	9/21/00	GSFC
MOD22	Photosynthetically Available Radiation (PAR)	2	Ocean	80-210 (7/15)	10/13/00	Available	9/15/00	GSFC
		3 (1d)	Ocean		11/9/00	Available	9/21/00	GSFC
		3 (8d)	Ocean		11/13/00	Available	9/21/00	GSFC
MOD23	Suspended-Solids Conc, Ocean Water	2	Ocean		10/13/00	Available	9/15/00	GSFC
		3 (1d)	Ocean		11/9/00	Available	9/21/00	GSFC
		3 (8d)	Ocean		11/13/00	Available	9/21/00	GSFC
MOD24	Organic Matter Concentration	2	Ocean		10/13/00	Available	9/15/00	GSFC
		3 (1d)	Ocean		11/9/00	Available	9/21/00	GSFC
		3 (8d)	Ocean		11/13/00	Available	9/21/00	GSFC
MOD25	Coccolith Concentration	2	Ocean		10/13/00	Available	9/15/00	GSFC
		3 (1d)	Ocean		11/9/00	Available	9/21/00	GSFC
		3 (8d)	Ocean		11/13/00	Available	9/21/00	GSFC
MOD26	Ocean Water Attenuation Coefficient	2	Ocean		10/13/00	Available	9/15/00	GSFC
		3 (1d)	Ocean		11/9/00	Available	9/21/00	GSFC
		3 (8d)	Ocean		11/13/00	Available	9/21/00	GSFC
MOD27	Ocean Primary Productivity	4	Ocean	150-210 (7/15)		1/22/01	11/8/00	GSFC
MOD28	Sea Surface Temperature	2	Ocean	150-210 (7/15)	10/13/00	Available	9/15/00	GSFC
		3 (1d)	Ocean		11/9/00	Available	9/21/00	GSFC
		3 (8d)	Ocean		11/13/00	Available	9/21/00	GSFC
MOD29	Sea Ice Cover	2	Cryo.			2/16/01	12/7/00	NSIDC
		3 (1d)	Cryo.			2/16/01	12/7/00	NSIDC

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MODIS TABLE OF PRODUCTS (Page 3)

MODIS Data Products

MODIS Data Products Release Dates
Updated 1/16/01

Product ID	Product Name	Level/Frequency*	Discipline	Planned release after launch on 12/18/99 (Earth Observer 01/99)	Date Released	Status	Start Date of Data Series	Archive Center
		3 (8d)	Cryo.			2/16/01	12/7/00	NSIDC
MOD31	Phycoerythrin Concentration	2	Ocean	150-210 (7/15)	10/13/00	Available	9/15/00	GSFC
		3 (1d)	Ocean	150-210 (7/15)	11/9/00	Available	9/21/00	GSFC
		3 (8d)	Ocean		11/13/00	Available	9/21/00	GSFC
MOD35	Cloud Mask	2	Atmos.	120-150 (5/16)	9/15/00	Available	8/30/00	GSFC
MOD36	Total Absorption Coefficient	2	Ocean		10/13/00	Available	9/15/00	GSFC
		3 (1d)	Ocean		11/9/00	Available	9/21/00	GSFC
		3 (8d)	Ocean		11/13/00	Available	9/21/00	GSFC
MOD37	Ocean Aerosol Properties	2	Ocean		10/13/00	Available	9/15/00	GSFC
		3 (1d)	Ocean		11/9/00	Available	9/21/00	GSFC
		3 (8d)	Ocean		11/13/00	Available	9/21/00	GSFC
MOD39	Clear Water Epsilon	2	Ocean	150-210 (7/15)	10/13/00	Available	9/15/00	GSFC
		3 (1d)	Ocean	150-210 (7/15)	11/9/00	Available	9/21/00	GSFC
		3 (8d)	Ocean		11/13/00	Available	9/21/00	GSFC
MOD43	Albedo 16-day L3	3 (16d)	Land		9/29/00	Available	7/11/00	EDC
	Nadir BRDF-Adjusted Reflectance	3 (16d)	Land		9/29/00	Available	7/11/00	EDC
	BRDF Ross-Li Model	3 (16d)	Land			2/2/01	10/31/00	EDC
MOD44	Vegetation Cover Conversion	4 (32d)	Land			3/30/01	2/28/01	EDC

* Frequency is daily unless otherwise noted.

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SOME MODIS CHALLENGE AREAS

- **Background**
  - **In orbit and operating for almost a year**
- **Instrument**
  - **Reaching characterization state so that Level 1b is validated**
- **Processing, Archiving, Distributing, etc.**
  - **Having appropriate power to process and reprocess, archiving, and distribution including assuring all efficiencies have been found and implemented**
  - **Direct Read-out interaction, support**
- **Science**
  - **Improving/examining products so as to get them ready for scientific use by the scientific community ("beta", "provisional", "validated")**
  - **Maximizing presentation and publication (refereed literature) of results**
- **Team**
  - **Being appropriately engaged, positioned, and prepared for phasing of existing efforts (re:Aqua launch) and eventual recompetition**