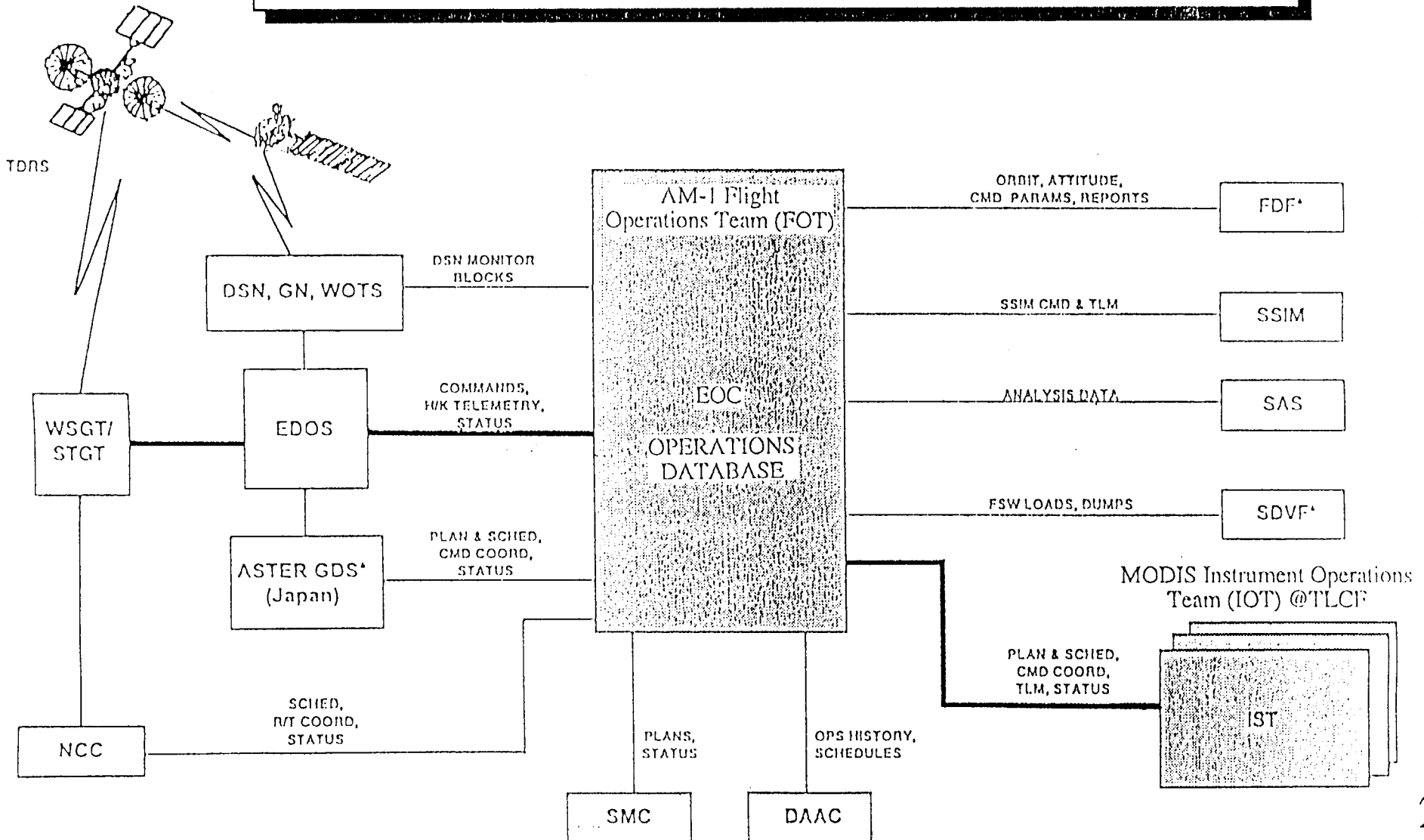# MODIS Operational Activities

On-Orbit Plans for Commanding the MODIS Instrument

Based on the

MODIS Operations Concept Document

Version 1.2

by K. Parker and E. Knight

Context

Operations Database

Activity Scheduling

Operational Activities

Future Plans

1

Operations Context

MCST Operations Presentation, 15 November 1995

TDRS

WSGT/
STGT

NCC

DSN, GN, WOTS

EDOS

ASTER GDS*
(Japan)

**DSN MONITOR
BLOCKS**

**COMMANDS,
H/K TELEMETRY,
STATUS**

**PLAN & SCHED,
CMD COORD,
STATUS**

**SCHED,
R/T COORD,
STATUS**

**AM-1 Flight
Operations Team (FOT)**

**EOC

OPERATIONS
DATABASE**

**ORBIT, ATTITUDE,
CMD PARAMS, REPORTS**

SSIM CMD & TLM

ANALYSIS DATA

FSW LOADS, DUMPS

FDF*

SSIM

SAS

SDVF*

MODIS Instrument Operations
Team (IOT) @TLCF

**PLAN & SCHED,
CMD COORD,
TLM, STATUS**

IST

**PLANS,
STATUS**

**OPS HISTORY,
SCHEDULES**

SMC

DAAC

Operations Database

- The Operations Database contains Activities, Commands, Schedules, Telemetry, and associated data.
- Operational Activities are:
  - Anything that voluntarily changes the state of the instrument
  - Defined sequences of instrument commands and procedures for the FOT to follow in operating the instrument
  - Discrete events that can be scheduled on a timeline
  - Database "pointers" for the FOT to get information required for building command loads
    - Prerequisites, constraints, power consumption, data rate changes, command blocks, associated telemetry and telemetry limits, any special actions required by the FOT

Activity Scheduling

- Baseline Schedule completed pre-launch
  - Activation and Evaluation Phase Schedule complete 1 year before launch
- 3 weeks before target day, MODIS IOT submits revisions to baseline
  - FOT resolves conflicts
- 2 days before target day, MODIS IOT agrees to schedule
  - FOT builds command load
- MODIS IOT submits modifications to Activity Database as needed
  - configuration controlled by FOT

Sample Operations Timeline
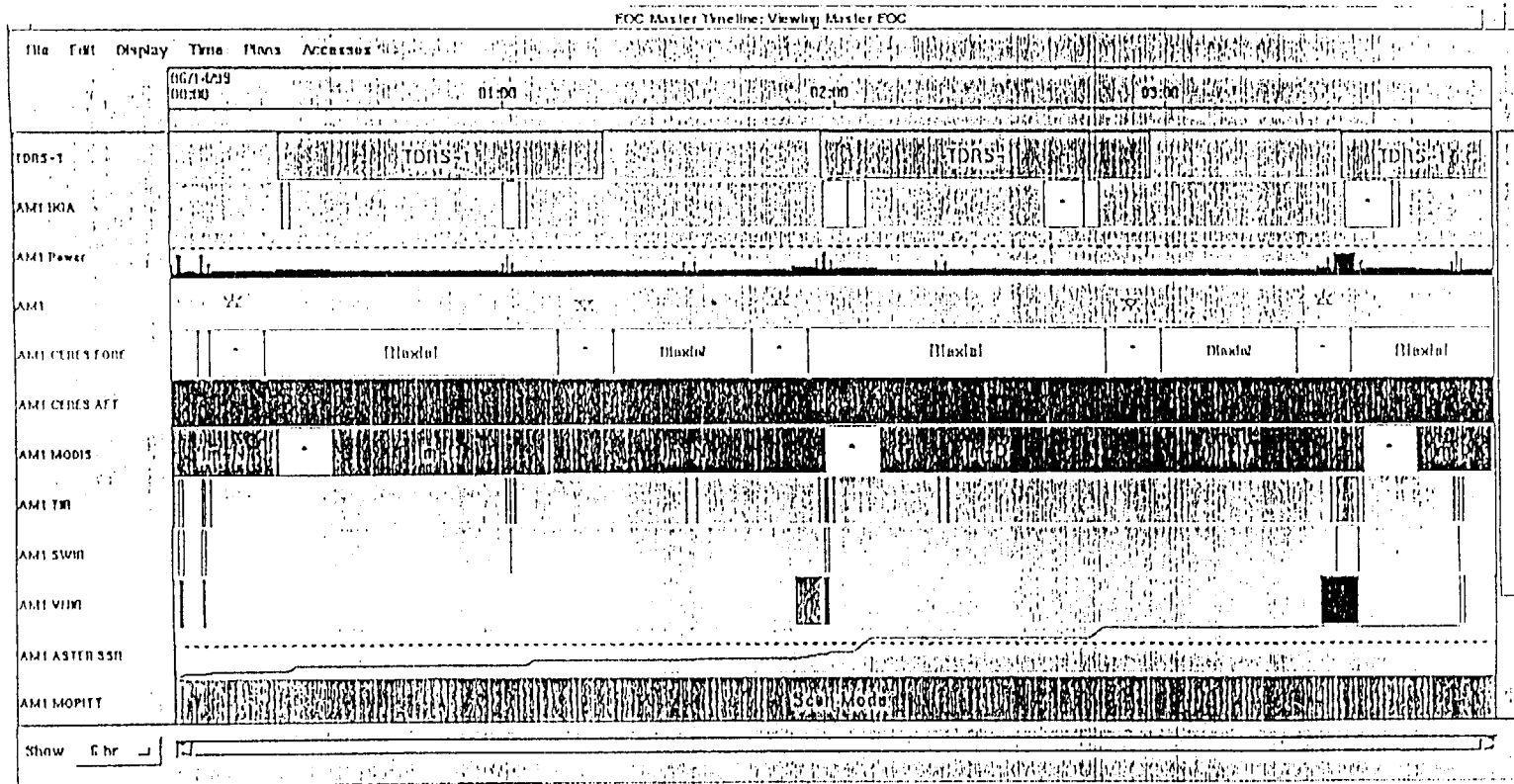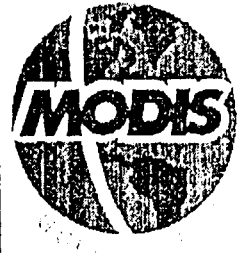
MCST Operations Presentation, 15 November 1995

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Science Requirements Drive Operational Activities

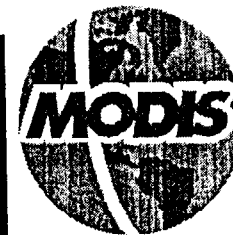| Science Requirement	Science Activity	Science Data Product	Product Category	Collection Method	Ops Activity
Data Collection					
Instrument Maintenance	Initial Checkout	none	NA	TBD	OA-01
	Instrument Mode Transitions	none	NA	Launch to Standby to Science	OA-02
	Safe/Survival Mode Recovery	none	NA	telemetry	OA-05
	Outgas	none	NA	Outgas & Science	OA-06
	DC Restore Verification	none	A	DC Restore Off	OA-07
	SAA Susceptibility Characterization	TBD	C	SDSM	OA-18
On-Going Data Collection	Day Band Data Collection	DN	A	Science Day Mode	OA-03
	Night Band Data Collection	DN	A	Science Night Mode	OA-04

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Science Requirements Drive More Operational Activities

Science Requirement	Science Activity	Science Data Product	Product Category	Collection Method	Ops Activity
		Radiometric Accuracy			
Reflective Band Calibration	Transfer Reflective Band Radiometric Calibration to Orbit	(L,DN)	A	SRCA Full Radiometric	OA-19
(5% Radiometric 2% Reflective)		$dL_{transfer}$	A	SRCA Full Spectral	OA-22
	Solar Calibration	(L,DN)	A	SD/SDSM Open	OA-15
		(L,DN)	A	SD/SDSM Screened	OA-16
	Radiometric Check on Reflective Band Linearity	%TBD	C	SRCA Full Radiometric	OA-19
				SD/SDSM Open/Screen	OA-15 OA-16

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Science Requirements Drive More Operational Activities

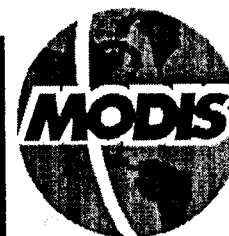| Science Requirement	Science Activity	Science Data Product	Product Category	Collection Method	Ops Activity
Radiometric Accuracy					
Reflective Band Calibration (con't) (5% Radiometric 2% Reflective)	Field Campaign Support	(L,DN)	B	Constraints on Special Operations	OA-11
	Improve Gains/Offsets	G, DN_0	A	Table Load	OA-12
	Lunar Calibration	(L,DN)	B	Nominal (SV Look)	none
		(L,DN)	B	S/C Maneuver	OA-08
	Reflective Band Noise Verification	DN	B	Day Mode Collection at S/C Night	OA-03
	SD Scattered Light Mapping	δL_{SD}	C	SD/SDSM and S/C Maneuvers	OA-15 OA-16 OA-09

Science Requirements Drive More Operational Activities

Science Requirement	Science Activity	Science Data Product	Product Category	Collection Method	Ops Activity
Radiometric Accuracy					
Thermal Band Calibration (1% Radiometric 0.75% - band 20 0.50% - bands 31 and 32)	Blackbody Calibration	(L,DN)	A	OBC Ambient Blackbody	none
		(L,DN)	A	OBC Heated Blackbody	OA-26
	Radiometric Check on Thermal Band Linearity	%TBD	C	OBC Heated Blackbody	OA-26
		%TBD	C	OBC Blackbody Cooldown	OA-26
	Field Campaign Support	(L,DN)	B	Constraints on Special Operations	OA-11
	Improve Gains/Offsets	G, DN_0	A	Table Load	OA-12
	Cavity Background Characterization	δL_{bkgd}	C	Sector Rotation	OA-14

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Science Requirements Drive More Operational Activities

Science Requirement	Science Activity	Science Data Product	Product Category	Collection Method	Ops Activity
Radiometric Accuracy					
Intra-Orbit Characterization for Reflective Bands	Intra-Orbit Radiometric Calibration	(L[t],DN[t])	B	SRCA Full Radiometric	OA-19
		(L[t],DN[t])	B	SRCA 10W Radiometric Continuous	OA-20
		(L[t],DN[t])	B	SRCA 1W Radiometric Continuous	OA-21
Response vs Scan Angle Characterization for Reflective and Thermal Bands	Response vs. Scan Angle	$R(\theta)$	B	S/C Maneuver	OA-10
		$R(\theta)$	B	SD Sector Shift	OA-17
Linearity Characterization (knowledge to <1%)	Electronic Linearity Bands 1 - 30	%TBD	A	PV Electronic Calibration	OA-27
	Electronic Linearity Bands 31 - 36	%TBD	A	PC Electronic Calibration	OA-28

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Science Requirements Drive More Operational Activities

| Science Requirement	Science Activity	Science Data Product	Product Category	Collection Method	Ops Activity
		Spectral Accuracy			
Spectral Characterization ($\Delta\lambda_{cw}$ to <2nm by band)	Spectral Characterization	$\Delta\lambda$ $\Delta\lambda^{cw}$ $\Delta\lambda^{bw}$ Out of Band^{shape}	A B C C	SRCA Full Spectral	OA-22
		Coregistration Accuracy			
Spatial Characterization (0.2 IFOV Δx, Δy 0.1 IFOV goal)	Detector and FPA Coregistration Measurement in Scan Direction	Δx	A	SRCA Full Spatial SRCA Along-Scan Spatial 1W Along-Scan Spatial	OA-23 OA-24 OA-25
	Band Centroid Position and FPA Coregistration Measurement in Track Direction	Δy	A	SRCA Full Spatial	OA-23
	Improve Coregistration	Δx	A	Table Load	OA-13

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Science Requirements Drive More Operational Activities

Science Requirement	Science Activity	Science Data Product	Product Category	Collection Method	Ops Activity
		MTF			
Spatial Characterization (>0.3@Nyquist)	Detector and FPA Coregistration Measurement in Scan Direction	$\Delta\theta$ MTF	C C	SRCA Along-Scan Spatial	OA-24
	Band Centroid Position and FPA Coregistration Measurement in Track Direction	MTF	C	SRCA Full Spatial	OA-23

Data Product Key
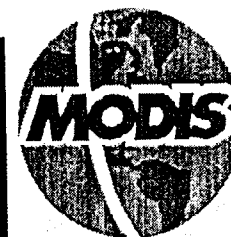
DN	Digital Number
(L,DN)	Radiance, Digital Number Pair for calibration
δL	Uncertainty in transfer of Radiometric Calibration to Orbit
$\%TBD^{transfer}$	not yet defined figure of merit
$\Delta\lambda$	shift in center wavelength
$\Delta\lambda^{cw}$	shift in bandwidth marked by 0.5 maximum response
$\Delta\lambda^{bw}$	change in spectral profile
Δx^{shape}	spatial shift in along-scan direction
Δy	spatial shift in along-track direction
$\Delta\theta$	focal plane rotation
MTF	Modulation Transfer Function
G	electronic gain
DN_0	electronic offset
$R(\theta)$	mirror reflectance as a function of scan angle
δL_{bkgd}	uncertainty due to instrument cavity background
δL_{SD}	uncertainty in solar diffuser calibration

A. Level 1B Standard Data Products
B. Level 1B Special Data Products
C. TLCF Products

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Operational Activities Table

Ops Activity	Activity	A&E Schedule	On-Going Schedule	Constraints (not complete)
OA-01	Initial Checkout	1	NA	
OA-02	Mode Transition	as needed	as needed	
OA-03	Science Day Mode			
OA-04	Science Night Mode			
OA-05	Safe/Survival Mode Recovery	as needed	as needed	
OA-06	Outgas	1	as needed	
OA-07	DC Restore On/Off	as needed	as needed	
OA-08	S/C Maneuver (Lunar Cal)	TBD	0 - 8/year	
OA-09	S/C Maneuver (SD Scattered Light)	2	TBR	
OA-10	S/C Maneuver (RVS)	6	1/year	
OA-11	Constraints on Special Operations	TBD	TBD	no S/C maneuvers
OA-12	Table Load (GAO)	as needed	as needed	real time contact only
OA-13	Table Load (coreg)	as needed	as needed	
OA-14	Sector Rotation	1	1 mid mission 1 end of mission	
OA-15	SD/SDSM Open	160 orbits	1/week	
OA-16	SD/SDSM Screened	80 orbits	1/week	

Operational Activities Table

| Ops Activity	Activity	A&E Schedule	On-Going Schedule	Constraints (not complete)
OA-17	SD Sector Shift	6	1/year	
OA-18	SDSM	TBR	TBR (when passes through SAA)	
OA-19	SRCA Full Radiometric	100	1/month	
OA-20	SRCA 10W Radiometric Continuous	100	1/week	
OA-21	SRCA 1W Radiometric Continuous	100	1/week	
OA-22	SRCA Full Spectral	100	1/month	
OA-23	SRCA Full Spatial	100	4/year	
OA-24	SRCA Along-Scan Spatial	NA	as needed	
OA-25	SRCA 1W Along-Scan Spatial	NA	as needed	
OA-26	OBC Blackbody On/Off	5	1/year	
OA-27	PV Electronic Calibration	>50 times	1/month	
OA-28	PC Electronic Calibration	>50 times	1/month	moon not in space view
OA-29	End Of Mission	NA	TBD	

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Future Plans
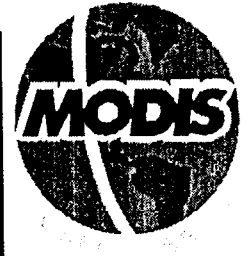
- Operations Concept Document
  - Version 1.2   December 1995
    - allow database construction, beginning with category A items
  - Version 2.0   Fall 1996
    - incorporation of PFM results, Level 1B 1996 ATBD, validation plan
    - Full day review?
  - Version 3.0   Fall 1997
    - incorporate S/C level interference test results
    - submit full database for configuration control
- Implementation Plan and First pass at Activity Database 1996
- Activation and Evaluation Phase Schedule
  - Set summer 1997 for resource/conflict/prerequisite purposes
  - Used for end-to-end tests in early 1998

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Conclusion
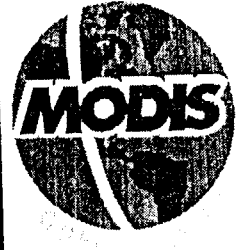
- **On-Orbit Operations Plans underway**
- **Operations defined by Activities in Operations Database**
- **Activities driven by science requirements**
- **Operations Concept Document captures activities**
  - vehicle for science team review
  - governing document for constructing database
- **Early input from science team desired**
  - the earlier the input, the easier to implement
  - final plans not locked in until 1997