MCST Presentation

to the

MODIS Science Team

from

MCST (MODIS Characterization Support Team)

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1400 Wednesday, 15 April 1992

Auditorium, Bldg 8 , Goddard Space Flight Center

Attachment 1.13

Overview of **MCST Presentation to MODIS Science Team**

MCST Objectives, Priorities, and Personnel
MODIS/MCST Calibration Data Products
- Strategy
- Data Products
- Calibration Plan
- Calibration Handbook

MODIS/MCST Utility Data Products
- Texture Algorithm
- Classification Overlay/Masking Algorithm

MCST-Related MODIS Scene Simulation Activities
- Requirements, Properties and Approach
- Atmospheric Models
- Global Site Selection
- Simulated MODIS U. S. Land/Water Mask

MCST Bulletin Board

MCST Priorities

unchanged from

1990 and 1991 MODIS Science Team Meetings

1. **Instrument-Related Characterization/Calibration**
2. Algorithms, Software and Hardware for EOC/MCST Monitoring of In-Orbit Data
3. Utility Products
4. Simulated MODIS Imagery
5. Cooperative Team Member and MCST Discipline-Related Product Sensitivity to Calibration

MCST Personnel

John Barker	925	MCST Head
Joann Harnden	925	Artificial Intelligence/Scene Simulation / Modeling
Brian Markham	923	Instrument Charact./Field Calibration/Simulation
Steve Ungar	923	MODIS Scene Simulation / Utility Algorithms

Civil Servants with Interfaces to MCST

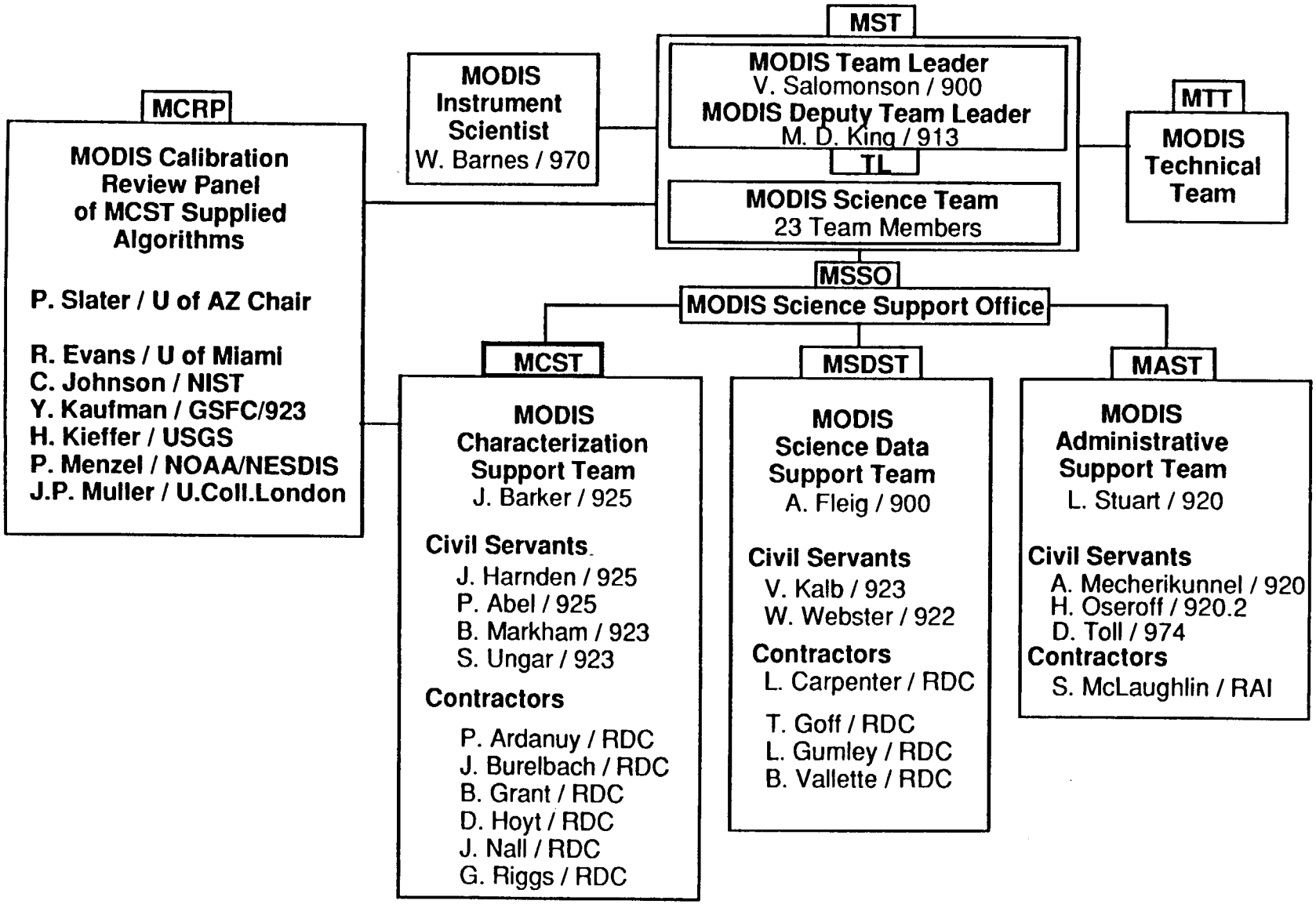
Peter Abel	925	Aircraft Underflights / Thermal
Bill Barnes	970	MODIS Instrument Scientist / SeaWiFS
Ken Brown	925	MODIS Airborne Simulator (MAS)
Wayne Esaias	971	MODIS Ocean Discipline Head / SeaWiFS
Bruce Guenther	925	EOS AM Project Scientist / EOS Calibration Scientist
Forrest Hall	923	Image-Based Radiometric Rectification Calibration
Chris Justice	923	MODIS Land Discipline Leader / AVHRR / NDVI
Michael D. King	913	Deputy Team Leader /Atmosphere Head / CERES

MCST Personnel

Contractors, RDC (Research and Data Systems Corporation)

Harold Geller	Out-Going Project Manager
Phil Ardanuy	Acting Project Manager
Jon Burelbach	Programmer /Analyst / Image Analysis
Barbara Grant	Optics Engineer / SBRC Interface / Calibration Plan
Doug Hoyt	Scientist / Solar Irradiance / MODIS Calibration Handbook
Janie Nall	Technical Editor / Meetings / Plans / MCST.BB
George Riggs	Scientist / Utility/Masking Algorithm / Snow / Ice

MODIS Science Team Organization Chart



MODIS/MCST Calibration Strategy

1. Use Alternative MODIS Calibration Methodologies

Several alternative calibration methodologies
will be implemented throughout 15-year mission
to provide a robust unique "official" calibration algorithm
and to allow for its validation by independent methods

2. Characterize Precision on a Time-Scale of Months

Post-launch quantitative characterization and monitoring
of the precision (repeatability) with which MODIS at-satellite radiances
are measured by various methods
will occur within 2 to 6 months

MODIS/MCST Calibration Strategy (continued)

3. Characterize Accuracy on a Time-Scale of Years

Post-launch quantitative characterization and monitoring
of the accuracy with which MODIS at-satellite radiances
are measured by various methods and on two in-orbit instruments
will occur within 3 to 5 years

4. Validate Math Model in 10-15 Years

Validation of the components of the predictive radiometric math models
for each MODIS instrument
(with an expected life-time of five-six years each)
will occur over the fifteen year life-time of EOS mission

At-Launch MODIS Calibration Data Products*
Primary MCST Product Generation Responsibilities
Instrument-Related Characterization/Calibration

Files for Appending/Accessing with Raw Level-1A or -1B Imagery

- Radiometric Calibration/Correction Parameters / Characteristics
- Within-Image Geometric Pixel Location Correction or Characteristics
- Spectral Characteristics
- Radiometric Math Model Parameters/Characteristics

Calibrated Level-1B Imagery

- At-Satellite Radiances

Derived Level-2 Imagery

- Earth-Sun Distance and Solar Zenith Normalized Exoatmospheric Reflectances
- Errors in At-Satellite Radiances

* MCST-generated algorithms and software for operational products, including associated algorithms for automated quality assurance, metadata, and browse products, are to be rehosted to EOSDIS by MSDST

At-Launch products will be up-dated after launch, as required.

Post-Launch MODIS Calibration Data Products*
Primary MCST Product Generation Responsibilities
Instrument-Related Characterization/Calibration

Files for Appending/Accessing with Level-1A or -1B Imagery

Solar Calibration Datasets from the Solar Diffuser used for Calibration
Lunar Calibration Datasets used for Calibration

Derived Level-2 Information or Imagery

Solar Irradiances
Lunar Irradiances
Lunar Reflectances
Errors in Reflectance after Atmospheric Correction
Errors in Pixel GeoLocation without Topographic Correction
Errors in Pixel GeoLocation with Topographic Correction

Derived Level--3 Information or Imagery with Critical Data Products

Errors in Reflectance after Atmospheric Correction
Errors in Pixel GeoLocation without Topographic Correction
Errors in Pixel GeoLocation with Topographic Correction

* MCST-generated algorithms and software for operational products, including associated algorithms for automated quality assurance, metadata, and browse products, are to be rehosted to EOSDIS by MSDST

MODIS/MCST Calibration Data Products*

Discipline Group	Parameter :: Qualifier		Investigator	Time	Original Product Name (from Investigator)
	At-Launch Products				
CAL	Characteristics::MODIS Instrument	Level-1	Salomonson/Barker	AL	
CAL	Radiance::MODIS At-Satellite	Level-1	Salomonson/Barker	AL	At-Satellite Radiances
CAL	Model::MODIS Instrument	Level-1	Salomonson/Barker	AL	Math Model
CAL	Reflectance::MODIS Exoatmospheric	Level-2	Salomonson/Barker	AL	Exoatmospheric Reflectances
CAL	Error::MODIS Radiance	Level-2	Salomonson/Barker	AL	
	Post-Launch Products				
CAL	Radiance::MODIS Solar Diffuser	Level-1	Salomonson/Barker	PL	Solar Calibration Datasets
CAL	Radiance::MODIS Lunar Reference	Level-1	Salomonson/Barker	PL	Lunar Calibration Datasets
CAL	Irradiance::MODIS Solar	Level-2	Salomonson/Barker	PL	Derived Solar Irradiances
CAL	Irradiance::MODIS Lunar	Level-2	Salomonson/Barker	PL	Derived Lunar Irradiances
CAL	Reflectance::MODIS Lunar	Level-2	Salomonson/Barker	PL	Lunar Reflectances
CAL	Error::MODIS Reflectance	Level-2	Salomonson/Barker	PL	
CAL	Error::MODIS Geometric	Level-2	Salomonson/Barker	PL	
CAL	Error::MODIS Geometric	Level-3	Salomonson/Barker	PL	

* As currently carried in the EOS Science Data Product Database (Yun Chi Lu/936)

* The question of whether there are unique EOSAM, EOSPM or combined EOSAM/EOSPM calibration data products has not been examined.

MODIS/MCST Calibration Plan
Version 1, April 13 1992

Objective

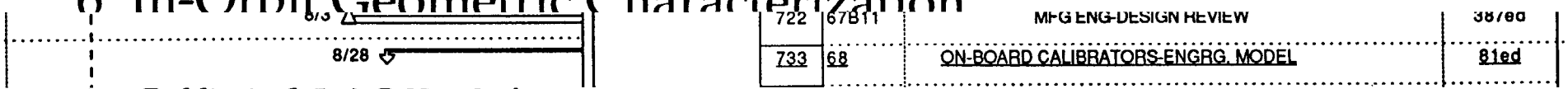
Provide a comprehensive overview and integration of all methodologies used to calibrate the MODIS instruments
for all phases of the mission:
pre-launch, and in-orbit

Approach

SBRC MODIS Calibration Management Plan
is the first and most important document
It will be included by reference
after the Preliminary Design Review (PDR)
in October, 1992 PDR

Outline of
MODIS Calibration/ Characterization Plan

1 Introduction
2 Pre-Launch Calibration/Characterization Methodology
3 Instrument Cross-Calibration
    Pre-Launch
    In-Orbit
4 Transfer of Calibration/Characterization from
    Pre-Launch to In-Orbit using On-Board Calibrators
5 In-Orbit Radiometric Calibration/Characterization
6 In-Orbit Geometric Characterization



8 Official MODIS/MCST Calibration Algorithm
9 MODIS/MCST Calibration Algorithm
    Validation and Upgrade
10 Definitions and References

MODIS/MCST Calibration Handbook

Objective

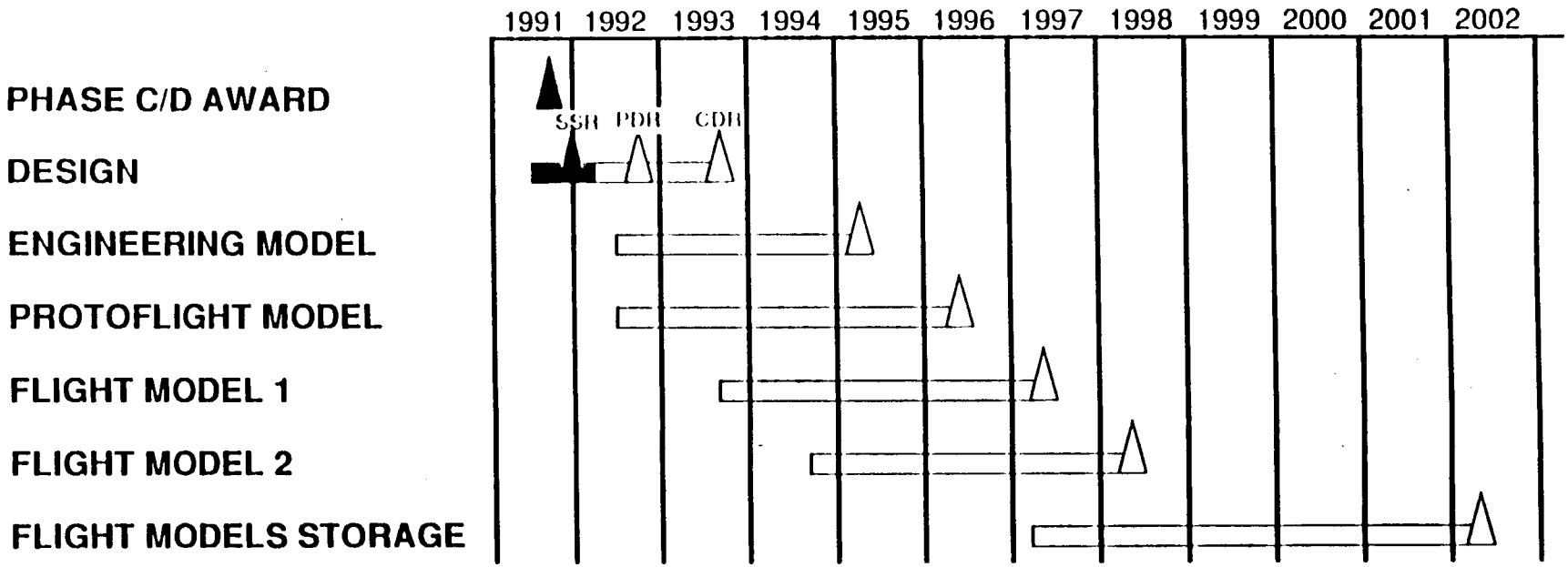
Provide **results** of calibration
and sufficient supporting information
to be able to scientifically use
and interpret MODIS data.

Approach

Produce a **stand-alone scientific user's guide**
containing all one needs to know
about calibration of MODIS data
throughout the lifetime of the EOS mission

This Handbook will be the starting point
for MODIS input to an EOS Calibration Handbook

Hughes/SBRC **MODIS Instrument Delivery Schedule**
Protoflight Model (PF) for launch June 1998 on EOSAM-1
Flight Model-1 (F1) for launch June 2000 on EOSPM-1
MCST plans to analyze test data as they are generated



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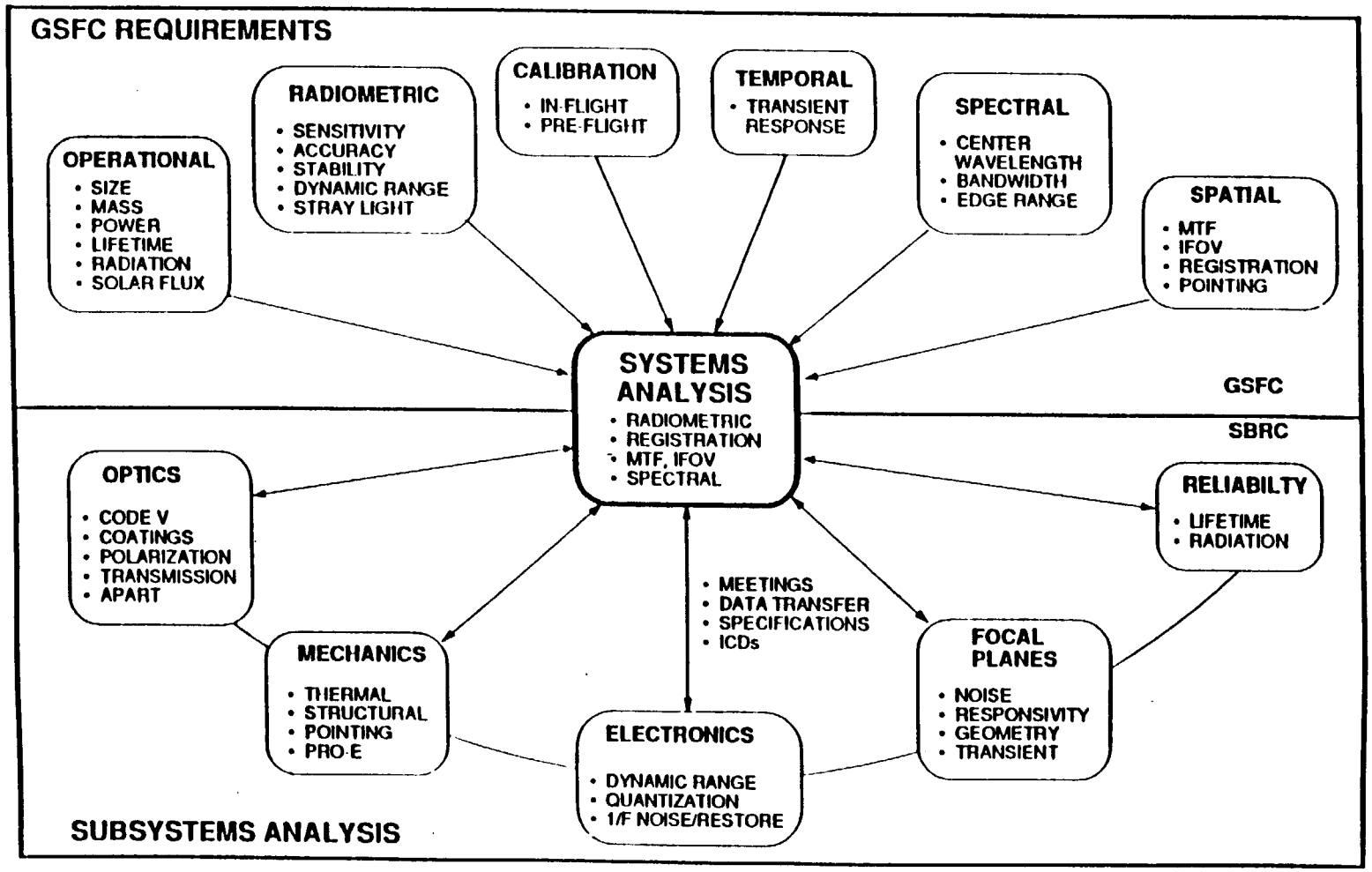
Hughes/SBRC MODIS Systems Analysis Overview including NASA/GSFC Instrument Requirements
MCST plans to document scientific rationale for any changes



At-Launch MODIS Utility Data Products*
MCST Product Generation Responsibilities

Derived Level-2 Imagery

Three level-2 image spatial products for sets of 250, 500, and 1000 m bands

Texture Products

Sixteen-Bit Radiometric Spatial Heterogeneity/Texture Image
derived from one or both of the 250 m MODIS bands

One-Bit "Pure Pixel" Binary Mask

Classification Overlay Map

Approximate priority order for developing the masks:

"Definitely" Cloud	"Definitely" Not Cloud
"Definitely" Snow/Ice	"Definitely" Not Snow/Ice
"Definitely" Water	"Definitely" Not Water
"Definitely" Land	"Definitely" Not Land
Image Terminator Line	Calculated Terminator Line
"Definitely" Glint	"Definitely" Not Glint
"Definitely" Vegetation	"Definitely" Not Vegetation
"Definitely" Shadow	"Definitely" Not Shadow

* At-launch products will be up-dated after launch
to go from radiance-based to reflectance and temporally-based algorithms,
including extension to critical level-3 products.

MODIS/MCST Land Data Products*

Discipline Group	Parameter :: Qualifier	Investigator	Time	Original Product Name (from Investigator)
LAND	Texture::MODIS Level-2	Salomonson/Barker	AL	Utility Algorithm with Strahler
LAND	Texture::MODIS Level-3	Salomonson/Barker	PL	Utility Algorithm with Strahler
LAND	Classification::MODIS Masks Level-2	Salomonson/Barker	AL	Cloud/Snow/Land/Water Utility Mask with Hall
LAND	Classification::MODIS Masks Level-3	Salomonson/Barker	PL	Cloud/Snow/Land/Water Utility Mask with Hall

* As currently carried in the EOS Science Data Product Database (Yun Chi Lu/936)

* The question of whether there are unique EOS-AM, EOS-PM or combined EOS-AM/EOS-PM land data products has not been examined.

MCST-Related MODIS Scene Simulation Activities
Requirements for Simulated Data Sets

Simulated data sets are required to develop, characterize and validate :

- Calibration algorithms and trade-off studies
  - for both the instrument and platform
- Science and utility algorithms
  - for information extraction
- Operational software for the processing algoriths
  - for the ground processing/data reduction computers

Simulated data sets can provide only a limited representation

- of the actual temporal data sets
- that will be acquired by the MODIS instruments in space
  - i. e., they are **not** intended for a priori
    - representative characterization of global processes

MCST-Related MODIS Scene Simulation Activities
Desired Properties of the Simulated Data Sets

Be derivable conveniently, cost-effectively and in a timely manner

Cover the spectral, radiometric , geometric, field-of-view, temporal
and other operational ranges of the MODIS instruments, including
typical or pseudo-realistic cases, and
limiting or extreme cases

Be structured for parametric sensitivity studies to readily reveal behavioral
characteristics of system under consideration

Allow scene modification/creation for unanticipated needs

Provide for easy validation against well understood existing real datasets
(the simulated data **correspondence** principle)

Be complete enough to allow for stressing all pathways in the software

MCST-Related MODIS Scene Simulation Activities
Approach to Simulating Data Sets

Synthetically and theoretically derived structured scenes
- Well defined geometric patterns of pure pixels to facilitate error analysis
- Groups of pixels possessing artificially defined statistical distributions
  - e.g. areas of given mean radiance and deviation
    - with along track gradient, cross track gradient, etc.
- Fractal generated scenes for representative studies

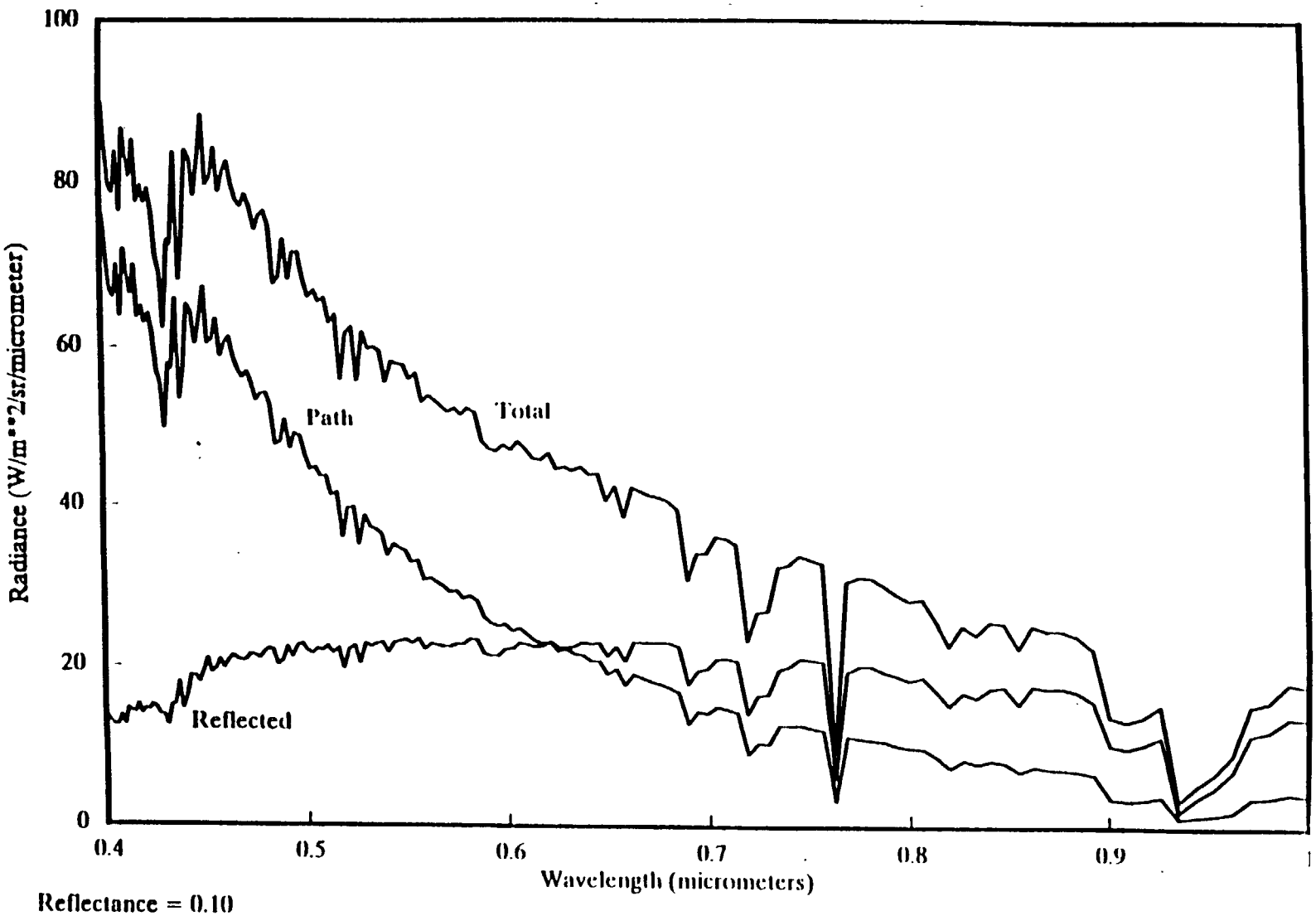
Scenes derived emprically from existing data sets
- Landsat TM, AVHRR, AVARIS, MAS, etc.

UNIX-based PRA shell for simulation activities
that includes modifiable sections for the
- source of irradiance
- scene
- atmosphere
- instrument

Radiance at Top of Atmosphere from LOWTRAN7 Output--1976 US Standard Atmosphere

23Km Visibility -- 1.125 g/cm**2 Water Vapor

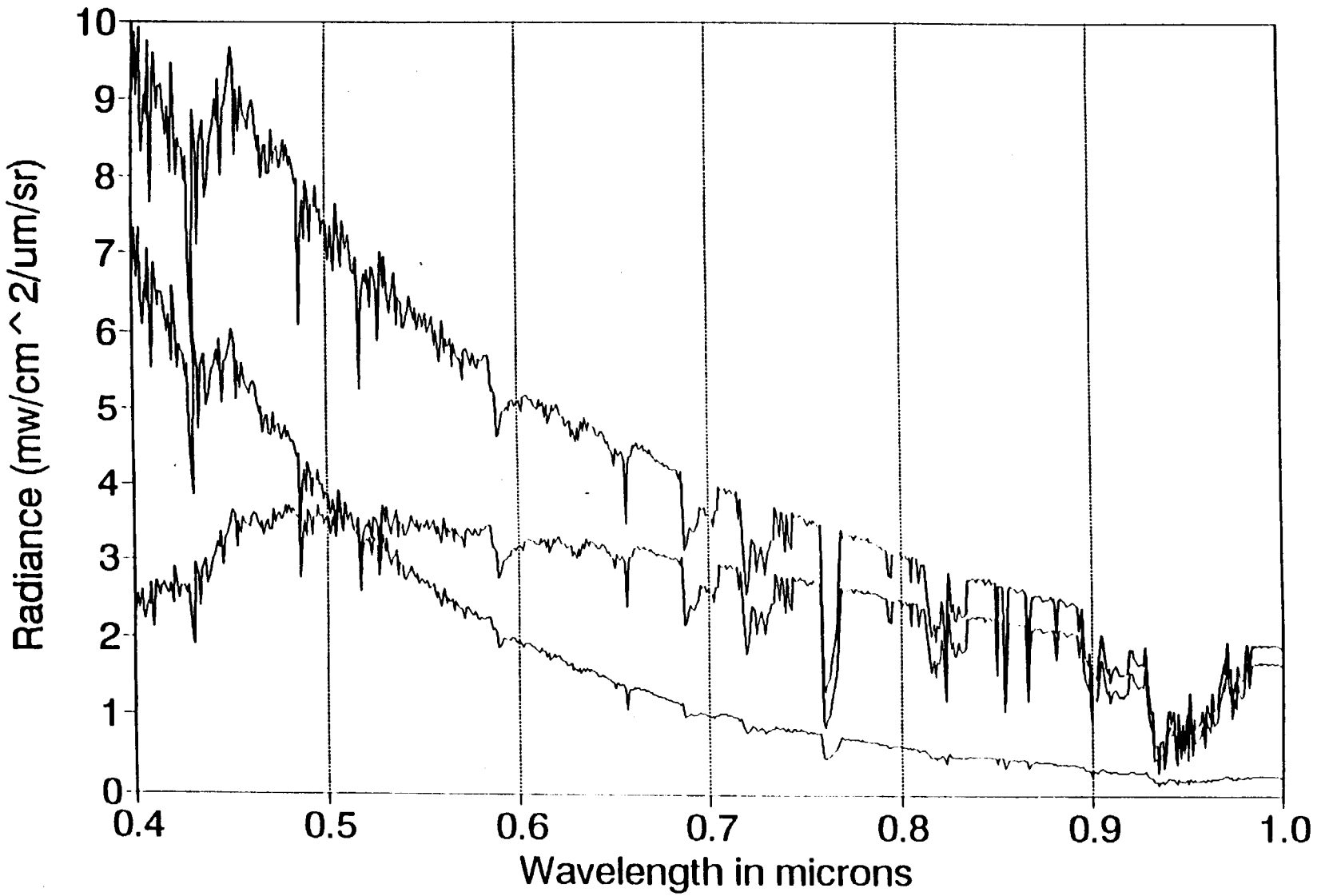
Total, Reflected and Path



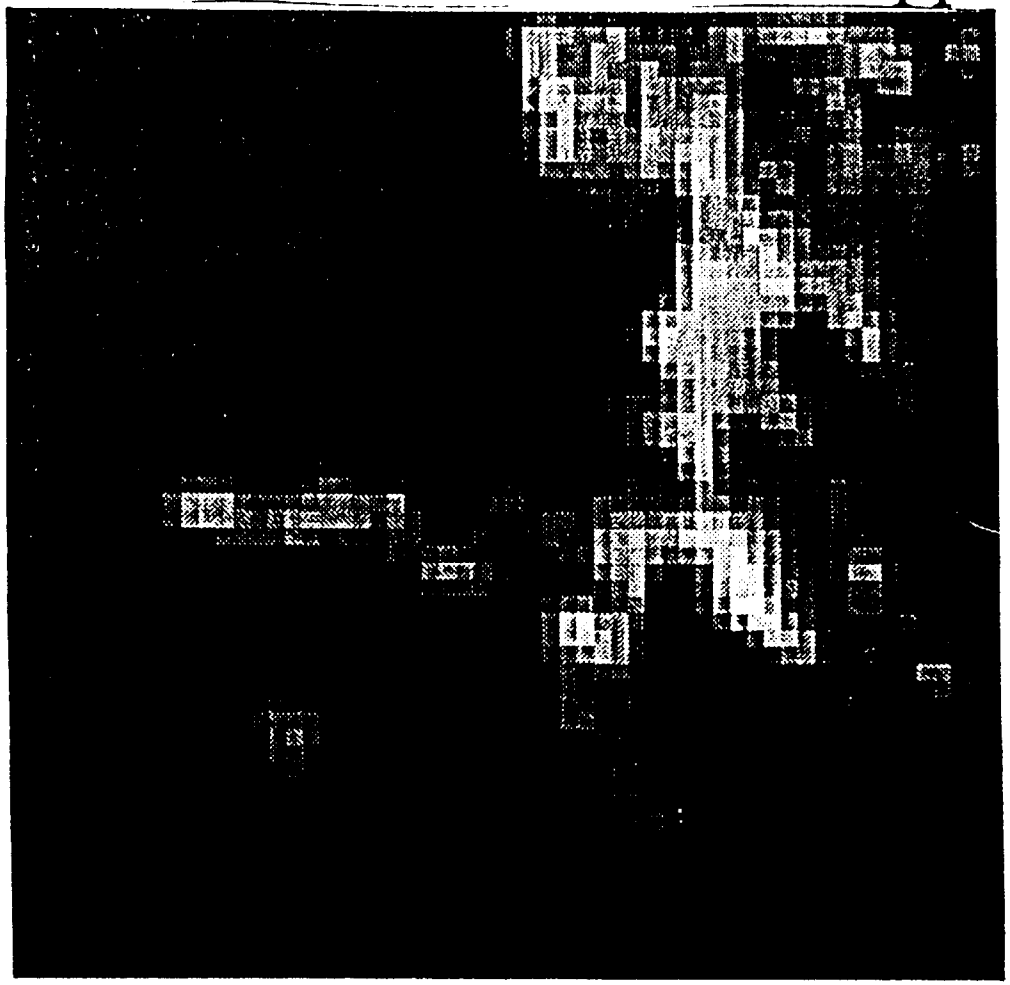
Reflectance = 0.10

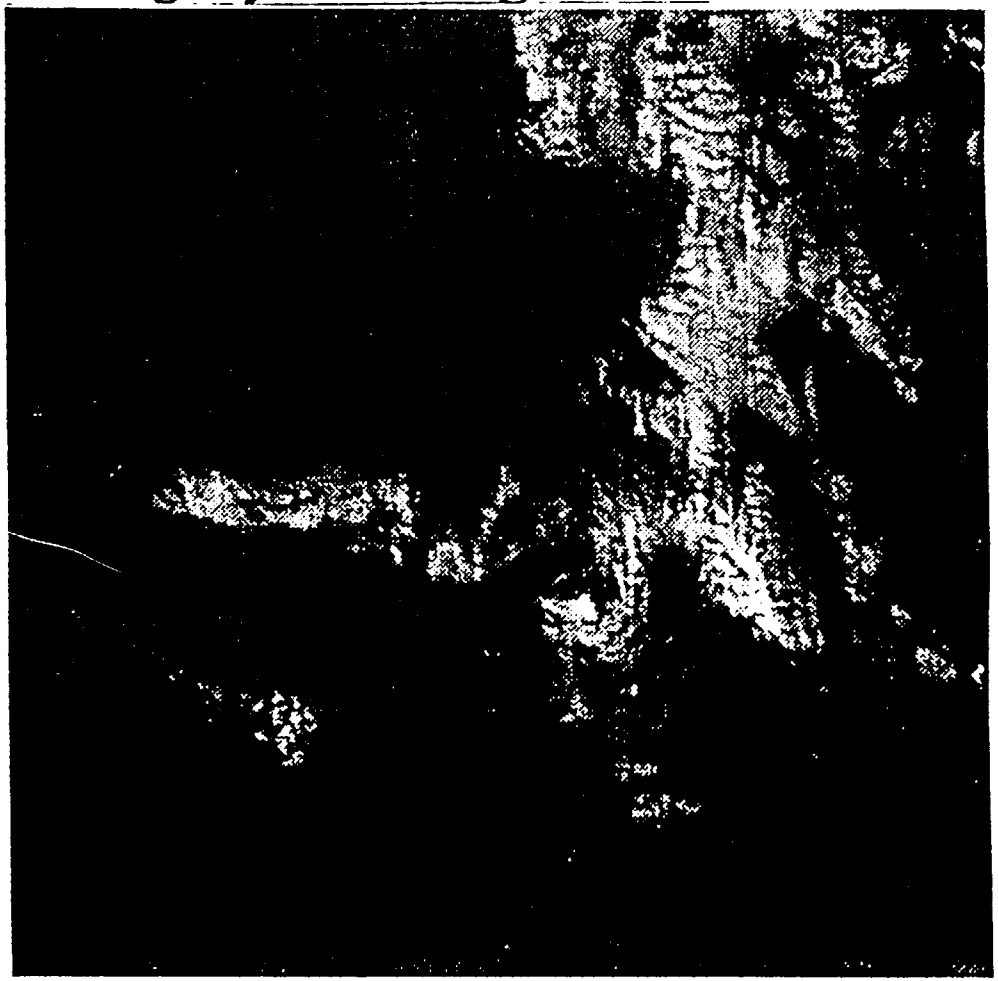
Radiance at Top of Atmosphere Derived from MCST Spreadsheet Model

Total, Reflected and Path



MODIS Simulation of 500m 1.6μm Band from Landsat Thematic Mapper Imagery of Chugach, Alaska





Simulated MODIS Band 6 (500m)
(1.640 ± 0.008 μm)

TM Band 5 (1.55 - 1.75 μm) (28.5m)

MODIS/MCST Feedback Sheet

on MODIS Calibration Handbook and MODIS Characterization/Calibration Plan

Questions ? **Concerns ?**

Suggestions ? **Actions for Next Meeting?**

Name: Date:

For E-mail correspondence address GSFCmail:JBarker or BGrant.
For updates on the latest events and available documents, CHECK MCST.BB bulletin board on GSFCmail.