MODIS
SCIENCE DATA SUPPORT TEAM PRESENTATION

June 26, 1992

AGENDA

ACTION ITEMS:

06/05/92 [Lloyd Carpenter] Update the Team Leader's Software and Data Management Plan. (An updated version was included in the handout and discussed at the meeting on 06/12/92.) STATUS: Open. Due Date: 07/10/92

06/05/92 [Lloyd Carpenter] Update the Team Leader's Science Computing Facility Plan. (An updated version will be discussed at the meeting, 06/26/92.) STATUS: Open. Due Date: 07/10/92

04/24/92 [J. J. Pan] Develop a detailed schedule for a typical algorithm integration into the Level-2 processing shell. (A detailed task list and schedule are included in the handout.) STATUS: Open. Due Date: 06/05/92

04/24/92 [Lloyd Carpenter & Team] Develop a staffing plan for the accomplishment of the tasks shown on the schedule. STATUS: Open. Due Date: 06/12/92

06/12/92 [Tom Goff] Develop separate detailed schedules using Microsoft Project for Level-1A and -1B software design and development. (Preliminary results were included in the handout and presented at the meeting on 06/19/92.) STATUS: Open. Due Date: 07/10/92

04/24/92 [Lloyd Carpenter] Develop a system for collecting time management data for the SDST effort. (An updated system is included in the handout.) STATUS: Open. Due Date: 06/26/92

MODIS Airborne Simulator status (Liam E. Gumley)

Progress up to 25 June 1992

(1) MAS ASTEX deployment

From 29 May to 23 June I participated in the MAS ASTEX (Atlantic Stratocumulus Transition Experiment) deployment on the Island of Terceira, Azores Islands, Portugal. The aircraft being used for this deployment is NASA ER-2 #709. At the time I departed, 10 ER-2 science flights had been completed, with another 3 to 4 flights expected in the last week of the deployment. Many of these flights were coordinated with satellite passes, as well as overflights of various combinations of other instrumented research aircraft.

The MAS generally performed well during all flights. The aircraft Exabyte recorder failed on 2 flights early in the mission and no data was recovered from these tapes. This problem was solved by pre-formatting the flight tapes prior to takeoff, and by having the pilot turn on the recorder just before the first flight line, rather than at takeoff. No further recorder failures were observed when this procedure was followed.

It was intended that the MAS Field Data System (FDS) developed in May would be used for examination of MAS data in the field. The software components of this system were used throughout the deployment, however the hardware components (PC, monitor, Exabyte) were held up in customs in Lisbon, and did not arrive at the field site until 19 June. The FDS software was run on borrowed hardware belonging to the GSFC CALS group, and was used successfully to characterize and assess the performance of the MAS, particularly the infrared channels. It was also possible to view the MAS image data in a "quick-look" mode using a system by developed by Ted Hildum at Ames for the EO Camera. This allowed viewing of the 6 most significant bits of each of the image channels, and was used to detect saturation in the MAS visible/near-IR channels. When the FDS hardware arrived on 19 June, it was found that the PC would not boot, and could not be repaired easily in the field. The FDS Exabyte drive was then attached to a PC borrowed from the Ames Sensor Shop crew, and was used to characterize the behavior of the MAS IR channels as the aircraft went from ground level to cruise altitude on 8 June 92. The "scavenged" FDS was fully functional at the time I departed, and was being used by Tom Arnold (GSFC) to continue to monitor the performance of the MAS.

(2) MAS performance during ASTEX

Several MAS performance issues were addressed in the field. Most of these related to changes which were made to the instrument at Daedalus just before the deployment. The items of interest were:

- (a) saturation and clipping effects in the visible and near-IR channels,
- (b) temperature range and sensitivity of the IR channels,
- (c) temperature stability of the IR channels,
- (d) noise estimates in all channels,
- (e) performance of the new 13.186 and 13.952 micron channels.

Assessment of the visible and near-IR channels was done using the system developed by Ted Hildum, which showed areas where the data was saturating (i.e. at maximum count level) or clipping (saturating at less than the maximum count level). Adjustments were consequently made in the field to several of these channels, particularly channel 2, which showed clipping at around 160 counts. Examination of subsequent data showed that most of these problems had been eliminated, except for some saturation over very bright cloud features.

The temperature range and sensitivity of the MAS IR channels was examined using the FDS software, as well as some additional software written by myself in the field. It was possible to view the MAS IR imagery on the Ted Hildum system, but to extract the engineering data required for calibration, the FDS software was required. It was necessary to check that the gain and offset for each infrared channel was set to give the appropriate temperature range and sensitivity. The following table was the first analysis performed on the data from 8 June 1992.

```
Date             : 08 June 1992
Time:            : 1300 - 1302 UTC
Number of lines  : 735
BB1 Temp.        : -26.3 C
BB2 Temp.        :  26.3 C
```

MAS Chan	Center Wavelength	# of Bits	BB1 cnt	BB2 cnt	dR/dC	dR/dC (noise)	SNR	Tmin (K)	Tmax (K)
07	3.725 um	8	80	130	0.0108	0.0008	13.5	229.12	331.84
08	13.952 um	8	80	150	1.0915	0.2	5.5	161.50	332.60
09	8.563 um	10	260	650	0.1246	0.004	31.2	140.99	330.87
10	11.002 um	10	270	650	0.1841	0.005	36.8	121.39	336.90
11	13.186 um	10	220	670	0.1694	0.020	8.5	179.91	344.56
12	12.032 um	10	180	800	0.1196	0.005	25.0	226.00	316.22

dR/dC = milliWatts per square meter per steradian per wavenumber per count

The most immediate concern raised was the apparently low signal to noise ratio (SNR) in the 13 micron channels. This was also evident from examination of the imagery in these channels, which showed that they were dominated by what appeared to be random striping and coherent 400 Hz noise. This deployment is the first where the 13 micron channels have been used, and thus their inflight characteristics had never been previously examined. In contrast, the other 4 IR channels were performing quite normally, with temperature ranges at about the right settings.

This information was relayed to Chris Moeller at Wisconsin, who agreed that channels 9, 10 and 12 were performing well. He suggested that lowering the maximum temperature in channel 7 would be of benefit since it would increase the temperature sensitivity at cooler temperatures. This would however be at the expense of lowering the maximum temperature detectable in channel 7, which is subject to the influence of reflected solar radiation at 3.7 microns. Examination of the data from 8 June 1992 had shown cloud features in channel 7 at temperatures of 316 K so it was decided not to change the gain settings in channel 7.

Of the two 13 micron channels, the 13.952 micron channel (ch 08) was the noisiest, and appeared to show very little signal or structure due to cloud features. Based on the sensitivity information shown above, it was decided to adjust the gain and offset in channel 8 to improve the sensitivity. Some code was developed in the field which allowed the appropriate ground settings to be determined, and these were used for the flight on 17 June 1992. A comparison of the resulting data is shown in the following table.

MAS Chan	Center Wavelength	# of Bits	dR/dC (06/08/92)	dR/dC (06/17/92)	Tmin (06/08/92)	Tmax (06/08/92)	Tmin (06/17/92)	Tmax (06/17/92)
07	3.725 um	8	0.0108	0.0110	229	330	229	332
08	13.952 um	8	1.0915	0.7817	124	357	162	333
09	8.563 um	10	0.1246	0.1263	141	329	141	331
10	11.002 um	10	0.1841	0.1873	121	335	121	337
11	13.186 um	10	0.1694	0.2116	206	331	180	345
12	12.032 um	10	0.1196	0.1220	224	314	226	316

Notes:

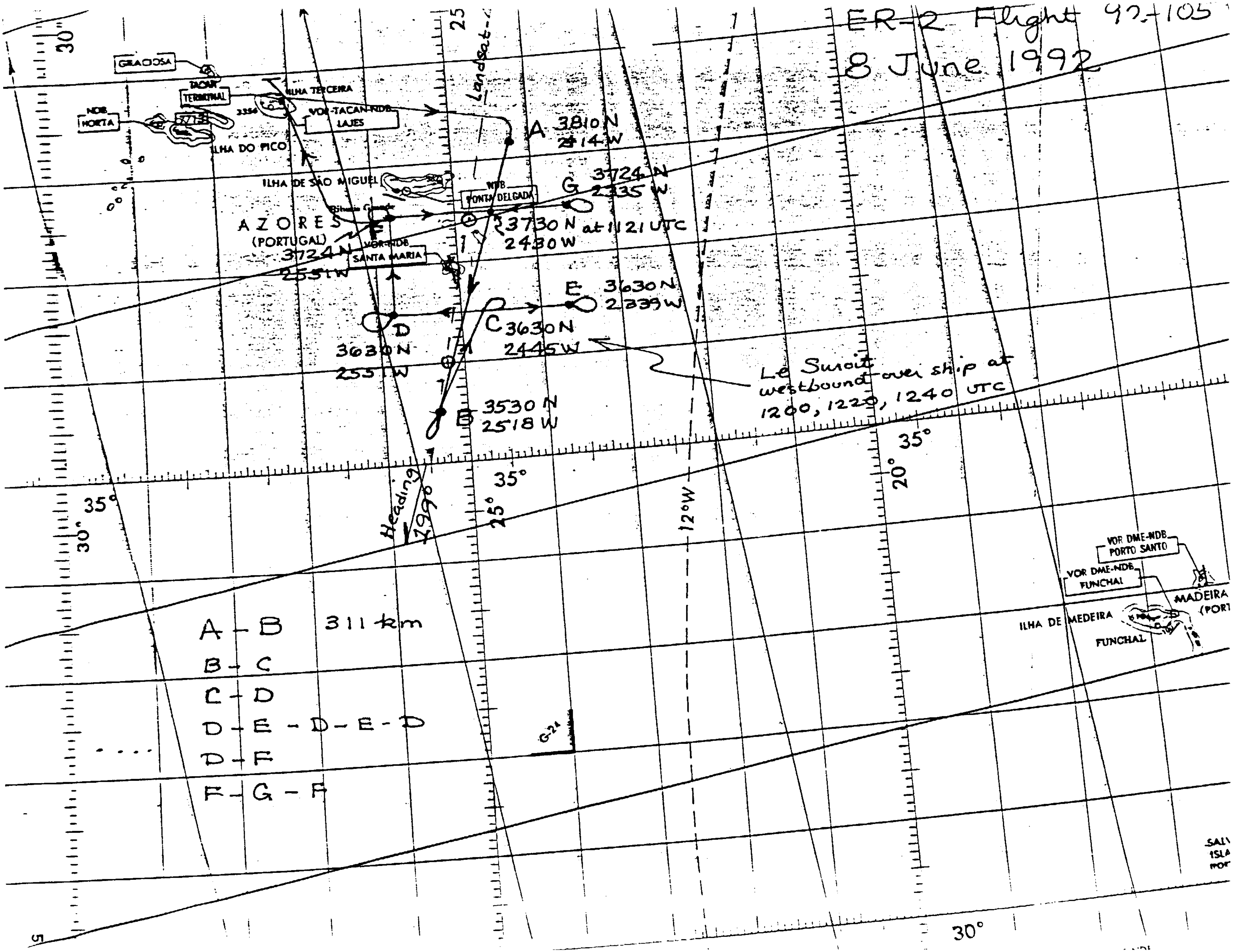
(1) Compiled from average over 735 lines on 06/08, and 990 lines on 06/17. Only blackbody counts and temperatures were used.
(2) Gain and offset were adjusted in channel 8 before 06/17 flight.
(3) Sensitivity in channel 7 at cooler temperatures could be improved at expense of lowering maximum temperature. Bright clouds at 316K have been observed in channel 7 flight data.
(4) Channels 8 and 11 are very noisy - signal is dominated by random striping and apparent 400 Hz coherent noise.

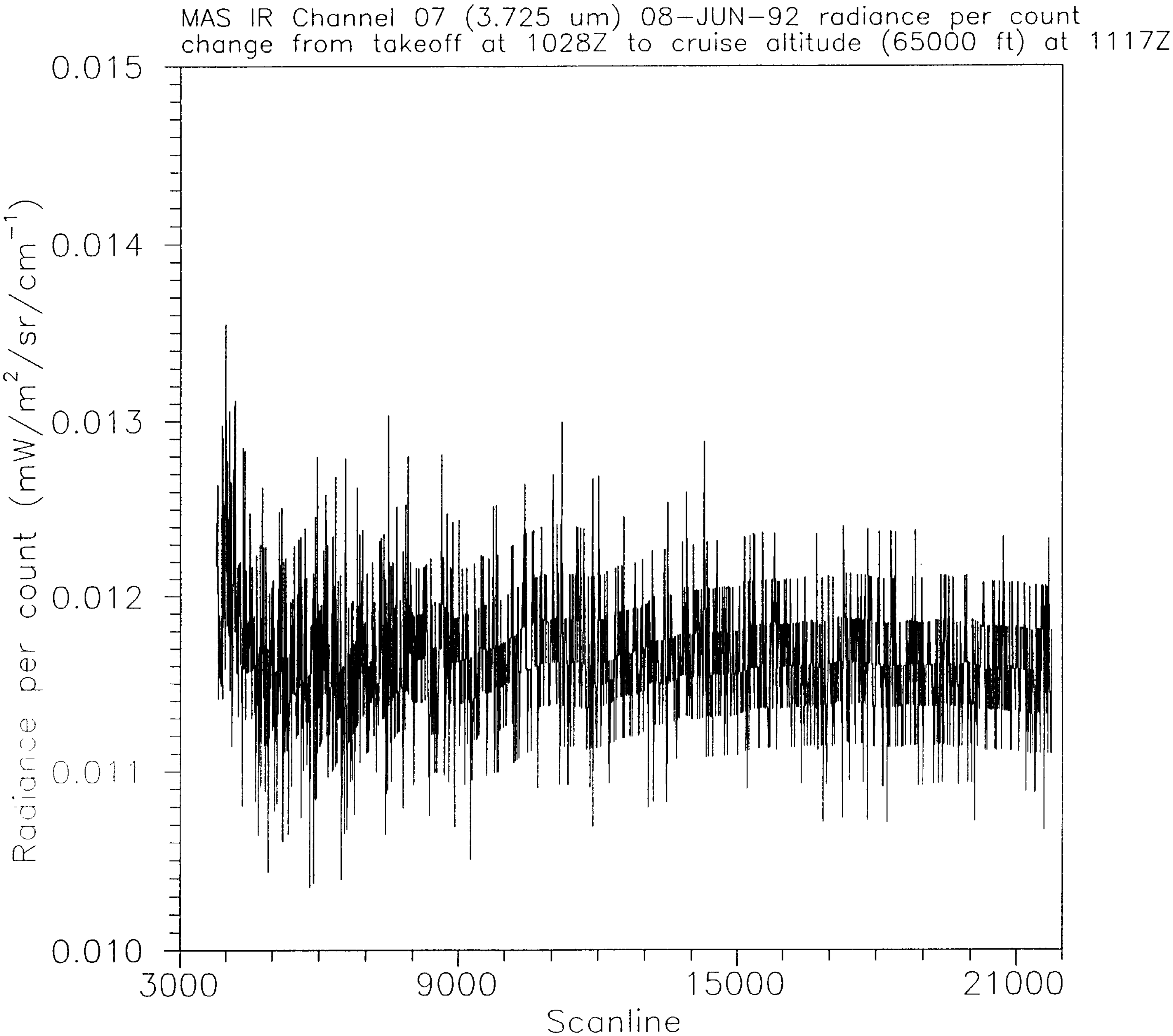
The numbers shown for channels 7, 9, 10 and 12 for both days are very similar. The sensitivity in channel 8 has increased noticeably, with a corresponding increase in temperature sensitivity. However, examination of the image data showed that channel 8 was as noisy as previously seen. It is intended that Daedalus will make some modifications to the 13 micron channels before the next deployment to improve their performance, as they are needed for cloud top temperature and height determination.

Noise estimates were done visually using both the Ted Hildum system and the borrowed FDS hardware. Initial examination of the data using the Hildum system showed surprisingly clean imagery in all channels (except the 13 micron channels). It was initially thought that most of the problems previously seen in the IR channels (400 Hz and striping) had been eliminated. However it was then discovered that this system only displays the most significant 6 bits of each pixel. Examination of the full 8 and 10 bit data using the FDS software showed that 400 Hz and striping noise were still apparent in all the IR channels, but that the visible/near-IR channels were as clean as usual.

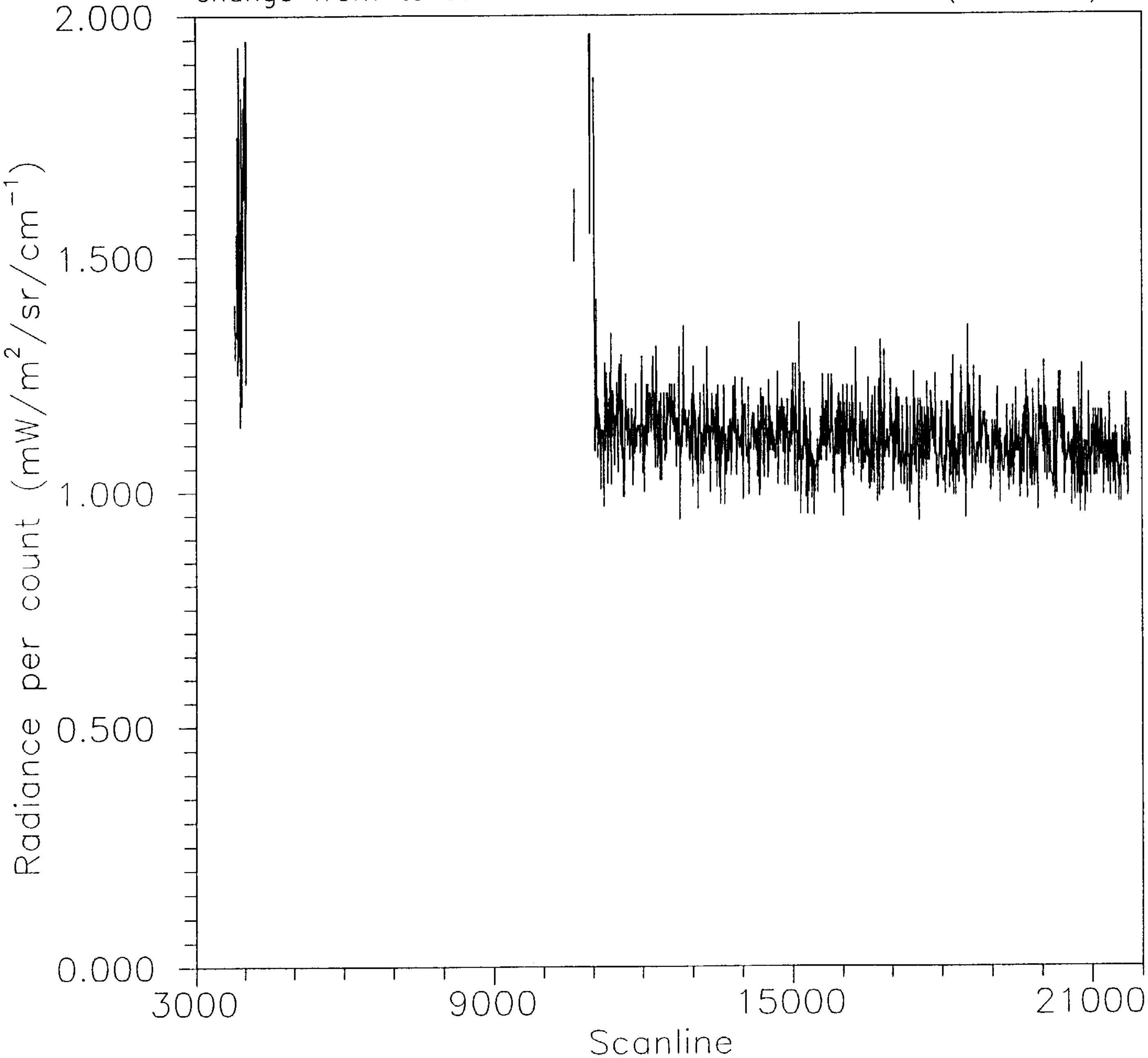
Once the FDS Exabyte arrived, it was connected to an Ames PC with a large hard disk. This enabled the extraction of a large enough data segment to examine the MAS IR channel performance from takeoff to cruising altitude. This has been a major concern in the past, since the gain and offset in all channels must be set on the ground. The flight on 8 June 1992 was examined, and every 10th line in the IR channels was calibrated and the results plotted. The plots appear to show increases in sensitivity in all channels, except for channel 7 which remains quite stable. However the magnitude of the changes are small enough to be of relatively minor concern.

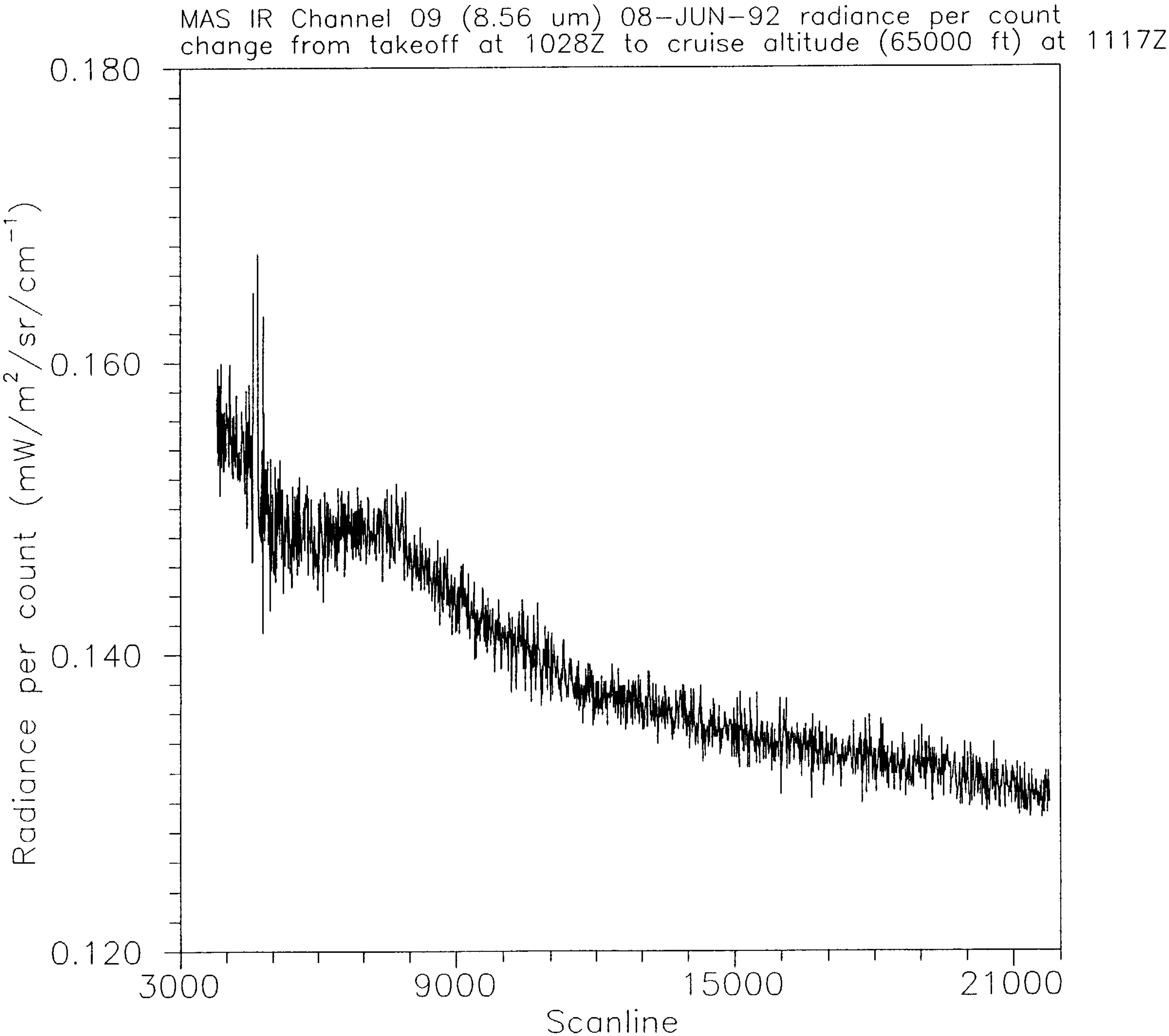
In summary, the performance of the MAS in the field was tested as thoroughly as possible and found to be generally within acceptable limits.


ER-2 Flight 92-105
8 June 1992
GRACIOSA
TACAN TERMINAL
ILHA TERCEIRA
NDB HORTA
VOR-TACAN-NDB LAJES
ILHA DO PICO
ILHA DE SÃO MIGUEL
NDB PONTA DELGADA
AZORES
(PORTUGAL)
VOR-NDB SANTA MARIA
Landsat-2
A 3810 N 2414 W
G 3724 N 2335 W
3730 N at 1121 UTC 2430 W
3724 N 2551 W
E 3630 N 2239 W
C 3630 N 2445 W
D 3630 N 2551 W
B 3530 N 2518 W
Le Suroit westbound over ship at 1200, 1220, 1240 UTC
Heading 199°
35°
30°
25°
20°
12°W
G-24
VOR DME-NDB PORTO SANTO
VOR DME-NDB FUNCHAL
MADEIRA
ILHA DE MEDEIRA
FUNCHAL
A - B 311 km
B - C
C - D
D - E - D - E - D
D - F
F - G - F

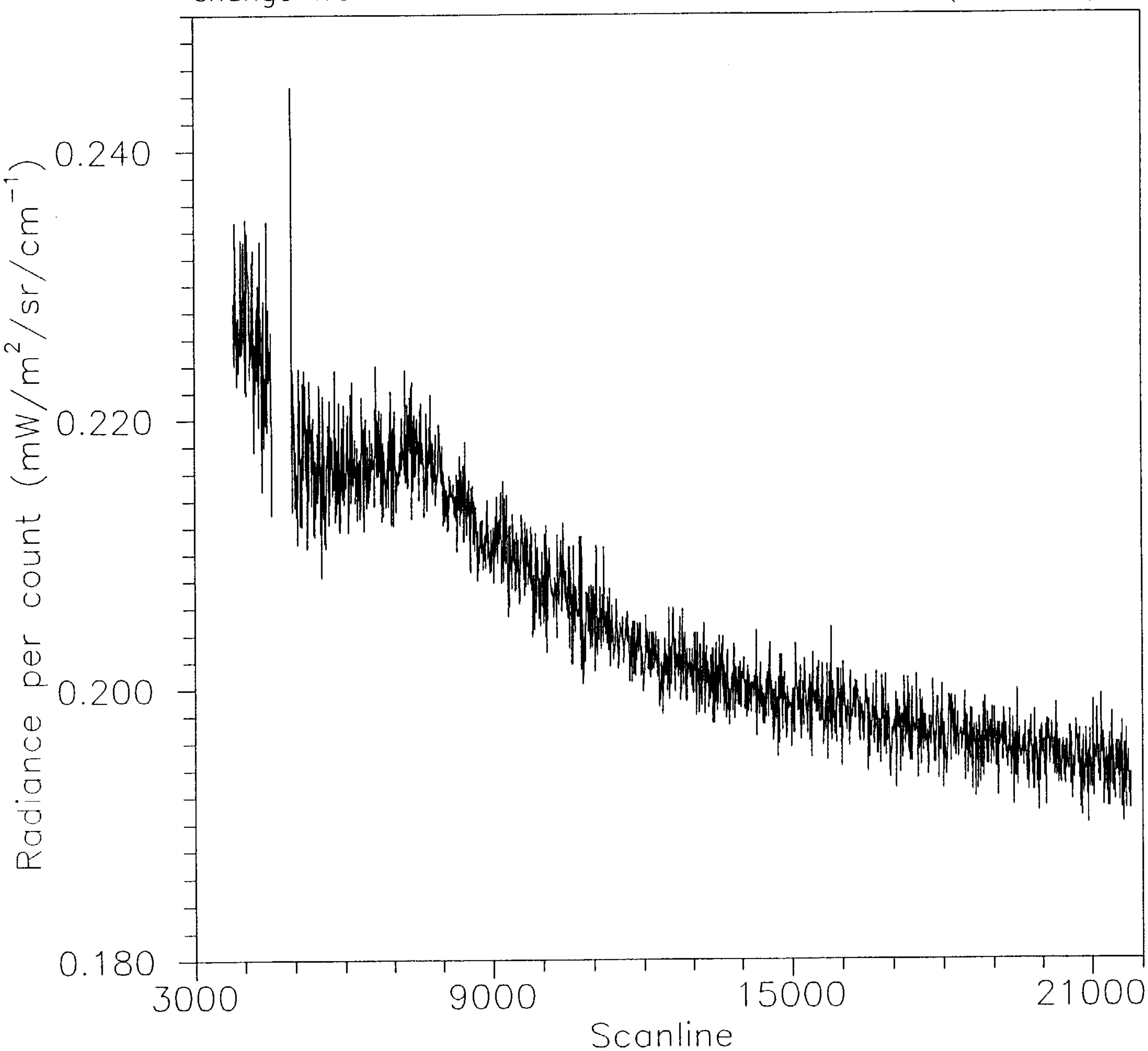

MAS IR Channel 07 (3.725 um) 08-JUN-92 radiance per count
change from takeoff at 1028Z to cruise altitude (65000 ft) at 1117Z
Radiance per count (mW/m²/sr/cm⁻¹)
0.015
0.014
0.013
0.012
0.011
0.010
3000
9000
15000
21000
Scanline

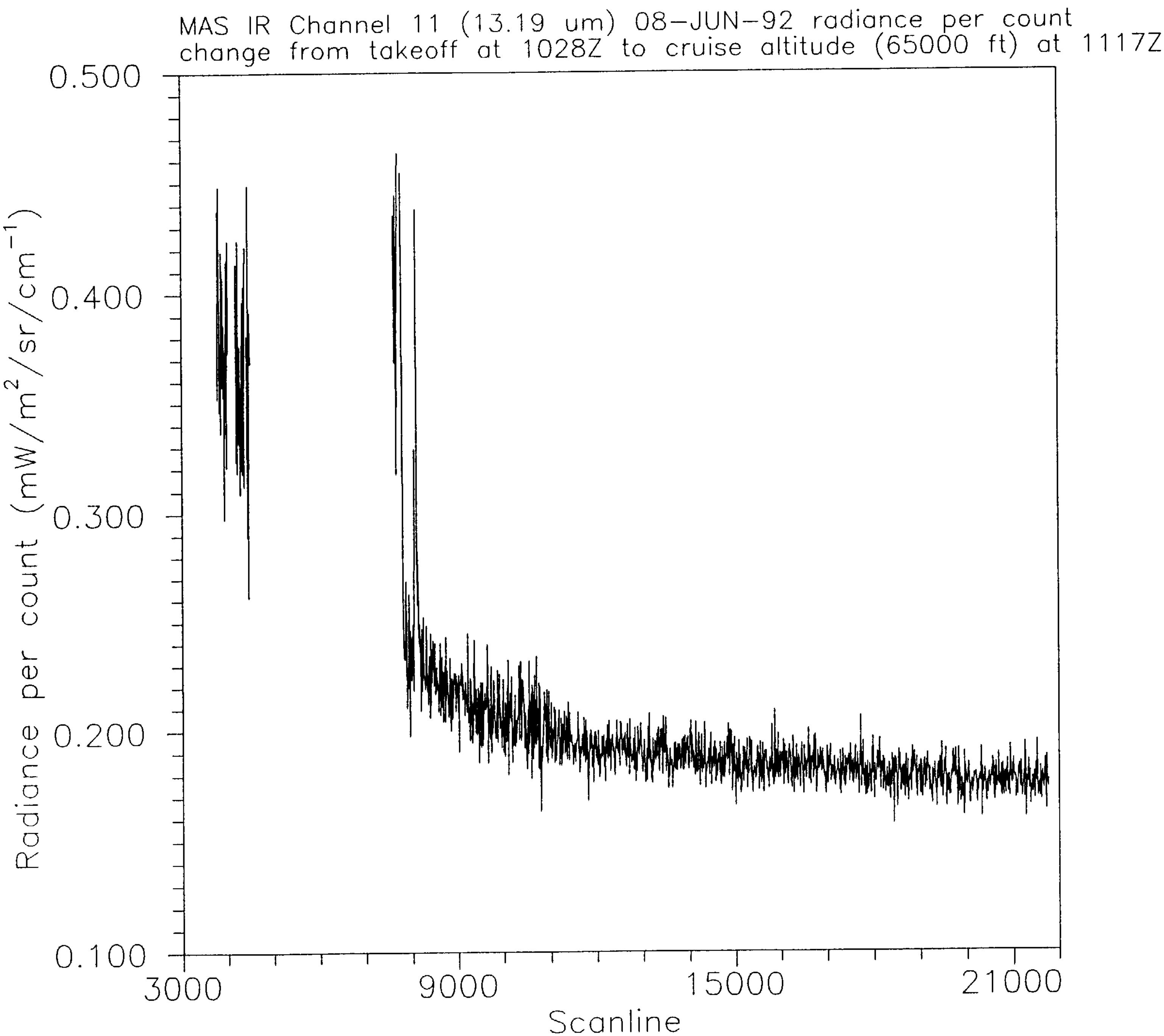
MAS IR Channel 08 (13.95 um) 08-JUN-92 radiance per count
change from takeoff at 1028Z to cruise altitude (65000 ft) at 1117Z



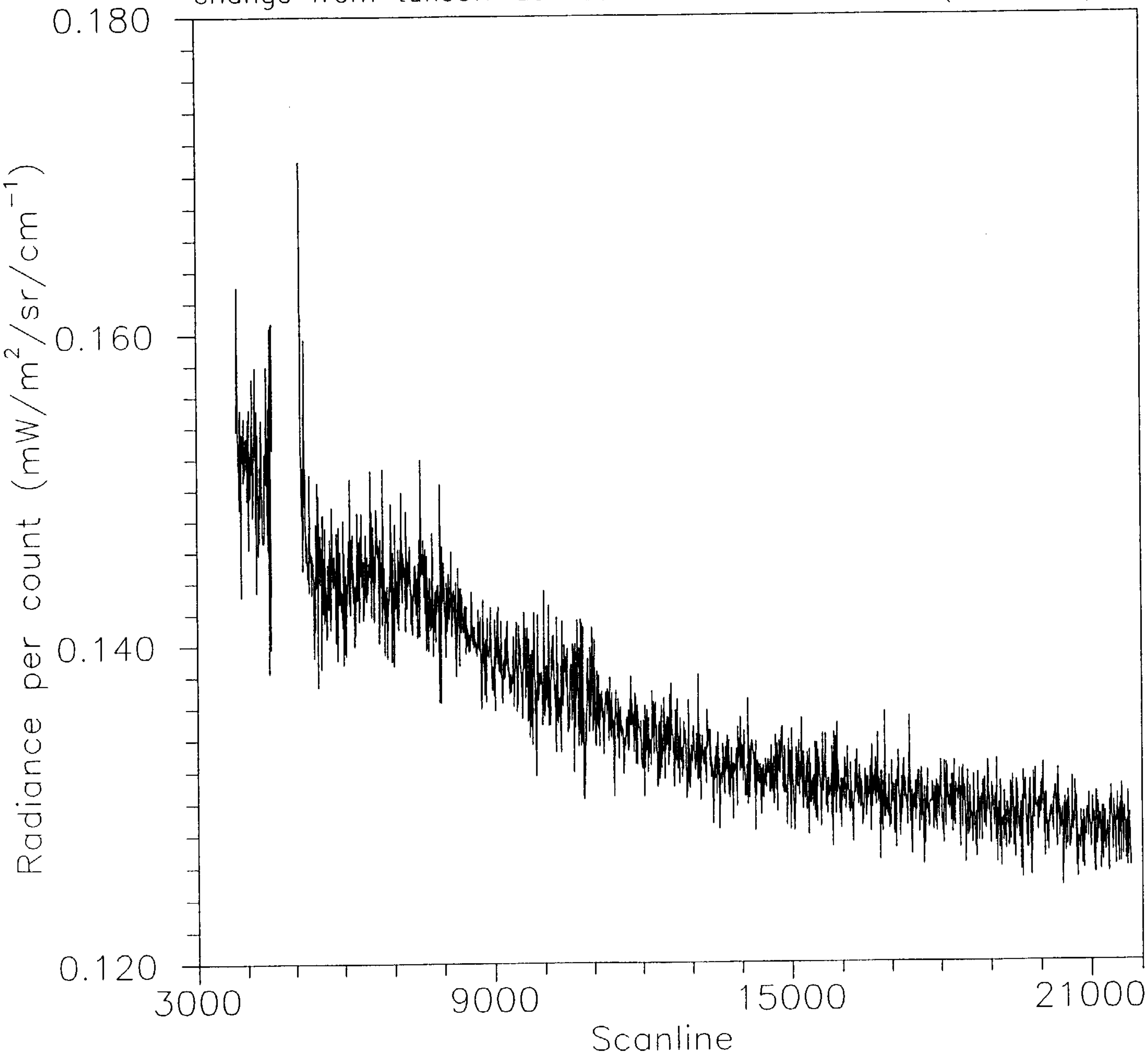

MAS IR Channel 09 (8.56 um) 08-JUN-92 radiance per count
change from takeoff at 1028Z to cruise altitude (65000 ft) at 1117Z
Radiance per count (mW/m²/sr/cm⁻¹)
0.180
0.160
0.140
0.120
3000
9000
15000
21000
Scanline

MAS IR Channel 10 (11.00 um) 08–JUN–92 radiance per count
change from takeoff at 1028Z to cruise altitude (65000 ft) at 1117Z




MAS IR Channel 11 (13.19 um) 08–JUN–92 radiance per count
change from takeoff at 1028Z to cruise altitude (65000 ft) at 1117Z
0.500
0.400
0.300
0.200
0.100
Radiance per count (mW/m2/sr/cm-1)
3000
9000
15000
21000
Scanline

MAS IR Channel 12 (12.03 um) 08-JUN-92 radiance per count
change from takeoff at 1028Z to cruise altitude (65000 ft) at 1117Z



The Log of the MODIS Level-2 Processing Shell Design

J. J. Pan
Research and Data Systems Corp.
(301) 982-3700

Date: June 19 - June 25, 1992

6/19 1. Received response from Dr. Krupp and updated the I/O data numbers of the algorithm 533. There was no error from duplication and dependency after checking with the ALGOCHK toolkit.

6/22-24 2. Revised the detailed schedule for a typical algorithm integration in level-2 processing shell using the Microsoft Project.

6/23 3. Attended QA Fortran and QA C demo. at NASA/GSFC.

6/24-6/25 4. Updated the diagrams of algorithms dependencies in level-2 processing. Currently these diagrams only emphasized the data which will be used by more than one algorithm. Several days more are required to check the accuracy of these dependencies.

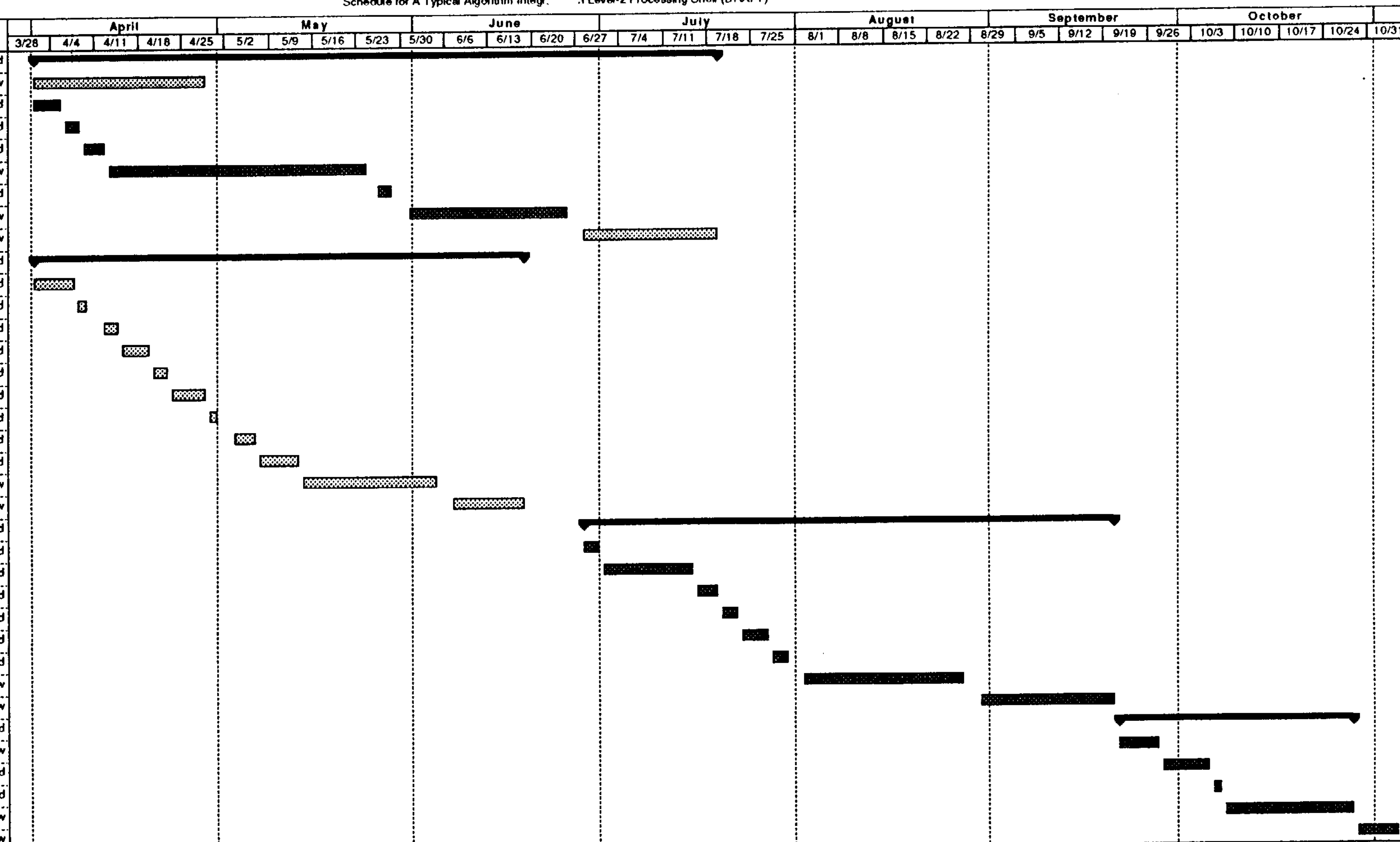
5. These diagrams provided some useful information in determining system requirements and specifications, data flow control, and the shell design. However, these diagrams will be revised again if the input/output data of TM algorithms are changed.
6. These diagrams will be updated using MacDraw.

Schedule for A Typical Algorithm Integration in Level-2 Processing Shell (DRAFT)

ID	Name	Duration	Scheduled Start	Scheduled Finish	Predecessors
1	L-2 Shell Prototype Develop.	109.38ed	4/1/93 8:00am	7/19/93 5:00pm	
2	PGS tools usage	4w	4/1/93 8:00am	4/28/93 5:00pm	
3	TM algorithms dependency	3d	4/1/93 8:00am	4/5/93 5:00pm	
4	"Common" data manipulation	3d	4/6/93 8:00am	4/8/93 5:00pm	3
5	Data flow control	2d	4/9/93 8:00am	4/12/93 5:00pm	4
6	Shell source code develop.	6w	4/13/93 8:00am	5/24/93 5:00pm	5
7	Simulation of code linking	3d	5/26/93 8:00am	5/28/93 5:00pm	6
8	Shell source code revision	4w	5/31/93 8:00am	6/25/93 5:00pm	7
9	Doucment/Report	2w	6/28/93 8:00am	7/19/93 5:00pm	8
10	TM Code Test	78.38ed	4/1/93 8:00am	6/18/93 5:00pm	
11	Overview of available code	5d	4/1/93 8:00am	4/7/93 5:00pm	
12	Selection of a typical algor.	2d	4/8/93 8:00am	4/9/93 5:00pm	11
13	Required tools checking	3d	4/12/93 8:00am	4/14/93 5:00pm	12
14	The algorithm installation	3d	4/15/93 8:00am	4/19/93 5:00pm	13
15	Code compiling/linking	3d	4/20/93 8:00am	4/22/93 5:00pm	14
16	Test using provided data	4d	4/23/93 8:00am	4/28/93 5:00pm	15
17	Test results checking	2d	4/29/93 8:00am	4/30/93 5:00pm	16
18	Test using invalid data	4d	5/3/93 8:00am	5/6/93 5:00pm	17
19	Code revision with TM	5d	5/7/93 8:00am	5/13/93 5:00pm	18
20	Iteration of 16-19	3w	5/14/93 8:00am	6/4/93 5:00pm	19
21	Document/Report	2w	6/7/93 8:00am	6/18/93 5:00pm	20
22	Shell and Algor. Integration	84.38ed	6/28/93 8:00am	9/20/93 5:00pm	
23	Test plan design	3d	6/28/93 8:00am	6/30/93 5:00pm	8
24	Modi. of shell/algo. with TM	5d	7/1/93 8:00am	7/15/93 5:00pm	23
25	Makefile for integration	2d	7/16/93 8:00am	7/19/93 5:00pm	24
26	Test using provided data	3d	7/20/93 8:00am	7/22/93 5:00pm	25
27	Test using invalid data	3d	7/23/93 8:00am	7/27/93 5:00pm	26
28	Shell revision	3d	7/28/93 8:00am	7/30/93 5:00pm	27
29	Iteration of 26-28	4w	8/2/93 8:00am	8/27/93 5:00pm	28
30	Document/Report	3w	8/30/93 8:00am	9/20/93 5:00pm	29
31	End-to-End Test	37.38ed	9/21/93 8:00am	10/28/93 5:00pm	
32	Installation on PGS	1w	9/21/93 8:00am	9/27/93 5:00pm	30
33	Test of simulated data	6d	9/28/93 8:00am	10/5/93 5:00pm	32
34	Evaluation of test results	2d	10/6/93 8:00am	10/7/93 5:00pm	33
35	Correction and retesting	3w	10/8/93 8:00am	10/28/93 5:00pm	34
36	Overview of the Integration	1w	10/29/93 8:00am	11/4/93 5:00pm	35

Schedule for A Typical Algorithm Integr. ... Level-2 Processing Shell (DRAFT)

ID	Name	Duration
1	L-2 Shell Prototype Develop.	109.38ed
2	PGS tools usage	4w
3	TM algorithms dependency	3d
4	"Common" data manipulation	3d
5	Data flow control	2d
6	Shell source code develop.	6w
7	Simulation of code linking	3d
8	Shell source code revision	4w
9	Doucment/Report	2w
10	TM Code Test	78.38ed
11	Overview of available code	5d
12	Selection of a typical algor.	2d
13	Required tools checking	3d
14	The algorithm installation	3d
15	Code compiling/linking	3d
16	Test using provided data	4d
17	Test results checking	2d
18	Test using invalid data	4d
19	Code revision with TM	5d
20	Iteration of 16-19	3w
21	Document/Report	2w
22	Shell and Algor. Integration	84.38ed
23	Test plan design	3d
24	Modi. of shell/algo. with TM	5d
25	Makefile for integration	2d
26	Test using provided data	3d
27	Test using invalid data	3d
28	Shell revision	3d
29	Iteration of 26-28	4w
30	Document/Report	3w
31	End-to-End Test	37.38ed
32	Installation on PGS	1w
33	Test of simulated data	6d
34	Evaluation of test results	2d
35	Correction and retesting	3w
36	Overview of the Integration	1w

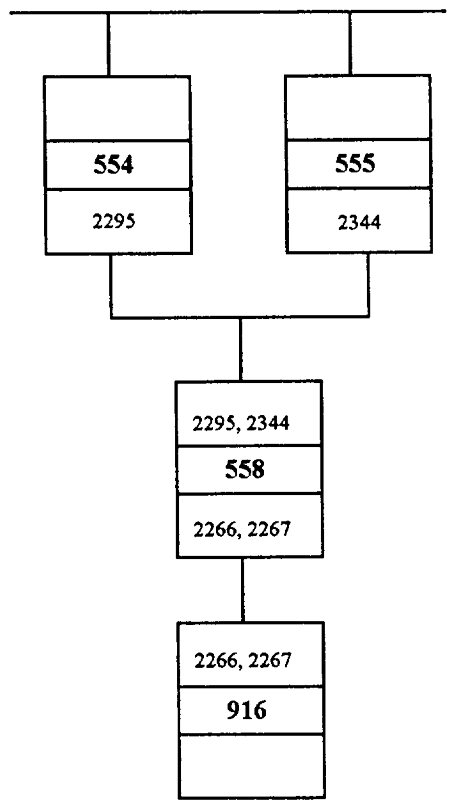


Project: A Typical Algo. Integrat.
Date: 6/25/92

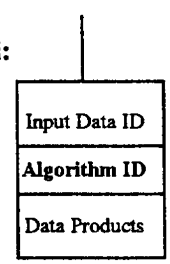
Critical — Noncritical — Progress — Milestone ◆ — Summary

MODIS/SDST/J.J.PAN

Algorithms Dependency in Level-2 Processing (Part 1)

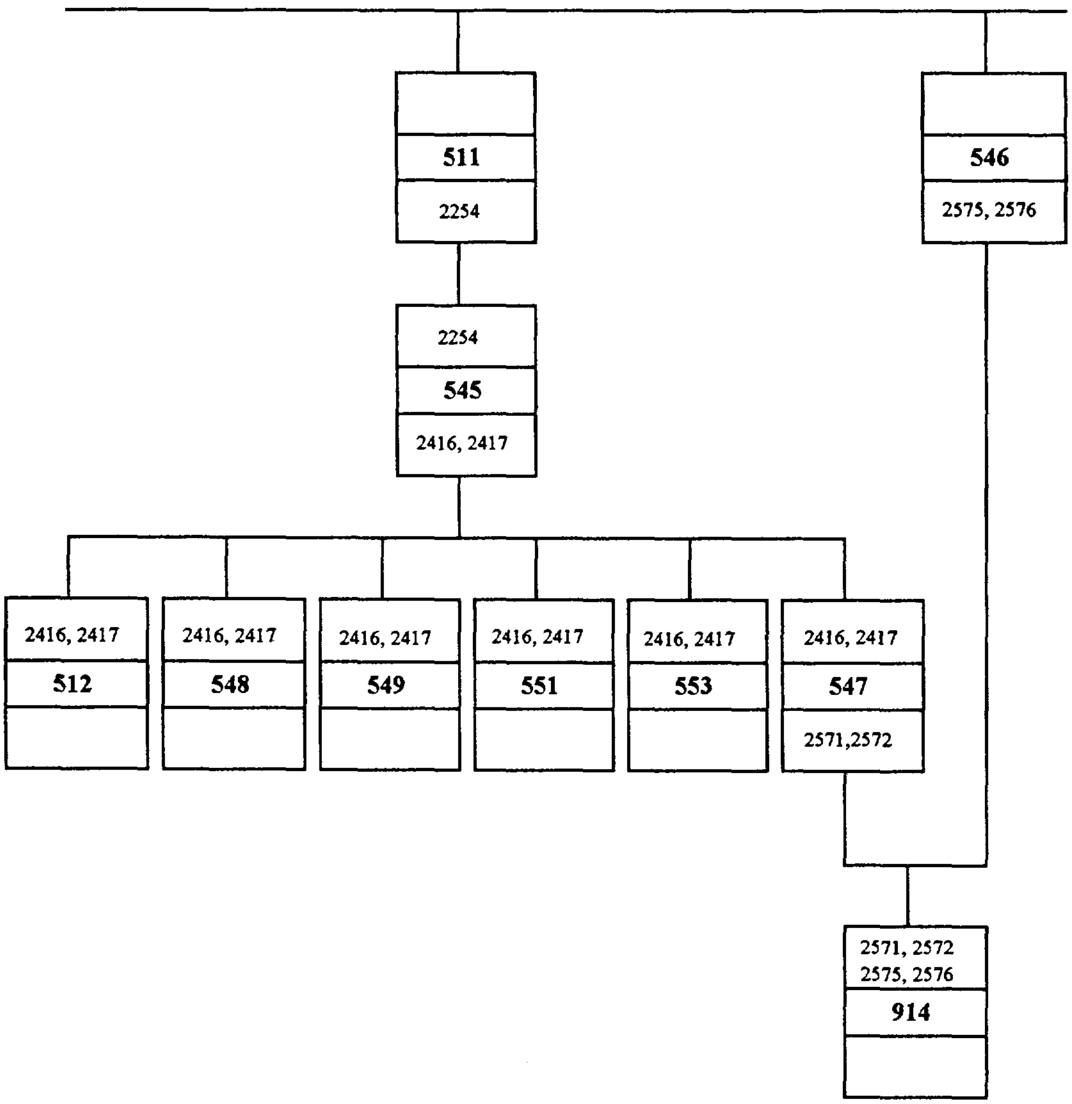


Legend:

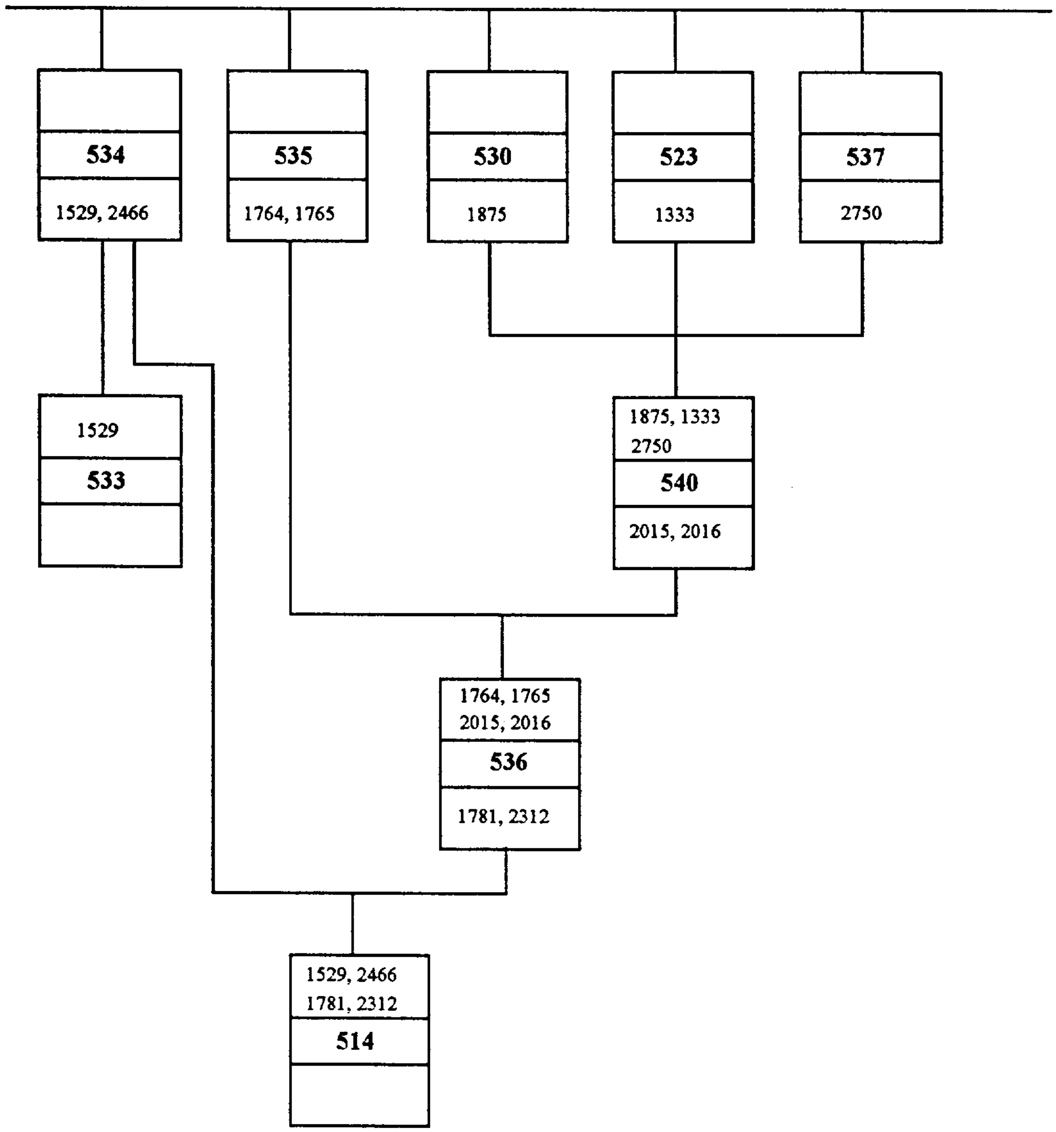


This diagram only emphasizes the data which will be used by more than one algorithm.
(The Level-1A & 1B data are stored in a "common" block.)

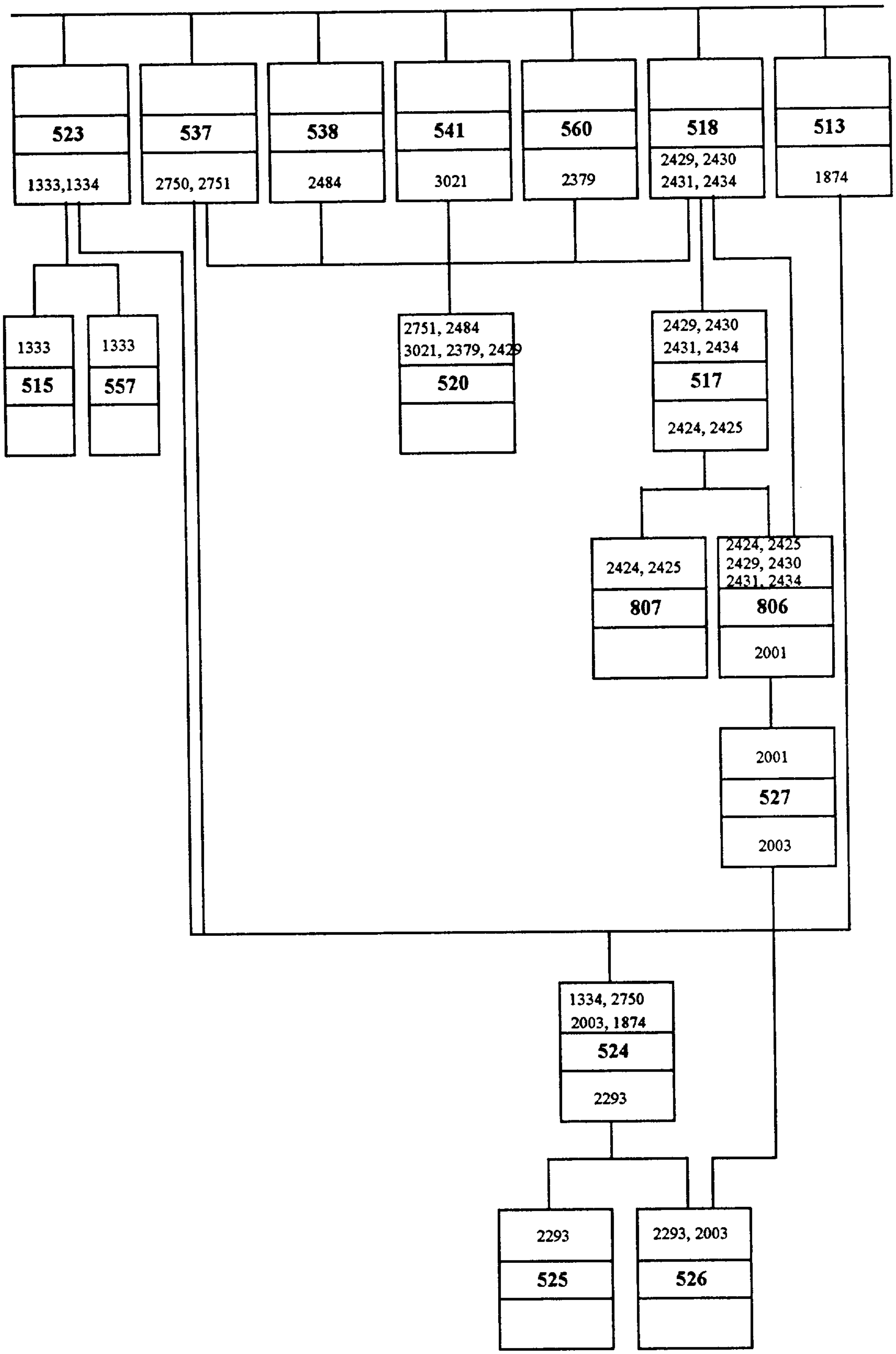
Algorithms Dependency in Level-2 Processing (Part 2)



Algorithms Dependency in Level-2 Processing (Part 3A)



Algorithms Dependency in Level-2 Processing (Part 3B)



MODIS SDST Time Record (Weekly)

Third Quarter, 1992

Name: ______________________________

	July 1992					August 1992				September 1992			
Week Ending	Fri 3	Fri 10	Fri 17	Fri 24	Fri 31	Fri 7	Fri 14	Fri 21	Fri 28	Fri 4	Fri 11	Fri 18	Fri 25
Level-1 Development													
Level-2, 3 and 4													
MAS Processing													
Plans and Documentation													
Project Interaction													
Management													
Training													
Meetings													
Non MODIS													

MODIS SDST Time Record (Daily)

Name:______________________________

	June 1992		July 1992									
	Mon 29	Tue 30	Wed 1	Thu 2	Fri H		Mon 6	Tue 7	Wed 8	Thu 9	Fri 10	
Level-1 Development												
Level-2, 3 and 4												
MAS Processing												
Plans and Documentation												
Project Interaction												
Management												
Training												
Meetings												
Non MODIS												

MODIS TEAM LEADER COMPUTING FACILITY (TLCF) PLAN

DRAFT

Table of Contents

DRAFT

MODIS TEAM LEADER COMPUTING FACILITY (TLCF) PLAN

1.0 INTRODUCTION

The MODerate-resolution Imaging Spectroradiometer (MODIS) is a passive Earth-radiation sensor scheduled for launch on the Earth Observing System (EOS) orbiting platform in 1998. MODIS senses reflected solar radiation during daylight hours and Earth-emitted thermal radiation (infrared) continuously (day and night).

Science products for the MODIS instrument will be developed and validated by a team of twenty-four Earth scientists selected for their expertise in instrument calibration, atmospheric science, ocean science, and land science. Since the team members were chosen for their scientific expertise, the team includes members with varying interests and abilities in data system implementation. To accommodate the individual differences, the MODIS Team Leader is allowing the science team members to themselves specify the extent to which they will develop the software they deliver to the project. Some team members may deliver prototype code that runs on the scientists home computing facility, and others may deliver full-up code, ready for operational use on the designated high-speed processing facilities.

Some required MODIS processing tasks are not included in any Science Team Member's domain of interest (e.g., basic MODIS Level-1 instrument data processing). To develop code to support this and to assist in porting scientist's code to operational data production facilities, the MODIS Team Leader has designated a software support group called the MODIS Science Data Support Team (SDST). The MODIS Team Leader Computing Facility (TLCF) is designed to provide the required computer support for the Team Leader. This document describes the functions to be performed by the TLCF, the required interfaces between the TLCF and other MODIS and EOS data groups, and the specific hardware needed to support near-term TLCF activities. This document presents an evolutionary approach to TLCF development, and it contains a functional description of the TLCF at each of several proposed phases of evolution.

In the near-term, the TLCF will support MODIS Level-1A and Level-1B algorithm development, development of the Level-2 Processing Shell, integration of Team Members Level-2 algorithms, CASE Tools, code checkers, and optimization tools. These tools will be made available to the Team Members. As the launch date approaches, the TLCF will support generation of simulated data, prototyping, development of test cases, testing at all levels, software optimization, configuration management, and any MODIS Team Member tasks which are too large to be done on the Team Member facilities. In the post-launch era, the TLCF will continue the previous support in addition to supporting algorithm updating, refinement or replacement, the generation of special products, and quality assurance of products.

Individual MODIS Science Team Members will have Science Computing Facilities (SCF) in their laboratories for the development, testing and refinement of their algorithms, for the validation and quality assurance of their data products, and for the generation of Special Data Products (research products not scheduled for routine production). The SCF configuration will vary between Team Members according to their individual requirements.

The ocean science members of the MODIS Science Team have joined together to form the MODIS Oceans Team for coordination of their research. A special computing facility called the MODIS Oceans Team Computing Facility (MOTCF) is established at the University of Miami for supporting the coordinated development, testing and refinement of the oceans science algorithms, and for validation, quality assurance, and special product generation for the Oceans Team. The MODIS Oceans Team will provide a description of the MOTCF.

The SDST will integrate and optimize Team Member's code for the EOSDIS Core System, but the Team Members are responsible for coding their algorithms, and they retain responsibility for their algorithms throughout the lifetime of the MODIS experiment.

2.0 THE TEAM LEADER COMPUTING FACILITY (TLCF) ENVIRONMENT

The overall data system that supports the EOS program is called the EOS Data and Information System (EOSDIS). The EOSDIS includes data communications components that handle data transfer to and from the platform as well as other components that generate the commands to be transferred to the platform and interpret the data received from the platform. Instrument command generation and the scientific interpretation, storage, and distribution of EOS data will be done in a subset of the EOSDIS called the EOSDIS Core System (ECS). See Figure 1. The ECS provides an Instrument Command Center (ICC) for each individual instrument. Operational processing of instrument data to generate Earth-science products will be done in a sub-facility of the ECS called the Product Generation System (PGS), and storage and distribution of data will be done in another facility called the Data Archive and Distribution System (DADS). The data user interface to the DADS is handled by the Information Management System (IMS). The basic structure is as indicated in Figure 1. The ECS also contains other components that do not interface with MODIS processing.

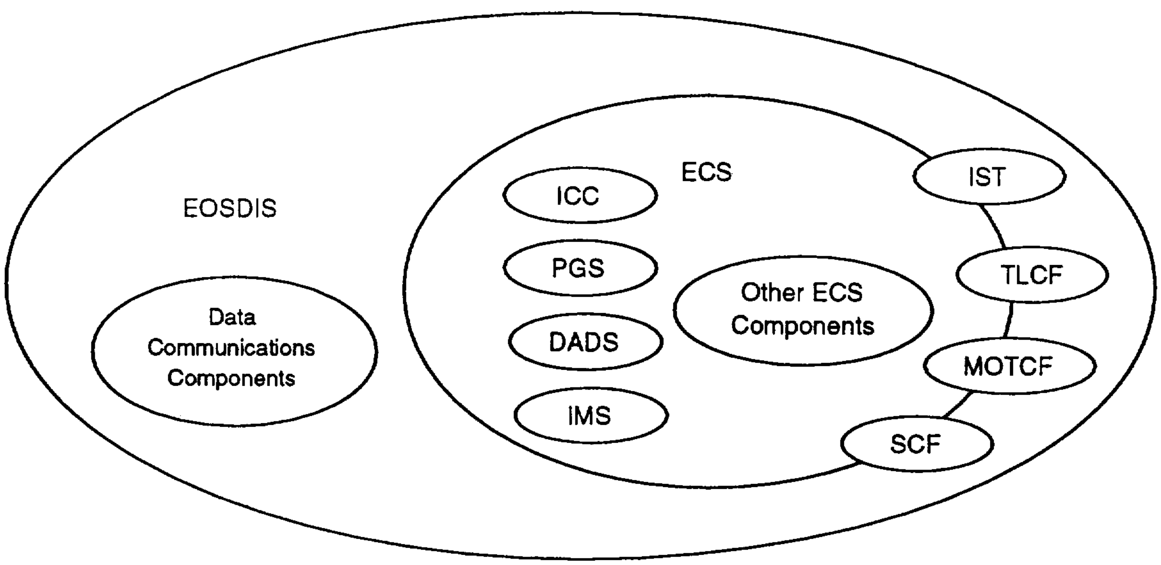


Figure 1. EOSDIS Structure and ECS Components Interfacing with MODIS Processing

To allow the Science Team Leader (and possibly other Science Team Members) to monitor instrument behavior and participate in instrument command decisions without being physically present at the ICC, the ECS will provide a software toolkit known as the Instrument Support Terminal (IST). The IST toolkit will run on a local terminal or workstation provided by the Team Leader, his designate, or other participating Team Members. The IST allows the Team Leader to interactively participate in instrument planning and scheduling, review engineering data, analyze instrument trends and investigate anomalies (as required), and interactively develop command requests.

The initial development of software to produce EOS Standard Products, the production of Special Data Products (research products generated for a subset of the available data and not scheduled for routine production on the PGS), the validation of Standard and Special Data Products, and research activities of the Science Team Members will be done independently at the individual scientist's home computing facility, called a Science Computing Facility (SCF), or on the Team Leader Computing Facility (TLCF), or on the MODIS Oceans Team Computing Facility (MOTCF). (The TLCF and the MOTCF are considered as special SCFs). The relationship between ECS facilities and the ISTs and SCFs is defined in the ECS Specification, and this specification is the formal basis for many of the requirements and functional relationships cited in this document.

Besides basic IST and SCF functions related to instrument monitoring and control and the production and validation of science products, the MODIS Team Leader must also support other functions related to his unique position as team leader. To assist with these functions, the MODIS Team Leader has defined the three support groups shown in Figure 2. The SDST was discussed above. The MODIS Characterization Support Team (MCST) provides support related to monitoring and calibration of the MODIS instrument. The MCST is planning a near-real-time instrument monitoring effort that will examine segments of the MODIS instrument data as these data are returned from the observing platform. The MCST will do a number of instrument-related investigations and will use general purpose computing facilities as well as special purpose computers dedicated to the instrument monitoring task. The MODIS Administrative Support Team (MAST) will provide basic administrative support to the Team Leader and the Science Team and will use computers only for administrative tasks.

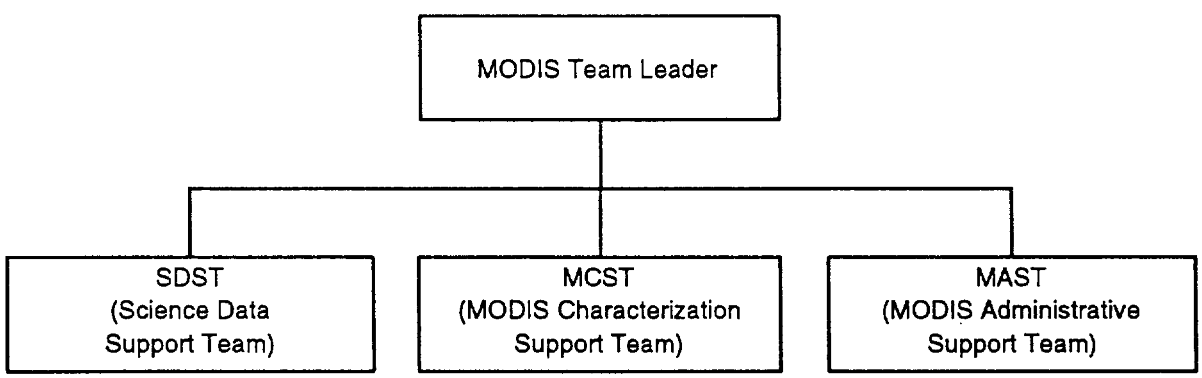


Figure 2. MODIS Support Teams

The ECS specification defines the support that the TLCF (and an SCF) must provide to the ECS. Information flows is both directions across the interface between the ECS and the Team Leader's facility, and the basic nature of the relationship is indicated in Figure 3. To provide a high-level overview, the data flows between the ECS and the TLCF have been shown generically in the diagram, e.g. data flow between the ECS and the TLCF has been shown as "PGS-TLCF Support" and "DADS-TLCF Support". The data flow diagram for the MODIS Oceans Team Computing Facility (MOTCF) is shown in Figure 4. A data dictionary defining data flows is included as Appendix A to this document.

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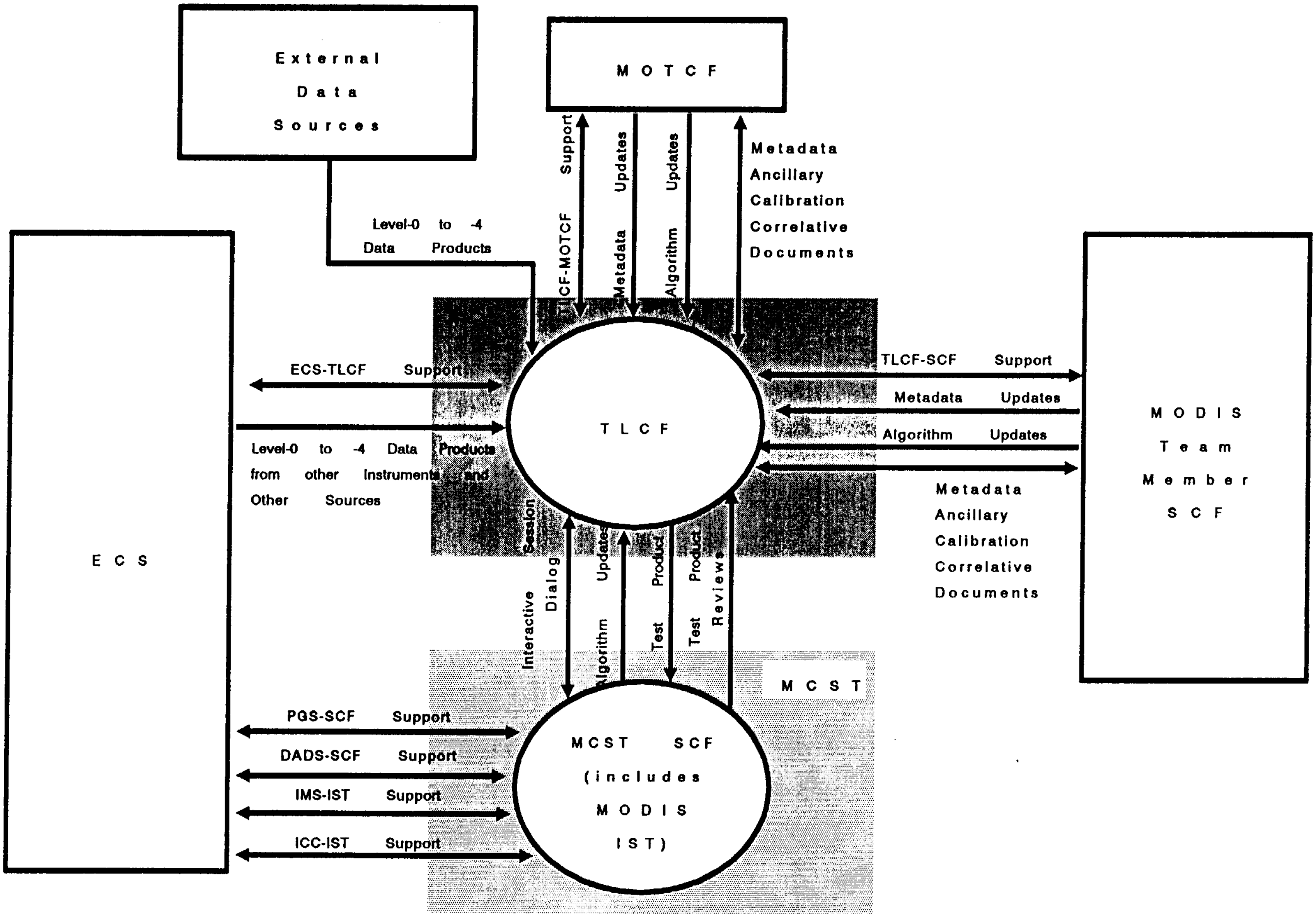

Figure 3. TLCF Data Flow Diagram Showing the Logical Components of the TLCF

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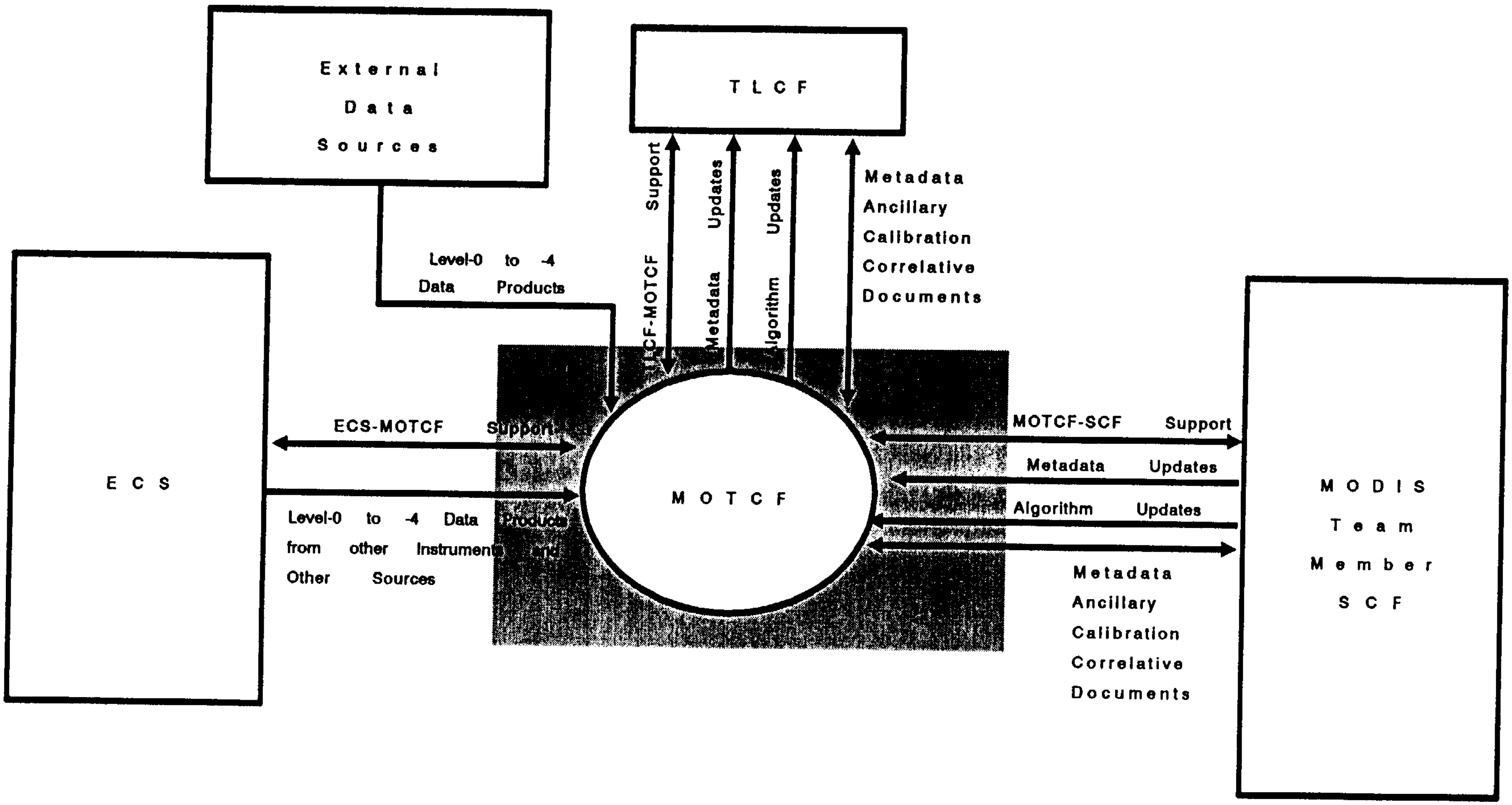

Figure 4. MOTCF Data Flow Diagram

Figure 3 shows other data system entities that interface with the TLCF. "External Data Sources" will provide Level-0 through Level-4 data products from non-EOS instruments that are needed for MODIS algorithm development and product validation. This is a one-way data flow from the external source to the TLCF.

It is the responsibility of the Science Team Leader or Members to initially obtain the external data required to develop and validate their products.

The corresponding data flow diagram for a Science Computing Facility (SCF) is shown in Figure 5. A diagram showing the expanded definition of data flows between the ECS and a SCF or the MOTCF are given in Figure 6. Services to be provided to the MOTCF or SCF by the TLCF include (potentially) code development for the individual Team Member, porting of data product code from the MOTCF or SCF to PGS-compatible facilities, and the integration of multiple Team Member algorithms into a single, efficient, operational MODIS product generation system. Proper ordering of data product generation will minimize data input requirements and improve efficiency, i.e. if several algorithms requiring the same input data are run sequentially while the data is retained in memory, data is input only once for the entire procedure, and not once of each individual product algorithm.

3.0 TLCF DEVELOPMENT PHASES

The MODIS Team Members will provide descriptions of their SCFs, including lists of items they have, and items they intend to acquire, and when they will be acquired.

The proposed TLCF development schedule is primarily determined by one key requirement related to software integration and testing. Although the ECS is developing a PGS toolkit that is intended to simulate the operational features of the PGS at the scientist's local SCF, it is expected that full cross-platform code portability from the SCF to the PGS cannot be assured, and MODIS algorithm integration and testing at the TLCF will be done using facilities fully compatible with the operational PGS. The ability to develop code in a timely fashion depends on the PGS Toolkit being available. Since algorithm integration and testing is critical to the timely completion of MODIS processing software by the launch date, integration and testing must begin as soon as possible, and the critical event shaping the development schedule is the availability of PGS-compatible hardware and software for TLCF use, along with algorithms from the Science Team (at least in prototype form). The ECS contract is not to be awarded until November, 1992; the PGS computing architecture may not be determined until perhaps a year later, and facility procurement will likely add at least another eight months of delay, so that, at best, a PGS-compatible facility may first be available in late-1994. Software integration and testing is critical and should begin on that date or as soon thereafter as possible.

The proposed facility development schedule is shown in Figure 7. As stated, use of PGS-compatible or "mini-PGS" facilities (Phase II) should begin in late-1994. Most Science Team Members will be only in the preliminary stages of testing at that time, and it is expected that a smaller PGS system, or "mini-PGS" will be adequate to meet requirements until perhaps a few years before launch, when development and testing efforts will become more intensive, and a full-up PGS-compatible system is required (Phase III). Present plans are to size the full-up TLCF to equal MODIS operational processing requirements at the PGS, i.e., in the absence of integration and test activity, the full-up facility would be capable of MODIS operational processing with no support from the PGS. Code development, testing, validation, maintenance,

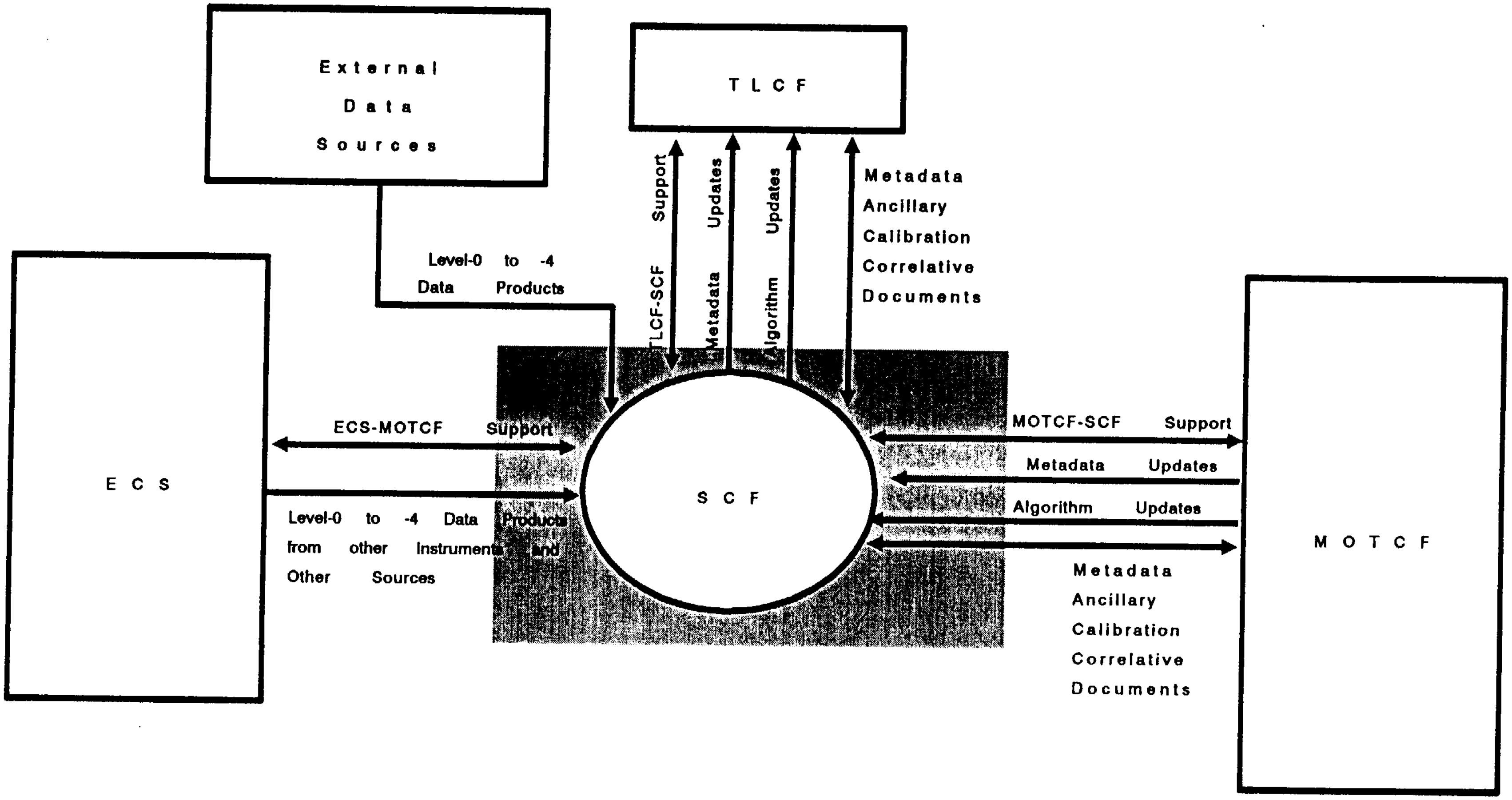

Figure 5. SCF Data Flow Diagram (Note: For non-oceans SCF's, there is no MOTCF connection.)

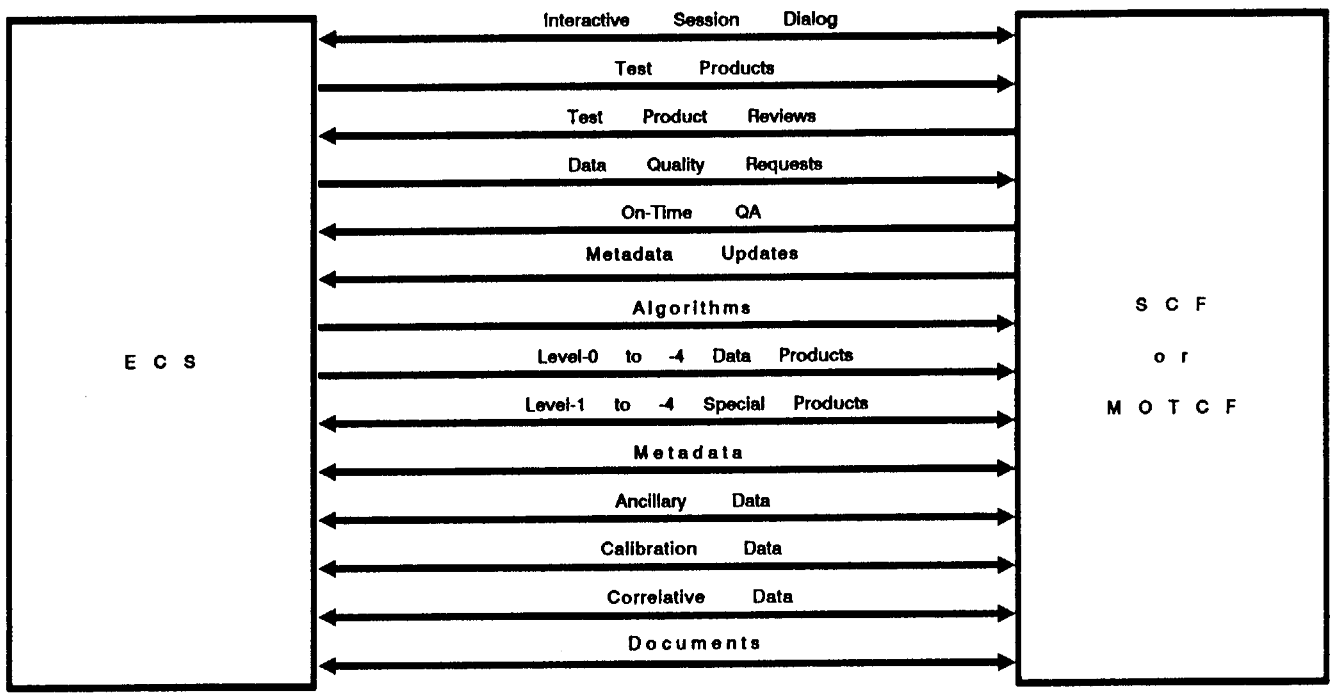

Figure 6. Expanded Definitions of ECS-SCF Support Components

etc. takes from one to ten times the processing power of operational processing. The TLCF is sized at the bottom end of this range.

The Phase I TLCF will support the processing of prototype data sets obtained from MODIS precursor instruments, the development of MODIS Level-1 processing code and MODIS Level-2 processing shell, and integration testing of prototype science algorithms.

The TLCF will also support the MODIS Land Team by providing a processing environment in which algorithms can be tested on a global AVHRR LAC dataset. The dataset will consist of 18 months of AVHRR data that will cover the globe at a resolution of 1 km. Team Members will be able to access the TLCF to run their algorithms and produce products that can be evaluated at the TLCF or at their SCF.

TLCF Development Phases							
	1992	1993	1994	1995	1996	1997	1998
Phase I--Unix Workstation							Launch▾
Phase II--Mini-PGS							
Phase III--Full-Up System							

Figure 7. TLCF Development Phases

4.0 FUNCTIONAL REQUIREMENTS FOR THE TLCF, MOTCF AND THE SCFS

The MODIS Oceans Team will provide a functional requirements statement for the MOTCF.

Many of the required TLCF functions can be inferred directly from the data flows shown in Figure 3. "PGS-TLCF Support" includes "Interactive Session Dialog" that supports general communication between the PGS and the TLCF for software integration and test. Algorithm Updates, Test Products, and Test Product Reviews support algorithm integration and test at the PGS. Algorithm Updates include the source code for the candidate algorithm, algorithm documentation, and a job step control skeleton that controls the execution sequence for the algorithm and the interchange of data with other programs being executed. Test products generated by the candidate algorithms are sent to the TLCF. Reviews of the test products are sent back to the PGS. Algorithm development, integration, and maintenance is one of the primary functions performed at the TLCF.

Validation of data products routinely produced at the PGS is an SCF function. This includes routine production Quality Assurance (QA) and post production QA. Routine production QA information is used to fill in the QA fields of the product metadata as the product is shipped to the DADS. Post production QA information goes directly to the DADS as "Metadata Updates".

Another SCF function is research investigations. If desired, the Team Member may access other scientist's algorithms stored at the DADS to support his own development efforts. Also to support his investigations at the local SCF, the Team Member may access "Data Group 1" items including Metadata on data items stored at the DADS, Ancillary, Calibration, and Correlative data, and algorithm documentation, as well as "Level-0 to -4 Data Products" for other instruments and "Level-1 to -4 Special Products" produced at other Team Member SCFs within the EOSDIS. Such investigations may or may not result in useful data products to be shared with other investigators. If not, the Team Member effort is a simple research investigation. If useful products are produced, these products are to be shared with other investigators and are known as Special Products. Special Products with their associated metadata and documentation are transferred from the SCF to the DADS.

The "Level-0 to -4 Data Products" flow from "External Data Sources" recognizes the fact that not all data needed by a Team Member for a scientific investigation will be available from the DADS. The Team Member can best identify appropriate "External Data Sources" for his investigation.

The relationship shown between the "TLCF" and the "MODIS Team Member SCF" recognizes the potential support function that the "TLCF" may provide to other Science Team Members. Besides integration and testing support for MODIS algorithms, the TLCF may also perform routine QA of Team Member products, if the Team Member desires. These support functions are embodied in the "PGS-SCF Support" flow between the TLCF and the Team Member SCF. Also, if the Team Member desires, the TLCF may support the production of Special Products for the Team Member if, for example, the hardware capability of the scientist's local SCF is inadequate to support the desired volume of Special Product generation. The Team Member will perform the QA of such products, and the Team Member will supply "Metadata Updates", as shown, to complete the QA field in the metadata for such Special Products. "Data Group 1" data flows are also related to potential Special Product generation at the Team Member SCF.

The relationship shown between the TLCF and the MCST SCF includes all aspects of the Team Leader relationship with any other SCF except that the TLCF is not likely to provide routine QA of data products for the MCST nor is it likely to produce Special Products for the MCST. The TLCF does support the integration and testing of MCST algorithms.

In addition to supporting formal functional relationships expressed in data flow diagrams and discussed above, the TLCF will also provide a number of short-term and special purpose support services for the MODIS Science Team. Figure 8 is a list of Team-Leader-unique support functions identified thus far in the effort. Since the Team Leader is responsible for providing services not otherwise provided within the Science Team, this list will doubtlessly evolve as implementation progresses and new needs are identified. For each function, the figure shows an associated time interval during which the support service is thought to be needed.

5.0 NETWORKING AND COMMUNICATIONS REQUIREMENTS FOR THE TLCF

Team Members will provide information on their networking and communications requirements as a function of time.

The basic networking and communications requirements for the TLCF can be derived from the data flow diagram shown in Figure 3 together with data volume information. The TLCF interfaces with PGS and DADS components of the ECS, with "External Data Sources", with the respective SCFs of other MODIS Science Team Members, and with the MCST portions of the TLCF. Of these, the TLCF, major portions of the MODIS PGS and DADS, the MCST SCF, and several MODIS Team Member SCFs are expected to be located at Goddard Space Flight Center (GSFC) and can use presently-existing (during Phase I) and enhanced (for Phase II and III) networking capability provided for EOS use at the Center.

Approximate Projections of Near-Term MODIS Team Leader SCF Utilization	1991				1992				1993				1994				1995			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
External Milestones								▼[1]				▼[2]			▼[3]					▼[4]
Software Implementation Support																				
Evaluate and select CASE Tools			■	■	■															
Run CASE Tools						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Software Guidelines and Standards Validation						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Software Configuration Management						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
ECS Toolkit Evaluation (Beta Testing)											■	■								
Prototype Data Processing																				
MAS[5] Algorithm Development and Maintenance			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
MAS[5] Operational Processing				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Data Format Implementation and Testing			■	■	■															
Image Registration Trials						■	■	■	■	■	■	■	■							
DEM Correction Trials								■	■	■	■	■	■	■	■					
Team-Member-Defined Support Processing						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
MODIS Level-1 Test Data							■	■	■	■	■	■	■	■	■	■	■	■	■	■
Integration with Version-0 DAAC											■	■	■	■						
MODIS Level-1 Software Implementation																				
Level-1A Algorithm Development	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Level-1B Algorithm Development	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Integration and Testing of Version-1 Software																				
Generate Simulated MODIS Data						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Preliminary Standalone Algorithm Tests						■	■	■	■	■	■	■	■	■	■	■	■			
Standalone Algorithm Tests																		■	■	
Integrated Algorithm Tests													■ 6	■	■	■ 7	■	■ 8	■	

[1]ECS Contract Award
[2]PDR-PGS Architecture Chosen (approx.)
[3]PGS-compatible machine delivered (approx.)
[4]Version 1 software due
[5]MODIS Airborne Simulator (MAS) or a successor instrument
[6]Team Member Version 0 code at SDST for integration and testing (with selected TMs, not contractually required), simulated data needed
[7]Review progress, make changes
[8]Team Member Version 1 code due at SDST for integration and testing

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5.1 The ECS-TLCF Interface

All MODIS Level-1 Data Products will be produced and stored at GSFC. The production and storage of MODIS Level-2 through Level-4 products will be distributed across three data centers as shown in Table 1. Besides GSFC, the contributing centers are the Earth Resources Observation System (EROS) Data Center (EDC) in Sioux Falls, South Dakota and the National Snow and Ice Data Center (NSIDC) in Boulder, Colorado. All MODIS atmospheric and ocean products will be produced and stored at GSFC. Level-2 land products will also be produced at GSFC. Level-3 and 4 land data products will be produced at EDC and Level-2 through Level-4 snow and ice products will be produced at NSIDC.

Table 1
Production and Storage of MODIS Level-2 through Level-4* Data Products

		Level-2	Level-3	Level-4
Atmospheric	PGS DADS	GSFC GSFC	GSFC GSFC	GSFC GSFC
Ocean	PGS DADS	GSFC GSFC	GSFC GSFC	GSFC GSFC
Land	PGS DADS	GSFC EDC	EDC EDC	EDC EDC
Snow/Ice	PGS DADS	NSIDC NSIDC	NSIDC NSIDC	NSIDC NSIDC
*All MODIS Level-1 Data Products are produced and stored at GSFC.				

The DADS is a distributed system and all DADS functions are accessible at any of the centers so that the TLCF at Goddard can access all DADS-supported functions for all the data centers at the local GSFC DADS. No special MODIS communications are required to support the DADS function.

Besides the local links within GSFC, two distant link requirements remain for the ECS-TLCF interface. PGS-SCF Support for Level-3 and 4 land products is required with the EDC in Sioux Falls, SD and PGS-SCF Support for Level-2, 3, and 4 snow and ice products is needed with the NSIDC in Boulder, CO. Examination of PGS-SCF Support as defined in Figure 5 reveals two basic functions that are involved: integration and testing of product algorithms at the remote sites and, potentially, routine QA of operational products produced at the remote sites (if the responsible Team Member requests Team Leader assistance with this task). Communications to support integration and testing will be needed only sporadically and will likely involve only relatively small volumes of data to be transferred. Although the communications requirement for routine QA is potentially larger, it is thought that most Science Team Members will not want to examine large volumes of their products at the SCF, and therefore, data volume for this function will also be moderate.

5.2 The "External Data Source"-TLCF/MOTCF/SCF Interface

{Summary of TM communications requirements to be supplied.}

SCF communications with "External Data Sources" could potentially involve a large segment of the worldwide Earth-science community. The EOSDIS Science Network (ESN) (to be developed by the ECS contractor) will provide gateway access to the NASA Science Internet (NSI), which will, in turn, provide the required access to the worldwide community. The MODIS project will not require special communications support once the services of ESN become available. In the near-term, the SCF will also have access to Internet services, and it is expected that most required access to "External Data Sources" can be handled via existing Internet services.

5.3 The TLCF-MODIS Team Member SCF Interface

Because of the unique roles dicsussed above, the TLCF is likely to have the largest intra-team communication requirement of any MODIS Team Member. Although data transfer volumes for the TLCF could be appreciable, most of the functions supported are not operationally pressing, and short delays in communications response may be tolerable. Since most of the ocean product code is being developed and integrated at the University of Miami, communications requirements with that facility may be particularly large. Intra-team communications requirements should be reanalyzed as Phase II facilities are acquired and ESN communication services to the SCFs are implemented. In the near-term, most Team Leader communications with MODIS Team Members can be handled via internet or other presently-existing data networks. [Specifics of Phase I communications requirements are listed below. Phase II requirements are TBD]

5.4 The TLCF-MCST SCF Interface

The TLCF and the MCST SCF will likely share at least some physical facilities at GSFC. For the near-term (Phase I), it appears that data communications requirements between these components can be adequately handled by the existing GSFC Ethernet network which has a 10 Mbps bandwidth. In the long-term (Phase II and III), the GSFC Ultranet network (1000 Mbps) and a fiber optic FDDI network (100 Mbps) will be used to link components of both computing facilities.

5.5 Near-Term TLCF Communications Requirements

The list of near-term TLCF functions given in Figure 8 has been examined to extract those functions requiring communications support. The resulting list of functions and communications requirements is given in Table 2. The near-term functions requiring communications support include the remote use of CASE tools, "Beta" testing of ECS-provided toolkits, Team-Member-defined support / integration and testing support, and integration of MODIS Airborne Simulator (MAS) and other prototype MODIS data sets with the Version 0 EOSDIS processing system. Proposed communications support is listed for each requirement. Besides Unix, TCP/IP and X-Window support (at least X-11, Revision 4) and a serial line protocol like SLIP, CSLIP, XREMOTE, or PPP is essential.

Table 2
Near-Term Phase I Communications Requirements for the MODIS Team Leader SCF

Function	User	Remote Site	Environment	Protocol	Medium	Rate (Kbps)
Run CASE Tools	SDST	Terminal Room	X-Windows/MOTIF	TCP/IP	Goddard Network	1,000
	TMs	SCFs	X-Windows/MOTIF	TCP/IP	Internet	
	TMs	SCFs	X-Windows/MOTIF	SLIP/CSLIP V32 bis, V42 bis	Phone Line (1)	14.4,
ECS Toolkit Evaluation (Beta Testing)						
ESN Toolkit	SDST	PGS			ESN	
SMC (CASE) Toolkit	SDST	PGS			ESN	
IMS Toolkit	SDST	PGS			ESN	
	SDST	Anywhere		TCP/IP	Internet	
	SDST	Anywhere		V32 bis, V42 bis	Phone Line (1)	14.4,
Team-Member-Defined Support/ Integration and Testing Support	TMs	SCFs	TELNET X-Windows/MOTIF	TCP/IP	Internet	
	TMs	SCFs	TELNET X-Windows/MOTIF	SLIP/CSLIP V32 bis, V42 bis	Phone Line (1)	14.4
Integration with Version-0	SDST	DAAC	TELNET X-Windows/MOTIF			

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6.0 THE PROPOSED PHASE I (NEAR-TERM) SYSTEM

Specific plans have been made to procure a Phase I (near-term) TLCF which will support software development by the SDST and algorithm testing and data processing activities of the Land and Atmosphere Teams. The system will include UNIX based workstations and X-terminals to support ten code developers, a workstation to support MODIS Airborne Simulator (MAS) data processing, digitizing ancillary data and data distribution to Science Teams and a system with access to global data sets for testing MODIS algorithms, like the 1km AVHRR LAC data set. Each element of the Phase 1 system is described in greater detail below.

By 1994 fifteen developers will be involved in the design, coding, documentation and testing of MODIS Level 1a and 1b processing software and the Level 2 Shell into which Science Team software will be integrated The code design, development and documentation processes will be automated through the use of: front-end CASE tools for structured design such as CADRE Technologies Teamwork; back-end CASE tools for interactive code development and debugging (Centerline's Code Center for C); an integrated document preparation package such as, Interleaf or FrameMaker; quality assurance software such as QA/FORTRAN and QA/C for static software testing and a configuration management package. These tools will be hosted on UNIX workstations and X-terminals. Current plans call for a workstation or X-terminal for each developer. On average, each workstation will support two X-terminals, the number may vary for an individual workstation depending on its processing load on a given day. In mid-1992 and early 1993, four Hewlett Packard 9000 workstations, each with 64Mb of memory, and six X-terminals will be purchased to support ten software developers. The workstations will each have 1GB of disk storage. Workstations and X-terminals will be purchased in late 1993 to support an additional five programmers.

A SUN 3/160 workstation in the Laboratory for Terrestrial Physics Computing Facility is being upgraded to a Sun SPARCserver 670MP to process MODIS Airborne Simulator (MAS) data, to handle digitizing and analysis of ancillary data from field campaigns and to serve as a distribution point for MAS data and utility programs to the MODIS Science Teams. The SPARCserver has four SPARC2 processors, 64Mb of memory, 8GB of disk storage and a 24bit frame buffer for image processing. The EASI/PACE software package from PCI will be used for image analysis activities, ESRI's ARC/INFO will be used for digitizing and GIS analyses and MAS data processing is handled by specialized software developed by the SDST.

The final component of the Phase I TLCF is a testbed for programs that require large data sets, hundreds of gigabytes, in order to adequately test their algorithms. This system is designed to handle the MODIS Land Team's requirement for testing algorithms on a 1km AVHRR LAC data which has global coverage and spans 18 months. The data set, which will arrive from the EDC Land DAAC is 3TB in size. However, complete global coverage with all AVHRR bands for one set of orbits requires only 5GB. In the near term TLCF, the Land requirement for analysis of this global data set could be met by maintaining a near line set of the data with sufficient online disk storage to permit the analysis a sub-set of the data at a global or continental scale.

To meet near-line storage requirements for global data sets, Exabyte EXB-120 optical jukebox with the capacity to store over 500GB of data will be purchased in 1993. The jukebox will provide a sustained data transfer rate of nearly 2Mb/sec. The vendor has predicted a doubling of data storage capacity and a quadrupling of data transfer rate by 1994 based on previous improvements in 8mm drive technology.

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Online data storage and analysis will by handled by UNIX workstations which share 100GB of disk storage. A Silicon Graphics 4D/480 workstation will handle the transfer of data from the Exabyte jukebox to the disk drives and data processing and analysis.

Staffing for the near-term TLCF will include an operator, programmer, UNIX system administrator and remote sensing analyst. Each of these individuals also supports other Projects the Laboratory for Terrestrial Physics Computing Facility or MODIS SDST and the total manpower is roughly 1.5MY/year.

This proposed system will be reexamined in the 1994 time frame.

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APPENDIX A
DATA DICTIONARY FOR TLCF DATA FLOWS

{To Be Expanded}

ALGORITHMS consist of the executable programs for science product generation, source code of these executable programs, job control scripts, and algorithm documentation. Algorithms are the result of new or updated science algorithms passing through the integration and test process, involving the scientist and the PGS's algorithm integration and test staff. After formal approval, algorithms are delivered by the PGS to the DADS for storage, and are retrieved as needed to support product production. The DADS shall also archive algorithms contributed as EOSDIS resources by other data centers. Algorithms shall be orderable and distributed to authorized users. Some frequently used algorithms may also be kept on line in the PGS.

ALGORITHM UPDATES are delivered to the PGS's integration and test environment by scientists at an SCF. They represent changes to existing production algorithms, or a new algorithm to produce a new Standard Product. Algorithm updates include the source code for the candidate algorithm, its associated documentation, and a job step control skeleton. The source code will be compiled to form an executable program suite as part of the integration and test process. The job step control skeleton contains instructions that control the sequence of execution of, and the interchange of data between programs from the executable program suite. Test data sets and calibration data should also be included.

ANCILLARY DATA refers to any data, other than Standard Products, that are required as input in the generation of a Standard Product. This may include selected engineering data from the EOS platform, ephemeris data, as well as non-EOS ancillary data. All ancillary data is received by the PGS from the DADS.

CALIBRATION is the collection of data required to perform calibration of the instrument science data, instrument engineering data, and the spacecraft or platform engineering data. It includes pre-flight calibration measurements, in-flight calibrator measurements, calibration equation coefficients derived from calibration software routines, and ground truth data that are to be used in the data calibration processing routine.

CORRELATIVE data are scientific data needed to evaluate and validate EOS data products.

DATA QUALITY REQUEST is a request issued by the PGS to a scientist at an SCF to perform QA of a particular product before future processing or distribution. A time window is applied to the request in keeping with the production schedule.

DOCUMENTS are the hardcopy or digitized references or records about an instrument or the products generated from its data. These shall be archived at the DADS.

INTERACTIVE SESSION DIALOG consists of messages that flow between a scientist at an SCF and the PGS that support general communication with the Integration and Test Service. This includes logins, mail messages, etc.

L0-L4 DATA PRODUCTS consist of L0 Data Products from the IPs, the ADCs and ODCs, and L1-L4 Standard Products produced in the PGS.

L1-L4 SPECIAL PRODUCTS are special science data products consisting of L1A, L1B, L2, L3, and L4 which are produced at the SCFs. These shall be archived at the DADS and distributed to authorized requestors.

METADATA is data which describes the content, format, and utility of a Standard Product. It includes standard metadata (i.e., algorithm and calibration numbers, size of product, date created, etc.), algorithm-derived metadata, QA information from the PI's, summary statistics and an audit trail. Metadata is received by each DADS with the corresponding data sets. DADS validates it physically, updates it with inventory information, enters it into a distributed database (to which the IMS has access), and archives it. Metadata about special products produced at SCF shall be sent to DADS along with their associated data products.

METADATA UPDATES are additional or changed metadata items relating to a previously delivered product.

ON TIME QA is a response to a data quality request that is received within the established production time window. It is received from a scientist at an SCF. It consists of data which will be used to complete the QA fields of the metadata. Overdue QA responses are sent directly to the DADS.

TEST PRODUCTS are science products generated by new or updated algorithms during the integration and test period. Test products are delivered to scientists at an SCF.

TEST PRODUCT REVIEWS are evaluations of test products that are used to determine how to proceed in the integration and test process for a new or updated algorithm. A review may indicate the need for further algorithm refinement, or it may indicate that a candidate algorithm is ready for formal adoption into the production environment. Test product reviews are received by the PGS from scientists at an SCF.