MODIS DATA STUDY
TEAM PRESENTATION

July 21, 1989

AGENDA

1. Required Attributes for MODIS Data Product Table
2. Required Attributes for MODIS Measurement Activity/Field Experiment Table
3. List of Hypothetical Questions Which a DBMS Should be Able to Answer
4. Revised Calculation of Effects of Refraction on MODIS Pixel Location
5. Revised Spectral Bands for MODIS-N (7/18/89)
6. Field Experiment Table Summary

REQUIRED ATTRIBUTES FOR MODIS DATA PRODUCT TABLE

BASIC DESCRIPTIVE INFORMATION

Attribute	Name	Data	
Eos Instrument	(Inst)	MODIS	
Discipline	(Discipl)	Oceanography (vs. meteorology, etc.)	
Data Product Name	(Prdtname)	Sea Surface Temperature	
Product ID code	(Idcode)	OL3IB0011	
Product Level	(Level)	3	
Product Type	(Type)	Standard	(vs. specialized)
Product Goal	(Goal)	At-launch	(vs. R&D)
Product Status	(Status)	Developing	(vs. implemented)
Expected implementation date	(Impldate)	October 1995	
Traceability/pedigree	(Origin)		
Other comments	(Comments)		

DEVELOPER'S DESCRIPTIVE INFORMATION

Developer's Last Name	(Lastname)	Barton
Developer's First Name	(Frstname)	Ian
Developer's Affiliation	(Org)	CSIRO Division of Atmospheric Res.
Developer's Address	(Address)	PMB No. 1, Mordialloc 3195, Victoria
Developer's Phone Number	(Phone)	61-3-5867666
Developer's Electronic Mail	(Email)	IBARTON
Codevelopers/collaborators	(Codev)	Otis Brown
Comments	(Sccommen)	

COVERAGE DESCRIPTIVE INFORMATION

Spatial coverage	(Spacover)	Global	(vs. regional)
Spatial resolution	(Spares)	0.5°	(or 0.25°)
Temporal coverage	(Temcover)	Total	(vs. on request)
Temporal resolution	(Temres)	Weekly	(vs. daily)
Timeliness	(Timelnss)	Routine	(vs. near-real-time)
Orbital data volume	(Orbitvol)	NA	
Daily data volume	(Dailyvol)	NA	
Weekly data volume	(Weekvol)	1 megabyte	
Monthly data volume	(Monthvol)	NA	
Annual data volume	(Yearvol)	NA	
Browse data volume	(Browsvol)		
Comments	(Cvcommen)	Both mean and dispersion assumed	

ALGORITHM DESCRIPTIVE INFORMATION

Algorithm Description	(Algmdesc)	
Algorithm Status	(Alstatus)	
Developer's Computer	(Devcomp)	
Developer's Operating System	(Devopsys)	
Developer's Language	(Devplang)	
Estimated MIPS	(Estmips)	
Estimated lines of code	(Estloc)	
Literature references	(Litref)	
Resources required to devel.	(Resource)	
Comments	(Alcommen)	

REQUIRED DEVELOPMENTAL DATA DESCRIPTIVE INFORMATION

Simulated MODIS data	(Simdata)	
Non-Eos satellite data	(Dvnoneos)	AVHRR, ATSR on ERS-1 and ERS-2
Conventional/in-situ data	(Dvgrndtr)	Buoy, ship, and airborne measurements
Related field experiments	(Dvfieldx)	016V
Comments	(Dvcommen)	

REQUIRED PRODUCTION DATA DESCRIPTIVE INFORMATION

Platform ancillary data	(npopldta)	None
MODIS-N ancillary data	(nancdata)	None
MODIS-T ancillary data	(tancdata)	None
MODIS-N spectral channels	(nchnnls)	None
MODIS-T spectral channels	(tchnnls)	None
MODIS data products	(Prmodata)	OL2IB0007
Other Eos Instrument data	(Preosins)	None
Non-Eos satellite data	(Prnoneos)	None
Conventional/in-situ data	(Prgrndtr)	None
Input data volume comments	(Incommen)	
Other comments	(Prcommen)	

REQUIRED VALIDATION DATA DESCRIPTIVE INFORMATION

Other MODIS data products	(Vamodata)	
Other Eos Instrument Data	(Vaeosins)	AMSU, AIRS, SCATT, ALT
Non-Eos satellite data	(Vanoneos)	AMRIR, ATSR on ERS-1 and ERS-2
Conventional/in-situ data	(Vagrndtr)	Buoy, ship, and airborne measurements
Related field experiments	(Vafieldx)	016V
Comments	(Vacommen)	

USER'S DESCRIPTIVE INFORMATION

MODIS data products	(child)	(e.g., OL4FH0028, OL4WE0035)
MODIS	(Modusers)	
Facility Instrument	(Facusers)	
PI Instrument	(Piusers)	
Interdisciplinary	(Idsusers)	Robertson
Others	(Genusers)	
Comments	(Uscommen)	

REQUIRED ATTRIBUTES FOR MODIS MEASUREMENT ACTIVITY/FIELD EXPERIMENT TABLE

BASIC DESCRIPTIVE INFORMATION

Attribute	Name	Data
Eos Instrument	(Inst)	MODIS
Discipline	(Discipl)	Oceanography (vs. meteorology, etc.)
Primary application	(Applic)	Validation (vs algorithm development)
Experiment name	(Expname)	Ground-truth SST measurements
Activity ID code	(Idcode)	016V
Purpose	(Purpose)	Provide in-situ observations of sea surface temperatures (generally from ship observations, but also from buoys and aircraft) to compare to MODIS-N SST products.

EXPERIMENTER'S DESCRIPTIVE INFORMATION

Experimenter's Last Name	(Lastname)	Barton
Experimenter's First Name	(Frstname)	Ian
Experimenter's Affiliation	(Org)	CSIRO Division of Atmospheric..
Experimenter's Address	(Address)	PMB No. 1, Mordialloc 3195,..
Experimenter's Phone Number	(Phone)	61-3-5867666
Experimenter's Electronic Mail	(Email)	IBARTON
Coexperimenters/collaborators	(Codev)	A. J. Prata (?)
Campaign chief scientist	(Chief)	
Comments	(Sccommen)	

RESOURCES AND COORDINATION DESCRIPTIVE INFORMATION

Experiment Resources Req's.	(Resreqr)	
University coordination	(Univcord)	
Interagency coordination	(Agencord)	
International coordination	(Intlcord)	
Special instrument comments	(Specdata)	
Other comments	(Comments)	Also to be used for algorithm dev.

COVERAGE DESCRIPTIVE INFORMATION

Location	(Location)	Coastal Australian Waters (?)
Temporal coverage	(Temcover)	
Temporal resolution	(Temres)	Weekly (vs. daily)
Frequency or Number	(Freq/num)	
Comments	(Cvcommen)	Both mean and dispersion assumed

REQUIRED PRODUCTION DATA DESCRIPTIVE INFORMATION

Platform ancillary data	(npopldta)	None
MODIS-N ancillary data	(nancdata)	None
MODIS-T ancillary data	(tancdata)	None
MODIS-N spectral channels	(nchnnls)	None
MODIS-T spectral channels	(tchnnls)	None
MODIS data products	(Prmodata)	OL2IB0007, AL3JS0043 (?)
Other Eos Instrument data	(Preosins)	None
Non-Eos satellite data	(Prnoneos)	None
Comments	(Prcommen)	

PERFORMANCE REQUIREMENTS AND IMPACTS DESCRIPTIVE INFORMATION

MODIS data priority	(Priority)	Near-real-time (?)
Direct broadcast requirement	(Dirbreqr)	
Communications requirements	(Commreqr)	
Near-real-time req's	(Nrtreqr)	
Special requirements	(Specreqr)	
MODIS impacts	(Modimpct)	
Input data volume comments	(Incommen)	
Data timeliness comments	(Ticommen)	
Other comments	(Prcommen)	

COLLECTED DATA DESCRIPTIVE INFORMATION

Aircraft in-situ data	(Aircdata)	Sea surface temperature
Radiosonde data	(Metdata)	
Land-based in-situ data	(Landdata)	None
Ship in-situ data	(Shipdata)	Sea surface temperature
Buoy in-situ data	(Buoydata)	Sea surface temperature
Special Instrument data	(Specdata)	
Collected daily data volume	(Dailyvol)	
Campaign data volume	(Campvol)	
Annual data volume	(Yearvol)	
Processing/archival status	(Dastatus)	
Comments	(Dacommen)	

USERS OF COLLECTED DATA DESCRIPTIVE INFORMATION

Archived in-situ products	(Archprod)	
Data products to be validated	(Prodval)	OL2IB0005, OL2IB0007, OL3IB0008, etc.
MODIS team members	(Modusers)	
Facility Instrument	(Facusers)	
PI Instrument	(Piusers)	
Interdisciplinary	(Idsusers)	Robertson
Others	(Genusers)	
Comments	(Uscommen)	

LIST OF HYPOTHETICAL QUESTIONS WHICH A DBMS SHOULD BE ABLE TO ANSWER

List all Level-2 oceanographic MODIS data products.

List all near-real-time MODIS data products.

List all MODIS products to be implemented between October 1997 and October 1998.

How many MIPS of processing capacity are required to generate MODIS standard products by October 1996?

How many additional MIPS will MODIS standard products require between October 1996 and 1997.

List the total standard product MIPS requirements for each team member.

What MODIS data products are required to generate primary productivity (OL4WE0035)?

What MODIS data products require NMC upper air data?

What MODIS data products use weekly sea surface temperature (OL2IB0007)?

What MODIS team members are proposing calibration data products?

List all MODIS data products to be produced on resolutions finer than 5 km.

List all field experiments for February 1997 requiring near-real-time MODIS data.

What is MODIS data product AL3JS0043?

List the data products required by interdisciplinary team members provided by MODIS.

List the data products required by interdisciplinary team members but not provided by MODIS.

List all data products requiring AIRS data for their generation.

List all products that each investigator is responsible for sorted by status, type, and goal.

List all the MODIS data products and their associated attributes, sorted by level.

List all products which have been updated in the last month.

List the validation requirements for each product, sorted by discipline and implementation date.

Product list, computer type, programming language, operating system sorted by science team member.

Product list sorted by language.

List all MODIS products which depend on another specific MODIS product (e.g., AL3JS0043).

List all special products sorted by address or affiliation.

List the history of algorithm changes for all products, sorted by product level and science team member.

Generate a list of all products updated by time (and science team member) since an arbitrary date.

List the data products associated with a specific output product sorted by scientific discipline.

List all standard products requiring buoy data for generation or validation in near-real-time.

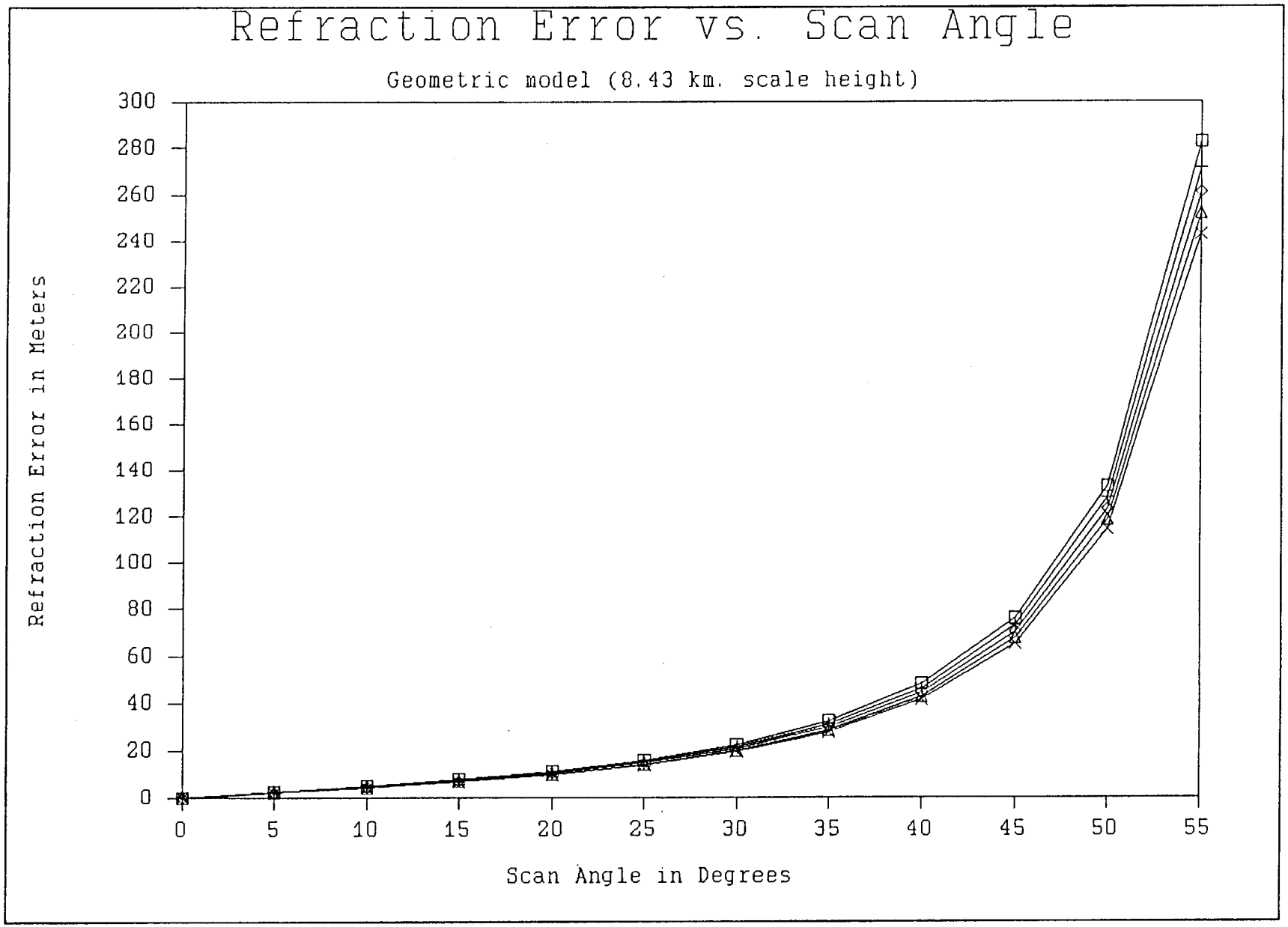
Do we want to be able to ask this sort of question:? "Algorithm list with effort expended to date sorted by investigator." Do we want to track costs, level of effort, priorities, and other administrative information in the data base?

REVISED CALCULATION OF EFFECTS OF REFRACTION ON MODIS PIXEL LOCATION

In a previous note (6/16/89), the effect of atmospheric refraction on the location of MODIS pixels was calculated. These calculations were simple geometric calculations rather than the more accurate ray tracing calculations. Implicit in the geometric calculations was the assumption that the refraction effect occurred equally along the entire path from the satellite to the Earth's surface. In reality the refraction effect occurs mostly where the atmosphere is most dense. If the non-uniform bending of light rays along the path is considered, the actual refraction effect is considerably reduced.

In the attached figure, the revised refraction errors as a function of scan angle are plotted. A geometric calculation is still used, but all the light bending is assumed to occur in the lowest scale height of the atmosphere (8.43 km.). A ray tracing calculation must be done at some point to check this assumption of one scale height since the errors in the figure are proportional to its value. It is evident from the figure that the refraction correction is generally small. However, for scan angles greater than 45 degrees, errors of more than 100 meters occur. Temperature, pressure, and wavelength effects may be negligible. Each curve in the figure corresponds to a 10 degree Celsius change in surface temperature, starting at -10 C (upper curve).

It appears from these calculations that the refraction effect is generally small and repeatible (i.e., invariant to meteorological conditions). For most MODIS applications, the effect can be easily calculated.


Refraction Error vs. Scan Angle
Geometric model (8.43 km. scale height)
Refraction Error in Meters
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
0
5
10
15
20
25
30
35
40
45
50
55
Scan Angle in Degrees

CHANNEL #	CENTER WAVELENGTH (um)	SPECTRAL BANDPASS (um)	LTYPICAL (*)	NEdL (*)	REQ'D S/N (nd)	LMAX (*)	LCLOUD (*)
1	0.470	0.020	35.3	0.124	284	593	570
2	0.555	0.020	29.0	0.127	228	518	554
3	0.665	0.020	17.1	0.121	141	690	460
4	0.880	0.020	25.2	0.089	284	255	283
5	0.413	0.015	44.9	0.051	875	175	573
6	0.443	0.010	41.9	0.050	830	133	585
7	0.490	0.010	32.1	0.040	796	101	539
8	0.520	0.010	27.9	0.037	745	84	538
9	0.565	0.010	21.0	0.028	743	64	528
10	0.653	0.015	9.99	0.008	1212	36	472
11	0.681	0.010	8.69	0.008	1063	31	440
12	0.750	0.010	10.2	0.017	586	26	373
13	0.865	0.015	6.17	0.012	503	16	286
14	0.908	0.035	11.38	0.084	136	271	252
15	0.936	0.006	3.6	0.031	115	256	267
16	0.950	0.020	2.69	0.023	118	249	244
17-19**	0.650	0.082	41.1	0.041	1010	460	466
20	1.240	0.020	5.37	0.045	120	68	138
21	1.640	0.020	7.30	0.024	310	70	68
22	2.060	0.050	1.21	0.011	111	27	31
23	2.130	0.050	0.97	0.009	110	22	27
24	0.575	0.150	27.3	0.127	215	481	545
25	0.860	0.100	24.5	0.086	286	256	293

NOTES:

(*)=(watts/square meter-micrometer-steradian)

**-Polarization bands 17-19 are notched from 0.6265-0.6590 micrometers

LTYPICAL =Typical spectral radiance

LMAX =Maximum spectral radiance

LCLOUD =Cloud spectral radiance

7/18/89

CHANNEL #	CENTER WAVELENGTH (um)	SPECTRAL BANDPASS (um)	TTYPICAL (K)	LTYPICAL (*)	REQ'D NEdT (K)	NEdL (*)	TMAX (K)	LMAX (*)
26	3.750	0.18	300	0.449	0.05	9.57E-04	335	1.71
27	3.959	0.05	300	0.671	0.07	1.90E-03	328	1.89
28	4.050	0.05	300	0.786	0.07	2.17E-03	328	2.16
29	8.550	0.30	300	9.577	0.05	8.99E-03	324	14.54
30	4.515	0.05	275	0.588	0.25	6.20E-03	285	0.88
31	4.565	0.05	275	0.632	0.25	6.59E-03	302	1.76
32	6.715	0.36	240	1.157	0.25	1.08E-02	271	3.21
33	7.325	0.30	250	2.185	0.25	1.72E-02	275	4.46
34	9.730	0.30	250	3.693	0.25	2.19E-02	275	6.34
35	11.030	0.50	300	9.550	0.05	7.01E-03	324	13.25
36	12.020	0.50	300	8.942	0.05	6.06E-03	324	12.10
37	13.335	0.30	260	4.523	0.25	1.83E-02	285	6.56
38	13.635	0.30	250	3.765	0.25	1.61E-02	268	5.02
39	13.935	0.30	240	3.110	0.25	1.41E-02	261	4.42
40	14.235	0.30	220	2.080	0.35	1.54E-02	238	2.96
26-HIGH	3.750	0.18	700	670.937	0.05	2.64E-01	700	670.94
29-HIGH	8.550	0.30	300	9.577	0.25	4.49E-02	700	258.94
35-HIGH	11.030	0.50	400	29.084	0.05	1.23E-02	400	29.08
36-HIGH	12.020	0.50	400	25.066	0.05	9.88E-03	400	25.07

NOTES:
1) The high range of channels 26 and 29 is from 335K to 700K with an NEdT less than 1.0 C.
2) The high range of channels 35 and 36 is from 335K to 400K with an NEdT less than 1.0 C.

LTYPICAL=Spectral radiance at typical scene temperature TTYPICAL.
LMAX=Spectral radiance at maximum scene temperature TMAX.

(*)=(watts/square meter-micrometer)

7/17/89

FIELD EXPERIMENTS

Team Member	Purpose	Quantities Measured	Location	Method	Schedule	Impacts
P. Slater C01V	Calibration & Validation for instrument	Spectral Reflectance Total precipital water Relative humidity at surface Spectral optical depth (at 1500 locations) Helicopter flights Barometric pressure	White Sands, New Mexico Edwards AFB, California	About three times per year when MODIS, Landsat, SPOT, AVHRR, AIS, AVIRIS, and other remote sensors can simultaneously sample the site	Three times per year. Post launch	Significant calibration studies. Radiometer development Data for archiving
V. Salomonson C02V	Instrument calibration and validation	Spectral reflectance. Directional radiance measurements. Irradiance measurements, and multi-spectral radiometers	White Sands, New Mexico; Rogers Dry Lake	Ground based measurements, may require MODIS-T in stare mode. May cooperate with Dr. Slater	Post launch	Specialized data sets to DADS
V. Solomonson L15V	Verify radiation budget components in snow covered regions	Spectral reflection, albedo,Directiona radiance measurements, irradiance measurments, and multi-spectral radiometers	Not yet determined	Ground based measurements of radiation budget components to compare with MODIS products	Post launch for two years	Specialized data sets to DADS
D. Tanre A03A	Algorithm development to develop radiative transfer codes	Radiation measurements. Irradiance measurements Desert related aerosol optical depth, size distribution, and absorption.	Not yet determined. Two previous experiments were done in Africa in 1986 and 1987	Ground based radiation values (at solar wavelengths) and MODIS calibrated outputs are used to develop algorithms for use over deserts	Both pre and post work required	Specialized data sets sent to DADS

Y. Ka n A04V	Provide ground measurements of aerosol optical depth and aerosol distribution for comparison with MODIS products	Radiation measurements. Will use sunphotometer-radiometer readings. Aerosol optical depth, size distribution and absorption.	Not deter l at this time	Ground measurements of atmospheric aerosol properties	Post launch	Specialized d to DADS
J. Susskind A05D	Collect existing synoptic meteorological observations for use in MODIS products	Project will use standard synoptic meteorological surface and upper air observations.	Will use observations from GTS or NMC	Arrange for a routine tap on a NMC node.	Post launch	This has a major impact. Meterological information requires reformatting into a standard MODIS format.
R. Evans H. Gordon 006D	Obtain accurate surface pressure values.	Project will use standard NMC synoptic surface pressure measurements	Will use observations from NMC or GTS	Arrange for a connection at an NMC node	Post launch	This is noise level compared to above project.
W. Menzel A07A A08V	Algorithm development	Experiment requires in-situ spectral cloud measurements, cloud extent, cloud type, cloud top pressure, and cloud emissivity.	Locations not determined	Aircraft flights using multi-spectral atmospheric mapping sensor and high resolution interferonometer sounder.	Pre-launch	Specialized data sets to DADS
M. King A09V	Cloud parameter validation	Measures cloud optical thickness, effective particle radius, and spectral single scattering albedo.	Locations not determined at this time	University of Washington C-131-A with in-situ microphysics instrumentation including a cloud absorption radiometer.	Post launch	Specialized data sets to DADS

A. Str ''er A10V	Algorithm development and validation	Measures directional radiance and spectral irradiance at the land surface. Leaf area index, leaf area density, biomass estimators.	Five to ei ' ' test site required world wide. International cooperation is required.	Ground truth measurements will use sunphotometers, directional radiance measurements, irradiance measurements, canopy structures, leaf area indexes, leaf area density, biomass estimators, and other parameters.	Post launch	Specialized da+ sets to DADS
J. Peter Muller L11A	Algorithm development and validation	Percentage vegetative cover, canopy height and growth stage, soil type, and cover, soil surface roughness, plant canopy architecture, leaf inclination as a time function, inter-tree spacing, inter-node branch lengths, branch lengths and orientation angles, canopy closure, tree canopy geometry, soil spectral reflectance, and SBDRF. Irradiance measurements at the land surface	Requires large homogeneous tracks of land. Candidate locations are Indonesia, Brazil, Tanzania, and Malaysia. Some southwestern soil samples will be examined in the laboratory.	Ground level measurements will be taken using vertical photographs, stereo photographs, upward pointing vertical photographs, stereo aerial photographs, field spectroradiometers with theodolites, laboratory spectroradiometers, pryheliometers, and pryanometers.	Pre and post launch.	Specialized data sets to DADS

S. Running L12V	Validate normalized difference vegetative index	Experiment will take surface synoptic observations including incoming shortwave radiation. Also measured are non meteorological data including stream discharge rates, soil water holding capacity, soil moisture, leaf indices, weekly composite AVHRR data, snow cover estimates	Coweeta Hydrologi station, North Carolina; Andrews Experimental Forest, Oregon; Lubrech Experimental Forest, Montana;Konza Prairie; Jornada (desert site); tropical and tundra site remain undetermined.	Measurements will be taken at established sites.	Pre and post launch	Specialized da to DADS
A. Huete L24V	Validation for "vegetation-detrius-soil spectral decomposition" algorithm	Experiment will use spectroradiometer to measure radiation between (0.4 to 1.0 mocrometers)	U.S. southwest, and Senegal	Radiation will be measured at ground level	Pre and post launch	None apparent
V. Vanderbilt L13A	algorithm development	Experiment will measure the polarized radiation spectra, angular dependence of incoming and scatter polarized spectra, canopy characteristics of plant scattered light.	Field locations not determined at this time. The selected site will require uniform canopies. It will also require laboratory measurements.	The experiment will measure Stokes spectral polarization over different canopies.	Pre-launch	None apparent
Z. Wan L14A	Algorithm validation	Infrared and thermometric temperatures will be measured at field locations.	Peoples Republic of China	Radiometric and thermometric temperatures measured using portable thermal infrared spectrometers and surface thermometers.	Pre-launch (?)	None apparent

I. Barton 016	Algorithm validation	Sea surface temperature from ships	Probably along great cir routes	Thermometers and injection temperatures	Post launch	Possibly major however routii SST values will be available from NMC
O. Brown 017V	Algorithm validation	Measures sea surface temperatures from drifting buoys (using Service Argos)	World's oceans	Thermometric sea surface temperature	post launch	If not used in routine preparation of a product, no major impact.
O. Brown, K. Carder 018V	Algorithm validation for MODIS-N sea surface temperature	Obtain sea surface temperatures from ship of opportunity project	Great circle routes in world oceans	Thermometric or injection temperatures	Post launch	None apparently
D. Clark 019V	Algorithm validation	The optical buoy can potentially measure downwelled spectral irradiance, upwelled spectral irradiance, water leaving spectral radiance, diffuse attenuation coefficients, photosyntheticall active phytoplankton, p-igment concentrations, total suspended matter, phaeopigment a concentrations	Locations not presently determined	The buoy will measure previous quantities at several depths. Data will be telemetered back through satellites.	Globally in world's oceans	Potential large impact if these data are used routinely. DADS will need a standard data format for routine use.

J. Parslow 020V	Product validation	This project will measure (in Australian waters) water leaving radiance, ocean color, chlorophyll pigment concentration, sea surface temperature, biological, chemical, and physical properties.	Hobart and other regions a: Australia	Experiment will use airborne ocean color sensor, and surface measured biological, chemical, and physical oceanographic quantities from Hobart.	Post launch	Specialized dat· set to DADS
F. Hoge 021V	Algorithm validation	Chlorophyll pigment concentrations determined from airborne LIDAR measurements.	MId-Atlantic Bight	Remote measure of chlorophyll fluorescence	Post launch	Specialized data sets to DADS
W. Esaias M. Abbott 022V	Algorithm validation	GOFS and JGOFS ships and buoys measurements will determine primary productivity values. Requires surface incident and surface leaving spectral irradiance	Locations not determined at this time.	In-situ measurements of chlorophyll concentrations, suspended pigments, and nutrients.	Post launch	Specialized data sets to DADS
M. Abbott 023V	Algorithm validation	Lagrangian drifters will measure parameters to determine primary productivity	Offshore California	In-situ measurements of chlorophyll derived products and nutrients	Pre and post launch	Specialized data sets to DADS