August 2, 1990

TO: 422/Deputy Project Manager for EOS Instruments

FROM: 900/Director of Earth Sciences

SUBJECT: Descoping Plan for MODIS-N

Per your memorandum of June 22, 1990, a descoping plan for the MODIS observing facility on EOS is provided as an attachment to this memorandum. Each of the items you have requested is discussed in the plan. This input has been developed in cooperation with: R. Weber, MODIS-N Instrument Manager; Dr. W. Barnes, Instrument Scientist, and his colleagues in the Sensor Concepts and Development Branch (Code 925); and the MODIS Science Team through the use of electronic mail and telefax.

We believe that we have met the requirements of your June 22, 1990, memorandum. As general points, I wish to emphasize the following:

a. Both MODIS-N and MODIS-T have already gone through descoping exercises in the past few months with the detailed participation of the MODIS Science Team. In the case of MODIS-T, there were very substantial changes in the performance requirements including reducing the number of bands from 64 to 32, reducing the spatial resolution to 1.1 kilometers, relaxing bandwidth requirements to between 10 and 15 nanometers, and reducing the polarization specification to 2.3% over a limited range of tilt angles. In the case of MODIS-N, discussions with the Science Team resulted in several changes that in the end reduced the number of bands from 40 to 36 or an overall reduction of about 10% in the total complexity, risk, etc., of the instrument.

b. Because of the substantial and documented reductions already implemented for MODIS-T, the attached descope plan does not treat MODIS-T any further.

c. Before any firm descoping plans for MODIS-N in its present form are to be contemplated, it is clear that the proposals from the competitors in the Phase C/D should be in hand. This information would supplement the in-house estimates of cost, complexity, and risk provided up to this time by Goddard personnel.

The characteristics of MODIS relative to science objectives have been derived after considerable thought and study over several years. From a scientific perspective, this effort at identifying descope possibilities has therefore been fairly painful. The Science Team would hope that the Project and Program would do everything possible to minimize the possibilities of reducing the capabilities of MODIS. The information provided in the descope plan for MODIS-N is based upon current knowledge of the instrument design and fabrication. There will undoubtedly be changes in this knowledge as progress into the MODIS-N program is achieved. In any case, please contact me at any time to provide any further input that you may desire.

Vincent V. Salomonson
MODIS Science Team Leader

Attachment

Attachment 5.4

MODIS-N Descoping Plan

Dated: August 1, 1990

Introduction

The following plan responds to the memorandum request from the EOS Deputy Project Manager for EOS Instruments dated June 22, 1990. This descoping plan only covers MODIS-N because MODIS-T has already gone through a very substantial descoping process. For each proposed, MODIS-N descope item, discussion is provided on the subjects listed below. It is noted that the June 22 memorandum requested the inclusion of a very rough estimate of the percent total science lost due to the implementation of a descope action. This has not been done due to the "percentage of what?" problem. We believe that the discussion of the scientific impact will be sufficient.

a. The impact on instrument performance requirements
b. The impact on planned science objectives
c. The schedule impact
d. The latest allowable date for its implementation
e. An estimate of cost saving derived from the proposed descope action

In the following list, after describing the descope item, the discussion of items a - e will follow using the listing above as the guide without reiterating the subject. The following notes apply to all the descoping actions listed.

Note 1: All options are listed in decreasing order of acceptability.

Note 2: It is the strong opinion of the Science Team that firm descoping actions should only be implemented after vendor proposals for Phase C/D have been received and selection made. With this approach new costs estimates can be combined with in-house Goddard estimates thereby allowing more accurate decisions to be made.

Note 3: In all cases calling for eliminating bands, reducing the swath width or field-of-view (FOV), or the instantaneous field-of-view (IFOV) there are reductions in data volume produced by the instrument. This subsequently reduces the cost of data processing over the 15 years covered by the EOS mission. These cost savings have not been estimated, but they could be very considerable.

Specific Options

1. INCREASE IFOV's FROM 856m TO 1000m, ETC

a. Implementing this option will increase the usable signal in each band and will also reduce the data rate from the instrument by an estimated 36%.
b. The impact on the science should be negligible.
c. If this option is implemented by the time of the Systems Study Review (SSR) which is scheduled for 3 months after contract initiation, there should be no schedule impact. If this option is implemented as late as the Preliminary Design Review, then there would be about a 3 month delay in the schedule.
d. Given the above, the latest date for implementation should be at the PDR.
e. A savings of about $2.0 is expected if this option is implemented at the SSR. One-half or $1M in savings would result if the implementation is delayed to the PDR. Furthermore, the cost savings in data costs could be very considerable. Before proceeding to further descoping of MODIS-N, these savings due to data processing should be estimated and given due consideration.

2. RELAX NEDT ON BANDS 33, 34, 35, 36

a. For cloud and atmospheric stability research, the NEDT for these bands can be relaxed by as much as factors of 2 or 3. This change could conceivably allow the instrument to operate at higher temperatures, to use less capable detectors, permit the cooler to operate at high temperatures, or combinations thereof.
b. Implementing this option would affect the accuracy of single pixel results, but for studies using aggregated pixels applicable to a 5 km grid resolution, for example, the impact would probably be negligible.
c. The schedule impact should be negligible if this option is implemented by the time of the PDR. If the implementation is delayed to the Conceptual Design Review, the schedule delay may amount to as much as 3 months.
d. This option should not be implemented later than the CDR.
e. A saving of about $0.5M to $1.0M if implemented by the PDR. Half of these saving would be realized if implementation is delayed to the CDR.

3. RELAX POLARIZATION SPECS TO 2.3%

a. The polarization specifications are persistently difficult and challenging. Reducing the specification from 2.0% to 2.3% simply makes this a more relaxed specification and results in a specification that is the same as the MODIS-T specification.
b. The principal objection to reducing this specification is that it increases the uncertainty in the ocean color observations, in particular. Given the importance of maintaining the highest quality radiometric observations possible in this area, reducing specifications is always of concern.
c. See comment 2c.
d. See comment 2d.
e. The cost savings are estimated to be $0.5M if implemented by the PDR. Half the savings would result if implementation decision occurs at the CDR.

4. ELIMINATE TROPOSPHERIC SOUNDING BANDS 24 AND 26

a. This option would simply reduce the number of bands and contribute to reducing the overall complexity of the instrument.
b. The consideration of eliminating these bands is facilitated because of the assumed presence of the AIRS instrument on the same platform. Eliminating these bands would eliminate the possibility of getting high spatial resolution views of the temperature structure around, for example, mesoscale meteorological systems. The low spatial resolution of the AIRS products will not permit such research efforts. This is a fertile scientific area that would be lost with this option. Band 25 should be retained to allow some characterization of atmospheric state (e.g., stability) and obtain total water vapor to be estimated at high spatial resolution through using this band in combination with bands 27 and 28. c. Same general comment as provided in 1c.
d. Same general comment as provided in 1d.
e. If this option is implemented by the SSR, a cost savings as high as $4M may result. If implementation is delayed to the PDR, cost savings would be about half or $2M.

5. ELIMINATE BANDS 25, 27, AND 28

a. Removing these bands will reduce the complexity of the instrument and related data volume.
b. Removing these bands effectively takes away any possibility for MODIS-N to provide concurrent, registered, relatively high spatial resolution observations of mesoscale or regional variability in tropospheric moisture and temperature. In essence, losing this capability does cut at the heart of some of the exciting atmospheric science presently planned using MODIS data. Such research would have to be done using the AIRS instrument insofar as possible. With this option the bulk of the temperature sounding capability of MODIS is removed. Therefore, if AIRS fails, there is no MODIS backup capability.
c. See comment 1c.
d. See comment 1d.
e. Cost savings for this option are estimated at $6M if implemented by the SSR. Half of these savings are estimated if the implementation decision occurs at the PDR.

6. ELIMINATE BAND 30

a. Removing this band will reduce the complexity of the instrument and related data volume.
b. Removing this band effectively eliminates any possibility of having a concurrent observation registered with other bands that permits removing atmospheric ozone absorption effects in observations of surface features. This is considered particularly important to the scientists wishing to observe ocean color. If this band is not present, then concurrent estimates will have to be obtained from the AIRS instrument on EOS-A. It is recognized that the 9.6 micrometer band estimates of ozone are not as accurate as from the multispectral capability of AIRS (or, better yet from an instrument like the SSBUV or TOMS). However, the delay in getting such an estimate from another instrument and registering to MODIS observations of ocean color, for example, make it clearly preferable to retain this capability if at all possible.
c. See comment 1c.
d. See comment 1d.
e. The cost savings from this option are estimated to be $2M if implemented by the SSR. Half of these savings would result if the descope is accomplished at the PDR.

7. ELIMINATE BANDS 34 AND 36

a. Removing these bands would reduce the complexity of the instrument and also the data volume. In these long wavelength bands, in particular, the challenges to detector technology and related aspects are a little larger than other thermal infrared bands. This is reflected in the cost savings for these bands.
b. Eliminating these bands starts to reduce a capability that is a core capability for the MODIS-N instrument as it relates to cloud climatology. The MODIS-N instrument can provide a unique capability with emphasis on cloud morphology including cloud height. MODIS-N complements considerably the AIRS/AMSU capability at lower spatial resolution. It will be possible to retain a large fraction of this capability (greater than 70%) if both bands are removed and assuming AIRS/AMSU data are readily available. It would be better to approach cost savings progressively by taking only one band (e.g., 36) off first and follow, if needed, by removing band 34. Here again, it must be recognized that cutting these bands very substantially impacts the plans for some of the atmospheric science, as related to global change, planned in conjunction with the use of MODIS-N data.

c. See comment 1c.
d. See comment 1d
e. The costs saving associated with this option are $6M if implemented by the SSR. Half of the savings would be realized if the descope decision is implemented until PDR.

8. REDUCE SWATH WIDTH TO +/-49 DEGREES
   a. Implementing this option will help to reduce the volume and mass of the instrument. In addition, it reduces the data rate by about 11%.
   b. There is very considerable support for approaching daily coverage with MODIS-N as closely as possible. Reducing the scan angle from 55 degrees to 49 degrees diminishes the percent of global coverage on a daily basis from about 89% to approximately 67% (Reference: Memorandum from E. Harrison to EOS IWG Panel Chairmen dated July 13, 1990). For detecting features with high temporal variability such as aerosols, dust storms, cloud features, sea surface temperatures, etc., any decrease in temporal coverage is considered highly objectionable. The option is only presented for +/- 49 degrees in order to retain compatibility with AIRS and, possibly, the HIMMS/MIMR capabilities. Reducing the swath to +/- 45 degrees would retain two-day coverage at 705 km but, of course, further reduce global coverage on a one-day basis.
   c. See comment 1c.
   d. See comment 1d.
   e. Cost savings from this option are estimated at $1M if implemented by the SSR. Half the savings would result from implementation at the PDR.

Conclusions

Eight descoping options have been presented for MODIS-N. The total cost savings to be realized from these options if implemented by the SSR are $22.0-22.5M.

MODIS-N BANDS

BAND	CENTER *	IFOV (m)	WIDTH	PURPOSE
	LAND AND CLOUD BOUNDARIES BANDS			
1	659	214	50	VEG CHLOROPHYLL ABS LAND COVER TRANS.
2	865	214	40	CLOUD AND VEGETATION LAND COVER TRANSF.
	LAND AND CLOUD PROPERTIES BANDS			
3	470	428	20	SOIL, VEG DIFFRNCS
4	555	428	20	GREEN VEGETATION
5	1240	428	20	LEAF/CANOPY PROPRTIES
6	1640	428	20	SNOW/CLOUD DIFFRNCES
7	2130	428	50	LAND & CLOUD PROPRTIES
	OCEAN COLOR BANDS			
8	415	856	15	CHLOROPHYLL
9	443	856	10	CHLOROPHYLL
10	490	856	10	CHLOROPHYLL
11	531	856	10	CHLOROPHYLL
12	565	856	10	SEDIMENTS
13	653	856	15	SEDIMENTS, ATMOSPHERE
14	681	856	10	CHLOR. FLUORESCENCE
15	750	856	10	AEROSOL PROPERTIES
16	865	865	15	AEROSOL/ATM PRPRTS
	ATMOSPHERE/CLOUD BANDS			
17	905	856	30	CLOUD/ATM PROPERTIES
18	936	856	10	CLOUD/ATM PROPERTIES
19	940	856	50	CLOUD/ATM PROPERTIES
	THERMAL BANDS			
20	3.75	856	0.18	SEA SURFACE TEMP
21	3.75	856	0.05	FOREST FIRES/VOLCANOES
22	3.96	856	0.05	CLOUD/SFC TEMPERATURE
23	4.05	856	0.05	CLOUD/SFC TEMPERATURE
24	4.47	856	0.05	TROP TEMP/CLD FRACTION
25	4.52	856	0.05	TROP TEMP/CLD FRACTION
26	4.57	856	0.05	TROP TEMP/CLD FRACTION
27	6.72	856	0.36	MID-TROP HUMIDITY
28	7.33	856	0.30	UPPER-TROP HUMIDITY
29	8.55	856	0.30	SFC TEMPERATURE
30	9.73	856	0.30	TOTAL OZONE
31	11.03	856	0.50	CLOUD/SFC TEMPERATURE
32	12.02	856	0.50	CLOUD/SFC TEMPERATURE
33	13.34	856	0.30	CLD HEIGHT & FRACTION
34	13.64	856	0.30	CLD HEIGHT & FRACTION
35	13.94	856	0.30	CLD HEIGHT & FRACTION
36	14.24	856	0.30	CLD HEIGHT & FRACTION

* BAND CENTER AND BANDWIDTH ARE IN NANOMETERS FOR BANDS 1-19 AND MICROMETERS FOR BANDS 20-36