

I.18

LOCKHEED MARTIN MISSILES & SPACE

ENGINEERING MEMORANDUM

<b>TITLE:</b> EDR Attribute Values for NPOESS	<b>EM NO.</b> 1166
<b>PREPARED BY:</b> K. Hardy, K. Hutchison, Y. Chiu, A. Roche, J. Kumer, R. Stewart, M. Davis, C. Steinkopff	<b>DATE:</b> 16 August 1995
<b>CHECKED BY:</b> D. Paul <i>David Paul 8/18/95</i>	<b>APPROVAL:</b> M. Whitten <i>M. Whitten 8/18/95</i>
<b><u>PURPOSE:</u></b> To complete the specification for the requirements or attributes for the 66 EDRs included in Appendix D: Performance Characteristics dated 11 January 1995.	
<b><u>APPROACH:</u></b> Appendix D provides requirements and goals for some of the EDRs. Requirements or attribute values that apply to several sensor options are established for all of the 66 EDRs through an approach that includes (1) demonstrations of EDR retrievals using available data from meteorological satellites, (2) an assessment of existing satellite sensors for observing the Earth's surface, atmosphere, and space environment, (3) theoretical and empirical studies that simulate the performance of new NPOESS sensors, and (4) interactions with the scientific community that help to define the limits for satellite sensing capabilities over the next 10 years.	
<b><u>SUMMARY AND CONCLUSIONS:</u></b> Requirements or attribute values are established for EDRs that rely on data from an electro-optical imager, a microwave imager, IR and microwave atmospheric sounders, an ozone profiler, several additional atmospheric sensors, and space sensors. The EDR requirements are specified for three options (1) a Design Reference System, (2) a High Cost Option 1, and (3) a High Cost Option 2. Four of the 66 EDRs are not covered by any of the three options; however, EM 1167: "Preliminary Assessment of 4 EDRs Excluded from the NPOESS Options" describes the remote sensing or technical issues that lead to the omission of the EDRs from any of the options. The attributes for each of the EDRs are listed in a separate table within one of the options.	

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### **NOTE ON THE LIST OF EDRs**

There are 66 EDRs listed in the DATA REQUIREMENTS (APPENDIX D, dated 1/11/95). (Three of the EDRs consist of multiple environmental parameters which sub-divide into an additional 5 EDRs ) Of the total of 66 EDRs, 31 form the Low Cost Option, an additional 10 form the Design Reference System for a total of 41; five more are included in High Cost Option #1 for a total of 46. High Cost Option #2 has one EDR that is included in High Cost Option #1 plus 16 new EDRs added to the 41 of the Design Reference System for a total of 58. High Cost Options #1 and 2 include 62 of the 66 EDRs. The remaining four EDRs are not addressed in any of the options; however, potential attribute values for these four have been tabulated. The Key Parameters Option is identical to the Low Cost Option except for the following:

**Low Cost Option:** Horizontal Spatial Resolution for Cloud Imagery is 0.65 km at nadir increasing to 1.3 km at the edge of scan.

**Key Parameters Option:** Horizontal Spatial Resolution for Cloud Imagery is  $\leq 0.65$  km.

## **LIST OF THE 31 EDRS FOR THE LOW COST OPTION\*\***

(The list of EDRs is identical to the Key Parameters Option except for the horizontal spatial resolution which is  $\leq 0.65$  km for the Key Parameters Option.)

- 40.1 Atmospheric Vertical Moisture Profile
- 40.2 Atmospheric Vertical Temperature Profile
- 40.3 Cloud Imagery (Horizontal Spatial Resolution of 0.65 km at nadir and 1.3 km at edge of scan)
- 40.4 Sea Ice
- 40.5 Sea Surface Temperature
- 40.6 Sea Surface Winds
- 40.7 Soil Moisture
- 40.9 Aerosol Optical Thickness
- 40.10 Suspended Matter
- 40.11 Albedo (Surface)
- 40.12 Auroral Boundary
- 40.20 Cloud Cover/Layers
- 40.21 Cloud Base Height
- 40.23 Cloud Liquid Water
- 40.25 Cloud Optical Depth/Transmittance
- 40.26 Cloud Top Pressure
- 40.27 Cloud Top Temperature
- 40.28 Cloud Top Height
- 40.33 Electron Density Profiles/Ionospheric Specification
- 40.35 Fresh Water Ice Concentrations
- 40.37 Ice Surface Temperature
- 40.40 Land Surface Temperature
- 40.43 Net Heat Flux
- 40.50 Precipitable Water
- 40.51 Precipitation (Type, Rate)
- 40.52 Pressure (Surface/Profile)
- 40.55 Snow Cover/Depth
- 40.56 Snow Water Equivalent
- 40.62 Total Water Content
- 40.63 Tropospheric Winds
- 40.65 Vegetation/Surface Type

**\*\*The attribute values of the EDRs for the Low Cost Option and the Key Parameters Option can be found within the 46 (41 EDRs) tables for the Design Reference System.**

## LIST OF THE 41\* EDRS OF THE DESIGN REFERENCE SYSTEM

- |   |  |
|---|--|
| 40.1 Atmospheric Vertical Moisture Profile                | 40.34.1 Supra-thermal/Auroral Particles                          |
| 40.2 Atmospheric Vertical Temperature Profile             | 40.34.2 Radiation Belt/Low Energy Solar Particles                |
| 40.3 Cloud Imagery  | 40.34.3 Solar/Galactic Cosmic Ray Particles                      |
| 40.4 Sea Ice  | 40.35 Fresh Water Ice Concentrations                             |
| 40.5 Sea Surface Temperature                              | 40.36 Geomagnetic Field  |
| 40.6 Sea Surface Winds                                    | 40.37 Ice Surface Temperature                                    |
| 40.7 Soil Moisture  | 40.38.1 In-Situ Plasma Density                                   |
| 40.9 Aerosol Optical Thickness                            | 40.38.2 In-Situ Plasma Temperature                               |
| 40.10 Suspended Matter                                    | 40.38.3 In-situ Ion Drift Velocity                               |
| 40.11 Albedo (Surface)                                    | 40.39.1 Ionospheric Scintillation                                |
| 40.12 Auroral Boundary                                    | 40.39.2 In-Situ Plasma Fluctuations                              |
| 40.14 Auroral Imagery                                     | 40.40 Land Surface Temperature                                   |
| 40.15 Total Auroral Energy Deposition                     | 40.43 Net Heat Flux  |
| 40.16 Upper Atmospheric Airglow                           | 40.46 Neutral Density Profiles/Neutral Atmospheric Specification |
| 40.20 Cloud Cover/Layers                                  | 40.49 Ozone Total Column/Profile                                 |
| 40.21 Cloud Base Height                                   | 40.50 Precipitable Water   |
| 40.23 Cloud Liquid Water                                  | 40.51 Precipitation (Type, Rate)                                 |
| 40.25 Cloud Optical Depth/Transmittance                   | 40.52 Pressure (Surface/Profile)                                 |
| 40.26 Cloud Top Pressure                                  | 40.55 Snow Cover/Depth   |
| 40.27 Cloud Top Temperature                               | 40.56 Snow Water Equivalent                                      |
| 40.28 Cloud Top Height                                    | 40.62 Total Water Content  |
| 40.32 Electric Fields                                     | 40.63 Tropospheric Winds   |
| 40.33 Electron Density Profiles/Ionospheric Specification | 40.65 Vegetation/Surface Type                                    |

- \* Note that (1) 40.34.1, 40.34.2, and 40.34.3 are considered as a single EDR,  
(2) 40.38.1, 40.38.2, and 40.38.3 are considered as a single EDR,  
(3) 40.39.1 and 49.39.2 are considered as a single EDR

## LIST OF THE 46\* EDRS OF THE HIGH COST OPTION 1

**Note:** High Cost Option #1 has the 41 EDRs of the Design Reference System plus five additional EDRs (shown in "**Bold**" type).

- |   |  |
|---|--|
| 40.1 Atmospheric Vertical Moisture Profile                | 40.34.3 Solar/Galactic Cosmic Ray Particles                      |
| 40.2 Atmospheric Vertical Temperature Profile             | 40.35 Fresh Water Ice Concentrations                             |
| 40.3 Cloud Imagery  | 40.36 Geomagnetic Field  |
| 40.4 Sea Ice (see EDRs for the Design Reference System)   | 40.37 Ice Surface Temperature                                    |
| 40.5 Sea Surface Temperature                              | 40.38.1 In-Situ Plasma Density                                   |
| 40.6 Sea Surface Winds                                    | 40.38.2 In-Situ Plasma Temperature                               |
| 40.7 Soil Moisture  | 40.38.3 In-situ Ion Drift Velocity                               |
| 40.9 Aerosol Optical Thickness                            | 40.39.1 Ionospheric Scintillation                                |
| 40.10 Suspended Matter                                    | 40.39.2 In-Situ Plasma Fluctuations                              |
| 40.11 Albedo (Surface)                                    | 40.40 Land Surface Temperature                                   |
| 40.12 Auroral Boundary                                    | 40.43 Net Heat Flux  |
| <b>40.13 Optical Backgrounds</b>                          | 40.46 Neutral Density Profiles/Neutral Atmospheric Specification |
| 40.14 Auroral Imagery                                     | <b>40.48 Ocean Wave Characteristics</b>                          |
| 40.15 Total Auroral Energy Deposition                     | 40.49 Ozone Total Column/Profile                                 |
| 40.16 Upper Atmospheric Airglow                           | 40.50 Precipitable Water   |
| 40.20 Cloud Cover/Layers                                  | 40.51 Precipitation (Type, Rate)                                 |
| 40.21 Cloud Base Height                                   | 40.52 Pressure (Surface/Profile)                                 |
| 40.23 Cloud Liquid Water                                  | <b>40.54 Sea Surface Height/Topography</b>                       |
| 40.25 Cloud Optical Depth/Transmittance                   | 40.55 Snow Cover/Depth   |
| 40.26 Cloud Top Pressure                                  | 40.56 Snow Water Equivalent                                      |
| 40.27 Cloud Top Temperature                               | <b>40.58 Surface Wind Stress</b>                                 |
| 40.28 Cloud Top Height                                    | 40.62 Total Water Content  |
| 40.32 Electric Fields                                     | 40.63 Tropospheric Winds   |
| 40.33 Electron Density Profiles/Ionospheric Specification | 40.65 Vegetation/Surface Type                                    |
| 40.34.1 Supra-thermal/Auroral Particles                   | <b>40.66 Wave Spectral Energy</b>                                |
| 40.34.2 Radiation Belt/Low Energy Solar Particles         |  |

\* Note that (1) 40.34.1, 40.34.2, and 40.34.3 are considered as a single EDR,  
(2) 40.38.1, 40.38.2, and 40.38.3 are considered as a single EDR,  
(3) 40.39.1 and 49.39.2 are considered as a single EDR

## LIST OF THE 58\* EDRS OF THE HIGH COST OPTION 2

**Note:** High Cost Option #2 has the 41 EDRs of the Design Reference System, plus one EDR from High Cost Option #1, and 16 additional EDRs (shown in "**Bold**" type) for a total of 58.

- |   |  |
|---|--|
| 40.1 Atmospheric Vertical Moisture Profile                | 40.34.3 Solar/Galactic Cosmic Ray Particles                      |
| 40.2 Atmospheric Vertical Temperature Profile             | 40.35 Fresh Water Ice Concentrations                             |
| 40.3 Cloud Imagery  | 40.36 Geomagnetic Field  |
| 40.4 Sea Ice  | 40.37 Ice Surface Temperature                                    |
| 40.5 Sea Surface Temperature                              | 40.38.1 In-Situ Plasma Density                                   |
| 40.6 Sea Surface Winds                                    | 40.38.2 In-Situ Plasma Temperature                               |
| 40.7 Soil Moisture  | 40.38.3 In-situ Ion Drift Velocity                               |
| <b>40.8 Aerosol Particle Size</b>                         | 40.39.1 Ionospheric Scintillation                                |
| 40.9 Aerosol Optical Thickness (See EDRs of DRS)          | 40.39.2 In-Situ Plasma Fluctuations                              |
| 40.10 Suspended Matter (See EDRs of DRS)                  | 40.40 Land Surface Temperature                                   |
| 40.11 Albedo (Surface)                                    | <b>40.41 Littoral Sediment Transport</b>                         |
| 40.12 Auroral Boundary                                    | <b>40.42 Longwave Radiation</b>                                  |
| 40.13 Optical Backgrounds (See EDRs of Option #1)         | 40.43 Net Heat Flux  |
| 40.14 Auroral Imagery                                     | <b>40.44 Net Radiation (Top of Atmosphere)</b>                   |
| 40.15 Total Auroral Energy Deposition                     | <b>40.45 Net Surface Shortwave Radiation</b>                     |
| 40.16 Upper Atmospheric Airglow                           | 40.46 Neutral Density Profiles/Neutral Atmospheric Specification |
| <b>40.19 CH<sub>4</sub> Column (Methane)</b>              | <b>40.47 Ocean Color/Chlorophyll</b>                             |
| 40.20 Cloud Cover/Layers                                  | 40.49 Ozone Total Column/Profile                                 |
| 40.21 Cloud Base Height (See EDRs of DRS)                 | 40.50 Precipitable Water   |
| <b>40.22 Cloud Ice Liquid Equivalent</b>                  | 40.51 Precipitation (Type, Rate)                                 |
| 40.23 Cloud Liquid Water                                  | 40.52 Pressure (Surface/Profile)                                 |
| <b>40.24 Cloud Ice Water Path</b>                         | 40.55 Snow Cover/Depth   |
| 40.25 Cloud Optical Depth/Transmittance                   | 40.56 Snow Water Equivalent                                      |
| 40.26 Cloud Top Pressure                                  | <b>40.57 Solar Extreme Ultraviolet (EUV) Flux</b>                |
| 40.27 Cloud Top Temperature                               | <b>40.59 Total Longwave Radiation (Top of Atmosphere)</b>        |
| 40.28 Cloud Top Height                                    | <b>40.60 Total Shortwave Radiation</b>                           |
| <b>40.29 CO Column (Carbon Monoxide)</b>                  | <b>40.61 Total Solar Irradiance (Full Spectrum)</b>              |
| <b>40.31 Currents</b>                                     | 40.62 Total Water Content  |
| 40.32 Electric Fields                                     | 40.63 Tropospheric Winds   |
| 40.33 Electron Density Profiles/Ionospheric Specification | <b>40.64 Turbidity</b>   |
| 40.34.1 Supra-thermal/Auroral Particles                   | 40.65 Vegetation/Surface Type                                    |
| 40.34.2 Radiation Belt/Low Energy Solar Particles         |  |

\* Note that 40.34.1, 40.34.2, and 40.34.3 are considered as a single EDR; 40.38.1, 40.38.2, and 40.38.3 are considered as a single EDR; and 40.39.1 and 40.39.2 are considered as a single EDR.

**LIST OF THE FOUR EDRs NOT ADDRESSED BY THE OPTIONS**

**40.17 Bathymetry**

**40.18 Bioluminescence**

**40.30 CO<sub>2</sub> Column (Carbon Dioxide)**

**40.53 Salinity**

## THE 41\* EDRS OF THE DESIGN REFERENCE SYSTEM

- |   |  |
|---|--|
| 40.1 Atmospheric Vertical Moisture Profile                | 40.34.1 Supra-thermal/Auroral Particles                          |
| 40.2 Atmospheric Vertical Temperature Profile             | 40.34.2 Radiation Belt/Low Energy Solar Particles                |
| 40.3 Cloud Imagery  | 40.34.3 Solar/Galactic Cosmic Ray Particles                      |
| 40.4 Sea Ice  | 40.35 Fresh Water Ice Concentrations                             |
| 40.5 Sea Surface Temperature                              | 40.36 Geomagnetic Field  |
| 40.6 Sea Surface Winds                                    | 40.37 Ice Surface Temperature                                    |
| 40.7 Soil Moisture  | 40.38.1 In-Situ Plasma Density                                   |
| 40.9 Aerosol Optical Thickness                            | 40.38.2 In-Situ Plasma Temperature                               |
| 40.10 Suspended Matter                                    | 40.38.3 In-situ Ion Drift Velocity                               |
| 40.11 Albedo (Surface)                                    | 40.39.1 Ionospheric Scintillation                                |
| 40.12 Auroral Boundary                                    | 40.39.2 In-Situ Plasma Fluctuations                              |
| 40.14 Auroral Imagery                                     | 40.40 Land Surface Temperature                                   |
| 40.15 Total Auroral Energy Deposition                     | 40.43 Net Heat Flux  |
| 40.16 Upper Atmospheric Airglow                           | 40.46 Neutral Density Profiles/Neutral Atmospheric Specification |
| 40.20 Cloud Cover/Layers                                  | 40.49 Ozone Total Column/Profile                                 |
| 40.21 Cloud Base Height                                   | 40.50 Precipitable Water   |
| 40.23 Cloud Liquid Water                                  | 40.51 Precipitation (Type, Rate)                                 |
| 40.25 Cloud Optical Depth/Transmittance                   | 40.52 Pressure (Surface/Profile)                                 |
| 40.26 Cloud Top Pressure                                  | 40.55 Snow Cover/Depth   |
| 40.27 Cloud Top Temperature                               | 40.56 Snow Water Equivalent                                      |
| 40.28 Cloud Top Height                                    | 40.62 Total Water Content  |
| 40.32 Electric Fields                                     | 40.63 Tropospheric Winds   |
| 40.33 Electron Density Profiles/Ionospheric Specification | 40.65 Vegetation/Surface Type                                    |

\* Note that (1) 40.34.1, 40.34.2, and 40.34.3 are considered as a single EDR,  
(2) 40.38.1, 40.38.2, and 40.38.3 are considered as a single EDR,  
(3) 40.39.1 and 49.39.2 are considered as a single EDR.

## 40.1: ATMOSPHERIC VERTICAL MOISTURE PROFILE

<b>40.1: ATMOSPHERIC VERTICAL MOISTURE PROFILE (Derived) [page 1 of 2]</b> Moisture profiles (relative and absolute humidity - mass of water vapor per unit volume of air) throughout the troposphere where moisture is normally measured via radiosonde.			<b>Lockheed PI: Dr. Ken Hardy</b>
<b>Solution Type:</b> Thru nadir scanned MIS for low resolution data in cloudy areas. Thru-nadir scanned IR Sounder for high resolution clear areas		<b>Risk:</b> Medium, Devel Req'd	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS	DESIGN REFERENCE SYSTEM	REMARKS
Horizontal Spatial Resolution	Minimum: TBD Goal: 10 km	50 km	IR for clear areas only
Vertical Sampling Interval	Minimum: Measurement of the total water vapor mass shall be in 20 mb increments between Sfc and 850 mb and 50 mb increments between 850 and 100 mb. Goal: 15 mb increments for all layers	FOR MIS: 6 levels: 150 mb intervals between 1000 and 700 mb; 200 mb intervals from 700 to 500 mb, and 100 mb intervals from 500 to 300 mb. FOR IR SOUNDER: 20 mb increments between Sfc and 850 mb and 50 mb increments between 850 and 100 mb.	MIS profiles for clear areas and clouds with water content $\leq 0.15 \text{ kg/m}^2$ . IR profiles in clear areas only

## 40.1: ATMOSPHERIC VERTICAL MOISTURE PROFILE (cont'd)

<b>40.1: ATMOSPHERIC VERTICAL MOISTURE PROFILE (Derived) [page 2 of 2]</b> <b>Moisture profiles (relative and absolute humidity - mass of water vapor per unit volume of air) throughout the troposphere where moisture is normally measured via radiosonde.</b>			<b>Lockheed PI: Dr. Ken Hardy</b>
<b>Solution Type:</b> Thru nadir scanned MIS for low resolution data in cloudy areas. Thru-nadir scanned IR Sounder for high resolution clear areas		<b>Risk:</b> Medium, Devel Req'd	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS	DESIGN REFERENCE SYSTEM	REMARKS
Measurement Range		0-100% RH; 0-70 kg/m <sup>2</sup> for total nadir-equivalent columnar water vapor	Added attribute
Mapping Accuracy	Minimum: TBD Goal: 1 km	7 km for MIS and IR Sounder	3 $\sigma$ value at edge of scan
Measurement Uncertainty	Minimum: TBD Goal: $\pm 10\%$ RH	FOR MIS: $\pm 15\%$ RH over oceans; $\pm 35\%$ RH over land. FOR IR SOUNDER: $\pm 15\%$ RH over oceans; $\pm 25\%$ RH over land.	1 $\sigma$ values. Requirement shall be for RH averaged over 1-km thick layers
Measurement Precision		1% for RH and 0.01 g/kg for Specific Humidity	Precision row can be added
Refresh	Minimum: TBD Goal: 3 hrs	13 hrs for two satellites	Depends upon cloud and rain climatology;

## 40.2: TEMPERATURE PROFILE

<b>40.2: ATMOSPHERIC VERTICAL TEMPERATURE PROFILE (Derived) [page 1 of 2]</b>		<b>Lockheed PI: Dr. Ken Hardy</b>	
<b>Solution Type:</b> Thru nadir scanned MIS for low resolution data in cloudy areas. Thru-nadir scanned IR Sounder for high resolution clear areas		<b>Risk:</b> Medium, Devel Req'd	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS	DESIGN REFERENCE SYSTEM	REMARKS
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD Goal: 5 km</b>	<b>50 km for MIS at nadir; 15 km for IR sounder at nadir</b>	<b>IR profiles for clear area only</b>
<b>Vertical Sampling Interval</b>	<b>Minimum:</b>  <b>Sfc - 850 mb, 20 mb increments; 850 - 300 mb, 50 mb incs; 300 -100 mb, 25 mb incs; 100 -10 mb, 20 mb incrs; 10 -1 mb, 2 mb incs; 1 - 0.1 mb, 0.2 mb incs; 0.1 - 0.01, 0.02 mb incs.</b>  <b>Goal Intervals: 15 mb inc below 100 mb, TBD above 100 mb</b>	<b>FOR MIS: 16 levels of temperature and geopotential height from sfc to 10 mb.</b>  <b>FOR IR SOUNDER: Sfc - 850 mb, 20 mb increments; 850 - 300 mb, 50 mb incs; 300 -100 mb, 25 mb incs; 100 -10 mb, 20 mb incrs; 10 -1 mb, 2 mb incs; 1 - 0.1 mb, 0.2 mb incs; 0.1 - 0.01, 0.02 mb incs.</b>	<b>For non-precipitating areas only.</b>  <b>For MIS: clear areas and within and below clouds with water content <math>\leq 0.15</math> kg/m<sup>2</sup>.</b>  <b>For IR sounder: Clear areas over the entire IFOV only</b>
<b>Measurement Range</b>		<b>170 - 330 K</b>	<b>Added Attribute</b>

## 40.2: TEMPERATURE PROFILE (cont'd)

<b>40.2: ATMOSPHERIC VERTICAL TEMPERATURE PROFILE (Derived) [page 2 of 2]</b>			<b>Lockheed PI: Dr. Ken Hardy</b>
<b>Solution Type: Thru-nadir scanned MIS for low resolution data in cloudy areas. Thru-nadir scanned IR Sounder for high resolution clear areas</b>		<b>Risk: Medium, Devel Req'd</b>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS	DESIGN REFERENCE SYSTEM	REMARKS
<b>Mapping Accuracy</b>	<b>Minimum: TBD Goal: 1 km</b>	<b>7 km</b>	<b>3<math>\sigma</math> value at edge of scan</b>
<b>Measurement Uncertainty</b>	<b>Minimum: TBD Goal: <math>\pm 0.5</math> K</b>	<b>For MIS:</b> $\pm 5$ K surface, 1000 mb, and tropopause levels; $\pm 2.5$ K, 925 to 10 mb,  <b>For IR Sounder:</b> $\pm 1.25$ K for surface to 10 mb; $\pm 3$ K 10 mb to 0.01 mb	<b>1<math>\sigma</math> values</b>  <b>1<math>\sigma</math> values for total profile</b>
<b>Measurement Precision</b>		<b><math>\pm 0.5</math> K</b>	<b>Precision can also be specified</b>
<b>Refresh</b>	<b>Minimum: TBD, globally Goal: 3 hrs</b>	<b>13 hours</b>	<b>See remarks for Vertical Sampling Interval</b>

## **CLOUD IMAGERY (page 1 of 2)**

**The capability to generate visible and infrared (IR) imagery in a displayable EDR format shall be provided. Daytime and nighttime visible imagery shall have a minimum apparent transition across the terminator. Striping in the visible/IR derived SDR and EDR imagery due to pixel nonuniformity shall be minimized and shall not affect the utility of the data. Geometrical distortion in the visible/IR imagery shall be minimized and shall not affect the utility of the imager. Absolute calibration of the radiances at all frequencies is required.**

**The horizontal resolution for processed cloud data (cover, type, and height) is defined by the resolution of the Nephanalysis mesh at the weather central. Current practice is to use a polar stereographic map projection for which each hemisphere is overlaid with a 512 x 512 square grid (called "eighth mesh"), which is true at 60 degrees latitude, i.e., the quoted geographical grid size of the mesh (25nm or 40km) is true at 60 degrees latitude. A future upgrade would be the implementation of a sixteenth mesh (20km) grid.**

**Imagery must be at sufficient resolution to enable analysts to discern atmospheric phenomena from cloud types to planetary scale ( $10^7$  m) weather patterns. At a minimum, classification of detected stratus, cirrus, and cumulus clouds is required. The goal for this system is to be able to identify all 18 cloud types as defined in AFI 15-111, Vol. I.**

### 40.3: CLOUD IMAGERY (page 2 of 2)

<b>40.3: CLOUD IMAGERY (Measured)</b> <b>[page 2 of 2]</b>			<b>Lockheed PI:</b> <b>Greg Logan</b>	
<b>Solution Type: Visible and IR Imager</b>				<b>Risk: Low</b>
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM	REMARKS
	MINIMUM	GOAL		
<b>Horizontal Spatial Resolution</b>				
1. Global	2.4 km	0.65 km	2.4 km global;	
2. Regional	0.65 km	0.1 km	0.65 km regional	
<b>Mapping Accuracy</b>	TBD	1 km	3 km	<b>3<math>\sigma</math> value at edge of scan</b>
<b>Refresh (Centrals and Field)</b>	4 hrs	1 hr	5.5 hrs	<b>Based on 3 satellites</b>

## 40.4: SEA ICE (page 1 of 3)

40.4: SEA ICE (page 1 of 3; Derived)		RISK: Low for EO & MIS Imagery; High for SAR		Lockheed PI: Mike Davis	
DATA REQUIREMENTS (APPENDIX D, 1/11/95) ***NOTE*** Vertical Sampling for ice thickness removed as per RI #3	SPECIFICATIONS		DESIGN REFERENCE SYSTEM		HIGH COST 1
	MINIMUM	GOAL	OASIS	MIS	SAR
<b>Sensing Depth</b>	ice surface	3 m	Ice surface	Ice surface	0.04 to 5 m (ice type)
<b>Horizontal Spatial Resolution</b>					
1. ice edge boundary	600 m	100 m	650 m at edge of scan	12.5 - 50 km	600 m
2. ice concentration	600 m	100 m	650 m	12.5 - 50 km	600 m
3. age	1000 m	100 m	N/A	12.5 - 50 km	600 m
4. leads/polynyas (width)	600 m	100 m	650 m		600 m
<b>Mapping Accuracy</b>	3000 m	1000 m	4000 m	7000 m	60 m

## 40.4: SEA ICE (page 2 of 3)

40.4: SEA ICE (page 2 of 3; Derived)		RISK: Low for EO & MIS Imagery; High for SAR		Lockheed PI: Mike Davis	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM		HIGH COST 1
	MINIMUM	GOAL	OASIS	MIS	SAR
<b>Measurement Range</b>					
1. ice edge boundary	600 to 1000 m	100 to 600 m	ice/no ice	ice/no ice	ice/no ice
2. ice concentration	1/10 to 10/10 cover	0/10 to 10/10 cover	0/10 or 10/10	0/10 to 10/10 cover	0/10 to 10/10 cover
3. age	1 to 36+ mos	TBD	N/A	new or multi-year	1 to 36+ mons
4. ice thickness	TBD	0-25 m	N/A	≤0.01 m or >0.01 m (new ice only)	0-5 m
5. ice motion	600 to 1000 m/day	0 to 100 m/day	0-2 km/day (clear scenes only)	N/A	600 to 2000 m per refresh period
6. leads/polynyas	600 to 1000 m	100 to 600 m	650 m	12.5-50 km	600 to 1000 m

## 40.4: SEA ICE (page 3 of 3)

40.4: SEA ICE (page 3 of 3; Derived)		RISK: Low for EO & MIS Imagery; High for SAR		Lockheed PI: Mike Davis	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM		HIGH COST 1
	MINIMUM	GOAL	OASIS	MIS	SAR
<b>Measurement Uncertainty</b>					
<b>1. ice edge boundary</b>	±10%	±5%	4 km (worst mapping accuracy)	12.5 to 50 km	±10% or 60 m (mapping accuracy)
<b>2. ice concentration</b>	±20%	±10%	±20%	±20%	±10%
<b>3. age</b>	separation of 1 yr old and 2+ yr old ice with 70% area defined correctly	separation of <1 yr old (new) ice, 1 yr old (first year) and 2+ yr old (multi-year) ice with 90% of area defined correctly	N/A	First and multi-year ice with 70% area defined correctly	separation of 1 yr old and 2+ yr old ice with 70% area defined correctly
<b>4. ice thickness</b>	TBD	0.2 m	N/A	new ice: <0.01 or >0.01 m	±2 m
<b>5. ice motion</b>	1000 m/day	100 m/day	1000 m/day (clear only)	N/A	600 m/day
<b>6. leads/polynyas</b>	±10%	±5%	4 km	12.5 to 50 km	±10% or 60 m
<b>Refresh</b>	24-48 hrs	Goal: 12 hours	24 hours (clear only)	24 hours	72 hrs

## 40.5 SEA SURFACE TEMPERATURE

<b>40.5: SEA SURFACE TEMPERATURE (Derived)</b> Temperature of the water at the sea/atmosphere boundary				<b>Lockheed PI: Dr. Keith Hutchison</b>
<b>Solution Type: EO Imagery</b>				<b>Risk: Low</b>
<b>DATA REQUIREMENTS (APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>DESIGN REFERENCE SYSTEM</b>	<b>REMARKS</b>
<b>Horizontal Spatial Resolution</b>	<b>Minimum</b>	<b>Goal</b>		
1. global	4 km	1 km	4 km	
2. coastal	TBD	0.25 km	4 km	
<b>Measurement Uncertainty</b>	<b>Minimum: 0.5° C</b>	<b>Goal: 0.25° C</b>	<b>0.5° C</b>	<b>Uses total integrated water vapor from MIS</b>
<b>Measurement Range</b>	<b>Minimum: TBD</b>	<b>Goal: -2 to 40° C</b>	<b>-2 to 40° C</b>	
<b>Precision</b>	<b>Minimum: TBD</b>	<b>Goal: ±0.1° C</b>	<b>±0.1° C</b>	
<b>Mapping accuracy</b>	<b>Minimum</b>	<b>Goal:</b>		
1. global	TBD	0.5 km	4 km	<b>3σ at edge of scan</b>
2. coastal	TBD	0.25 km	4 km	
<b>Refresh</b>	<b>Minimum: 6 hrs</b>	<b>Goal: 3 hours</b>	<b>5.5 hours for clear areas</b>	<b>Depends on cloud coverage</b>

## 40.6: SEA SURFACE WINDS

<b>40.6: SEA SURFACE WINDS (Derived)</b> <b>Measure of atmospheric wind speed/direction at the sea/atmosphere interface. Wind speed at the sea surface as a threshold, speed and direction as an objective.</b>				<b>Lockheed PI:</b> <b>Mike Davis</b>
<b>Solution Type: Conically scanned MIS*</b>			<b>Risk: Low</b>	
<b>DATA REQUIREMENTS</b> <b>(APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>DESIGN REFER-</b> <b>ENCE SYSTEM</b>	<b>REMARKS</b>
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 1 km</b>	<b>50 km</b>	
<b>Mapping Accuracy</b>  <b>1. global</b>  <b>2. regional</b>	<b>Minimum</b>  <b>30 km global</b>  <b>10 km regional</b>	<b>Goal:</b>  <b>20 km global</b>  <b>1 km regional</b>	  <b>7 km</b>  <b>7 km</b>	
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: <math>\pm 10\%</math> for speed; <math>\pm 20</math> deg for direction</b>	<b><math>\pm 2</math> m/s (<math>1\sigma</math>) for speed; no directional information</b>	<b>Clear, cloudy, and rain <math>\leq 2</math> mm/hr</b>
<b>Precision</b>	<b>Minimum: TBD</b>	<b>Goal: <math>\pm 0.1</math> m/s for speed <math>\pm 10</math> deg for direction</b>	<b><math>\pm 0.1</math> m/s for speed; no directional measurement</b>	
<b>Refresh</b>	<b>Minimum: 6 hrs</b>	<b>Goal: 1 hr</b>	<b>9 hours</b>	<b>No refresh for rain <math>&gt; 10</math> mm/hr</b>
<b>Measurement Range</b>			<b>3 to 25 m/s</b>	<b>Suggest "Measurement Range" be added</b>

\* NOTE: Additional information on the sea surface and winds obtained from both SAR and a radar altimeter.

## 40.7 SOIL MOISTURE

<b>40.7: SOIL MOISTURE (Derived)</b> Measure of moisture on (surface) or within (subsurface) soil.				<b>Lockheed PI:</b> <b>Mike Davis</b>
<b>Solution Type: Conically scanned MIS*</b>				<b>Risk: Low</b>
<b>DATA REQUIREMENTS</b> <b>(APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>DESIGN REFER-</b> <b>ENCE SYSTEM</b>	<b>REMARKS</b>
<b>Sensing Depth</b>	<b>Minimum: Surface</b>	<b>Goal: Surface to -80 cm</b>	<b>Surface to 0.1cm</b>	
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 2 km</b>	<b>50 km</b>	
<b>Vertical Sampling Interval</b>	<b>Minimum: TBD</b>	<b>Goal: 5 cm</b>	<b>N/A</b>	
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: 1 km</b>	<b>7 km</b>	
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: <math>\pm 1</math> cm/m<sup>2</sup></b>	<b><math>\pm 1.5</math> cm (API) (assumed to be over a unit area)</b>	<b>Estimate API from <math>\mu</math>wave brightness temp. Bare soils and vegetation &lt;10 cm only</b>
<b>Measurement Precision</b>			<b>0.5 cm (API)</b>	
<b>Refresh</b>	<b>Minimum: 6 hrs</b>	<b>Goal: 3 hrs</b>	<b>9 hours</b>	<b>Worst case with 100% coverage</b>
<b>Measurement Range</b>			<b>0 to 8 cm (API)</b>	<b>"Measurement Range" added</b>

**\*NOTE: Improved information on soil moisture obtained at radiometer frequencies of 10 and 6.8 GHz.**

## 40.9 AEROSOL OPTICAL THICKNESS

<b>40.9: AEROSOL OPTICAL THICKNESS (Derived)</b> <b>Vertical visibility</b>			<b>Lockheed PI:</b> <b>Dr. Keith Hutchison</b>	
<b>Solution Type: EO Imagery, Lidar</b>			<b>Risk: Medium</b>	
<b>DATA REQUIREMENTS (APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>DESIGN REFERENCE SYSTEM</b>	<b>HIGH COST 2: LIDAR</b>
<b>Sensing Depth</b>	<b>Minimum: Sfc to 15 km</b>	<b>Goal: Sfc to 30 km</b>	<b>Sfc to 30 km (clear areas only)</b>	<b>Sfc to 30 km</b>
<b>Horizontal Spatial Resolution</b>	<b>Minimum: 10 km</b>	<b>Goal: 1 km</b>	<b>10 km</b>	<b>1 km</b>
<b>Vertical Sampling Interval</b>	<b>Minimum: 0-2 km, 0.5 km intervals; 2-5 km, 1 km intervals; &gt;5 km, 2 km intervals</b>	<b>Goal: 0-2 km, 0.25 km intervals; 2-5 km, 0.5 km intervals; &gt;5 km, 1 km intervals</b>	<b>Total Column, sfc to 30 km</b>	<b>Minimum: 0-2 km, 0.5 km intervals; 2-5 km, 1 km intervals; &gt;5 km, 2 km intervals</b>
<b>Mapping Accuracy</b>	<b>Minimum: 4 km</b>	<b>Goal: 1 km</b>	<b>4 km</b>	<b>1 km</b>
<b>Measurement Range</b>	<b>Minimum: TBD</b>	<b>Goal: 0 - 50 km</b>	<b>0.1 to 2 for visible spectrum*</b>	<b>0.1 to 2 for visible spectrum*</b>
<b>Precision</b>	<b>Minimum: 0.03</b>	<b>Goal: 0.01</b>	<b>0.03*</b>	<b>0.03*</b>
<b>Measurement Uncertainty</b>	<b>Minimum: 0.05 to 0.10</b>	<b>Goal: 0.01 to 0.03</b>	<b>0.1*</b>	<b>0.1*</b>
<b>Refresh</b>	<b>Minimum: 12 hrs</b>	<b>Goal: 4 hrs</b>	<b>11 hours</b>	<b>12 hours for nadir view only</b>

**\*NOTE: Values are for Aerosol Optical Thickness and need confirmation**

## 40.10: SUSPENDED MATTER

<b>40.10: SUSPENDED MATTER (Derived)</b>			<b>Lockheed PI: Dr. Keith Hutchison</b>	
<b>Solution Type: EO Imagery, Lidar</b>			<b>Risk: Medium</b>	
<b>DATA REQUIREMENTS (APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>DESIGN REFERENCE SYSTEM</b>	<b>HIGH COST 2: LIDAR</b>
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 1 km</b>	<b>10 km</b>	<b>1 km nadir view only</b>
<b>Vertical Sampling Interval</b>	<b>Minimum: TBD</b>	<b>Goal: 0.2 km,</b>	<b>Stratosphere or troposphere</b>	<b>1 km nadir view only</b>
<b>Measurement Range</b>	<b>Minimum:</b>	<b>Goal</b>		
<b>1. Detect Aerosols</b>	<b>dust, sand, and ash</b>	<b>dust, sand, ash, and sea salt</b>	<b>Dust,sand, &amp; ash</b>	<b>Dust,sand, &amp; ash</b>
<b>2. Radioactive/Smoke Plumes</b>	<b>TBD</b>	<b>0-100µg/m<sup>3</sup> (smoke)</b>	<b>50 - 100 µg/m<sup>3</sup></b>	<b>20 - 100 µg/m<sup>3</sup></b>
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>50% incorrect aerosol type*</b>	<b>50% incorrect aerosol type*</b>
<b>Precision</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>Dust, sand or ash*</b>	<b>Dust, sand or ash*</b>
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>4 km</b>	<b>4 km</b>
<b>Refresh</b>	<b>Minimum: TBD</b>	<b>Goal: 3 hrs</b>	<b>11 hours</b>	<b>12 hours for nadir view only</b>

\*NOTE: Values need confirmation

## 40.11: ALBEDO

<b>40.11: ALBEDO (SURFACE) (Derived)</b>			<b>Lockheed PI: Dr. Keith Hutchison</b>	
<b>Solution Type: EO Imagery</b>			<b>Risk: Low</b>	
<b>DATA REQUIREMENTS (APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>DESIGN REFERENCE SYSTEM</b>	<b>REMARKS</b>
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 0.5 km</b>	<b>0.65km</b>	<b>Clear areas only</b>
<b>Vertical Sampling Interval</b>	<b>Minimum: TBD</b>	<b>Goal: 1 km</b>	<b>Surface only</b>	<b>Ambiguous "Goal"</b>
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: 10 km</b>	<b>4 km</b>	
<b>Measurement Range</b>	<b>Minimum: TBD</b>	<b>Goal: 0 - 100%</b>	<b>0 - 100%</b>	<b>Band dependent</b>
<b>Precision</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>0.1%</b>	<b>10 bit data</b>
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: ±1.25%</b>	<b>5%</b>	
<b>Refresh</b>	<b>Minimum: 6 hrs</b>	<b>Goal: 4 hrs</b>	<b>11 hrs in clear (daytime) areas</b>	<b>Depends on cloud free areas</b>

## 40.12: AURORAL BOUNDARY

<b>40.12: AURORAL BOUNDARY (Derived)</b> The boundary of the auroral zone, a roughly oval shaped region at high latitudes in which auroral disturbances occur.*			Lockheed PI: Dr. Yam Chiu	
Solution Type: MEPS, GPSR, ABIS			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM	REMARKS
Coverage	Minimum: Global	Goal Global	MEPS: along track global only; ABIS: 100 km cross track; GPSR: 1000 km cross track	Model reqd to integrate data from various sensors
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	MEPS: 2 km along track; ABIS: 10 km along swath; GPSR: 2-1000 km depending on geometry	Model reqd to integrate data from various sensors
Mapping Accuracy	Minimum: TBD	Goal: 10 km	Better than 10 km (w/GPS)	Model reqd to integrate data from various sensors
Measurement Range	Minimum: TBD	Goal: Global	Global (w/model); along constellation swath without model	Model reqd to integrate data from various sensors
Precision	Minimum: TBD	Goal: 10 km	10 km (along track only)	Impacted by data integration into model
Measurement Uncertainty	Minimum: TBD	Goal: 10 km	10 km (along track only)	Impacted by data integration into model
Refresh	Minimum: 2/orbit	Goal: 15 min	2/orbit	15 min not possible for global coverage

\*This is a key parameter in modeling magnetosphere environment

## 40.14: AURORAL IMAGERY (page 1 of 2)

40.14: AURORAL IMAGERY (Derived)*			Lockheed PI: Dr. Yam Chiu	
Solution Type: ABIS, Low-Light Sensor, NADIS			Risk: Low to Medium	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFER- ENCE SYSTEM	REMARKS
Coverage	Minimum: TBD	Goal: Global	Along const. swaths only	Global not pos. @ 800 km orbit
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	10 km along track only; ~ 30 km at edge of swath	
Mapping Accuracy	Minimum: TBD	Goal: 10 km	10 km (w/GPS) along track; 30 km for edge of swath	
Measurement Range	Minimum:	Goal:		
1. wavelength	TBD	IR, visible, UV, and/or X-ray	UV, (IR, visible)	Long wave IR and X-ray req separate instruments
2. IR	TBD	TBD	No measurement range for IR band	7 year life achievable
3. visible	TBD	TBD	$10^4 - 10^6$ R	
4. UV	TBD	0.5-15 kR @ 121.6 nm, 0.1-20 kR @ 130.4 nm, 0.05-4 kR @ 135.6 nm, 0.05-5 kR @ 140-180 nm	0.5-15 kR @ 121.6 nm, 0.1-20 kR @ 130.4 nm, 0.05-4 kR @ 135.6 nm, 0.05-5 kR @ 140-180 nm	7 year life achievable FUV sensor life is much less than 7 years
5. X-ray	TBD	TBD	$\geq 10$ Kev	Not manifested in SESS due to limited utility. Can be added to SES if cost not a factor

\* Obtaining auroral images in various wavelengths. Images change rapidly in space, time, and wavelength. Also key parameter magnetosphere environment models

**40.14: AURORAL IMAGERY (page 2 of 2)**

<b>40.14: AURORAL IMAGERY (Derived)</b>			<b>Lockheed PI: Dr. Yam Chiu</b>	
<b>Solution Type: ABIS, Low-light sensor, NADIS</b>			<b>Risk: Low to Medium</b>	
<b>DATA REQUIREMENTS (APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>DESIGN REFERENCE SYSTEM</b>	<b>REMARKS</b>
<b>Precision</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>10 %</b>	<b>Reference not clear*</b>
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: 5%</b>	<b>10 % per pixel</b>	<b>Reference not clear*</b>
<b>Refresh</b>	<b>Minimum: each orbit</b>	<b>Goal: 30 min</b>	<b>Earth Orbit: Neither min nor goal achievable because aurora changes rapidly in space, time, and wavelength. Images from orbit to orbit have little correlation due to changes in time, orbit location, and auroral condition. Goal of 30 min not possible with 3 sats at 800 km. Auroras are keyed to magnetic fields and solar-interplanetary conditions, so concept of "refresh" has to be defined for such a case</b>	

\* It is not clear what and how to define "Precision" and "Measurement Uncertainty" for an image. Do we go to pixel level or EDR Image recognition level?

## 40.15: TOTAL AURORAL ENERGY DEPOSITION

<b>40.15: TOTAL AURORAL ENERGY DEPOSITION</b> (Physical heat input parameter required for models of atmospheric densities.)			<b>Lockheed PI: Dr. Yam Chiu</b>	
<b>Solution Type: MEPS</b>			<b>Risk: Low</b>	
<b>DATA REQUIREMENTS (APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>DESIGN REFERENCE SYSTEM</b>	<b>REMARKS</b>
<b>Coverage</b>	<b>Minimum: Auroral Zone</b>	<b>Goal: Auroral Zone</b>	<b>Auroral zone</b>	<b>Min and goal are in statistical sense</b>
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 10 km</b>	<b>10 km along track 0 km cross track</b>	<b>A sort of cross track info can be obtained by correlation with auroral imagery data, but results are statistical and can hardly be quantitative</b>
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: 10 km</b>	<b>10 km (w/GPS)</b>	
<b>Measurement Range</b>	<b>Minimum: TBD</b>	<b>Goal: electrons: 10<sup>-5</sup> - 1 W m<sup>-2</sup>  ions: 10<sup>-5</sup> - 10<sup>-1</sup> W m<sup>-2</sup></b>	<b>Electrons: 10<sup>-5</sup> - 1 W m<sup>-2</sup>  ions: 10<sup>-5</sup> - 10<sup>-1</sup> W m<sup>-2</sup></b>	
<b>Precision</b>	<b>Minimum:</b>	<b>Goal:</b>		<b>1. Reqs complex cal for 5% flux accuracy which is energy dependent</b>
<b>1. Flux</b>	<b>TBD</b>	<b>5%</b>	<b>1. 10%</b>	
<b>2. Mean Energy</b>	<b>TBD</b>	<b>20%</b>	<b>2. 20%</b>	
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: 10%</b>	<b>10%**</b>	

**\*\* Does not include sensitivity differences of sensors on different spacecraft. Historical records indicate inter-calibration differences of as much as a factor of 2 between NOAA-6 and TIROS-N.**

## 40.16: UPPER ATMOSPHERE AIRGLOW (page 1 of 2)

<b>40.16: UPPER ATMOSPHERE AIRGLOW (Derived)</b> Measurements of airglow in the extreme and far ultraviolet portions of the spectrum can be used to infer the density of upper atmospheric neutral and ionized constituents.			<b>Lockheed PI: Dr. Yam Chiu</b>	
<b>Solution Type: ABIS, NADIS</b>			<b>Risk: Low to Medium: ABIS    NADIS</b>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM	REMARKS
<b>Coverage</b>	<b>Minimum: TBD</b>	<b>Goal: Global</b>	<b>Constellation swaths only</b>	No global model to integrate data exists
<b>Sensing Depth</b>	<b>Minimum: TBD</b>	<b>Goal: 80 - 750 km</b>	<b>100 - 750 km*</b>	
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 10 km</b>	10 km (w/GPS) along track; >200 km cross track	
<b>Vertical Sampling Interval</b>	<b>Minimum: TBD</b>	<b>Goal: 5 km</b>	<b>10 km (NADIS)</b>	ABIS very coarse vertical
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: 10 km</b>	10 km along track; ~30 km @ edge of scan (ABIS); 200 km cross track (NADIS)	
<b>Measurement Range</b>	<b>Minimum: TBD</b>	<b>Goal:</b>		
1. Limb	TBD	10-1000 R @ 83.4 nm, 0.1-10 kR @ 135.6 nm, 0.1-30 kR @ 140-180 nm	10-1000 R @ 83.4 nm, 0.1-10 kR @ 135.6 nm, 0.1-30 kR @ 140-180 nm (NADIS)	
2. Disk	TBD	0.5-30 kR @ 121.6 nm, 1-4000 R @ 135.6 nm, 1-5000 R @ 140-180 nm	0.5-30 kR @ 121.6 nm, 1-4000 R @ 135.6 nm, 1-5000 R @ 140-180 nm (ABIS)	

\* Highly line specific and dependent on solar illumination; 80 km region cannot be resolved for the FUV lines as seen from 800 km; sensing depth here is meant in the integration sensing and does not involve vertical resolution of the EDR.

\*\* Because of optical thickness problems with some of the lines, "Vertical Sampling Interval" does not imply vertical resolution of EDR.

## 40.16: UPPER ATMOSPHERE AIRGLOW (page 2 of 2)

<b>40.16: UPPER ATMOSPHERE AIRGLOW (Derived)</b> <b>Measurements of airglow in the extreme and far ultraviolet portions of the spectrum can be used to infer the density of upper atmospheric neutral and ionized constituents.</b>			<b>Lockheed PI:</b> <b>Dr. Yam Chiu</b>	
<b>Solution Type: ABIS, NADIS</b>			<b>Risk:</b> <b>Low to Medium</b> <small>ABIS      NADIS</small>	
<b>DATA REQUIREMENTS (APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>DESIGN REFERENCE SYSTEM</b>	<b>REMARKS</b>
<b>Precision</b>	<b>Minimum: none at this time</b>	<b>Goal: TBD</b>	<b>N/A</b>	<b>Modeling reqd to determine stat precision</b>
<b>Measurement Uncertainty</b>	<b>Minimum: none at this time</b>	<b>Goal: 5%</b>	<b>5% impossible to maintain over instrument life, which will be much less than 7 years</b>	
<b>Refresh</b>	<b>Minimum: each orbit</b>	<b>Goal: 30 min</b>	<b>Once each orbit</b>	<b>30 min not possible w/3 sat constellation</b>

## 40.20: CLOUD COVER/LAYERS

<b>40.20: CLOUD COVER/LAYERS (Derived)</b> <b>Separate distinct cloud levels/coverage.</b>			<b>Lockheed PI:</b> <b>Dr. Keith Hutchison</b>	
<b>Solution Type: EO Imagery</b>			<u><b>Risk: Low</b></u>	
<b>DATA REQUIREMENTS (APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>DESIGN REFERENCE SYSTEM</b>	<b>REMARKS</b>
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>0.65 km</b>	
<b>Vertical Sampling Interval</b>	<b>Minimum: TBD</b>	<b>Goal: 300 m increments</b>	<b>1.5 km</b>	<b>with MIS temp profile</b>
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: 1 km</b>	<b>4 km</b>	
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: ±10%</b>	<b>±15 %</b>	<b>May meet goal with 1.38 micron band</b>
<b>Refresh</b>	<b>Minimum: TBD</b>	<b>Goal: 4 hrs</b>	<b>5.5 hours</b>	<b>Worst case for 105% coverage</b>

## 40.21: CLOUD BASE HEIGHT

<b>40.21: CLOUD BASE HEIGHT (Derived)</b>			<b>Lockheed PI: Dr. Keith Hutchison</b>	
<b>Solution Type: Combined EO and MIS Imagers, &amp; Moisture Sounder; Lidar for thin cirrus.</b>			<b>Risk: High</b>	
<b>DATA REQUIREMENTS (APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>DESIGN REFERENCE SYSTEM</b>	<b>HIGH COST 2: LIDAR</b>
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 10 km</b>	<b>50 km</b>	<b>10 km for thin clouds only at nadir</b>
<b>Vertical Sampling Interval</b>	<b>Minimum: TBD</b>	<b>Goal: Sfc to 30 km, 0.25 km</b>	<b>Sfc to 10 km, 2 km*</b>	<b>Sfc to 10 km, 1 km for thin clouds only at nadir*</b>
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: 1 km</b>	<b>2 km*</b>	<b>1 km for thin clouds only at nadir*</b>
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: 1 km</b>	<b>4 km (3<math>\sigma</math>)</b>	<b>1 km</b>
<b>Refresh</b>	<b>Minimum: TBD</b>	<b>Goal: 4 hrs</b>	<b>13 hours</b>	<b>12 hours nadir view only</b>

\*Values need to be confirmed.

## 40.23: CLOUD LIQUID WATER

<b>40.23: CLOUD LIQUID WATER (Derived)</b> <b>Measurement of water equivalent within clouds.</b>			<b>Lockheed PI:</b> <b>Dr. Keith Hutchison</b>	
<b>Solution Type: MISS</b>			<b><u>Risk: Low</u></b>	
<b>DATA REQUIREMENTS (APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>DESIGN REFERENCE SYSTEM</b>	<b>REMARKS</b>
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 5 km</b>	<b>50 km</b>	<b>Over ocean surfaces only</b>
<b>Vertical Sampling Interval</b>	<b>Minimum: TBD</b>	<b>Goal: 0.3 km</b>	<b>Total column</b>	<b>Lidar needed for vert intvl</b>
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: <math>\pm 0.01</math> mm</b>	<b><math>\pm 0.06</math> mm</b>	<b>Based on MIS simulations</b>
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: 1 km</b>	<b>7 km</b>	
<b>Refresh</b>	<b>Minimum: TBD</b>	<b>Goal: 4 hrs</b>	<b>9 hours</b>	<b>Worst case</b>

## 40.25: CLOUD OPTICAL DEPTH / TRANSMITTANCE

<b>40.25: CLOUD OPTICAL DEPTH/TRANSMITTANCE</b> (Derived) Measurement of cloud optical thickness and emissivity in the visible and IR portions of the spectrum.			<b>Lockheed PI:</b> <b>Dr. Keith Hutchison</b>	
<b>Solution Type: IR Profiler</b>			<b>Risk: Medium</b>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM	REMARKS
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	15 km at nadir	IR profiler may meet goal at nadir
Measurement Uncertainty	Minimum: TBD	Goal: $\pm 5\%$	$\pm 10\%$ for emissivity from 0.6 to 1 and $\pm 20\%$ for emissivity from 0.1 to 0.5	Applies only to single layers of thin cirrus clouds
Mapping Accuracy	Minimum: TBD	Goal: 10 km	7 km	
Refresh	Minimum: TBD	Goal: 3 hrs	20.5 hours	Worst case for 81% AIRS coverage

## 40.26: CLOUD TOP PRESSURE

<b>40.26: CLOUD TOP PRESSURE (Derived)</b> Derived pressure at cloud tops.			<b>Lockheed PI:</b> <b>Dr. Keith Hutchison</b>	
<b>Solution Type: EO Imager, IR profiler, AMSU-A1 &amp; A2 heritage</b>			<b>Risk: Low</b>	
<b>DATA REQUIREMENTS</b> (APPENDIX D, 1/11/95)	<b>SPECIFICATIONS</b>		<b>DESIGN</b> <b>REFERENCE</b> <b>SYSTEM</b>	<b>REMARKS</b>
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 10 km</b>	<b>0.65 km</b>	<b>15 km for IR profiler and 50 km for MIS profiler</b>
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: 30 mb</b>	<b>50 mb (water clouds)</b>	<b>50-100 mb (ice clouds)</b>
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: 10 km</b>	<b>4 km</b>	<b>7 km</b>
<b>Refresh</b>	<b>Minimum: TBD</b>	<b>Goal: 6 hrs</b>	<b>13 hours</b>	<b>81% coverage for AMSUs</b>

## 40.27: CLOUD TOP TEMPERATURE

<b>40.27: CLOUD TOP TEMPERATURE (Derived)</b>			<b>Lockheed PI: Dr. Keith Hutchison</b>	
<b>Solution Type: EO Imager, IR and MIS profilers</b>			<b>Risk: Low</b>	
<b>DATA REQUIREMENTS (APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>DESIGN REFERENCE SYSTEM</b>	<b>REMARKS</b>
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 10 km</b>	<b>0.65km  15 km</b>	<b>EO Imager  IR Profiler</b>
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>3 K for water clouds  10 K for ice clouds</b>	<b>OASIS  IR Profiler</b>
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: 1 km</b>	<b>4 km  7 km</b>	<b>EO Imager  IR Profiler</b>
<b>Refresh</b>	<b>Minimum: TBD</b>	<b>Goal: 6 hrs</b>	<b>13 hours</b>	<b>81% coverage for AMSUs</b>

## 40.28: CLOUD TOP HEIGHT

<b>40.28: CLOUD TOP HEIGHT (Derived)</b>			<b>Lockheed PI: Dr. Keith Hutchison</b>	
<b>Solution Type: EO Imager, IR profiler, AMSU-A1 &amp; A2 heritage</b>			<b>Risk: Low</b>	
<b>DATA REQUIREMENTS (APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>DESIGN REFERENCE SYSTEM</b>	<b>REMARKS</b>
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 10 km</b>	<b>0.65 km 15 km</b>	<b>EO Imager IR Profiler</b>
<b>Vertical Sampling Interval</b>	<b>Minimum: TBD</b>	<b>Goal: 0.25 km</b>	<b>1 km, sfc to 5 km 2 km, 5 to 20 km</b>	
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: 0.25 km</b>	<b>0.5 km for water clouds 2-3 km for ice clouds</b>	<b>OASIS IR Profiler</b>
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: 10 km</b>	<b>4 km</b>	<b>7 km</b>
<b>Refresh</b>	<b>Minimum: TBD</b>	<b>Goal: 6 hrs</b>	<b>13 hours</b>	<b>81% coverage for AMSUs</b>

## 40.32: ELECTRIC FIELDS

<b>40.32: ELECTRIC FIELDS (Derived)</b> Electric field data in the auroral and polar cap regions are needed as real-time input to operational space environmental models of the magnetosphere and ionosphere.*				<b>Lockheed PI: Dr. Yam Chiu</b>
<b>Solution Type: RPAD</b>			<b><u>Risk:</u> Low</b>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM	REMARKS
<b>Coverage</b>	<b>Minimum: Polar/Auroral</b>	<b>Goal: Global</b>	<b>Polar/Auroral region only</b>	<b>Modeling reqd for true global coverage</b>
<b>Horizontal Spatial Resolution</b>	<b>Minimum: 10 km</b>	<b>Goal: 3 km</b>	<b>10 km along track only</b>	<b>No cross- track spatial resolution</b>
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: 10 km</b>	<b>10 km with GPS</b>	
<b>Measurement Range</b>	<b>Minimum: TBD</b>	<b>Goal: <math>\pm 500</math> mV/m</b>	<b><math>\pm 500</math> mV/m</b>	
<b>Precision</b>	<b>Minimum: TBD</b>	<b>Goal: <math>\pm 1</math> mV/m</b>	<b><math>\pm 1</math> mV/m</b>	
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: <math>\pm 2</math> mV/m</b>	<b><math>\pm 2</math> mV/m</b>	
<b>Refresh</b>	<b>Minimum: 2/orbit</b>	<b>Goal: 15 min</b>	<b>2/orbit</b>	<b>goal not possible with 3 satellites</b>

\* EDR must be cast in the form of model for global or polar/auroral coverage

## 40.33: ELECTRON DENSITY PROFILES / IONOSPHERIC SPECIFICATION

<b>40.33: ELECTRON DENSITY PROFILES/IONOSPHERIC SPECIFICATION</b> <b>(Derived): Ionosphere affects electromagnetic wave propagation over the range from radio to microwave frequencies. page 1 of 2</b>			<b>Lockheed PI:</b> <b>Dr. Yam Chiu</b>	
<b>Solution Type: GPSR, RPAD, ABIS, NADIS</b>			<b>RISK:</b> <b>Low; NADIS Medium</b>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM	REMARKS
Coverage	Minimum: TBD	Goal: Global	Global	May be integ w/ other operational models and ground data
Sensing Depth	Minimum: TBD	Goal: 90-36,000 km	170-20,000 km	Satellite-borne sensor cannot reach 90-170 km for longer than a couple of perigee passes
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	RPAD: 3 km along track GPSR: Tomog: 300 km globally ABIS: 10 km on swath NADIS: 10 km along track, 300 km swath cross track	
Vertical Sampling Interval	Minimum: TBD	Goal: 5 km	GPSR: 2 km RPAD: No in-situ ABIS: >20 km NADIS: 5 km	
Mapping Accuracy	Minimum: TBD	Goal: 10 km	10 km (GPS)	

## 40.33: ELECTRON DENSITY PROFILES / IONOSPHERIC SPECIFICATION

<b>40.33: ELECTRON DENSITY PROFILES/IONOSPHERIC SPECIFICATION</b> (Derived): Ionosphere affects on electromagnetic wave propagation over the range from radio to microwave frequencies. page 2 of 2			Lockheed PI: Dr. Yam Chiu	
<b>Solution Type: GPSR, RPAD, ABIS, NADIS</b>			<b>RISK</b> Low; NADIS Medium	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM	REMARKS
<b>Measurement Range</b>	Minimum: TBD	Goal: local density: $10^4$ - $10^7$ $\text{cm}^{-3}$ ; TEC: $10^{15}$ - $2 \times 10^{18}$ $\text{m}^{-2}$ ; $f_0F_2$ : 1 -30 MHz	RPAD:local density: $10^4$ - $10^7$ GPSR, NADIS: TEC lower limit $10^{16}$ $\text{m}^{-2}$ , $f_0F_2$ : 1 -30 MHz	May be used in conjunc. with other operational models and ground data
<b>Precision</b>	Minimum: TBD	Goal: $10^4$ $\text{cm}^{-3}$ ;  TEC: $0.5 \times 10^{16}$ $\text{m}^{-2}$	$10^4$ $\text{cm}^{-3}$ for local density;  TEC: $0.5 \times 10^{16}$ $\text{m}^{-2}$	
<b>Measurement Uncertainty</b>	Minimum: TBD	Goal: local density: $\pm 10^4$ $\text{cm}^{-3}$ ; NmF2: 5%; HmF2: 5 km; TEC: $\pm 10^{16}$ $\text{m}^{-2}$ ;	local density: $\pm 10^4$ $\text{cm}^{-3}$ NmF2: $\pm 10\%$ HmF2: $\pm 10$ km; TEC: $\pm 10^{16}$ $\text{m}^{-2}$	F2 peak is usually broad so HmF2 to 5 km is overkill
<b>Refresh</b>	Minimum: each orbit	Goal: 30 min	each orbit	30 min not possible with 3 sats

## 40.34.1: SUPRA-THERMAL CHARGED PARTICLES

40.34: ENERGETIC CHARGED PARTICLES 40.34.1: SUPRA-THERMAL/AURORAL PARTICLES [Derived]			Lockheed PI: Dr. Yam Chiu	
Solution Type: MEPS			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM	REMARKS
Coverage	Minimum: Global	Goal: Global	Global in sense of along trk only	Fluxes of these particles change rapidly; only statistical models exist
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	10 km along track only; no cross track resolution	
Mapping Accuracy	Minimum: TBD	Goal: 10 km	10 km (w/GPS)	
Measurement Range 1. Energy 2. Flux	Minimum: TBD TBD	Goal: 1. 30 eV to 30 keV 2. $10^8$ - $10^{15}$ m <sup>-2</sup> sec <sup>-1</sup> ster <sup>-1</sup> keV <sup>-1</sup>	1. 30 eV to 30 keV 2. $10^8$ - $10^{15}$ m <sup>-2</sup> sec <sup>-1</sup> ster <sup>-1</sup> keV <sup>-1</sup>	
Precision 1. Energy 2. Flux	Minimum: TBD TBD	Goal: 1. $\Delta E/E = 0.1$ 2. 5%	1. $\Delta E/E = 0.1$ 2. $\pm 10\%$	2. Flux spectrum calibration energy dependent; 5% difficult to maintain
Measurement Uncertainty	Minimum: TBD	Goal: 10%	10%	
Refresh	Minimum: TBD	Goal: TBD	Once per orbit along track only	Due to rapid fluct refresh not meaningful

## 40.34.2: RADIATION BELT / LOW ENERGY SOLAR PARTICLES (page 1 of 2)

<b>40.34: ENERGETIC CHARGED PARTICLES</b> <b>40.34.2: RADIATION BELT/LOW ENERGY SOLAR PARTICLES [Derived]</b>			<b>Lockheed PI:</b> <b>Dr. Yam Chiu</b>	
<b>Solution Type: HEPS</b>			<b>Risk: Low</b>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM	REMARKS
<b>Coverage</b>	<b>Minimum:</b> Global	<b>Goal:</b> Global	Global in sense of along track only	Some mapping along field lines for global cover possible; require model to provide global coverage
<b>Horizontal Spatial Resolution</b>	<b>Minimum:</b> TBD	<b>Goal:</b> 30 km	30 km along trk only; no ctrk res	
<b>Mapping Accuracy</b>	<b>Minimum:</b> TBD	<b>Goal:</b> 30 km	30 km (w/GPS)	
<b>Measurement Range</b>	<b>Minimum:</b>	<b>Goal:</b>		
<b>1. Energy</b>	TBD	ions: 30 keV to 10 MeV in 8 bands, electrons: 30 keV to 10 MeV in 8 bands	ions: 30 keV to 10 MeV in 8 bands, electrons: 30 keV to 10 MeV in 8 bands	
<b>2. Flux</b>	TBD	ions: $10^6$ - $10^{12}$ $m^{-2} sec^{-1} ster^{-1}$ , electrons: $10^6$ - $10^{12}$ $m^{-2} sec^{-1} ster^{-1}$	ions: $10^6$ - $10^{12}$ $m^{-2} sec^{-1} ster^{-1}$ , electrons: $10^6$ - $10^{12} m^{-2}$ $sec^{-1} ster^{-1}$	

## 40.34.2: RADIATION BELT / LOW ENERGY SOLAR PARTICLES (page 2 of 2)

<b>40.34: ENERGETIC CHARGED PARTICLES</b> <b>40.34.2: RADIATION BELT/LOW ENERGY SOLAR PARTICLES [Derived]</b>			<b>Lockheed PI:</b> <b>Dr. Yam Chiu</b>	
<b>Solution Type: HEPS</b>			<b>Risk: Low</b>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM	REMARKS
<b>Precision</b>	<b>Minimum: TBD</b>	<b>Goal: 5%</b>	<b>10% optimal</b>	Flux precision strongly dependent on flux level. 10% cannot be guaranteed over the entire dynamic range
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: 10%</b>	<b>10% optimal</b>	Flux precision strongly dependent on flux level. 10% cannot be guaranteed over the entire dynamic range
<b>Refresh</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>Once per orbit along track only</b>	

### 40.34.3: SOLAR / GALTACTIC COSMIC RAY PARTICLES (page 1 of 2)

<b>40.34: ENERGETIC CHARGED PARTICLES</b> <b>40.34.3: SOLAR/GALACTIC COSMIC RAY PARTICLES [Derived]</b>			<b>Lockheed PI:</b> <b>Dr. Yam Chiu</b>	
<b>Solution Type: HEPS</b>			<b>Risk: Low</b>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM	REMARKS
<b>Coverage</b>	<b>Minimum:</b> Global	<b>Goal:</b> Global	Global in sense of along trk only	Reqd model for global coverage
<b>Horizontal Spatial Resolution</b>	<b>Minimum:</b> TBD	<b>Goal:</b> 50 km	50 km along trk only; no ctrk resolution	Model res much less than 200 km
<b>Mapping Accuracy</b>	<b>Minimum:</b> TBD	<b>Goal:</b> 50 km	50 km along trk only (w/GPS)	
<b>Measurement Range</b> 1. Energy	<b>Minimum:</b> TBD	<b>Goal:</b> protons: 10 MeV to 1000 MeV in 8 bands, alphas: 10 MeV to 1000 MeV in 8 bands heavy ions: (CNO): 10-100 MeV in 4 bands heavy ions (Fe): 10- 100 MeV in 4 bands	protons: 10 MeV to 1000 MeV in 8 bands, alphas: 10 MeV to 1000 MeV in 8 bands heavy ions: (CNO): 10-100 MeV in 4 bands heavy ions (Fe): 10-100 MeV in 4 bands	

## 40.34.3: SOLAR / GALACTIC COSMIC RAY PARTICLES (page 2 of 2)

<b>40.34: ENERGETIC CHARGED PARTICLES</b> <b>40.34.3: SOLAR/GALACTIC COSMIC RAY PARTICLES [Derived]</b>				<b>Lockheed PI:</b> <b>Dr. Yam Chiu</b>
<b>Solution Type: HEPS</b>			<b>Risk:</b> <b>Low</b>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM	REMARKS
<b>Measurement Range</b> <b>2. Flux</b>	<b>Minimum:</b> <b>TBD</b>	<b>Goal:</b> protons: $10^2$ - $10^{10}$ $m^{-2} sec^{-1} ster^{-1}$ , alphas: $10^2$ - $10^8$ $m^{-2} sec^{-1} ster^{-1}$ , heavy ions (CNO): $10^{-5}$ - 1.0 $m^{-2} sec^{-1} ster^{-1}$ , heavy ions (Fe): $10^{-5}$ - 1.0 $m^{-2} sec^{-1} ster^{-1}$	protons: $10^2$ - $10^{10} m^{-2} sec^{-1} ster^{-1}$ , alphas: $10^2$ - $10^8 m^{-2} sec^{-1} ster^{-1}$ , heavy ions (CNO): $10^{-5}$ - 1.0 $m^{-2} sec^{-1} ster^{-1}$ , heavy ions (Fe): $10^{-5}$ - 1.0 $m^{-2} sec^{-1} ster^{-1}$	
<b>Precision</b>	<b>Minimum:</b> TBD	<b>Goal:</b> 5%	<b>10% optimal</b>	Flux precision strongly dependent on flux level. 10% cannot be guaranteed over the entire dynamic range
<b>Measurement Uncertainty</b>	<b>Minimum:</b> TBD	<b>Goal:</b> 10%	<b>10% optimal</b>	Flux precision strongly dependent on flux level. 10% cannot be guaranteed over the entire dynamic range
<b>Refresh</b>	<b>Minimum:</b> TBD	<b>Goal:</b> TBD	<b>Once per orbit along track only</b>	

## 40.35: FRESH WATER ICE CONCENTRATIONS (page 1 of 2)

40.35: FRESH WATER ICE CONCENTRATIONS (Derived)		RISK: Low for EO & MIS Imagers; High for SAR		Lockheed PI: Mike Davis	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERNCE SYSTEM		HIGH COST 1
	MINIMUM	GOAL	OASIS(a)	MIS	SAR
<b>Sensing Depth</b>	ice surface	1 m	Ice surface	Ice surface	Sfc to 1 m
<b>Horizontal Spatial Resolution</b>					
1. ice edge boundary	600 m	100 m	650 m	12.5 to 50 km	600 m
2. ice concentration	600 m	100 m	650 m	12.5 - 50 km	600 m
<b>Vertical Sampling Interval</b>					
1. ice thickness	TBD	20 cm	N/A	≤0.01 m or >0.01 m	0.5 m
<b>Mapping Accuracy</b>	3 km	1 km	3 km	7 km	60 m
<b>Measurement Range</b>					
1. ice edge boundary	TBD	TBD	650 m	12.5 - 50 km	600 m
2. ice concentration	1/10 to 10/10 cover	0/10 to 10/10 cover	0/10 or 10/10	0/10 to 10/10 cover	0/10 to 10/10 cover
3. ice thickness	TBD	0 to 1.5 m	N/A	≤0.01 m or >0.01 m (new ice only)	0-1 m

(a) Clear skies only

## 40.35: FRESH WATER ICE CONCENTRATIONS (page 2 of 2)

40.35: FRESH WATER ICE CONCENTRATIONS ( Derived)		RISK: Low for OASIS & MIS High for SAR		Lockheed PI: Mike Davis	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM		HIGH COST 1
	MINIMUM	GOAL	OASIS	MIS	SAR
<b>Measurement Uncertainty</b>					
1. ice edge boundary	±10%	±5%	4 km (worst mapping accuracy)	12.5 to 50 km	±10% or 60 m (mapping accuracy)
2. ice concentration	±20%	±10%	±20%	±20%	±10%
3. ice thickness	TBD	±10%	N/A	new ice: <0.01 or >0.01 m	±50%
<b>Refresh</b>	12 hrs	6 hours	24 hours (clear areas)	24 hours	24-48 hrs

## 40.36: GEOMAGNETIC FIELD

<b>40.36: GEOMAGNETIC FIELD (Derived)</b> <b>Measurements of the Earth's vector magnetic field.</b>			<b>Lockheed PI:</b> <b>Dr. Yam Chiu</b>	
<b>Solution Type: VECMAG</b>			<b>Risk: Low</b>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM	REMARKS
<b>Coverage</b>	<b>Minimum: TBD</b>	<b>Goal: Global</b>	<b>Int Field: Global</b> <b>Ex Field: Local</b>	<b>Ex Field Uncertain</b> <b>due to space-time</b> <b>flucts</b>
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 500 m</b>	<b>Int Field: 500m</b> <b>Ex Field: &gt;1000 km</b>	<b>Ex Field goal</b> <b>not possible</b>
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: 100 m SEP</b>	<b>100 m (w/GPS)</b>	
<b>Measurement Range</b>	<b>Minimum: TBD</b>	<b>Goal: 20,000-</b> <b>50,000 nT</b>	<b>20,000-50,000 nT</b>	
<b>Precision</b>	<b>Minimum: TBD</b>	<b>Goal: 0.5 nT</b>	<b>1 nT</b>	
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: 2 nT</b>	<b>2 nT</b>	
<b>Sensor Attitude</b>	<b>Minimum: TBD</b>	<b>Goal: 1 arc min</b>	<b>1 arc min</b>	<b>Strongly</b> <b>dependent on</b> <b>boom design</b>
<b>Timing Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: 0.5 msec</b>	<b>0.5 msec</b>	
<b>Refresh</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>Internal field: 1/orbit;</b> <b>External field: N/A</b>	

## 40.37: ICE SURFACE TEMPERATURE

<b>40.37: ICE SURFACE TEMPERATURE (Derived)</b> Ambient temperature at the ice/air interface.			<b>Lockheed PI:</b> <b>Dr. Keith</b> <b>Hutchison</b>	
<b>Solution Type: OASIS</b>			<b>Risk:</b> <b>Medium</b>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM	REMARKS
<b>Horizontal Spatial Resolution</b>	<b>Minimum: 30 km</b>	<b>Goal: 10 km</b>	<b>30 km</b>	<b>OASIS</b>
<b>Measurement Range</b>	<b>Minimum: -60 to +20° C</b>	<b>Goal: TBD</b>	<b>-60 to +20° C</b>	<b>OASIS</b>
<b>Measurement Uncertainty</b>	<b>Minimum: ±2° C</b>	<b>Goal: ±1° C</b>	<b>±2° C for OASIS</b>	<b>Cloud-free areas only</b>
<b>Mapping Accuracy</b>	<b>Minimum: 3 km</b>	<b>Goal: 1 km</b>	<b>4 km</b>	<b>OASIS</b>
<b>Refresh</b>	<b>Minimum: 48 hrs</b>	<b>Goal: 12 hrs</b>	<b>~24 hrs</b>	<b>Depends on cloud-free areas</b>

## 40.38.1: IN-SITU PLASMA DENSITY

<b>40.38: IN-SITU MEASUREMENTS</b> <b>40.38.1: IN-SITU PLASMA DENSITY [Derived]</b> Ion composition information is required to determine the altitude of transition between oxygen and lighter ion species, which is an input to high altitude ionospheric models*.			<b>Lockheed PI:</b> <b>Dr. Yam Chiu</b>	
<b>Solution Type: RPAD (with mass descimation added?)</b>			<b>Risk: Low</b>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM	REMARKS
<b>Coverage</b>	<b>Minimum: TBD</b>	<b>Goal: Global</b>	<b>Along track only</b>	Global In modeling sense; see 40.33: Electron Density
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 10 km</b>	10 km along track with <del>no</del> mass discrimination	Mass discrim reqs longer Integ & cycling times
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: 10 km</b>	<b>10 km (w/GPS)</b>	
<b>Measurement Range</b>	<b>Minimum: TBD</b>	<b>Goal: 10<sup>2</sup>-10<sup>7</sup> cm<sup>-3</sup></b>	<b>10<sup>2</sup>-10<sup>4</sup> cm<sup>-3</sup> (what mass?)</b>	Large dynamic range requires longer cycle time. At 800 km, 10 <sup>7</sup> cm <sup>-3</sup> is overkill by 10 <sup>3</sup> .
<b>Precision</b>	<b>Minimum: TBD</b>	<b>Goal: 2%</b>	<b>10% (what mass?)</b>	2% not possible due to rapid fluctuations
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: 5%</b>	<b>10% (what mass?)</b>	2% not possible due to rapid fluctuations
<b>Refresh</b>	<b>Minimum: each orbit</b>	<b>Goal: each orbit</b>	<b>Each orbit</b>	

\* In-situ means at the satellite altitude. A single altitude (800 km) measurement cannot determine the transition altitude between oxygen and lighter ions, even if mass discrimination is added to RPAD. Also, specs do not specify mass discrimination. There seems to be an inconsistency in requirements.

## 40.38.2: IN-SITU PLASMA TEMPERATURE

<b>40.38: IN-SITU MEASUREMENTS</b> <b>40.38.2: IN-SITU PLASMA TEMPERATURE [Derived]</b> <b>Plasma temperatures are used in the mid-latitude region.</b>				<b>Lockheed PI:</b> <b>Dr. Yam Chiu</b>
<b>Solution Type: RPAD</b>			<b>Risk: Low</b>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM	REMARKS
Coverage	Minimum: TBD	Goal: Global	Along const tracks only	No global model exists in this EDR
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	10 km along trk only; no ctrk res	
Mapping Accuracy	Minimum: TBD	Goal: 10 km	10 km (w/GPS)	
Measurement Range	Minimum: TBD	Goal: 500-10,000 K	500 - 10,000 K	
Precision	Minimum: TBD	Goal: 50 K	50K@ optimal conditions	Large fluctuations degrade precision
Measurement Uncertainty	Minimum: TBD	Goal: 5%	5%@ optimal conditions	Large fluctuations degrade measurements
Refresh	Minimum: each orbit	Goal: each orbit	Each orbit	

### 40.38.3: ION DRIFT VELOCITY

<b>40.38: IN-SITU MEASUREMENTS</b> <b>40.38.3: ION DRIFT VELOCITY [Derived]</b> <b>Measurements of in-situ plasma drift velocities are used to infer electric field strengths and patterns in the auroral polar cap regions.</b>				<b>Lockheed PI:</b> <b>Dr. Yam Chiu</b>
<b>Solution Type: RPAD</b>			<b>Risk:</b> <b>Low</b>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM	REMARKS
<b>Coverage</b>	<b>Minimum: Polar/Auroral</b>	<b>Goal: Global</b>	<b>Along const tracks only</b>	<b>Global coverage in the sense of model only</b>
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 10 km</b>	<b>Along track only</b>	<b>Model resolution is very coarse &gt;300 km</b>
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: 10 km</b>	<b>10 km (w/GPS)</b>	
<b>Measurement Range</b>	<b>Minimum: TBD</b>	<b>Goal: ±10 km/sec</b>	<b>±10 km/sec</b>	
<b>Precision</b>	<b>Minimum: TBD</b>	<b>Goal: 25 m/sec</b>	<b>25 m/sec; limited by integ time</b>	<b>Fast fluctuations degrade precision</b>
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: 50 m/sec</b>	<b>50 m/sec@ optimal conds</b>	<b>Fast fluctuations degrade measurements</b>
<b>Refresh</b>	<b>Minimum: 2/orbit</b>	<b>Goal: 15 min</b>	<b>2/orbit</b>	<b>15min impossible for global; rapid auroral changes reqs definition of 'refresh'</b>

## 40.39.1: IONOSPHERIC SCINTILLATION (page 1 of 2)

<b>40.39: IONOSPHERIC MEASUREMENTS</b> <b>40.39.1: IONOSPHERIC SCINTILLATION [Derived]</b> <b>Measured Quantity: <math>C_k L</math>, the height-integrated strength of the ionospheric irregularity spectrum at a one km scale size; <math>q</math>, the slope of the in-situ irregularity spectrum; and <math>V_d</math>, the ion drift velocity. The following requirements are for <math>C_k L</math>. The measurement range, precision, and accuracy for <math>q</math> and <math>V_d</math> should be consistent with meeting the <math>C_k L</math> requirements. Note that <math>V_d</math> is the same drift velocity used for electric field determination required elsewhere in the system specification and might need to meet a more stringent requirement for that purpose.*</b>			<b>Lockheed PI: Dr. Yam Chiu</b>	
<b>Solution Type: Radio Beacon Receiver. EDR is not included in any of the 4 alternative Concepts</b>			<b><u>Risk: Low</u></b>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM	REMARKS
<b>Coverage</b>	<b>Minimum: Global</b>	<b>Goal: Global</b>	<b>At globally distributed ground beacon sites only</b>	<b>global coverage in the sense of model update only</b>
<b>Sensing Depth</b>	<b>Minimum: TBD</b>	<b>Goal: 200-800 km</b>	<b>200-800 km @ gnd beacon sites</b>	
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>10 km along track and 100 km cross track</b>	<b>Model resolution not known</b>
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: 10 km</b>	<b>10 km (w/GPS)</b>	

**\*Note: Scintillation measurements of  $C_k L$  and  $q$  require a bistatic observational set-up. The WIDEBAND satellite, from which WBMOD is derived, has demonstrated the measurements with a multiple frequency transmitter on board and a single receiver station at Poker Flats, Alaska. For NPOESS, WBMOD needs measurements from a global set of receiver stations (auroral, mid-latitude and equatorial) in order to provide continuous verification and refresh of WBMOD predictions. Similar to WIDEBAND, a 10-frequency transmitter is placed on board NPOESS satellites. The instruments are proven and the methods of analyses are known.**

## 40.39.1: IONOSPHERIC SCINTILLATION (page 2 of 2)

<b>40.39: IONOSPHERIC MEASUREMENTS</b> <b>40.39.1: IONOSPHERIC SCINTILLATION [Derived]      <u>page 2 of 2</u></b> <b>Measured Quantity: <math>C_kL</math>, the height-integrated strength of the ionospheric irregularity spectrum at a one km scale size; <math>q</math>, the slope of the in-situ irregularity spectrum; and <math>V_d</math>, the ion drift velocity. The following requirements are for <math>C_kL</math>. The measurement range, precision, and accuracy for <math>q</math> and <math>V_d</math> should be consistent with meeting the <math>C_kL</math> requirements. Note that <math>V_d</math> is the same drift velocity used for electric field determination required elsewhere in the system specification and might need to meet a more stringent requirement for that purpose.</b>			<b>Lockheed PI: Dr. Yam Chiu</b>	
<b>Solution Type: Radio Beacon Receiver. EDR is not included in any of the 4 alternative Concepts</b>		<b><u>Risk: Low</u></b>		
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM	REMARKS
<b>Measurement Range</b>	<b>Minimum: TBD</b>	<b>Goal: <math>C_kL</math>: <math>10^{27}</math>-<math>10^{37}</math></b>	<b><math>10^{28}</math>-<math>10^{37}</math></b>	<b>@ optimal, no saturation conditions; <math>10^{27}</math> is probably overkill because such small values of <math>C_kL</math> (i.e. PDS) also implies large measurement errors</b>
<b>Precision</b>	<b>Minimum: TBD</b>	<b>Goal: <math>10^{27}</math></b>	<b><math>10^{28}</math></b>	<b>@ optimal: see above</b>
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: factor of 2</b>	<b>factor of 2</b>	
<b>Refresh</b>	<b>Minimum: each orbit</b>	<b>Goal: each orbit</b>	<b>Each orbit in model update sense</b>	

## 40.39.2 IN-SITU PLASMA FLUCTUATIONS

<b>40.39: IONOSPHERIC MEASUREMENTS</b> <b>40.39.2: IN-SITU PLASMA FLUCTUATIONS [Derived]</b> <b>The ionospheric structures responsible for scintillation occur primarily at altitudes near the peak of the F<sub>2</sub> region (250 - 400 km)*.</b>			<b>Lockheed PI: Dr. Yam Chiu</b>	
<b>Solution Type: RPAD</b>			<b>Risk: Low</b>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM	REMARKS
<b>Coverage</b>	<b>Minimum: Global</b>	<b>Goal: Global</b>	<b>Global along track</b>	<b>No global model exists</b>
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>10 km along track only</b>	
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: 10 km</b>	<b>10 km (w/GPS)</b>	
<b>Measurement Range</b>	<b>Minimum: TBD</b>	<b>Goal: <math>\Delta N/N</math>: 10<sup>-4</sup>-1.0</b>	<b>10<sup>-2</sup> - 1.0</b>	<b>10<sup>-4</sup>@ 800 km where N~10<sup>3</sup>-10<sup>4</sup> cm<sup>-3</sup> not possible</b>
<b>Precision</b>	<b>Minimum: TBD</b>	<b>Goal: 10%</b>	<b>10% @ optimal conditions</b>	<b>Measurement degrades when density is in the low range</b>
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: <math>\pm 10\%</math></b>	<b><math>\pm 10\%</math>@ optimal conditions</b>	<b>Measurement degrades when density is in the low range</b>
<b>Refresh</b>	<b>Minimum: each orbit</b>	<b>Goal: each orbit</b>	<b>Each orbit in the sense of revisit along track</b>	<b>No plasma fluct model exists</b>

\* In-situ measurement means at the satellite. NPOESS @ 800 km cannot make in-situ plasma fluctuation measurement for (250-400 km) F<sub>2</sub> region peak. There seems to be an inconsistency in the requirements. All responses to this EDR are for in-situ measurements at 800 km. There is no currently known way to measure plasma fluctuations at the F-peak from 800 km.

## 40.40: LAND SURFACE TEMPERATURE

<b>40.40: LAND SURFACE TEMPERATURE [Derived]</b> <b>Measurement of the temperature of the soil at the surface.</b>				<b>Lockheed PI:</b> <b>Dr. Keith</b> <b>Hutchison</b>
<b>Solution Type: OASIS/MIS</b>			<b>Risk: Low</b>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM	REMARKS
Horizontal Spatial Resolution	Minimum: TBD	Goal: 1 km	0.65 km  12.5 to 50 km	Clear areas only  Cloudy areas only
Mapping Accuracy	Minimum: TBD	Goal: 1 km	4 km	OASIS
Precision	Minimum: TBD	Goal: 0.25 K	0.25 K	
Measurement Uncertainty	Minimum: TBD	Goal: ±1 K	±3 K	OASIS  TBR for MIS
Refresh	Minimum: TBD	Goal: 3 hrs	9 hours	Clear areas only for OASIS

## 40.43: NET HEAT FLUX

<b>40.43: NET HEAT FLUX [Derived]</b>			<b>Lockheed PI: Dr. Ken Hardy</b>	
<b>Solution Type: OASIS. IR Sounder</b>			<b><u>Risk:</u> Medium</b>	
<b>DATA REQUIREMENTS (APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>DESIGN REFERENCE SYSTEM</b>	<b>REMARKS</b>
<b>Sensing Depth</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>air/sea interface</b>	<b>Clear areas only</b>
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 5 km</b>	<b>50 km</b>	
<b>Vertical Sampling Interval</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>air/sea interface</b>	<b>Surface only</b>
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>4 km</b>	
<b>Measurement Range</b>	<b>Minimum: TBD</b>	<b>Goal: 0 - 1000 W/m<sup>2</sup></b>	<b>0 to 1000 W/m<sup>2</sup></b>	
<b>Precision</b>	<b>Minimum: TBD</b>	<b>Goal: ±1 W/m<sup>2</sup></b>	<b>±1 W/m<sup>2</sup></b>	
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: ±1 W/m<sup>2</sup></b>	<b>±50 W/m<sup>2</sup></b>	<b>Needs confirmation</b>
<b>Refresh</b>	<b>Minimum: TBD</b>	<b>Goal: 3 hrs</b>	<b>11 hours</b>	<b>Worst case for 105% OASIS coverage</b>

## 40.46: NEUTRAL DENSITY PROFILES / NEUTRAL ATMOSPHERIC SPECIFICATION

<b>40.46: NEUTRAL DENSITY PROFILES / NEUTRAL ATMOSPHERIC SPECIFICATION [Derived]</b> <b>Measurements of upper atmospheric densities and scale heights.(page 1 of 2)</b>			<b>Lockheed PI:</b> <b>Dr. Yam Chiu</b>	
<b>Solution Type: NADIS</b>			<b>Risk: Medium</b>	
<b>DATA REQUIREMENTS (APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>DESIGN REFERENCE SYSTEM</b>	<b>REMARKS</b>
<b>Coverage</b>	<b>Minimum: TBD</b>	<b>Goal: Global</b>	<b>Constellation swaths only</b>	<b>Global coverage in the sense of model/algorithm updates</b>
<b>Sensing Depth</b>	<b>Minimum: TBD</b>	<b>Goal: 90-1000 km</b>	<b>Emission line specific: 100 - 800 km</b>	<b>Goal may be possible in sense of modeling</b>
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 100 km</b>	<b>100 km along trk only; cross trk res &gt;200 km</b>	<b>Model resolution &gt;1000 km</b>
<b>Vertical Sampling Interval</b>	<b>Minimum: TBD</b>	<b>Goal: 5 km</b>	<b>5 km</b>	<b>Scale height (~20 km) for model</b>
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: 50 km</b>	<b>50 km (w/GPS)</b>	

# 40.46: NEUTRAL DENSITY PROFILES / NEUTRAL ATMOSPHERIC SPECIFICATION

<b>40.46: NEUTRAL DENSITY PROFILES / NEUTRAL ATMOSPHERIC SPECIFICATION [Derived]</b> <b>Measurements of upper atmospheric densities and scale heights. (page 2 of 2)</b>			<b>Lockheed PI: Dr. Yam Chiu</b>	
<b>Solution Type: NADIS</b>			<b>Risk: Medium</b>	
<b>DATA REQUIREMENTS (APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>DESIGN REFERENCE SYSTEM</b>	<b>REMARKS</b>
<b>Measurement Range</b>	<b>Minimum: TBD</b>	<b>Goal: <math>10^4</math>-<math>10^{16}</math> cm<sup>-3</sup> (varies with altitude)</b>	<b><math>10^5</math>-<math>10^{16}</math> cm<sup>-3</sup> ; line specific</b>	<b>Weak emissions from low density (<math>10^4</math> cm<sup>-3</sup>) regions get buried by background light</b>
<b>Precision</b>	<b>Minimum: TBD</b>	<b>Goal: 1%</b>	<b>15% on SDR; 30% on modeling</b>	
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: <math>\pm 5\%</math> up to 500 km, <math>\pm 10\%</math> 500-700 km, <math>\pm 15\%</math> 700-1000 km</b>	<b>Goal not possible; Uncertainty due to model/algorithm depending on Inputs outside of NPOESS</b>  <b>SDR: <math>\pm 15\%</math> 100-500 km <math>\pm 20\%</math> 500-1000 km EDR (models): <math>\pm 30\%</math></b>	<b>Only some constituents can be monitored by NADIS, others are not measurable by NPOESS-type satellites</b>
<b>Refresh</b>	<b>Minimum: each orbit</b>	<b>Goal: each orbit</b>	<b>Each orbit</b>	

## 40.49: OZONE TOTAL COLUMN / PROFILE (page 1 of 2)

<b>40.49: OZONE TOTAL COLUMN/PROFILE [Derived]</b>			<b>Lockheed PI: Dr. Aidan Roche</b>	
<b>Solution Type: TES (Tropospheric Emission Spectrometer - for Tropo profile), TOMS, SAGE (Total Ozone Measurement Spectrometer, Stratospheric Aerosol/Gas Experiment for total column). Solid state TOMS Profiler</b>			<b>Risk: Low for column; Medium for Profile</b>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM	REMARKS
<b>Sensing Depth</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>16 to 50 km</b>	
<b>Horizontal Spatial Resolution</b>	<b>Minimum:</b>	<b>Goal:</b>		
1. total column	TBD	250 km	250 km	
2. profile (troposphere)	TBD	250 km	250 km	
<b>Vertical Sampling Interval (Profile)(troposphere)</b>	<b>Minimum: TBD</b>	<b>Goal: 1 km</b>	<b>5 km</b>	<b>TES lists 2-6 km</b>
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>20 km</b>	

## 40.49: OZONE TOTAL COLUMN / PROFILE (page 2 of 2)

<b>40.49: OZONE TOTAL COLUMN/PROFILE [Derived]</b>			<b>Lockheed PI: Dr. Aidan Roche</b>	
<b>Solution Type: TES (Tropospheric Emission Spectrometer - for Tropo profile), TOMS, SAGE (Total Ozone Measurement Spectrometer, Stratospheric Aerosol/Gas Experiment for total column). Solid state TOMS Profiler</b>			<b>DESIGN REFERENCE SYSTEM</b>	
<b>DATA REQUIREMENTS (APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>DESIGN REFERENCE SYSTEM</b>	<b>REMARKS</b>
<b>Measurement Range</b>	<b>Minimum:</b>	<b>Goal:</b>		
1. total column	0-0.65 atm-cm	TBD	0-0.65 atm-cm	
2. profile (0-15 km)	0-15 ppmv	TBD	0.01 - 3 ppmv	
<b>Precision</b>	<b>Minimum:</b>	<b>Goal:</b>		
1. total column	1%/decade	0.1%/decade	1%/decade	
2. profile	3%/decade	0.3%/decade	3%/decade	
<b>Measurement Uncertainty</b>	<b>Minimum:</b>	<b>Goal:</b>		
1. total column	TBD	1%	3%	
2. profile	TBD	3%	6%	
<b>Refresh</b>	<b>Minimum: 24 hrs</b>	<b>Goal: TBD</b>	<b>28 hours</b>	<b>Noon satellite, daytime only</b>

## 40.50: PRECIPITABLE WATER

<b>40.50: PRECIPITABLE WATER [Derived]</b> Measure of precipitable water within a specified volume of atmosphere.				Lockheed PI: Dr. Ken Hardy
Solution Type: MIS			<u>Risk: Low</u>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM	REMARKS
Sensing Depth	Minimum: TBD	Goal: TBD	0 - 10 km	Total column only
Horizontal Spatial Resolution	Minimum: TBD	Goal: 1 km	50 km	
Vertical Sampling Interval	Minimum: TBD	Goal: TBD	0 - 10 km	
Mapping Accuracy	Minimum: TBD	Goal: TBD	7 km	
Measurement Range	Minimum: TBD	Goal: 0 - 100 mm	0 - 80 mm	
Precision	Minimum: TBD	Goal: $\pm 1$ mm	$\pm 1$ mm	
Measurement Uncertainty	Minimum: TBD	Goal: $\pm 1$ mm	$\pm 1$ mm $\pm 3$ mm	polar areas tropics
Refresh	Minimum: 6 hrs	Goal: less than 6 hrs	9.hours	Worst case with 100% coverage

## 40.51: PRECIPITATION (TYPE, RATE)

<b>40.51: PRECIPITATION (TYPE, RATE) [Derived]</b> Type-identify rain vs. cloud water or ice.				<b>Lockheed PI: Dr. Ken Hardy</b>
<b>Solution Type: MIS</b>			<b><u>Risk: Low</u></b>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM	REMARKS
Horizontal Spatial Resolution	Minimum: TBD	Goal: 100 m	25 - 50 km	
Mapping Accuracy	Minimum: TBD	Goal: 100 m	7 km	
Measurement Range	Minimum: TBD	Goal: 0 - 200 mm/hr	0 - 60 mm/hr	60 mm/hr not exceeded at resolu of 25-50 km
Precision	Minimum: TBD	Goal: 1.0 mm/hr	1 mm/hr	
Measurement Uncertainty	Minimum: TBD	Goal: ±2 mm/hr	±5 mm/hr	
Refresh	Minimum: TBD	Goal: 3 hrs	9. hours	Worst case with 100% coverage

## 40.52: PRESSURE (SURFACE / PROFILE)

<b>40.52: PRESSURE (SURFACE/PROFILE) [Derived]</b>			<b>Lockheed PI: Dr. Ken Hardy</b>	
<b>Solution Type: MIS, Profiler Suite</b>		<b><u>Risk:</u> Medium</b>		
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM	RE- MARKS
<b>Sensing Depth</b>	<b>Minimum: TBD</b>	<b>Goal: Surface - 30 km</b>	<b>Sfc to 30 km</b>	
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 5 km</b>	<b>50 km</b>	
<b>Vertical Sampling Interval</b>	<b>Minimum: TBD</b>	<b>Goal: 0.25 km increments from 0-2 km; 0.5 km increments from 2-5 km; 1.0 km increments above 5 km</b>	<b>1 km</b>	<b>Needs confirm- ation</b>
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: 10 km</b>	<b>7 km</b>	
<b>Measurement Range</b>	<b>Minimum: TBD</b>	<b>Goal: 10-1050 mb</b>	<b>10 - 1050 mb</b>	
<b>Precision</b>	<b>Minimum: TBD</b>	<b>Goal: 2 mb</b>	<b>2 mb</b>	
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: ±3% from 0-10 km; ±5% from 10-30 km</b>	<b>±5% from 0-30 km</b>	<b>Needs confirm- ation</b>
<b>Refresh</b>	<b>Minimum: 12 hrs</b>	<b>Goal: 1 hr</b>	<b>20.5 hours</b>	

## 40.55: SNOW COVER / DEPTH

<b>40.55: SNOW COVER / DEPTH (Derived)</b>				<b>Lockheed PI: Mike Davis</b>
<b>Solution Type: OASIS/MIS</b>			<b>Risk: Low for cover; High for depth</b>	
<b>DATA REQUIREMENTS (APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>DESIGN REFERENCE SYSTEM</b>	<b>REMARKS</b>
<b>Sensing Depth</b>	<b>Minimum: TBD</b>	<b>Goal: Determine if depth is 0 - 25 cm or &gt;25 cm</b>	<b>0 - 40 cm</b>	<b>Dry snow only</b>
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 1 km</b>	<b>25 km  0.65 km</b>	<b>MIS foot-prints  OASIS for cover in clear areas only</b>
<b>Vertical Sampling Interval</b>	<b>Minimum: TBD</b>	<b>Goal: 12.5 cm</b>	<b>12.5 cm</b>	
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: 1 km</b>	<b>7 km</b>	
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: ±10% for snow</b>	<b>11 cm</b>	
<b>Refresh</b>	<b>Minimum: TBD</b>	<b>Goal: 3 hrs</b>	<b>9 hours</b>	<b>Worst case with 100% coverage</b>

## 40.56: SNOW WATER EQUIVALENT

<b>40.56: SNOW WATER EQUIVALENT (Derived)</b>				<b>Lockheed PI: Mike Davis</b>
<b>Solution Type: MIS?</b>			<b><u>Risk: High</u></b>	
<b>DATA REQUIREMENTS (APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>DESIGN REFERENCE SYSTEM</b>	<b>REMARKS</b>
<b>Sensing Depth</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>Surface</b>	
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 1 km</b>	<b>12.5 -50 km</b>	<b>MIS foot- prints</b>
<b>Vertical Sampling Interval</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>Surface only</b>	
<b>Measurement Range</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>dry/wet*</b>	<b>2 choices only</b>
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: ±10%</b>	<b>±25%</b>	<b>75% correct category</b>
<b>Precision</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>dry or wet</b>	
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: 1 km</b>	<b>7 km</b>	
<b>Refresh</b>	<b>Minimum: TBD</b>	<b>Goal: 12 hrs</b>	<b>9 hours</b>	<b>Worst case with 100% coverage</b>

\* Dry when density of snow is  $\leq 0.5$  times the density of water

## 40.62: TOTAL WATER CONTENT

<b>40.62: TOTAL WATER CONTENT (Derived)</b> <b>Measure of moisture in a given volume of the atmosphere.</b>			<b>Lockheed PI:</b> <b>Mike Davis</b>	
<b>Solution Type: MIS</b>			<b>Risk: Low</b>	
<b>DATA REQUIREMENTS</b> <b>(APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>DESIGN</b> <b>REFERENCE</b> <b>SYSTEM</b>	<b>REMARKS</b>
<b>Horizontal Spatial Resolution</b>	<b>Minimum: 50 km</b>	<b>Goal: 30 km</b>	<b>50 km</b>	
<b>Vertical Sampling Interval</b>	<b>Minimum: TBD</b>	<b>Goal: 1 km</b>	<b>Surface to 10 km</b>	
<b>Measurement Uncertainty</b>	<b>Minimum: CLWC:</b> <b>±0.1 kg/m<sup>2</sup> over</b> <b>ocean only</b> <b>TIWC: ±3.0 kg/m<sup>2</sup></b>	<b>Goal: TBD</b>	<b>CLWC: ±0.1 kg/m<sup>2</sup></b> <b>over ocean only</b> <b>TIWC: ±3.0 kg/m<sup>2</sup></b>	<b>Goal for</b> <b>CLWC: ±0.06</b> <b>kg/m<sup>2</sup> over</b> <b>ocean only</b>
<b>Refresh</b>	<b>Minimum: 12 hrs</b>	<b>Goal: 3 hrs</b>	<b>9 hours</b>	<b>Worst case</b> <b>with 100%</b> <b>coverage</b>

## 40.63: TROPOSPHERIC WINDS (page 1 of 2)

<b>40.63: TROPOSPHERIC WINDS [Derived]</b> Wind measured throughout the atmosphere.			<b>Lockheed PI:</b> <b>Dr. Ken Hardy</b>	
<b>Solution Type: Profilers</b>			<b>Risk:</b> Low for Geostrophic Winds; High for true winds	
<b>DATA REQUIREMENTS</b> (APPENDIX D, 1/11/95)	<b>SPECIFICATIONS</b>		<b>DESIGN</b> <b>REFERENCE</b> <b>SYSTEM</b>	<b>REMARKS</b>
<b>Sensing Depth</b>	<b>Minimum: TBD</b>	<b>Goal: Sfc to 20 km</b>	Sfc to 20 km	Geostrophic
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 50 km</b>	200 km	Geostrophic
<b>Vertical Sampling Interval</b>	<b>Minimum: TBD</b>	<b>Goal: 0.1 km</b>	2-5 km	Geostrophic
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: 10 km</b>	20 km	

## 40.63: TROPOSPHERIC WINDS (page 2 of 2)

<b>40.63: TROPOSPHERIC WINDS [Derived]</b> Wind measured throughout the atmosphere.			<b>Lockheed PI:</b> <b>Dr. Ken Hardy</b>	
<b>Solution Type: Profilers</b>			<b>Risk:</b> <b>Low for Geostrophic Winds;</b> <b>High for true winds</b>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM	REMARKS
<b>Measurement Range</b>	<b>Minimum: TBD</b>	<b>Goal: speed 0-100 m/s</b>	<b>0-100 m/s</b>	<b>Geostrophic</b>
<b>Precision</b>	<b>Minimum: TBD</b>	<b>Goal: speed 0.5 m/s in each horizontal vector component</b>	<b>±1 m/s</b>	<b>Geostrophic</b>
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: speed ±1 m/s in each horizontal vector component</b>	<b>±10 m/s (1σ)</b>	<b>Geostrophic</b>
<b>Refresh</b>	<b>Minimum: 12 hrs</b>	<b>Goal: 1 hr</b>	<b>13 hours</b>	<b>81% coverage</b>

## 40.65: VEGETATION / SURFACE TYPE

<b>40.65: VEGETATION/SURFACE TYPE [Derived]</b> Predominant vegetation type in a given area, coupled with type of soil.				<b>Lockheed PI: Mike Davis</b>
<b>Solution Type: EO and MIS Imagers</b>			<b>Risk: Medium</b>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM	REMARKS
Horizontal Spatial Resolution	Minimum: TBD	Goal: 1.0 km global, 0.25 km coastal	0.65 km for EO 50 km for MIS	Clear areas
Mapping Accuracy	Minimum: TBD	Goal: 1 km	4 km OASIS 7 km MIS	
Measurement Range	Minimum: TBD	Goal: identify 20 surface types, 0-100% vegetation	x classes, ice, snow, water, vegetated land	Merge into EO/IR/MW classification
Precision	Minimum: TBD	Goal: 0.1%	1 % albedo with OASIS	
Measurement Uncertainty	Minimum: TBD	Goal: ±2%	90 % probability of correct class	
Refresh	Minimum: 12 hrs	Goal: 3 hrs	9 hours	Clear day-time areas only

## LIST OF THE 46\* EDRS OF THE HIGH COST OPTION 1

**Note:** High Cost Option #1 has the 41 EDRs of the Design Reference System plus five additional EDRs (shown in "**Bold**" type). Only the five additional EDRs (**Bold Type**) are tabulated in this Section.

40.1 Atmospheric Vertical Moisture Profile	40.34.3 Solar/Galactic Cosmic Ray Particles
40.2 Atmospheric Vertical Temperature Profile	40.35 Fresh Water Ice Concentrations
40.3 Cloud Imagery	40.36 Geomagnetic Field
40.4 Sea Ice (see EDRs for the Design Reference System)	40.37 Ice Surface Temperature
40.5 Sea Surface Temperature	40.38.1 In-Situ Plasma Density
40.6 Sea Surface Winds	40.38.2 In-Situ Plasma Temperature
40.7 Soil Moisture	40.38.3 In-situ Ion Drift Velocity
40.9 Aerosol Optical Thickness	40.39.1 Ionospheric Scintillation
40.10 Suspended Matter	40.39.2 In-Situ Plasma Fluctuations
40.11 Albedo (Surface)	40.40 Land Surface Temperature
40.12 Auroral Boundary	40.43 Net Heat Flux
<b>40.13 Optical Backgrounds</b>	40.46 Neutral Density Profiles/Neutral Atmospheric Specification
40.14 Auroral Imagery	<b>40.48 Ocean Wave Characteristics</b>
40.15 Total Auroral Energy Deposition	40.49 Ozone Total Column/Profile
40.16 Upper Atmospheric Airglow	40.50 Precipitable Water
40.20 Cloud Cover/Layers	40.51 Precipitation (Type, Rate)
40.21 Cloud Base Height	40.52 Pressure (Surface/Profile)
40.23 Cloud Liquid Water	<b>40.54 Sea Surface Height/Topography</b>
40.25 Cloud Optical Depth/Transmittance	40.55 Snow Cover/Depth
40.26 Cloud Top Pressure	40.56 Snow Water Equivalent
40.27 Cloud Top Temperature	<b>40.58 Surface Wind Stress</b>
40.28 Cloud Top Height	40.62 Total Water Content
40.32 Electric Fields	40.63 Tropospheric Winds
40.33 Electron Density Profiles/Ionospheric Specification	40.65 Vegetation/Surface Type
40.34.1 Supra-thermal/Auroral Particles	<b>40.66 Wave Spectral Energy</b>
40.34.2 Radiation Belt/Low Energy Solar Particles	

\* Note that (1) 40.34.1, 40.34.2, and 40.34.3 are considered as a single EDR,  
(2) 40.38.1, 40.38.2, and 40.38.3 are considered as a single EDR,  
(3) 40.39.1 and 49.39.2 are considered as a single EDR

## 40.13: OPTICAL BACKGROUNDS

40.13: OPTICAL BACKGROUNDS (Derived)			Lockheed PI: Dr. Yam Chiu	
Solution Type: CVF/IRR (Mechanical cooling)			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		DESIGN REFER- ENCE SYSTEM	REMARKS
Coverage	Minimum: TBD	Goal: Global	Along const. swath only	Global not possible as conditions change rapidly and Instrument has very limited FOV and depth of view
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	15 km along track 200 km cross track	
Mapping Accuracy	Minimum: TBD	Goal: 50 km	Better than 10 km (w/GPS)	
Measurement Range	Minimum:	Goal:	1. 0.4 - 0.7 $\mu\text{m}$ can be covered by NADIS; 0.7 - 12 $\mu\text{m}$ by CVF/IRR	1. 12-29 $\mu\text{m}$ subject to coolant lifetime and reliable design not available.
1. Wavelength	TBD	1-29 $\mu\text{m}$ , 0.4-0.7 $\mu\text{m}$ , 0.04-0.2 $\mu\text{m}$	2. $10^{-8}$ W/cm <sup>2</sup> sr $\mu\text{m}$ for 0.7 -5.2 $\mu\text{m}$ ; $10^{-7}$ W/cm <sup>2</sup> sr $\mu\text{m}$ for 5.2 to 12 $\mu\text{m}$ ;	2. Cooled detectors only. Brightness calibration from astronomical bodies
2. Brightness	TBD	TBD		
Precision	Minimum: TBD	Goal:	0.5%; subject to calibration	User requirements on precision are usually not revealed
Measurement Uncertainty	Minimum: TBD	Goal: TBD	10%; consistent with uncertainties in emissivity of astronomical bodies	NS-5 has dynamic range of $6 \times 10^4$ ; NS-6D has dynamic range of $10^7$ .
Refresh	Minimum: TBD	Goal: Each orbit	Each orbit	Conditions change rapidly over durations shorter than 1 orbit

## 40.48: OCEAN WAVE CHARACTERISTICS

40.48: OCEAN WAVE CHARACTERISTICS [Derived] Data on the height and period/frequency of ocean waves.			Lockheed PI: Mike Davis	
Solution Type: Altimeter			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		High Cost 1: Altimeter	REMARKS
<b>Horizontal Spatial Resolution</b>	<b>Minimum:</b>	<b>Goal:</b>		
1. global	TBD	20 km	20 km	Along track only
2. regional	TBD	0.25 km	10 km	
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>		
1. global	TBD	10 km	10 km	
2. regional	TBD	3 km	4 km	
<b>Measurement Range</b>	<b>Minimum: TBD</b>	<b>Goal: 0.5 - 30 m (height)</b>	<b>0.5 - 30 m</b>	
<b>Precision</b>	<b>Minimum: TBD</b>	<b>Goal: 0.1 m (height)</b>	<b>0.3 m</b>	
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: ±0.2 m</b>	<b>±0.6 m</b>	
<b>Refresh</b>	<b>Minimum: TBD</b>	<b>Goal: 6 hrs</b>	<b>10 - 20 days</b>	

## 40.54: SEA SURFACE HEIGHT / TOPOGRAPHY

<b>40.54: SEA SURFACE HEIGHT/TOPOGRAPHY [Derived]</b> Longwave horizontal variation in the height of the sea surface.			Lockheed PI: Mike Davis	
<b>Solution Type: Altimeter</b>			<b>Risk: Medium</b>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		High Cost 1 Altimeter	REMARKS
<b>Sensing Depth</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>50 km</b>	<b>Sensing range for the altimeter</b>
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 1 km</b>	<b>6 km</b>	
<b>Vertical Sampling Interval</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>unk</b>	
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: 1 km</b>	<b>TBR</b>	
<b>Measurement Range</b>	<b>Minimum: TBD</b>	<b>Goal: <math>\pm 10^4</math> cm</b>	<b><math>\pm 10^4</math> cm</b>	<b>TOPEX Data</b>
<b>Precision</b>	<b>Minimum: TBD</b>	<b>Goal: 2 cm</b>	<b>3 cm</b>	<b>TOPEX Data</b>
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: <math>\pm 5</math> cm</b>	<b><math>\pm 3</math> cm</b>	<b>TOPEX Data</b>
<b>Refresh</b>	<b>Minimum: TBD</b>	<b>Goal: 3 hrs</b>	<b>75 days for 2 satellites</b>	<b>TOPEX Data</b>

## 40.58: SURFACE WIND STRESS

<b>40.58: SURFACE WIND STRESS [Derived]</b> The frictional stress of the wind acting on the sea surface, causing it to move as a wind-drift current, and causing the formation of waves.				Lockheed PI: Ken Hardy
Solution Type: Altimeter, MIS			<u>Risk:</u> High	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		High Cost 1 Altimeter	REMARKS
Horizontal Spatial Resolution	Minimum: TBD	Goal: 20 km	50 km	
Vertical Sampling Interval	Minimum: TBD	Goal:	Surface only	
Mapping Accuracy	Minimum: TBD	Goal: 10 km	7 km	
Measurement Range	Minimum: TBD	Goal: TBD	0.1 to 20 dynes cm <sup>-2</sup>	
Precision	Minimum: TBD	Goal: ±10%	±20%	
Measurement Uncertainty	Minimum: TBD	Goal: ±30%	±40%	
Refresh	Minimum: TBD	Goal: 12 hrs	9 hours	>75 days at nadir for altimeter

## 40.66: WAVE SPECTRAL ENERGY

<b>40.66: WAVE SPECTRAL ENERGY [Derived]</b> The wave energy of ocean surface gravity waves as a function of wave number and direction.				Lockheed PI: Mike Davis
Solution Type: Altimeter and or SAR?			<u>Risk</u> : High	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		High Cost 1: Altimeter &/or SAR	REMARKS
Horizontal Spatial Resolution	Minimum: TBD	Goal: 50 km Global; 10 km regional	250 km	25 km with SAR
Mapping Accuracy	Minimum: TBD	Goal: 25 km Global; 5 km regional	10 km	
Measurement Range	Minimum: TBD	Goal: TBD	0 - 360 deg for dir; 0 - 20 m for wave height	
Precision	Minimum: TBD	Goal: TBD	±20 deg for dir ±25% for wave height	
Measurement Uncertainty	Minimum: TBD	Goal: ±15%	±20 deg for dir ±25% for wave height	
Refresh	Minimum: TBD	Goal: 6 hrs	~12 hrs with one satellite	Nadir view only

## LIST OF THE 58\* EDRS OF THE HIGH COST OPTION 2

**Note:** High Cost Option #2 has the 41 EDRs of the Design Reference System, plus one EDR from High Cost Option #1, and 16 additional EDRs (shown in "Bold" type) for a total of 58. Only the 16 additional EDRs (**Bold Type**) are tabulated in this Section.

- |   |  |
|---|--|
| 40.1 Atmospheric Vertical Moisture Profile                | 40.34.3 Solar/Galactic Cosmic Ray Particles                      |
| 40.2 Atmospheric Vertical Temperature Profile             | 40.35 Fresh Water Ice Concentrations                             |
| 40.3 Cloud Imagery  | 40.36 Geomagnetic Field  |
| 40.4 Sea Ice  | 40.37 Ice Surface Temperature                                    |
| 40.5 Sea Surface Temperature                              | 40.38.1 In-Situ Plasma Density                                   |
| 40.6 Sea Surface Winds                                    | 40.38.2 In-Situ Plasma Temperature                               |
| 40.7 Soil Moisture  | 40.38.3 In-situ Ion Drift Velocity                               |
| <b>40.8 Aerosol Particle Size</b>                         | 40.39.1 Ionospheric Scintillation                                |
| 40.9 Aerosol Optical Thickness (See EDRs of DRS)          | 40.39.2 In-Situ Plasma Fluctuations                              |
| 40.10 Suspended Matter (See EDRs of DRS)                  | 40.40 Land Surface Temperature                                   |
| 40.11 Albedo (Surface)                                    | <b>40.41 Littoral Sediment Transport</b>                         |
| 40.12 Auroral Boundary                                    | <b>40.42 Longwave Radiation</b>                                  |
| 40.13 Optical Backgrounds (See EDRs of Option #1)         | 40.43 Net Heat Flux  |
| 40.14 Auroral Imagery                                     | <b>40.44 Net Radiation (Top of Atmosphere)</b>                   |
| 40.15 Total Auroral Energy Deposition                     | <b>40.45 Net Surface Shortwave Radiation</b>                     |
| 40.16 Upper Atmospheric Airglow                           | 40.46 Neutral Density Profiles/Neutral Atmospheric Specification |
| <b>40.19 CH<sub>4</sub> Column (Methane)</b>              | <b>40.47 Ocean Color/Chlorophyll</b>                             |
| 40.20 Cloud Cover/Layers                                  | 40.49 Ozone Total Column/Profile                                 |
| 40.21 Cloud Base Height (See EDRs of DRS)                 | 40.50 Precipitable Water   |
| <b>40.22 Cloud Ice Liquid Equivalent</b>                  | 40.51 Precipitation (Type, Rate)                                 |
| 40.23 Cloud Liquid Water                                  | 40.52 Pressure (Surface/Profile)                                 |
| <b>40.24 Cloud Ice Water Path</b>                         | 40.55 Snow Cover/Depth   |
| 40.25 Cloud Optical Depth/Transmittance                   | 40.56 Snow Water Equivalent                                      |
| 40.26 Cloud Top Pressure                                  | <b>40.57 Solar Extreme Ultraviolet (EUV) Flux</b>                |
| 40.27 Cloud Top Temperature                               | <b>40.59 Total Longwave Radiation (Top of Atmosphere)</b>        |
| 40.28 Cloud Top Height                                    | <b>40.60 Total Shortwave Radiation</b>                           |
| <b>40.29 CO Column (Carbon Monoxide)</b>                  | <b>40.61 Total Solar Irradiance (Full Spectrum)</b>              |
| <b>40.31 Currents</b>                                     | 40.62 Total Water Content  |
| 40.32 Electric Fields                                     | 40.63 Tropospheric Winds   |
| 40.33 Electron Density Profiles/Ionospheric Specification | <b>40.64 Turbidity</b>   |
| 40.34.1 Supra-thermal/Auroral Particles                   | 40.65 Vegetation/Surface Type                                    |
| 40.34.2 Radiation Belt/Low Energy Solar Particles         |  |

\* Note that 40.34.1, 40.34.2, and 40.34.3 are considered as a single EDR; 40.38.1, 40.38.2, and 40.38.3 are considered as a single EDR; and 40.39.1 and 40.39.2 are considered as a single EDR.

## 40.8: AEROSOL PARTICLE SIZE

<b>40.8: AEROSOL PARTICLE SIZE (Derived)</b>			<b>Lockheed PI: Dr. Keith Hutchison</b>	
<b>Solution Type: OASIS, Lidar</b>			<b>Risk: High</b>	
<b>DATA REQUIREMENTS (APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>DESIGN REFERENCE SYSTEM</b>	<b>HIGH COST 2: LIDAR</b>
<b>Sensing Depth</b>	<b>Minimum: Sfc to 15 km</b>	<b>Goal: Sfc to 30 km</b>	<b>Possibly stratosphere or troposphere</b>	<b>Sfc to 15 km for nadir viewing only</b>
<b>Horizontal Spatial Resolution</b>	<b>Minimum: 10 km</b>	<b>Goal: 1 km</b>	<b>10 km</b>	<b>1 km along track</b>
<b>Vertical Sampling Interval</b>	<b>Minimum: 0-2 km, 0.5 km intervals; 2-5 km, 1 km intervals; &gt;5 km, 2 km intervals</b>	<b>Goal: 0-2 km, 0.25 km intervals; 2-5 km, 0.5 km intervals; &gt;5 km, 1 km intervals</b>	<b>Troposphere or stratosphere total column</b>	<b>Minimum: 0-2 km, 0.5 km intervals; 2-5 km, 1 km intervals; &gt;5 km, 2 km intervals</b>
<b>Mapping Accuracy</b>	<b>Minimum: 4 km</b>	<b>Goal: 1 km</b>	<b>4 km</b>	<b>1 km</b>
<b>Measurement Range</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>0.1-3*</b>	<b>0.1-3*</b>
<b>Precision</b>	<b>Minimum: 0.3</b>	<b>Goal: 0.1</b>	<b>0.3*</b>	<b>0.3*</b>
<b>Measurement Uncertainty</b>	<b>Minimum: 0.3</b>	<b>Goal: 0.1</b>	<b>0.3*</b>	<b>0.3*</b>
<b>Refresh</b>	<b>Minimum: 12 hrs</b>	<b>Goal: 4 hrs</b>	<b>~14 hours for 2 satellites</b>	<b>12 hours for nadir view only</b>

\*NOTE: Values need confirmation

## 40.19: CH<sub>4</sub> COLUMN (METHANE)

<b>40.19: CH<sub>4</sub> Column (Methane) (Derived)</b>			<b>Lockheed PI: Dr. Aidan Roche</b>	
<b>Solution Type: MOPITT(1998) or TES(2002) - to fly on EOS AM-1 and CHEM</b> (MOPITT-Measurement of Pollutants in the Troposphere (Univ of Toronto, Can) TES- Tropospheric Emission Spectrometer (JPL))			<b>Risk: Low to Medium</b>	
<b>DATA REQUIREMENTS (APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>HIGH COST 2: MOPITT</b>	<b>REMARKS</b>
<b>Sensing Depth</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>Surface</b>	
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 10x10 km</b>	<b>22x22 km</b>	<b>Orbital track separation is ~1800 km for MOPITT</b>
<b>Vertical Sampling Interval (profile)</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>3 weighting functions 0-15 km</b>	<b>TES lists 2-6 km from 0-33 km alt</b>
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>10%</b>	<b>TES: 8% of footprint MOPITT: 8%</b>
<b>Measurement Range (profile: 0-15 km)</b>	<b>Minimum: TBD</b>	<b>Goal: 40 - 80 μmoles/cm<sup>2</sup></b>	<b>1500-1600 ppbv 40-60 μmoles/cm<sup>2</sup></b>	
<b>Precision (column)</b>	<b>Minimum: TBD</b>	<b>Goal: 0.5%</b>	<b>1%</b>	<b>MOPITT ~1% TES ~1-2.5%</b>
<b>Measurement Uncertainty (column)</b>	<b>Minimum: TBD</b>	<b>Goal: ±5%</b>	<b>8%</b>	
<b>Refresh</b>	<b>Minimum: TBD</b>	<b>Goal: 24 hrs</b>	<b>36 hrs</b>	<b>Large cross-track swaths can cover selected areas more frequently (TES)</b>

## 40.22: CLOUD ICE, LIQUID EQUIVALENT

<b>40.22: CLOUD ICE, LIQUID EQUIVALENT (Derived)</b> <b>Mixing ratio of ice, expressed as a mixing ration of the ice converted to liquid water by melting.</b>		<b>Lockheed PI:</b> <b>Dr. Keith Hutchison</b>		
<b>Solution Type: EO Imager combined with Lidar and IR profiler. EDR not included in the DESIGN REFERENCE.</b>		<u>Risk: High</u>		
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		HIGH COST 2 LIDAR	REMARKS
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 10 km</b>	<b>10 km at nadir only</b>	
<b>Vertical Sampling Interval</b>	<b>Minimum: TBD</b>	<b>Goal: 0.3 km</b>	<b>1 km</b>	
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: 1 km</b>	<b>1 km</b>	
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: 10<sup>-4</sup> gm/gm</b>	<b>2x10<sup>-4</sup> gm/gm</b>	<b>Nadir view and for thin cirrus only</b>
<b>Refresh</b>	<b>Minimum: TBD</b>	<b>Goal: 4 hrs</b>	<b>12 hours for one satellite</b>	<b>Nadir view only</b>

## 40.24: CLOUD ICE WATER PATH (page 1 of 2)

<b>40.24: CLOUD ICE WATER PATH (Derived) [page 1 of 2]</b> <b>A measure of the equivalent water mass of the ice particles in unit vertical column through the cloud. Measured information must be sensitive to the number of particles, their sizes, and their densities.</b>				<b>Lockheed PI: Dr. Keith Hutchison</b>
<b>Solution Type: OASIS combined with Lidar and IR ptofiler. EDR not included in the DESIGN REFERENCE.</b>			<b>Risk: High</b>	
<b>DATA REQUIREMENTS (APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>HIGH COST 2: LIDAR</b>	<b>REMARKS</b>
<b>Sensing Depth</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>Sfc to 20 km for ice clouds</b>	<b>Nadir view only</b>
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 10 km</b>	<b>10 km at nadir only</b>	
<b>Vertical Sampling Interval</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>1 km</b>	<b>Nadir view only</b>
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>1 km</b>	

## 40.24: CLOUD ICE WATER PATH (page 2 of 2)

<b>40.24: CLOUD ICE WATER PATH (Derived)</b> A measure of the equivalent water mass of the ice particles in unit vertical column through the cloud. Measured information must be sensitive to the number of particles, their sizes, and their densities.				Lockheed PI: Dr. Keith Hutchison
Solution Type: OASIS combined with Lidar and IR profiler.			<u>Risk</u> : High	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		HIGH COST 2: LIDAR	REMARKS
Measurement Range	Minimum: TBD	Goal: 0-1 mm	0-1 mm	Effective cloud optical depth may be retrieved with IR profiler when only ice clouds are present
Precision	Minimum: TBD	Goal: TBD	0.05 mm	
Measurement Uncertainty	Minimum: TBD	Goal: $\pm 0.01$ mm	$\pm 0.1$ mm	Nadir view only for thin cirrus
Refresh	Minimum: TBD	Goal: 4 hrs	12 hours for one satellite	Nadir view only

## 40.29: CO COLUMN (CARBON MONOXIDE)

<b>40.29: CO COLUMN (CARBON MONOXIDE) (Derived)</b>			<b>Lockheed PI: Dr. Aidan Roche</b>	
<b>Solution Type: MOPITT(1998) or TES(2002) - to fly on EOS AM-1 and CHEM</b> (MOPITT-Measurement of Pollutants In the Troposphere (Univ of Toronto, Can) TES- Tropospheric Emission Spectrometer (JPL))			<b>Risk: Low to medium</b>	
<b>DATA REQUIREMENTS (APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>HIGH COST 2: MOPITT</b>	<b>REMARKS</b>
<b>Sensing Depth</b>	<b>Minimum: TBD</b>	<b>Goal TBD</b>	<b>Surface</b>	
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 100 km</b>	<b>22x22 km</b>	<b>Orbital track separation is ~1800 km for MOPITT, Swath ~ 600 km</b>
<b>Vertical Sampling Interval (profile)</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>3 weighting functions 0-15 km</b>	<b>MOPITT~5 km TES~2-3 km</b>
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>10 km</b>	<b>MOPITT:8% of IFOV TES: 8% of IFOV</b>
<b>Measurement Range (profile 0-15 km)</b>	<b>Minimum: TBD</b>	<b>Goal: 0 - 7 <math>\mu\text{moles}/\text{cm}^2</math></b>	<b>37-100 ppbv 0.4-6 <math>\mu\text{moles}/\text{cm}^2</math></b>	
<b>Precision (column)</b>	<b>Minimum: TBD</b>	<b>Goal: 1%</b>	<b>5%</b>	<b>TES~10% for profile</b>
<b>Measurement Uncertainty (column)</b>	<b>Minimum: TBD</b>	<b>Goal: <math>\pm 3\%</math></b>	<b>6%</b>	<b>MOPITT~10% for profile</b>
<b>Refresh</b>	<b>Minimum: TBD</b>	<b>Goal: 24 hrs</b>	<b>36 hrs</b>	<b>EOS-type sun-synchron orbit</b>

## 40.31: CURRENTS

<b>40.31: CURRENTS [Derived]</b> Large scale movements of the surface waters of the ocean driven by wind, and the distribution of water density. Currents are a vector quantity with both speed and direction.				<b>Lockheed PI:</b> <b>Dr. Keith Hutchison</b>
<b>Solution Type: SeaWiFS Heritage</b>			<b><u>Risk:</u> High</b>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		HIGH COST 2: SeaWiFS	REMARKS
<b>Sensing Depth</b>	<b>Minimum: TBD</b>	<b>Goal: 0 - 30 m</b>	<b>0 - 10 m</b>	<b>Depth of reflecting layer</b>
<b>Horizontal Spatial Resolution</b>	<b>Minimum: 20 km Global, 10 km Regional</b>	<b>Goal: TBD Global, 5 km Regional</b>	<b>15 km</b>	
<b>Vertical Sampling Interval</b>	<b>Minimum: TBD</b>	<b>Goal: 1 m</b>	<b>N/A</b>	
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: 5 km</b>	<b>4 km</b>	
<b>Measurement Range</b>	<b>Minimum: TBD</b>	<b>Goal: 0 -500 cm/s</b>	<b>0-500 cm/s</b>	<b>Needs confirmation</b>
<b>Precision</b>	<b>Minimum: TBD</b>	<b>Goal: 0.1 cm/sec</b>	<b>1 cm/s</b>	<b>Needs confirmation</b>
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: ±10%</b>	<b>±20%</b>	<b>Needs confirmation</b>
<b>Refresh</b>	<b>Minimum: 24 hrs</b>	<b>Goal: 12 hrs</b>	<b>24 hrs for clear areas on two successive satellite passes</b>	<b>Derived from daily changes in ocean features</b>

## 40.41: LITTORAL SEDIMENT TRANSPORT

<b>40.41: LITTORAL SEDIMENT TRANSPORT [Derived]</b> <b>The transport of sediment by river systems and along shore currents.</b>			<b>Lockheed PI:</b> <b>Dr. Keith</b> <b>Hutchison</b>	
<b>Solution Type: Like SeaWiFS.Heritage</b>			<b>Risk: High</b>	
<b>DATA REQUIREMENTS</b> <b>(APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>High Cost 2:</b> <b>SeaWiFS</b>	<b>REMARKS</b>
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 10 km</b>	<b>1.3 km</b>	
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>4 km</b>	
<b>Measurement Range</b>	<b>Minimum: TBD</b>	<b>Goal: 100 m</b>	<b>0-5000 cu m/day</b> <b>(needs confirmation)</b>	<b>Does the Goal</b> <b>have the</b> <b>correct unit?</b>
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: cu m/day</b>	<b>2000 cu m/day</b> <b>(needs confirmation)</b>	<b>Need</b> <b>numerical</b> <b>value for</b> <b>goal?</b>
<b>Refresh</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>24 hrs</b>	<b>Cloud-free</b> <b>areas only</b>

## 40.42: LONGWAVE RADIATION

<b>40.42: LONGWAVE RADIATION [Derived] Downward longwave radiation (DLR)</b>			<b>Lockheed PI: Dr. Ken Hardy</b>	
<b>Solution Type: CERES Heritage, Profilers</b>			<b><u>Risk</u>: Low</b>	
<b>DATA REQUIREMENTS (APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>High Cost 2: CERES</b>	<b>REMARKS</b>
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 10 km</b>	<b>40 km at nadir</b>	
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>10 km</b>	<b>Needs confirmation</b>
<b>Measurement Range</b>	<b>Minimum: TBD</b>	<b>Goal: 0 -500 W/m<sup>2</sup></b>	<b>0 -500 W/m<sup>2</sup></b>	
<b>Precision</b>	<b>Minimum: TBD</b>	<b>Goal: 0.1 W/m<sup>2</sup></b>	<b>0.1 W/m<sup>2</sup></b>	
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: ±1 W m<sup>-2</sup></b>	<b>±5 W/m<sup>2</sup></b>	
<b>Refresh</b>	<b>Minimum: TBD</b>	<b>Goal: 6 hrs</b>	<b>14 hrs</b>	<b>Worst case for 1 satellite</b>

## 40.44: NET RADIATION (TOP OF ATMOSPHERE)

<b>40.44: NET RADIATION (TOP OF ATMOSPHERE) [Derived]</b> Difference between the net solar radiation and outgoing longwave radiation, 24 hour average.				Lockheed PI: Dr. Ken Hardy
Solution Type: CERES Heritage			Risk: Medium	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		High Cost 2: CERES	REMARKS
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	40 km	CERES FOV at nadir
Mapping Accuracy	Minimum: TBD	Goal: TBD	10 km	Needs confirmation
Measurement Range	Minimum: TBD	Goal: 0 -1,400 W/m <sup>2</sup>	0 -1,400 W/m <sup>2</sup>	Relates to incoming solar and not the net
Precision	Minimum: TBD	Goal: 0.1 W/m <sup>2</sup>	0.1 W/m <sup>2</sup>	
Measurement Uncertainty	Minimum: TBD	Goal: ±1 W/m <sup>2</sup>	±10 W/m <sup>2</sup>	Needs confirmation
Refresh	Minimum: TBD	Goal: 12 hrs	24 hrs	

## 40.45: NET SURFACE SHORTWAVE RADIATION

<b>40.45: NET SURFACE SHORTWAVE RADIATION [Derived]</b> <b>Absorbed solar radiation - amount of solar energy absorbed by the Earth-atmosphere system. (daily averaged estimate)</b>				<b>Lockheed PI: Dr. Ken Hardy</b>
<b>Solution Type: CERES Heritage</b>			<b>Risk: Medium</b>	
<b>DATA REQUIREMENTS (APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>High Cost 2: CERES</b>	<b>REMARKS</b>
<b>Sensing Depth</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>Applies to surface only</b>	
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 100 km</b>	<b>250 km</b>	<b>values mapped into 250 km grid</b>
<b>Vertical Sampling Interval</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>Surface only</b>	
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: 10 km</b>	<b>~10 km</b>	
<b>Measurement Range</b>	<b>Minimum: TBD</b>	<b>Goal: 0-500 W/m<sup>2</sup></b>	<b>0 - 500 W/m<sup>2</sup> (daily average)</b>	<b>largest over tropical oceans</b>
<b>Precision</b>	<b>Minimum: TBD</b>	<b>Goal: 0.1 W/m<sup>2</sup></b>	<b>1 W/m<sup>2</sup></b>	
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: 1 W/m<sup>2</sup></b>	<b>20 W/m<sup>2</sup></b>	<b>surface classification</b>
<b>Refresh</b>	<b>Minimum: TBD</b>	<b>Goal: 24 hrs</b>	<b>24 hrs</b>	<b>depends on cloud climatology</b>

## 40.47: OCEAN COLOR / CHLOROPHYLL

<b>40.47: OCEAN COLOR/CHLOROPHYLL [Derived]</b> Color of ocean as seen from a distance of at least 1 meter or chlorophyll content of the water.			<b>Lockheed PI:</b> <b>Dr. Keith Hutchison</b>	
<b>Solution Type: SeaWiFS Heritage</b>			<b>Risk: Low</b>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		High Cost 2: SeaWiFS	REMARKS
<b>Horizontal Spatial Resolution</b>	<b>Minimum:</b>	<b>Goal:</b>		
1. global	TBD	1 km	1.3 km	at nadir
2. regional	TBD	0.25 km	1.3 km	at nadir
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>		
1. global	TBD	0.5 km	4 km	4 km
2. regional	TBD	0.25 km	4 km	4 km
<b>Measurement Range</b>	<b>Minimum: TBD</b>	<b>Goal: 0-100 mg/m<sup>3</sup></b>	<b>0.05 - 50 mg/m<sup>3</sup></b>	
<b>Precision</b>	<b>Minimum: TBD</b>	<b>Goal: ±10%</b>	<b>±10%</b>	
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: ±30%</b>	<b>±35%</b>	
<b>Refresh</b>	<b>Minimum: TBD</b>	<b>Goal: 12 hrs</b>	<b>~48 hrs</b>	<b>cloud-free areas only</b>

## 40.57: SOLAR EXTREME ULTRAVIOLET (EUV) FLUX

<b>40.57: SOLAR EXTREME ULTRAVIOLET (EUV) FLUX</b> The portion of the solar spectrum which is responsible for creation of the Earth's ionosphere as well as much of the heating of the upper atmosphere		<b>Lockheed PI: Dr. Yam Chiu</b>		
<b>Solution Type : Solar Full Disk FUV / EUV photometer</b>				
DATA REQUIREMENTS (APPENDIX D, 1/1/95)	SPECIFICATIONS		DESIGN REFERENCE SYSTEM	REMARKS
<b>Coverage</b>	<b>Minimum : TBD</b>	<b>Goal : TBD</b>	<b>Monitors full solar disk</b>	<b>For 24 hr monitoring full constellation of 2 (or 3) satellites is necessary</b>
<b>Horizontal and Vertical Spatial Resolution</b>	<b>Minimum : N/A</b>	<b>Goal : N/A</b>	<b>N/A</b>	
<b>Mapping Accuracy</b>	<b>Minimum : N/A</b>	<b>Goal : N/A</b>	<b>N/A</b>	
<b>Measurement Range</b>	<b>Minimum : TBD</b>	<b>Goal : 230-1500 Angstroms. (50-2000 Angstrom bins)</b>	<b>Bins: approx. 200-400; 400-1000; 1000-1500 Angstroms</b>	<b>50 Angstrom bins require a much more complex spectrometer.</b>
<b>Precision</b>	<b>Minimum : TBD</b>	<b>Goal : TBD</b>	<b>Bin Definition : +/- 30 Angstroms</b>	
<b>Measurement Accuracy</b>	<b>Minimum : TBD</b>	<b>Goal : TBD</b>	<b>Flux calibration based on astronomical bodies : Approx. +/- 20%</b>	<b>Calibration essential due to FUV / EUV sensor degradation</b>
<b>Refresh</b>	<b>Minimum : TBD</b>	<b>Goal : TBD</b>	<b>24 hr. continuous monitoring.</b>	

\* Such experiments have been flown with short mission lifetimes, notably on NASA / SMM mission. Risks for long-term mission are sensor degradation and special solar pointing platform requirements. Instrument calibration is also an important issue for this EDR, which is important for upper atmosphere dynamics

## 40.59: TOTAL LONGWAVE RADIATION (TOP OF ATMOSPHERE)

<b>40.59: TOTAL LONGWAVE RADIATION (TOP OF ATMOSPHERE)</b> Outgoing longwave radiation required during daytime and nighttime.			<b>[Derived]</b>	<b>Lockheed PI: Dr. Ken Hardy</b>
<b>Solution Type: CERES Heritage</b>			<b>Risk: Low</b>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		High Cost 2: CERES	REMARKS
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 10 km</b>	<b>40 km at nadir</b>	
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>~5 km</b>	
<b>Measurement Range</b>	<b>Minimum: TBD</b>	<b>Goal: 0-500 W/m<sup>2</sup></b>	<b>0 - 500 W/m<sup>2</sup></b>	
<b>Precision</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>1 W/m<sup>2</sup></b>	
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: ±2.5 W/m<sup>2</sup></b>	<b>±5 W/m<sup>2</sup></b>	
<b>Refresh</b>	<b>Minimum: 12 hrs</b>	<b>Goal: 6 hrs</b>	<b>~12 hrs for one satellite</b>	

## 40.59: TOTAL LONGWAVE RADIATION (TOP OF ATMOSPHERE)

<b>40.60: TOTAL SHORTWAVE RADIATION [Derived]</b> In-coming shortwave radiation required during daytime and nighttime.			<b>Lockheed PI: Dr. Ken Hardy</b>	
<b>Solution Type: CERES Heritage</b>			<u>Risk: Medium</u>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		High Cost 2: CERES	REMARKS
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	40 km at nadir	
Mapping Accuracy	Minimum: TBD	Goal: TBD	~ 5 km	
Measurement Range	Minimum: TBD	Goal: 0-500 W/m <sup>2</sup>	0 - 1400 W/m <sup>2</sup>	Assume incoming at top of atm
Precision	Minimum: TBD	Goal: TBD	1 W/m <sup>2</sup>	
Measurement Uncertainty	Minimum: TBD	Goal: ±2.5 W/m <sup>2</sup>	10 W/m <sup>2</sup>	Modeled
Refresh	Minimum: 12 hrs	Goal: 6 hrs	~12 hrs for one satellite	

## 40.61: TOTAL SOLAR IRRADIANCE (FULL SPECTRUM)

<b>40.61: TOTAL SOLAR IRRADIANCE (FULL SPECTRUM)</b> <b>[Measured]</b> Incident radiation measurements.			<b>Lockheed PI: Dr. Ken Hardy</b>	
<b>Solution Type: An ACRIM concept</b>			<u>Risk:</u> Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		High Cost 2:	REMARKS
<b>Measurement Range</b>	<b>Minimum: 0 - 1400 W/m<sup>2</sup></b>	<b>Goal: TBD</b>	<b>0 - 1400 W/m<sup>2</sup></b>	<b>Why not 1300 - 1500 W/m<sup>2</sup>?</b>
<b>Precision</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>0.0005/year%</b>	
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: ±2.5 W/m<sup>2</sup></b>	<b>±1.4 W/m<sup>2</sup></b>	
<b>Refresh</b>	<b>Minimum: 24 hrs</b>	<b>Goal: TBD</b>	<b>24 hrs for one satellite</b>	

## 40.64: TURBIDITY

<b>40.64: TURBIDITY [Derived]</b> <b>Measure of suspended matter in the ocean.</b>			<b>Lockheed PI:</b> <b>Dr. Keith Hutchison</b>	
<b>Solution Type: SeaWiFS Heritage</b>			<u><b>Risk: High</b></u>	
<b>DATA REQUIREMENTS</b> <b>(APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>High Cost 2:</b> <b>SeaWiFS</b>	<b>REMARKS</b>
<b>Sensing Depth</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	~ 20 m	
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 0.25 km</b>	1.3 km	
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: 0.25 km</b>	4 km	
<b>Measurement Range</b>	<b>Minimum: TBD</b>	<b>Goal: 0 - 100 mg/L</b>	0 - 50 mg/L	
<b>Precision</b>	<b>Minimum: TBD</b>	<b>Goal: 0.1 mg/L</b>	5 classes; 0 - 5, 5 - 10, 10 - 25, 25 - 50, > 50 mg/L	assumes info on bottom spectral pigment features is known
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: ±0.1 mg/L</b>	± 1 class	
<b>Refresh</b>	<b>Minimum: TBD</b>	<b>Goal: 24 hrs</b>	~48 hrs from near noon satellite	Cloud-free areas only

**POTENTIAL ATTRIBUTE VALUES FOR THE  
FOUR EDRs NOT ADDRESSED BY THE OPTIONS**

**40.17 Bathymetry**

**40.18 Bioluminescence**

**40.30 CO<sub>2</sub> Column (Carbon Dioxide)**

**40.53 Salinity**

**Note: EM 1167: "Preliminary Assessment of 4 EDRs Excluded from the NPOESS Options" describes the remote sensing or technical issues that lead to the omission of the EDRs from any of the options.**

## 40.17: BATHYMETRY (page 1 of 2)

<b>40.17: BATHYMETRY (Derived) (Deep Ocean and Near Shore).</b>				<b>Lockheed PI: Ken Hardy</b>
<b>Solution Type: EO Imager, SeaWiFS Heritage, Altimeter</b>			<b>Risk: High</b>	
<b>DATA REQUIREMENTS (APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>POSSIBLE VALUES</b>	<b>ALTIMETER FOR DEEP OCEAN</b>
<b>Sensing Depth</b>	<b>Minimum:</b>	<b>Goal:</b>		
1. near shore	TBD	0 -200 m	0 - 5 m except 0 - 20 m in non- polluted water	N/A
2. deep ocean	TBD	0 - 300 m	N/A	0-4,000 m
<b>Horizontal Spatial Resolution</b>	<b>Minimum:</b>	<b>Goal:</b>		
1. near shore	TBD	TBD	0.65 to 1.3 km	N/A
2. deep ocean	TBD	300 m	N/A	15 km
<b>Vertical Sampling Interval</b>	<b>Minimum: TBD</b>	<b>Goal: deep ocean &amp; near shore, 1 m</b>	5 m	± 100 m
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: 10 m</b>	4 km	10 m

## 40.17: BATHYMETRY (page 2 of 2)

<b>40.17: BATHYMETRY (Derived) (Deep Ocean and Near Shore).</b>			<b>Lockheed PI: Ken Hardy</b>	
<b>Solution Type: EO Imager, SeaWiFS Heritage, Altimeter</b>			<b>Risk: High</b>	
<b>DATA REQUIREMENTS (APPENDIX D, 1/11/95)</b>	<b>SPECIFICATIONS</b>		<b>POSSIBLE VALUES</b>	<b>ALTIMETER FOR DEEP OCEAN</b>
<b>Measurement Range</b>	<b>Minimum:</b>	<b>Goal:</b>		
1. near shore	TBD	0 -200 m	0 - 20 m	N/A
2. deep ocean	TBD	0 -300 m	N/A	0 - 4,000 m
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: deep ocean &amp; near shore, ±0.3 m</b>	± 20 %	±10 %
<b>Refresh</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	~48 hrs with near noon satellite: clear areas only	Deep ocean needs to be done once only

## 40.18: BIOLUMINESCENCE

<b>40.18: BIOLUMINESCENCE (Derived)</b> <b>A measurement of the number of bioluminescent organisms present in sea water within a region.</b>			<b>Lockheed PI:</b> <b>Dr. Keith Hutchison</b>	
<b>Solution Type: Low-Light Level Band of EO Imager.</b>			<b>Risk: High</b>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		POSSIBLE ATTRIBUTE VALUES	REMARKS
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>3.25 - 6.5 km</b>	
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>4 km</b>	
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>Bioluminescence detected (Yes/No), Goal: 10 % of emitted radiance</b>	
<b>Refresh</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>&gt;24 hours</b>	<b>Clear areas only</b>
<b><i>Measurement Range</i></b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>Minimum emission level that can be detected</b>	<b>Recommend "Measurement Range" be added as a requirement</b>

## 40.30: CO<sub>2</sub> COLUMN (CARBON DIOXIDE)

<b>40.30: CO<sub>2</sub> COLUMN (CARBON DIOXIDE) (Derived)</b>		<b>Lockheed PI: Dr. Aidan Roche</b>		
<b>Solution Type:IMG</b> (Interferometric Measurement of Greenhouse Gases (IR), <b>TERSE</b> (Tuneable Etalon Radiometer for Earth Sensing (IR,Vis), <b>SCIAMACHY</b> (Scanning Imaging Absorption Spectrometer for Atmospheric Cartography (UV-Vis-NearIR). Selected sensor can be added to one of the options.		<b>Risk:</b> IMG: Low-Med TERSE: High SCIAM: Low-Med		
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		POSSIBLE EDR ATTRIBUTE VALUES	REMARKS
<b>Sensing Depth</b>	<b>Minimum: TBD</b>	<b>Goal TBD</b>	<b>Surface</b>	
<b>Horizontal Spatial Resolution</b>	<b>Minimum: TBD</b>	<b>Goal: 100 km</b>	<b>20x20 km</b>	
<b>Vertical Sampling Interval (profile)</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>5 km</b>	
<b>Mapping Accuracy</b>	<b>Minimum: TBD</b>	<b>Goal: TBD</b>	<b>10%</b>	
<b>Measurement Range (profile: 0-15 km)</b>	<b>Minimum: TBD</b>	<b>Goal: 11,000 - 15,000 μmoles/cm<sup>2</sup></b>	<b>11,000 - 15,000 μmoles/cm<sup>2</sup></b>	
<b>Precision (column)</b>	<b>Minimum: TBD</b>	<b>Goal: 0.1%</b>	<b>1 %</b>	
<b>Measurement Uncertainty</b>	<b>Minimum: TBD</b>	<b>Goal: ±1%</b>	<b>±1%</b>	
<b>Refresh</b>	<b>Minimum: TBD</b>	<b>Goal: 24 hrs</b>	<b>36 hours</b>	

## 40.53: SALINITY (page 1 of 2)

<b>40.53: SALINITY [Derived]</b> <b>A measure of the quantity of dissolved materials in sea water. A formal definition is "the total amount of solid materials, in grams, contained in one kilogram of sea water, when all the carbonate has been converted to oxide, the bromine and iodine converted to chlorine, and all organic matter is completely oxidized. Units of measurements are parts per thousand, by weight".</b>				<b>Lockheed PI: Dr. Ken Hardy</b>
<b>Solution Type: Modified MIS.</b>			<b>Risk: High</b>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Possible Attribute Values	REMARKS
<b>Sensing Depth</b>	<b>Minimum: TBD</b>	<b>Goal: 0 - 300 m</b>	<b>Near surface</b>	
<b>Horizontal Spatial Resolution</b>	<b>Minimum:</b>	<b>Goal:</b>		<b>Need freq of &lt; 2 MHz; lowest possible freq for MIS is 6.8 GHz</b>
1. Global	TBD	20 km	100s of km	
2. Regional	TBD	0.25 km	100s of km	
<b>Vertical Sampling Interval</b>	<b>Minimum:</b>	<b>Goal:</b>	<b>Surface only</b>	
1. Global	TBD	±10 m		
2. Regional	TBD	±2 m		

## 40.53: SALINITY (page 2 of 2)

<b>40.53: SALINITY [Derived]</b> A measure of the quantity of dissolved materials in sea water. A formal definition is "the total amount of solid materials, in grams, contained in one kilogram of sea water, when all the carbonate has been converted to oxide, the bromine and iodine converted to chlorine, and all organic matter is completely oxidized. Units of measurements are parts per thousand, by weight".			<b>Lockheed PI: Dr. Ken Hardy</b>	
<b>Solution Type: Modified MIS.</b>			<b>Risk: High</b>	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Possible Attribute Values	REMARKS
<b>Mapping Accuracy</b>	<b>Minimum:</b>	<b>Goal:</b>		Need freq of < 2 MHz
1. Global	TBD	5 km	7 km	
2. Regional	TBD	0.25 km	7 km	
<b>Measurement Range</b>	<b>Minimum: TBD</b>	<b>Goal: 0 - 40 ppt</b>	0 - 40 ppt	
<b>Precision</b>	<b>Minimum: TBD</b>	<b>Goal: 0.1 ppt</b>	1 ppt	
<b>Measurement Uncertainty</b>	<b>Minimum:</b>	<b>Goal:</b>		Need freq of < 2 MHz
1. Global	TBD	TBD	5 ppt	
2. Regional	TBD	0.5 ppt	5 ppt	
<b>Refresh</b>	<b>Minimum: TBD</b>	<b>Goal: 72 hr</b>	72 hr	