

**Internal Government Studies**

**1995**

**ADMINISTRATIVE BINDER**

**INTERNAL GOVERNMENT STUDIES - FY 1995  
ADMINISTRATIVE BINDER**

<u>Presentation/Paper Title</u>	<u>Author(s)</u>	<u>Date</u>
"NPOESS/IPO Internal Government Status Review, FY95"	D. Blersch	SEPT 95
"NPOESS ICS Interim Status Review Meeting: Attendance"	-----	29-30 JUNE 95
"ICS Interim Status Review Meeting(Finalized Agenda)"	D. Blersch	22 JUNE 95
"NOAA Working Group on Space Based LIDAR Meetings on 19-21 July 95, Request for IPO Participation"	W. Baker	15 JUNE 95
"NPOESS ICS Studies for FY 95(Master List and Detailed Study Description Listing(as of June 95))"	D. Blersch	13 JUNE 95
"Follow-up to the ICS Official Kick-off Meeting" [5 Attachments: (1)NPOESS Programmatic Notes(NPOESS CARD Input-Upcoming IPO ICS Meeting Dates; ICS Monthly Status Report); (2) ICS Kick-off Meeting Agenda(22-23 March 95); (3) ICS Kick-off Meeting Attendance List(22-23 March 95); (4) ICS Phone Lists; (5) ICS Inputs to the CARD, STATUS]"	D. Blersch	4 APRIL 95
"ICS Kick-off Meeting Notes"	D. Blersch	22-23 MAR 95

# **INTERNAL GOVERNMENT STUDIES - FY 1995**

**Interferometer Thermal Sounder [ITS] - Part I**

**Interferometer Thermal Sounder [ITS] - Part II**

**Electro-Optical Imager & Radiometer**

**Climate Study Suite**

**Program Synchronization**

**Direct Downlink (LRPT) & Frequency Allocation (HRPT)**

**Active Sensors**

**Microwave Sounding & Imaging Capabilities**

**Passive Microwave Polarimetry for Ocean Wind Field (Speed & Direction)**

**Spaceborne Wind Radiometry Concept**

## **MISCELLANEOUS PRESENTATIONS/PROPOSALS**

**SPACE ENVIRONMENTAL SUITE (SES)**

**LIDAR**

**FORMATION FLYING**

**RADIOMETER SYNTHETIC APERTURE RADAR (RADSAR)**

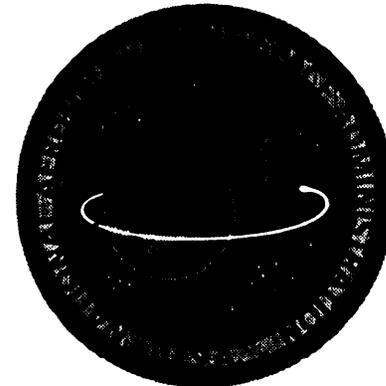
**SMALL SATELLITE**

**NWS BRIEF**

**SOIL MOISTURE BRIEF**

**OZONE BRIEF-NASA**

# NATIONAL POLAR-ORBiting OPERATIONAL ENVIRONMENTAL SATELLITE SYSTEM



## NPOESS/IPO IGS STATUS REVIEW

September, 1995

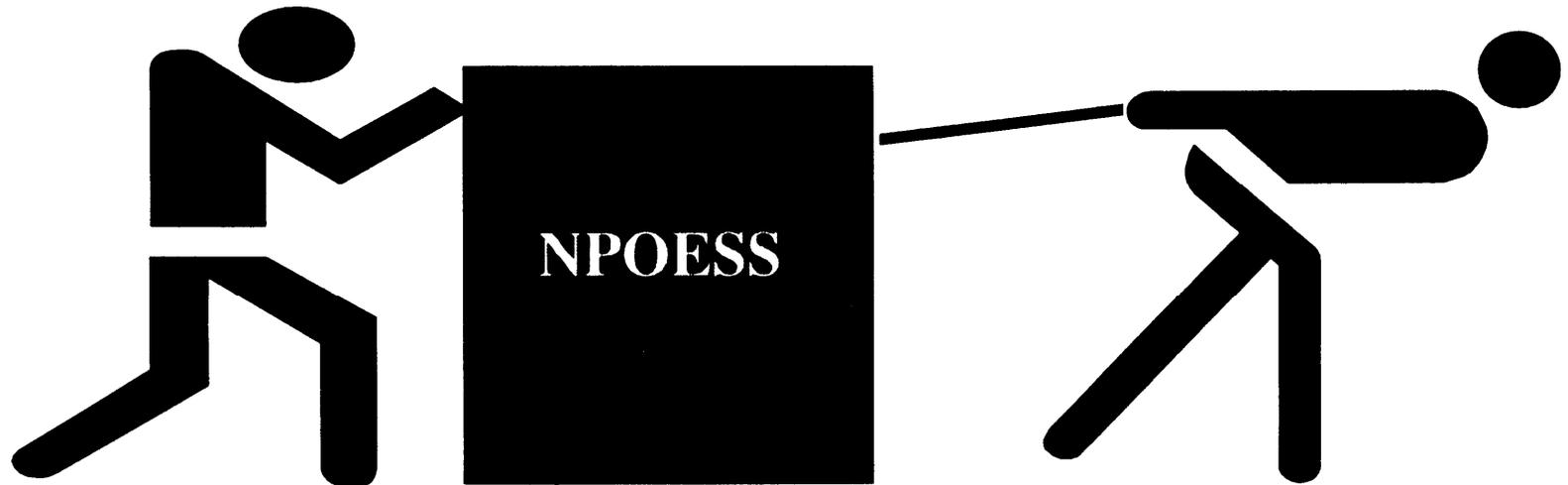
Silver Spring, MD

Mr. Donald Blersch, Systems Engineer  
(FY-95 Internal Government Studies Manager)

# “Drivers for NPOESS”

**Technology**

**Requirements/Cost**

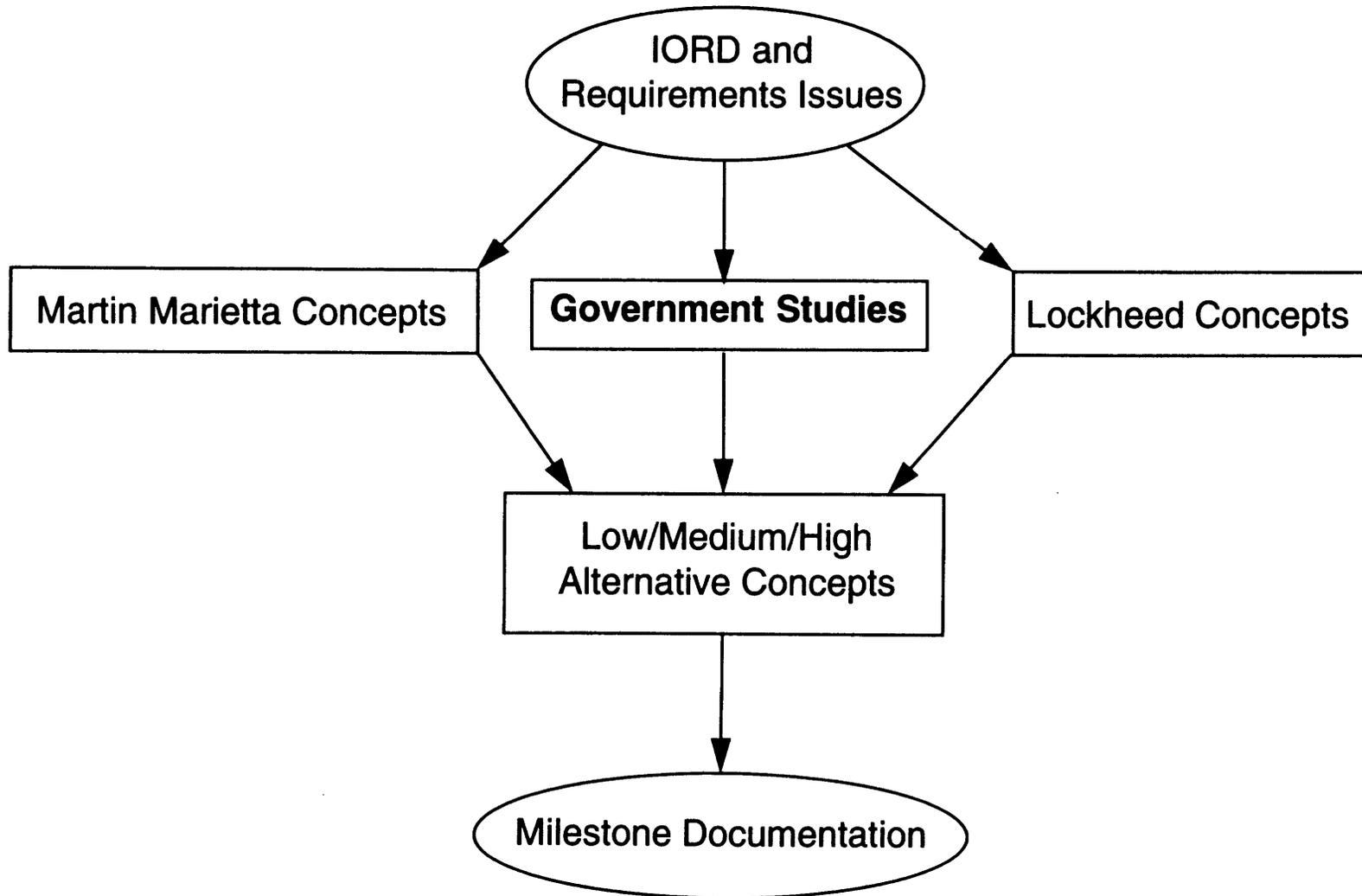


- ◆ Technology Inserts
- ◆ Price-Performance
  - ◆ Spin-on
  - ◆ COTS
- ◆ Prime Contractor Concept Studies
- ◆ **Internal Government Studies**

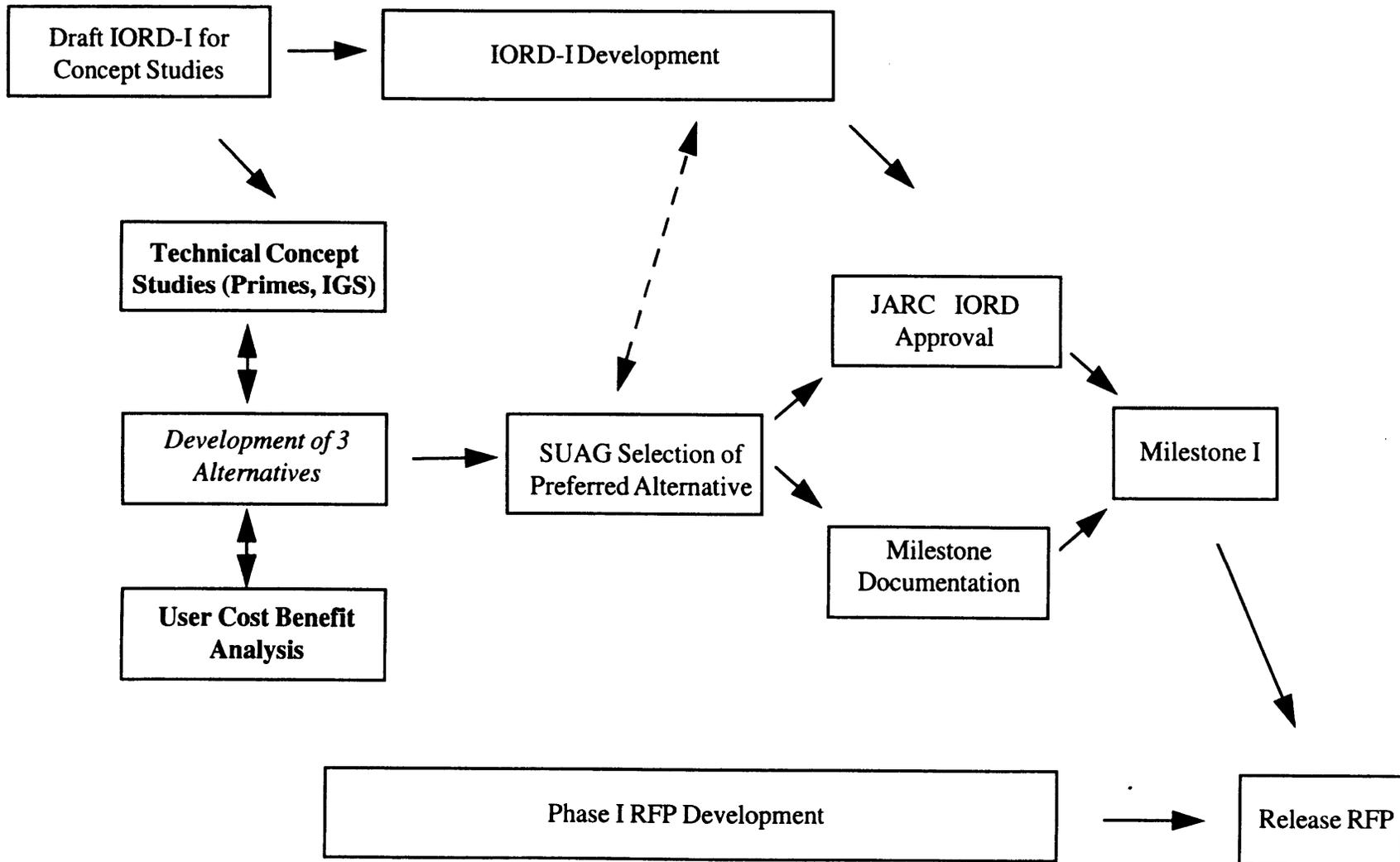
- ◆ IORD Environmental Data Records (EDRs)

# NPOESS PHASE 0

## Concept Exploration & Definition



# Concept Exploration & Definition



# Internal Government Studies (Background)

- ◆ **Integrated Program Office funded a number of independent government studies in FY-95**
  - An initial set of eleven IGS efforts were approved on March 15, 1995 and are now underway with one additional proposal recently approved
- ◆ **Purpose:**
  - Reduced technology risk - utilize internal expertise
  - Establish potential reference for comparison with contract proposals
- ◆ **Participants:**
  - Federal agencies
  - Federal laboratories
  - Federally Funded Research and Development Centers
  - Academic institutions

# Internal Government Studies (Major Events/Activities)

## ◆ March 1995

- Internal Government Studies *kick-off meeting* held on 22-23 March at the NPOESS IPO. Reviewed study team plans and individual task assignments, work break-out statements, schedules, and resources required.
- Addressed April 15 CARD inputs, mid-term/final results inputs, as well as providing monthly status reports to the IPO IGSM.

## ◆ April 1995

- IGS study teams provided required “first look” technical information to IPO for inclusion into the *NPOESS CARD* as requested by the ADA office.

## ◆ May 1995

- IGS study teams to provided standard monthly progress input.

# Internal Government Studies (Major Events/Activities)

## ◆ June 1995

- Held Interim Results/Status Review on 29-30 June. Team members provided IPO staff with mid-term results in the form of detailed presentations, briefing charts, and white papers. Data feed directly into ongoing IPO activities aimed at developing a preferred system alternative.

## ◆ July/August 1995

- *Final Draft* study reports/briefing due to IPO by end of month. Study teams are on-call to answer specific questions/concerns that arise during preferred system alternative definition activities.

## ◆ September 1995

- *Final* study reports/briefing due to IPO. Final results meeting and report presentations to be held at IPO on 28-29 September.

# Internal Government Studies

## (Status/Upcoming Events)

- ◆ All studies proceeding according to agreed upon schedules. Close cooperation noted amongst multi-organization study teams
- ◆ IGS study teams providing required technical information to IPO for inclusion in draft NPOESS CARD and COBRA/NPOESS alternatives study
- ◆ Final Draft reports/briefings due to IPO late August. Final reports due end of September

# NPOESS IPO Internal Government Studies FY95

## ◆ GENERAL OVERVIEW

# NPOESS IPO Internal Government Studies FY95

<u>STUDY TITLE</u>	<u>ORGANIZATION</u>
1. Interferometer Thermal Sounder (ITS) - Part I	MIT - Lincoln Laboratories
2. Interferometer Thermal Sounder (ITS) - Part II	NOAA/ORA & NASA/GSFC
3. Electro/Optical Imager & Radiometer	NOAA/ORA & Aerospace
4. Small Satellite Options <sup>+</sup>	JHU/APL & Aerospace
5. Direct Downlink (LRPT) & Frequency Allocation (HRPT)	NOAA/OSD & Aerospace
6. Program Synchronization	ANSER & Aerospace

+ Pending Final Approval

# **NPOESS IPO Internal Government Studies FY95 (continued)**

<b><u>STUDY TITLE</u></b>	<b><u>ORGANIZATION</u></b>
<b>7. Climate Study Suite</b>	<b>NOAA/ORA, NRL, U of MD</b>
<b>8. Active Sensors</b>	<b>NRL &amp; NOAA/ORA</b>
<b>9. Microwave Sounding &amp; Imaging Capabilities</b>	<b>Aerospace, NOAA/ORA, NRL, PL, &amp; NOAA/OSD</b>
<b>10. High Incidence Angle Microwave Radiometry</b>	<b>Phillips Lab, NRL, &amp; Aerospace</b>
<b>11. Passive MW Polarimetry for Ocean Wind Field (Speed &amp; Direction) - Part I (Airborne Validation of Concept)</b>	<b>JPL, NRL, NOAA/ORA &amp; Aerospace</b>
<b>12. <i>Passive MW Polarimetry for Ocean Wind Field (Speed &amp; Direction) - Part II (Spaceborne Concept Study)</i></b>	<b><i>NRL &amp; JPL (NEW START)</i></b>

			<b>Total :</b>	3803
<b>+ Pending Final Approval</b>				

		<b>NOAA/ORA</b>	<b>50</b>	
		<b>Aerospace</b>	50	
Pass <b>MW Pol for Ocean Wind Vector Part II - Spaceborne Concept</b>	Steve Mango	JPL	150	300
		<b>NRL</b>	150	
		Aerospace		
Pass <b>MW Pol for Ocean Wind Vector Part I - Airborne Val of Concept</b>	Steve Mango	JPL	150	350
		<b>NRL</b>	100	
		<b>NOAA/OSD</b>	11	
		Phillips Lab		
High Incidence Angle Microwave Radiometry	Lt. <b>Robert Lew</b>	Phillips Lab	2 0 0	200
		<b>NRL</b>		
		<b>NOAA/ORA</b>	68	
Microwave Sounding and Imaging Capabilities	Lt. <b>Robert Lew</b>	<b>Aerospace</b>	150	417
		<b>NRL</b>	150	
		<b>NOAA/ORA</b>	100	
	Steve Mango	<b>NOAA/ORA</b>	150	284
		<b>NRL</b>	134	
		University of Maryland	*	
Active Sensors	Steve Mango	<b>NRL</b>	68	136
Program Synchronization and Replenishment	Lt. Col. Joseph Parsley	Anser	*	67
		<b>Aerospace</b>	67	
Climate Study Suite	Steve Mango	<b>NOAA/ORA</b>	150	294
		<b>Aerospace</b>	34	
Direct Downlink (LRPT) Frequency Allocation (HRPT)	Don Blersch	<b>NOAA/OSD</b> 34	68	
		<b>Aerospace</b> 34		
Electro/Optical Imager & Radiometer	Lt. Kevin Westley	<b>NOAA/ORA</b>	150	300
		<b>Aerospace</b>	150	
Small Satellite Options +	Don Blersch	<b>JHU/APL</b>	200	234
Interferometer Thermal Sounder [ITS] - Part I	Don Blersch	Lincoln Labs	1247	1247
Interferometer Thermal Sounder [ITS] - Pan II	Don Blersch	<b>NOAA/ORA</b>	150	200
		<b>NASA/GSFC</b>	50	

**(Budget Breakout)**

Study Title	IPO Coordinator	Participating Organizations	Org. \$K	Study Total \$K
<b>NPOESS IPO Internal Government Studies FY95</b>				
<b>(Budget Breakout)</b>				

# NPOESS IPO Internal Government Studies FY95 (Schedule)

**DRAFT**

## INTERNAL CONCEPT STUDIES SUMMARY SCHEDULE

6/9/95

ID	Task Name	'95												'96												'97													
		S	O	N	D	J	F	M	A	M	J	J	A	S	S	O	N	D	J	F	M	A	M	J	J	A	S	S	O	N	D	J	F	M	A	M	J	J	A
3	2.1 Phase 0 Internal Govt Technical Studies	↑————— —————↑ 6/17																																					
4	2.1.1 Interferometer Thermal Sounder (ITS) Part I (Tech Demo)	↑————— —————↑ 10/2																																					
9	2.1.2 ITS Part II (AIRS vs ITS)	3/15 ↑————— —————↑ 9/29																																					
14	2.1.3 Electro-Optical Imager & Radiometer	3/15 ↑————— —————↑ 9/29																																					
19	2.1.4 Microwave Sounding & Imaging Capabilities	3/15 ↑————— —————↑ 9/29																																					
25	2.1.5 Small Satellite Options*	3/15 ↑————— —————↑ 9/29																																					
30	2.1.6 Direct Downlink Communication (LRPT) & Frequency Allocation (HRF)	3/15 ↑————— —————↑ 5/31																																					
34	2.1.7 Program Synch Support	3/15 ↑————— —————↑																																					
38	2.1.8 Climate Study Suite	3/15 ↑————— —————↑ 9/29																																					
43	2.1.9 Active Sensors	3/15 ↑————— —————↑ 9/29																																					
48	2.1.10 Passive MW Polarimetry for Ocean Wind Field (Speed & Direction)	3/15 ↑————— —————↑ 9/29																																					
53	2.1.11 High Incidence Angle Microwave Radiometry	3/15 ↑————— —————↑ 12/15																																					
58	2.1.12 Passive MW Polarimetry for Ocean Wind Field - Spaceborne Concept	7/5 ↑————— —————↑ 6/17																																					

# NPOESS IPO Internal Government Studies FY95

## ◆ DETAILED STUDY DESCRIPTIONS

# Internal Government Studies

## Interferometer Thermal Sounder (ITS) - Part I

### ◆ Purpose

- Develop the ITS mechanical systems as an alternative to AIRS

### ◆ Objective

- Produce a cost effective sensor alternative that will meet NPOESS requirements for more accurate temperature and humidity profiles of the atmosphere as specified in the IORD

### ◆ Approach

- Continue Lincoln Labs efforts aimed at studying the means for developing the ITS as a possibly smaller, lighter and less power demanding alternative to AIRS. Specific elements include:
  - Investigating several mechanical issues of the ITS to reduce the overall risk of this mission critical sensor. The study will consist of two phases:
    - The first phase will run until mid-FY95 and will focus on risk reduction of the primary moving mirror assembly;
    - The next phase (mid-FY95 to mid-FY96) will develop flight qualifiable mechanical systems of the interferometer using the tested assemblies of the previous studies.

# Internal Government Studies

## Interferometer Thermal Sounder (ITS) - Part II

### ◆ Purpose

- Investigate the applicability of the ITS system as an alternative to the AIRS

### ◆ Objective

- To evaluate the ability of the proposed ITS system design to meet temperature and moisture profile requirements specified in the NPOESS IORD and compare these results with other proposed sensors especially AIRS.

### ◆ Approach

- Major elements of this task include:
  - Evaluating, via simulations, the relative merits of the ITS with respect to the AIRS for retrieving atmospheric temperature and water vapor profiles
  - Establishing the retrieval algorithm, radiative transfer models and any other agreed-upon components of the algorithm to be used in the simulations
  - Comparing simulated retrieval products with a base set of parameters available from an ensemble of ground-based radiosondes
  - Assessing the ability of the ITS to meet IORD requirements using statistical parameters such as bias and standard deviation as criteria.

# Internal Government Studies

## Electro/Optical Imager & Radiometer

### ◆ Purpose

- Meet primary radiometric and imaging requirements of the civilian and military community.

### ◆ Objective

- Develop an in-house conceptual design of an electro/optical instrument that will meet the NPOESS radiometric and imaging requirements.

### ◆ Approach

- The major elements of the task include:
- Study the number of sensors required to meet user requirements; the practicality of including spectral bands for coastal zone monitoring; the practicality of including spectral bands for measurement of ocean color;
- Specify sensor characteristics -- spectral bands, resolution, sampling, and sensitivities -- that would support the generation of the EDRs as set forth in the IORD;
- Develop a top level sensor design including optics, scanner, focal plane array, and cryo-radiators. Provide size, weight, and power estimates, including definition of pre-launch and onboard calibration requirements to ensure needed accuracy and precision to meet NPOESS EDR requirements;
- Perform risk assessment and evaluation of technology requirements for the major sensor subsystems.

# Internal Government Studies

## Small Satellite Options+

### ◆ Purpose

- Examine feasibility of using Small Satellite technology for selected sensors on NPOESS

### ◆ Objective

- Determine cost/mission opportunities (if any) that SmallSats may offer within NPOESS system architecture.

### ◆ Approach

- Specific efforts include:
- Investigation of placing selected NPOESS instruments, such as the Search and Rescue, ARGOS (DCS), SBUV/2, and solar environment sensors on a SmallSat.
- Examine the potential for placing selected instruments on SmallSats both as an emergency gap filler capability between on-orbit satellite failures and as a separate (operational) on-orbit infrastructure element of the NPOESS constellation.

+ Pending Final Approval

# Internal Government Studies

## Direct Downlink (LRPT) & Frequency Allocation (HRPT)

### ◆ Purpose

- (A) Establish a baseline direct downlink plan for transmitting low-resolution, U.S. and European polar orbiting satellite data to the user community. (B) Identify potential issues and problems related to the adoption of extended bandwidths or new bands (HRPT), especially any EUMETSAT impacts

### ◆ Objective

- (A) To define formats for Low Rate Picture Transmission (LRPT) in order to present to the Europeans our concept of the LRPT data stream architecture to allow implementation on METOP-1. (B) Define HRPT frequencies to facilitate transition from DMSP and POES to NPOESS and METOP. The goal is to achieve compatibility between METOP and NPOESS.

### ◆ Approach

- (A) The LRPT study will define what data, other than imagery, goes into the LRPT; what compression mechanism should be used to facilitate the delivery of 1 km imagery data to the user community; what antenna should be used by the user community to receive the LRPT data; and how to keep the proposed 137-138 MHz signal noise free at field user sites. (B) The HRPT study will define frequencies and data format to be used by METOP and NPOESS.

# Internal Government Studies Program Synchronization

## ◆ Purpose

- There have been a number of attempts to have NOAA and DOD justify the polar program synchronization plan as outlined in the Implementation Plan for Polar Satellite Convergence. The attempts to alter the plan have been based on the insistence by program budget analysts in DOD and Capital Hill that the two agencies can best make use of their assets by sharing their resources. This would imply that NOAA fly one or two DMSP satellites, if needed, in order to use all of the existing hardware left from the DMSP program.

## ◆ Objective

- To define and analyze system replenishment strategies and critical sensor impacts on system availability and satellites procured.

## ◆ Approach

- The study will address all the scenarios for an earlier convergence, including the implications of transferring DMSP spacecraft to NOAA to be flown as NOAA satellites. Key items include:
- Identifying alternatives for transition from current spacecraft to converged space segment to maintain availability
- Developing GAP Models for each alternative

## Internal Government Studies Climate Study Suite

### ◆ Purpose

- Investigate the use of existing sensors and proposed sensors to meet climate data measurements requirements of ozone, aerosols and trace species in the middle atmosphere and for monitoring the Earth's radiation budget from space
  - Ozone, aerosols, and trace species profiles are required on a global scale to elucidate the chemistry and dynamics of ozone production-and-loss mechanisms

### ◆ Objective

- Determine utility of existing climate monitoring instrument(s) vs proposed sensors and evaluate the impact to long-term climatological databases

### ◆ Approach

- Investigate use of Polar Ozone and Aerosol Measurement (POAM) (measures water vapor, N<sub>2</sub>O, temperature), Millimeter Wave Spectrometer (MWS) (measures ClO, N<sub>2</sub>O, CO, HCL), Space Based UV (SBUV), Total Ozone Mapping Spectrometer (TOMS)
- Determine best combination of these sensors on one or more satellites to take advantage of their capabilities
  - E.g., good vertical resolution (1 km) and high frequency of daily measurements
- Examine sensors such as Cloud and Earth's Radiant Energy System (CERES), Scanner for Radiation Budget (ScaRab), and Active Cavity Radiometer Irradiance Monitor (ACRIM) for cost effective tradeoffs associated with the Earth's radiation budget

# Internal Government Studies

## Active Sensors

### ◆ Purpose

- Study accommodation of active microwave sensors on spacecraft

### ◆ Objective

- To perform an engineering analysis to determine the feasibility of accommodating active sensors such as laser/lidar, altimeter, scatterometer, SAR on the spacecraft to meet the NPOESS requirements which may not be achievable by passive sensors

### ◆ Approach

- Estimate complexity of processing data on the ground including algorithms and data rates
- Determine types of active techniques to meet IORD requirements
- Determine sensor power, weight, field of view, size, risk and cost estimates

# Internal Government Studies

## Microwave Sounding & Imaging Capabilities

### ◆ Purpose

- Study microwave sensor capabilities, evaluate existing technology, formulate a government position on a potential microwave sensor suite

### ◆ Objective

- To evaluate systems employing both conical and cross-track scanning patterns that have been flown and are being considered as potential future flight instruments.

### ◆ Approach

- The study will consist of two basic tasks:
- Evaluate the existing new microwave sensors (SSMIS, AMSU, MIMR, TRMM) against requirements. Recommend changes to these existing sensors (additional frequencies, pixel size, co-registration, Nyquist sampling, earth incidence angle, coverage, etc.) in order to satisfy requirements
- Evaluate the feasibility of combining data from different scan geometries (i.e. cross-track scanning versus conical scanning). Evaluate impacts of a combined scan geometry database to operational users, as well as climate researchers. The study will also consider the effects of Doppler shift on mesospheric profiles from a conical sounder.

# Internal Government Studies

## High Incidence Angle Microwave Radiometry

### ◆ Purpose

- To investigate utility of passively sensed microwave data taken at high Earth incidence scan angles

### ◆ Objective

- Determine the overall effectiveness of using passive microwave sensors to acquire data at high Earth incidence angles as part of an operational capability.

### ◆ Approach

- Develop information regarding the feasibility of taking data at high incidence angles in order to provide contiguous coverage at the equator to satisfy requirements such as refresh for environmental data and tracking severe weather patterns. The study will:
- Analyze North Tower test results in surface emissivity data to support the F-8 tilt test. Buoy data from the Tower test will also be provided to compare with F-8 data,
- Compare data from the F-8 SSM/I tilt test to F-10 and F-11 data and analyze the results,
- Provide high incidence angle data, sea surface wind data for Toga-Coare flights, and emissivity studies for 10-220 Ghz range.

## Internal Government Studies

### Passive MW Polarimetric Sensing of Ocean Wind Vector- Part I: Airborne Validation of Concept

#### ◆ Purpose

- Evaluate capability of passive polarimetric microwave remote sensing for measurement of ocean surface wind (OSW) vector

#### ◆ Objective

- Determine the performance capability of sensing OSW direction and speed with passive microwave polarimetry
- Assess the optimal sensor design and viewing geometries
- Analyze a unique set of passive polarimetric data collected in 1994 joint NRL/JPL aircraft program

#### ◆ Approach

- Flights measured first 3 Stokes parameters for 10.8, 19.35, 22.235, 37 GHz
- Study relationship between the Stokes parameters and OSW velocity
  - Sensitivity of available frequencies on signature and viewing geometry
- Analyze removal of ambiguities

## Internal Government Studies

### Passive MW Polarimetric Sensing of Ocean Wind Vector- Part II: Spaceborne Concept Study

#### ◆ Purpose

- Part A will entail the development and evaluation of the performance requirements and capabilities of an “optimum” space-based microwave polarimetric radiometer instrument to sense ocean wind speed and direction to satisfy the NPOESS requirements and development of a program plan to achieve an expeditious operational capability. Part B will entail performing a top-level concept study aimed at defining the requirements, performance, schedule, and cost for the development and demonstration of a polarimetric radiometer wind measuring technique and instrument hardware design before 2001, to allow for an operational instrument to be ready for launch by the 2004 timeframe.

#### ◆ Objective

- Part A will evaluate the feasibility of retrieving local ocean surface wind vector information solely from polarimetric radiometer measurements. Part B will develop conceptual designs for a spaceborne polarimetric radiometer for wind measurements to satisfy NPOESS requirements.

#### ◆ Approach

- Part A will involve the evaluation of the feasibility and performance associated with modifications of both the current SSM/I and SSMIS instruments to sense the global ocean surface wind vector field to achieve this operational capability before the year 2000. Part B will involve the evaluation and development of various conceptual designs for a spaceborne polarimetric radiometer for surface wind measurements including the development of a Performance Measuring Tool to be used in the evaluation of the different wind instrument designs for space.