NOAA SATELLITE PROGRAMS AND TECHNOLOGY REQUIREMENTS

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NOAA'S SPACE PHILOSOPHY

PRESENT

- Maintain 2 GOES operating systems
- Maintain 2 POLAR operating systems
- NOAA will continue to be the source of environmental observations for global change studies for the 1990's
  - Snow cover
  - Ice Analysis
  - Sea Surface Temperature
  - Earth Radiation Budget
  - Vegetation Index
  - Ozone
  - Advanced Microwave Soundings
  - Improved Ozone Measurements
- Europeans to provide morning polar-orbiting worldwide satellite service in late 1990's

NESDIS FY 1993 BUDGET SUMMARY

(Dollars in Thousands)

	FY 1992	FY 1993	INC/DEC
SATELLITE OBSERVING SYSTEMS			
Polar Orbiting System	130,289	216,553	+ $ 86,264
Geostationary System	118,000	128,896	+ 10,896
Landsat Commercialization	2,000	0	- 2,000
Landsat Operations	7,560	0	- 7,560
Environmental Observing Services	52,943	52,943	0
SUBTOTAL	$310,792	$398,392	+ $87,600
ENVIRONMENTAL DATA MANAGEMENT SYSTEM	$34,028	$39,596	+ 5,568
TOTAL NESDIS	$344,820	$437,988	+ $ 93,168

2/5/92

LANDSAT

LANDSAT PROGRAM STATUS

- o LANDSAT 4, 5 CONTINUE TO OPERATE
- o LANDSAT - 6 LAUNCH SCHEDULED FOR JANUARY 22, 1993 WITH ETM
- o ADMINISTRATION COMMITTED TO CONTINUITY OF LANDSAT TYPE DATA
  - DETAILS BEING WORKED WITH NASA AND DOD

GOES

WHY GOES?

Warnings to Public -- Detect, Track and Characterize

HURRICANES
SEVERE OR POSSIBLY TORNADIC STORMS
FLASH FLOOD PRODUCING WEATHER SYSTEMS

Imagery for Weather Forecasting

Direct National and International Users
Value Added Companies for Media and other Agencies

Winds for Aviation and NWS Numerical Models

Environmental Data Collection - Platforms including Buoys, Rainguages..

HISTORY OF GEOSTATIONARY SATELLITES

SATELLITES	*LAUNCHED*	*MISSION-INSTRUMENTATION*
SMS-1	May 1974	Proved Geostationary imaging feasible
SMS-2	February 1975	Both SMS's had VISSR, DCS, SEM
GOES-1	October 1975	First NOAA funded
GOES-2	June 1977	Basic VISSR, DCS, SEM instruments
GOES-3	June 1978	Instrumented like GOES-1 & -2
GOES-4	September 1980	First VAS sounder instrument added
GOES-5	May 1981	First Stepable Lamp Voltage
GOES-6	April 1983	Additional incandescent bulbs added
GOES-7	February 1987	LED and SAR experiment added

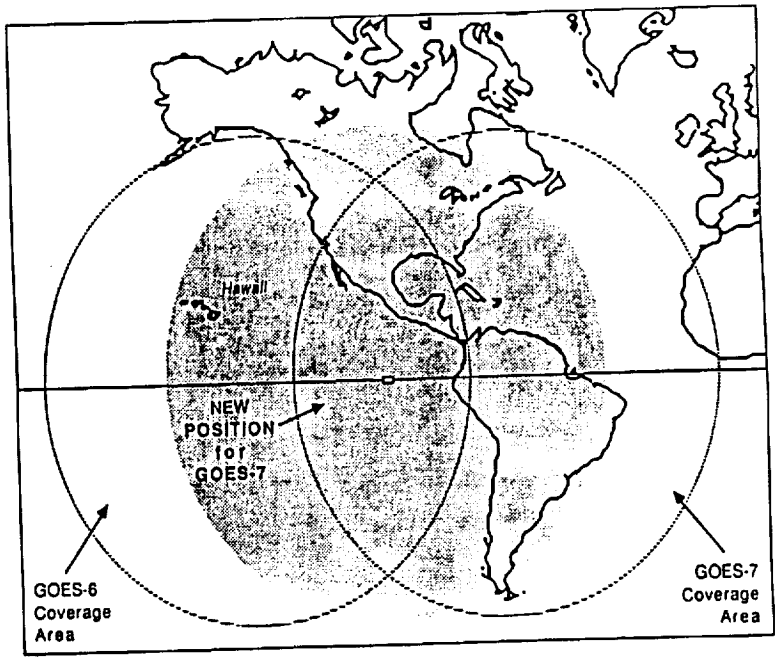
(VISSR - Visible and Infrared Spin Scan Radiometer)
(DCS - Data Collection System)
(SEM - Space Environmental Monitor) (VAS - VISSR Atmospheric Sounder)
(SAR - Search and Rescue Experiment) (LED - Light Emitting Diode)

GOES PROGRAM

- NORMALLY A 2 GOES PROGRAM
  - -- (75°W AND 135°W)
  - -- GOES - 7 CURRENTLY AT CENTRAL LOCATION
- LAUNCH NEW GOES IN ANTICIPATION OF A GOES FAILURE
- 5 YEAR DESIGN LIFE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NATIONAL ENVIRONMENTAL SATELLITE, DATA, AND INFORMATION SERVICE



CURRENT GOES INSTRUMENTS

Remote Sensing

VAS - Visible/Infrared Spin Scan Radiometer (VISSR) Atmospheric Sounder

SEM - Space Environment Monitor
- -- High Energy Particles
- -- Solar X - Rays
- -- Earth's Geomagnetic Field

Communications

Direct Broadcast (Western hemisphere and U. S. private sector)

WEFAX - Weather Facsimile

DCS - Data Collection System - 6000 platforms

SAR - Search and Rescue experiment

IMPROVED GOES CAPABILITIES

GOES - 7	GOES I - M
● Earth location accuracy 10 Km	● Earth location accuracy 2-4 Km
● IR Resolution - 8 Km	● IR Resolution - 4 Km *Improved Tracking & Detection of Severe Storms/Flash Floods*
● Sounder Resolution - 14 Km	● Sounder Resolution - 8 Km 7 more channels
● Images or Soundings	● Simultaneous Imaging/Sounding
● Limited "Small Picture" repetitive viewing	● Can take "Small Picture" view of a Severe Storm every 5 minutes

GEOSTATIONARY SATELLITE FUTURE

- o GOES - I 1993
- o GOES - J 1994
- o GOES - K 1998
- o GOES - L 1999
- o GOES - M 2003
- o GOES I-M LAUNCH USING COMMERCIAL LAUNCH SERVICES (ATLAS CENTAUR)

POES

WHY POLAR ORBITERS?

ESSENTIAL Global Temperature and Humidity Vertical Profiles

Input to NWS numerical models to describe current state of the atmosphere - Input to initialize model with quantitative temperature and humidity data

Worldwide Imagery Coverage

Cloud/frontal/snow cover inputs to numerical models
Warnings of tropical cyclones and volcanic eruptions

Shipping/Fishing

Sea surface temperature
Ice analysis

Global Warming - Worldwide monitoring of ozone, vegetation index

Flying/Boating - Search and Rescue

HISTORY OF TIROS R & D SATELLITES

SATELLITES	LAUNCHED	MISSION - APPLICATIONS
TIROS - I	April 1, 1960	Proved TV operation in space feasible
TIROS - II	November 1960	First ice floes observed-First IRRAD
TIROS - III	July 1961	First hurricane observed
TIROS - IV	February 1962	First international use of data
TIROS - V	June 1962	Broader image coverage
TIROS - VI	September 1962	Hurricane watch program begun
TIROS - VII	June 1963	Supported Indian Ocean Experiment
TIROS - VIII	December 1963	Direct Readout APT system
TIROS - IX	January 1965	Daily global coverage
TIROS - X	July 1965	Near Polar orbit - sun synchronous

(APT - Automatic Picture Transmission)
(IRRAD - Infrared radiometer)

HISTORY OF ESSA OPERATIONAL SATELLITES

SATELLITES	LAUNCHED	MISSION - INSTRUMENTATION
ESSA-1	February 1966	First Global Operational Satellite
ESSA-2	February 1966	First Global Operational APT
ESSA-3	October 1966	First Global Operational AVCS/LRIR
ESSA-4	January 1967	APT Operational Satellite
ESSA-5	April 1967	AVCS Operational Satellite
ESSA-6	November 1967	APT Operational Satellite
ESSA-7	August 1968	First AVCS with S-Band
ESSA-8	September 1968	APT Operational Satellite
ESSA-9	February 1969	First AVCS with dual S-Band

(APT - Automatic Picture Transmission)
(AVCS - Advanced Videcon Camera System)
(LRIR - Low Resolution Infrared)

HISTORY OF ITOS/NOAA SATELLITES

SATELLITES	LAUNCHED	MISSION - INSTRUMENTATION
ITOS-1	January 1970	First SR & Solar Proton Flat Plate First Three Axis Stabilization
NOAA-1	December 1970	Configured like ITOS-1
NOAA-2	October 1972	First VHRR & VTPR
NOAA-3	November 1973	First Direct Readout VTPR
NOAA-4	November 1974	Configured like NOAA-3
NOAA-5	July 1976	Configured like NOAA-3

(SR - Scanning Radiometer)
(VHRR - Very High Resolution Radiometer)
(VTPR - Vertical Temperature Profile Radiometer)

HISTORY OF TIROS-N/NOAA SATELLITES

SATELLITES	LAUNCHED	MISSION - INSTRUMENTATION
TIROS-N	October 1978	First AVHRR,HIRS/2,MSU,SSU,DCS,SEM
NOAA-6	June 1979	Configured like TIROS-N
NOAA-7	June 1981	Increased AVHRR channels from 4 to 5
NOAA-8	March 1983	First Search and Rescue Payload
NOAA-9	December 1984	First SBUV/2 & ERBE Instruments
NOAA-10	September 1986	Configured like NOAA-9
NOAA-11	September 1988	First Capable of 0-80 Degree Sun Angle
NOAA-12	May 1991	First "Re-cycled" Satellite

(ERBE - Earth Radiation Budget Experiment)
(AVHRR - Advanced Very High Resolution Radiometer)
(SBUV - Solar Backscatter UltraViolet) *(MSU - Microwave Sounding Unit)*
(DCS - Data Collection System) *(HIRS - High Resolution Infrared Sounder)*
(SEM - Space Environmental Monitor) *(SSU - Stratospheric Sounding Unit)*

POLAR METSAT

PLANNING LAUNCH SCHEDULE

SATELLITE NAME	PROJECTED LAUNCH DATE	NEED DATE
I	SEP 1992(31)	-
J(AM)	DEC 1993(31)	MAR 1993
K	APR 1995(31)	JUN 1994
L(AM)	JUL 1996(31)*	OCT 1995
M	NOV 1997(31)	JAN 1997
N	JUN 2000(31)	MAY 1998
O	JAN 2002(36)**	DEC 2000
P	JAN 2005(36)	JUL 2002
Q	JAN 2008(36)	JUL 2005

CURRENT POLAR - ORBITING SATELLITE INSTRUMENTS

Remote Sensing

AVHRR - Advanced Very High Resolution Radiometer
-- 1 Km and 4 Km Imagery

HIRS - High Resolution Infrared Sounder
SSU - Stratospheric Sounding Unit — *Sounder*
MSU - Microwave Sounding Unit

SEM - Space Environment Monitor
-- MEPED Moderate Energy Particle and Electron Detector
-- TED Total Energy Detector

* ERBE - Earth Radiation Budget Experiment
SBUV - Solar Backscatter Ultraviolet - Ozone

**CARRIED ONLY ON NOAA 9 AND 10*

Communications

Direct Broadcast - 120 + Countries depend on this data
DCS - Data Collection System (ARGOS) - 2000 Platforms
SARSAT - Search and Rescue > 1400 lives saved

INTERNATIONAL INSTRUMENTS ON NOAA SATELLITES

Stratospheric Sounding Unit (SSU)	United Kingdom
Advanced Microwave Sounding Unit - B	United Kingdom
ARGOS Data Collection System	France
Search and Rescue	Canada, France

NOAA K, L, M, UPGRADES

* AMSU - A, B, REPLACES SSU AND MSU
* AVHRR GAINS 1.6 UM CHANNEL
* INCREASED CAPACITY FOR ARGOS DATA COLLECTION AND LOCATION SYSTEM

POLAR ENVIRONMENTAL SATELLITE FUTURE PROGRAM

- o AGREEMENT IN PRINCIPLE BETWEEN U.S. AND EUROPE (ESA & EUMETSAT) FOR EUROPE TO ASSUME RESPONSIBILITY FOR MORNING MISSION, AND NOAA TO CONTINUE AFTERNOON MISSION.
- o NOAA TO PROVIDE OPERATIONAL METEOROLOGICAL FLIGHT INSTRUMENTS TO EUROPE (EUMETSAT).
- o FIRST LAUNCH OF MORNING SEGMENT OPERATIONAL EUROPEAN SPACECRAFT, POEM-1, NEAR END OF DECADE (1998).
- o EUROPE TO PROVIDE HIGH LATITUDE GROUND STATION TO READ OUT DATA FROM BOTH SATELLITES (IN ADDITION TO FAIRBANKS/WALLOPS).
- o DATA EXCHANGED IN TIMELY WAY (LESS THAN 2 HOURS) BETWEEN EUROPE AND U.S.
- o NOAA TO ACQUIRE EOS PROTOTYPE OPERATIONAL INSTRUMENT DATA IN NEAR REAL TIME FROM WHITE SANDS

POLAR ENVIRONMENTAL SATELLITE
FUTURE PROGRAM (CONTINUED)

- o BASELINE JOINT PROGRAM WITH EUROPE (EUMETSAT)
  - EUROPE AM MISSION (POEM-1 AND FOLLOW-ON)

    (10:00 AM, LST, DESCENDING NODE)
  - U.S. PM MISSION (NOAA O,P,Q)

    (1:45 PM, LST, ASCENDING NODE)
- o U.S. SUPPLIED OPERATIONAL COMMON INTERFACE INSTRUMENTS (CII) FLOWN ON BOTH U.S. & EUROPEAN MISSIONS.
  - COMPETITIVE PHASE B STUDIES FEB 92 - MAY 93
  - PHASE C/D BEGIN MID 1993

NOAA O,P,Q SPACECRAFT

- o PHASE A STUDIES COMPLETED THE FIRST QUARTER OF 1992
- o INCREASED LIFETIME REQUIREMENT AS COMPARED TO NOAA K,L,M
- o ORBITAL DRIFT LIMITED TO +/- TEN MINUTES OVER THREE YEARS
- o STUDIES INCLUDE POSSIBLE ACCOMMODATION OF NASA PROTOTYPE OPERATIONAL INSTRUMENTS: AIRS, ALT, CERES, HIRDLS, MIMR, SCATT
- o COMPETITIVE PHASE B CONTRACTS START FIRST QUARTER CY 1993
- o PHASE C/D START CY 1995

EUROPEAN POLAR PROGRAM PLANNING

- o ESA
  - POEM-1 SPACECRAFT (MID 1998)
  - ARIANE 5 LAUNCH
- o EUMETSAT
  - PAYLOAD INTERFACES
  - AMSU-B/MHS INSTRUMENTS
  - SPACECRAFT SUBSYSTEMS
- QUARTERLY NOAA/NASA-GSFC/ESA/EUMETSAT COORDINATION MEETINGS
- SEMI-ANNUAL EOS-ICWG MEETING (U.S./EUROPE/CANADA/JAPAN)

UPGRADED DATA HANDLING AND COMMUNICATIONS SERVICES FOR NOAA O,P,Q AND OPNL POEM-1 METEOROLOGICAL PAYLOAD

- o ALL HIGH RESOLUTION (1KM) IMAGER DATA STORED AND PLAYED BACK
- o HRPT DATA RATE INCREASED TO 3.0 - 3.5 MBPS
- o 100 MBPS RECORDED PLAYBACK RATE FOR GLOBAL DATA
- o ANALOG APT REPLACED WITH DIGITAL LRPT

IMAGER

OLD		NEW
AVHRR/3	NAME	VIRSR
6	NO. OF SPECTRAL CHANNELS	7
5	NO. OF SIMULTANEOUS CHANNELS	7
10 (11 EFF)	RESOLUTION (BITS)	12
1.1	RESOLUTION (KM)	1.1
0.12	NEDT (CH. 4-7)	0.10
	IN-ORBIT CALIBRATION (%)	
1 NONE	INFRA-RED VISIBLE	1 3
ANTI-SUN TO SUN	SCAN DIRECTION	SUN TO ANTI-SUN
$\pm$57.0	SCAN COVERAGE (DEG)	$\pm$57.0
6	SCAN RATE (SCANS PER SEC.)	~6

INFRA-RED SOUNDER

OLD		NEW
HIRS/3	NAME	IRTS
20	NO. OF SPECTRAL CHANNELS	20
12	RESOLUTION (BITS)	12
21	RESOLUTION AT NADIR (KM)	19.5
2	IN-ORBIT CALIBRATION (%)	2
SUN TO ANTI-SUN	SCAN DIRECTION	SUN TO ANTI-SUN
$\pm$49.5	SCAN COVERAGE (DEG)	$\pm$49.5
6.4	SCAN-TIME (SECS)	8 INC. CALIB.

MICROWAVE TEMPERATURE SOUNDER

OLD		NEW
AMSU-A	NAME	MTS
15	NO. OF SPECTRAL CHANNELS	21
45	MAX SOUNDING ALTITUDE (KM)	73
14	RESOLUTION (BITS)	14
45	RESOLUTION AT NADIR (KM)	45
2	IN-ORBIT CALIBRATION (%)	2
SUN TO ANTI-SUN	SCAN DIRECTION	SUN TO ANTI-SUN
$\pm$48.3	SCAN COVERAGE (DEG)	$\pm$48.3
8 INC. CALIB.	SCAN TIME (SECS)	8 INC. CALIB.

MICROWAVE SOUNDER (WATER VAPOR & PRECIPITATION)

OLD		NEW
AMSU-B	NAME	MHS
5	NO. OF SPECTRAL CHANNELS	5
14	RESOLUTION (BITS)	14
15	RESOLUTION AT NADIR (KM)	15
2	IN-ORBIT CALIBRATION (%)	2
SUN TO ANTI-SUN	SCAN DIRECTION	SUN TO ANTI-SUN
8/3	SCAN TIME (SECS)	8/3
$\pm$49.0	SCAN COVERAGE (DEG)	$\pm$49.0

OZONE MONITOR

OLD		NEW
SBUV	NAME	SBUV
12	NO. OF SPECTRAL CHANNELS	12
14	RESOLUTION (BITS)	14
165	RESOLUTION (KM)	165
DIFFUSER PLATE + REFLECTANCE/ TRANSMITTANCE	IN-ORBIT CALIBRATION	DIFFUSER PLATE + REFLECTANCE/ TRANSMITTANCE

OZONE MAPPER

OLD		NEW
NONE	NAME	TOMS
	NO. OF SPECTRAL CHANNELS	6
	RESOLUTION (BITS)	14
	RESOLUTION AT NADIR (KM)	45
	SNR	>30 MIN. SCENE RADIANCE
	IN-ORBIT CALIBRATION	DIFFUSER PLATE + REFLECTANCE
	SCAN DIRECTION	ANTI-SUN TO SUN
	SCAN COVERAGE (DEG)	$\pm$51.0
	SCAN TIME (SECS)	8.0

NOAA'S SPACE BASED OBSERVATIONS

FUTURE

- NOAA will be an IMPORTER of satellite data by end of the decade.

NOAA WILL:

-- Negotiate for access to all foreign and non-NOAA remote sensing platforms with needed data
-- Provide information to users in Near-Real time
-- Depend on "Free and Open" exchange of data

- To achieve this: NOAA plans to Improve ground capabilities including communications, workstations, directories, scientific and technical infrastructure to Support real-time access to environmental information

NOAA'S ROLE IN "MISSION TO PLANET EARTH"

NOAA will be provided access, in near real time, to prototype operational sensor data from the Earth Observing System (EOS) platforms. The following EOS instruments will be designed with standardized interfaces to allow for possible flight on future NOAA spacecraft.

HiRDLS - Ozone Limb Scanner
MIMR - Passive Microwave Imager
CERES - Earth Radiation Budget Sensor
AIRS - Atmospheric Infrared Sounder
Scatterometer
Altimeter

FOREIGN SATELLITE DATA ACQUISITION ACTIVITIES

- NOAA SUPPORTING LAUNCH OF JERS-1 (NET FEBRUARY 11)
- SIGNING OF ERS-1 DATA MOU BETWEEN NOAA/ESA SCHEDULED FOR FEBRUARY 26
- NOAA TO DISTRIBUTE CANADIAN RADARSAT DATA TO U.S. USERS
- NOAA NEGOTIATING WITH NASA AND JAPAN/NASDA FOR OPERATIONAL ACCESS TO ADEOS SCATTEROMETER AND OCEAN COLOR DATA

SATELLITE OBSERVATION SYSTEMS FOR THE CLIMATE AND GLOBAL CHANGE ERA

(1990 TO 2010)

SENSOR GENERIC TYPE	NOAA-10 TO NOAA-J	DMSP	ERS-1 ERS-2	UARS	JERS-1	TOPEX	SEA WIFS	NOAA-K TO NOAA-N	RADAR SAT	GEOSAT FO	ADEOS	TRMM	EPOP/ POEM	EOS	JEOS	NOAA* OPO
(LAUNCH / SERVICE PERIOD)	86-93	90+	91-97	91	92	92	93	94-01	94	95+	95	96	97+	98+	99	01-05
VISIBLE/INFRARED IMAGER	X	X	X		X			X			X	X	X	X	X	X
MICROWAVE IMAGER		X										X	X	X	X	
ALTIMETER			X			X				X			X	X		
SCATTEROMETER			X								X		X	X		
OCEAN COLOR SENSOR							X				X		X	X	X	
RADAR (SYNTHETIC AND REAL APERTURE)			X		X				X			X	X	X	X	
IR/MICROWAVE SOUNDERS	X	X	X			X		X				X	X	X		X
WIND SOUNDERS				X										X	X	
EARTH RADIATION BUDGET INST.											X		X	X		
TRACE GASES & OZONE	X			X				X			X		X	X		X
SPACE ENVIRONMENT MONITOR	X	X		X				X					X	X		X

NON-NOAA DATA SOURCE OF INTEREST

NOT MANIFESTED ON NOAA SATELLITES

* MAY HAVE PAYLOAD GROWTH CAPABILITY