



Evolution of NOAA's Observing System Integrated Analysis (NOSIA)

**Presented to the 13th Symposium on Societal Applications:
Policy, Research and Practice (paper 9.1)**

Louis Cantrell Jr., and D. Helms, R. C. Reining, A. Pratt, B. Priest, and V. Ries

**98th Annual Meeting
American Meteorological Society
Austin, Texas**

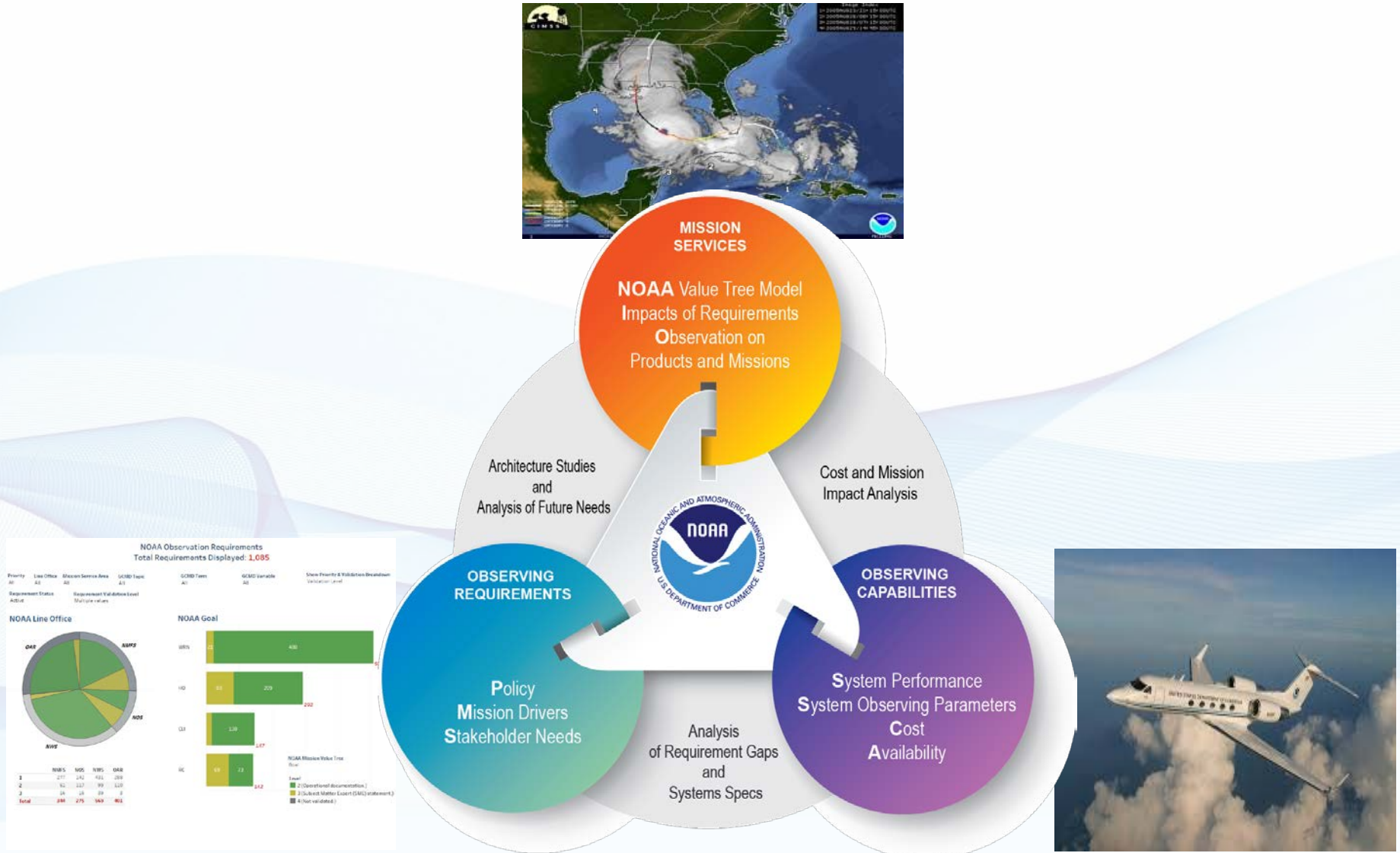


Overview

1 How NOSIA Informs Portfolio Decision Making

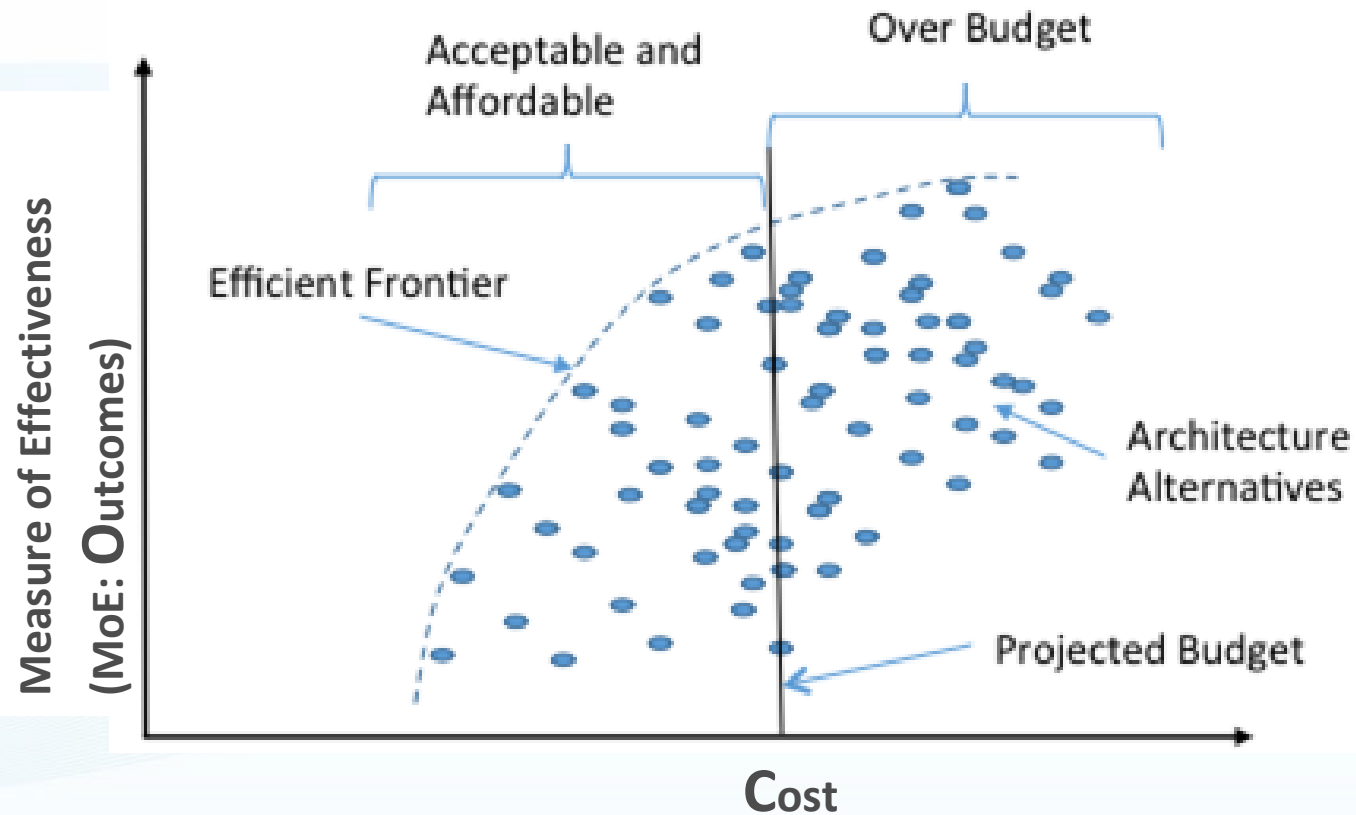
2 How NOSIA is Evolving

Observing System Portfolio Management



System Engineering Measure of Effectiveness

Each point on the **Efficient Frontier** represents an optimum Portfolio of Observing Programs within a Constrained Budget



Capability Improvement Prioritization



NOAA Emerging Technologies *for Observations* Workshop

Sponsored by the NOAA Observing Systems Council

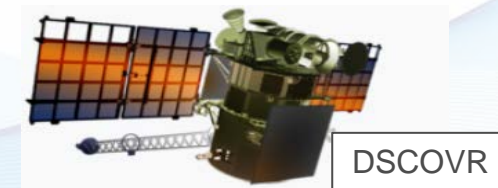
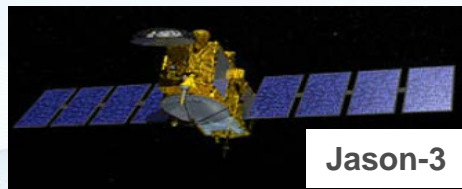
August 22-23, 2017 - NCWCP

Identifying Capability Improvements for the Greatest NOAA-wide Benefit

- National Water Level Observation Network
- Tropical Atmosphere Ocean Buoy Ocean Profiles
- Commercial Fisheries Dependent Data Surveys
- ARGO
- Integrated Ocean Observing System Regionals
- Animal Borne Sensors
- National Observer Program (NOP)
- Drifting Buoy Network
- NEXRAD Precipitation Products
- Program-funded Habitat Surveys
- Coastal Weather Buoys Atmospheric Surface Observations
- Recreational Fish Surveys
- Historical Habitat Databases
- Chartered Vessels Research
- NWS Upper Air Soundings
- Coastal-Marine Automated Network
- GOES Imagery
- NERR_SWMP
- Automated Weather Observing System
- Global Ocean Observing System Carbon Network

Future Architecture Definition

Programmed Acquisitions



Planning Future Acquisitions

NOSIA Value Tree Can Inform
a Definition of an Optimized
Future Architecture Acquisition

Global Earth Observing Satellite System



Spectrum Impact Analysis

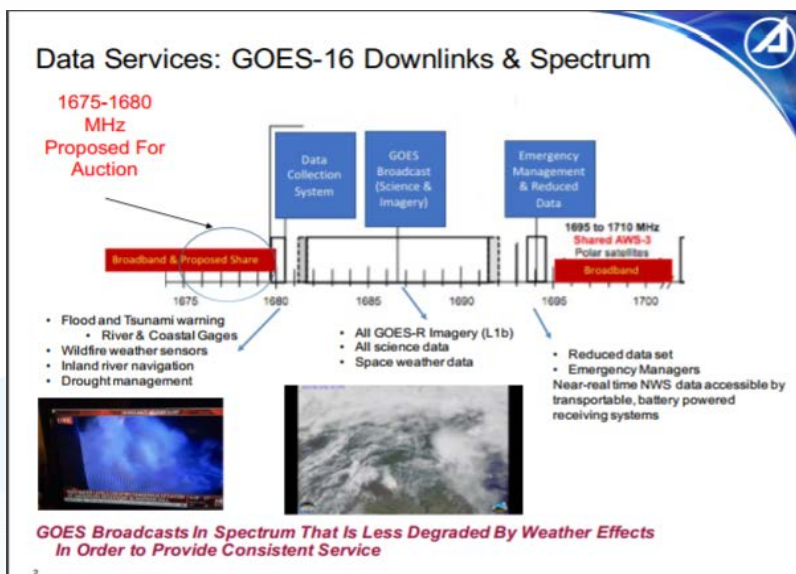
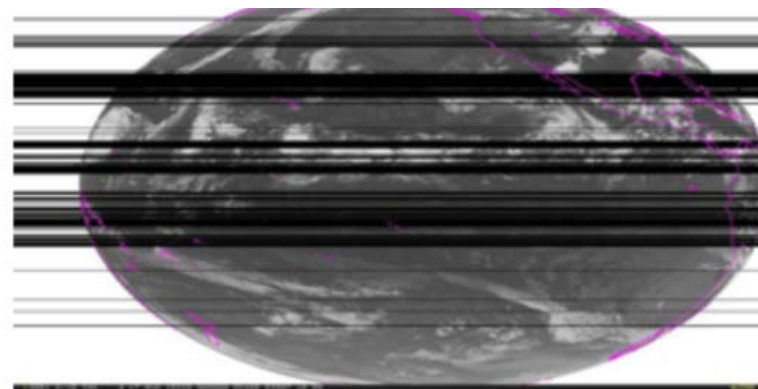


Figure 21: USGS Streamgages



Terrestrial Interference to NOAA Imagery Reception
August 17, 2015 GOES
Source: NOAA

<https://www.nesdis.noaa.gov/content/noaa's-environmental-observations-spectrum-matters>

GOES Data Collection System

Loss Impact Analysis



NESDIS Communication Service: In-situ data relay

- Coastal-Marine Automated Network
- Gulf of Mexico Oil Platforms
- National Estuarine Research Reserve System-Wide Monitoring Program
- National Water Level Observation Network
- Cooperative Observer Program Stream Gage Network
- Ocean Acidification Gliders
- OAR Radars
- Physical Oceanographic Real-Time System
- Interagency Remote Automated Weather Stations
- USACE Stream Gage Network
- USDOI/BR Stream Gage Network
- USFWS Stream Gage Network
- USGS Mobile Surge Sensors
- USGS Rain Gage Network
- USGS Tide Gages

Impact from loss of ...

	NOAA	CLI	HO	RC	WRN
Communication Service: Direct broadcast	12%	9%	3%	27%	8%
Communication Service: In-situ data relay					

Ship Decommissioning & Scheduling Impact Analysis

NOAA FISHERIES

Science Centers

Alaska
Northeast
Northwest
Pacific Islands
Southeast and Caribbean
Southwest



NOAA Ship Henry B. Bigelow
Northeast Fisheries Science Center

NOAA Ships

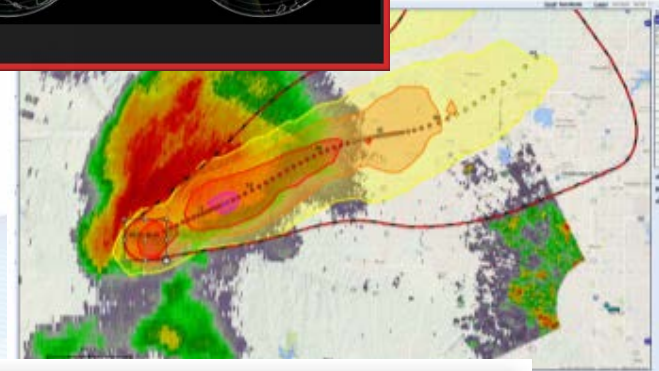
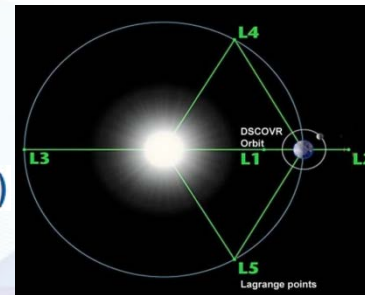
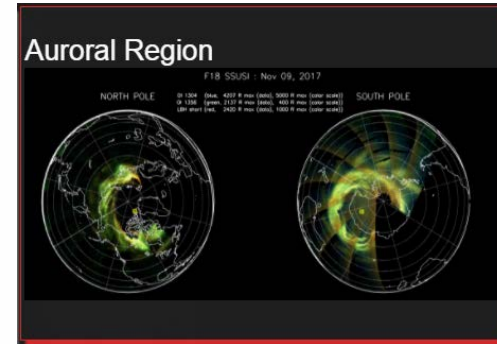
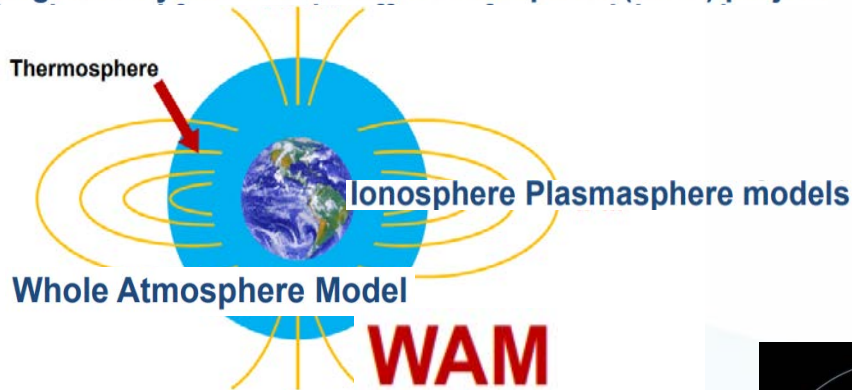
		% Impact	Impact Category
NOAA	NOAA	5.92	Very High
Climate Adaptation and Mitigation	CLI	4.65	High
Assessments of Climate changes and its impacts	CLI_ACC	4.76	High
Climate Mitigation and Adaptation strategies	CLI_CMA	7.52	High
Climate Prediction and Projections	CLI_CPP	2.27	Moderate
Climate Science and Improved Understanding	CLI_SIU	4.19	High
Healthy Oceans	HO	12.62	Very High
Ecosystems Monitoring, Assessment and Forecast	HO_ECO	20.40	Very High
Fisheries Monitoring, Assessment and Forecast	HO_FMA	8.67	High
Habitat Monitoring and Assessment	HO_HAB	12.99	Very High
Protected Species Monitoring and Assessments	HO_PSM	12.67	Very High
Healthy Ocean Science, Services, and Stewardship Advances	HO_SSS	10.14	Very High
Resilient Coastal Communities and Economies	RC	8.32	Very High
Coastal Water Quality	RC_CWQ	6.35	Very High
Marine Transportation	RC_MTS	4.63	High
Resilience to Coastal Hazards and Climate Change	RC_RCC	3.56	High
Planning and Management	RC_PAM	8.48	Very High
Resilient Coasts Science, Services, and Stewardship Advances	RC_SSS	18.28	Very High
Arctic Matrix Program	RC_AMP	3.24	High
Weather Ready Nation	WRN	0.14	Supplemental
Aviation Weather and Volcanic Ash	WRN_AWX	N/A	
Fire Weather	WRN_FWX	N/A	
Hurricane/ Tropical Storms	WRN_HUR	N/A	
Hydrology and Water Resources (Integrated Water Forecasting)	WRN_IWF	N/A	
Marine Weather and Coastal Events	WRN_MWX	N/A	
Routine Weather	WRN_RWX	N/A	
Severe Thunderstorms, Tornadoes and Flash Floods	WRN_SEV	N/A	
Space Weather	WRN_SWX	N/A	
Tsunami	WRN_TSU	1.08	Low
Weather Ready Nation Science, Services, and Stewardship Advances	WRN_SSS	0.19	Low
Winter Weather	WRN_WWX	N/A	
Environmental Modeling Prediction	WRN_EMP	1.35	Moderate

key

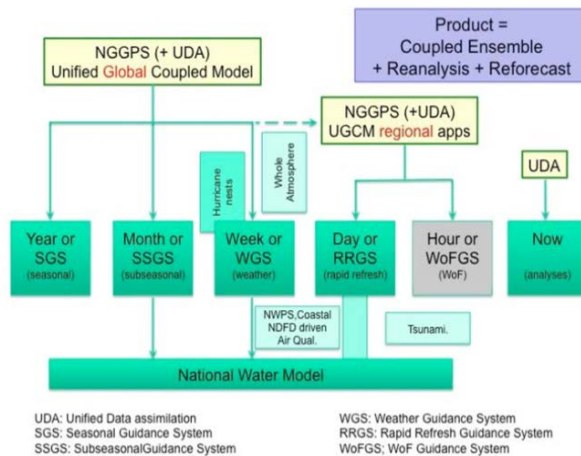
Very High
High
Moderate
Low
Supplemental
No Impact

Evolution of NOAA Services

Integrated Dynamics in Earth's Atmosphere (IDEA) project

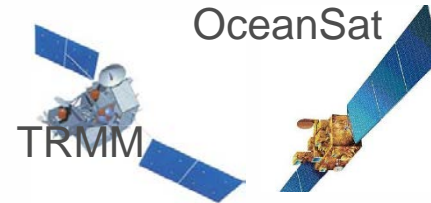
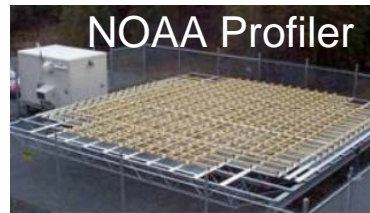


Next Generation Global Prediction System (NGGPS)

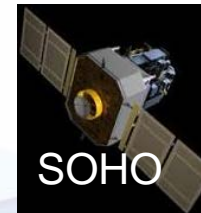


Evolution of the Observing System Architecture

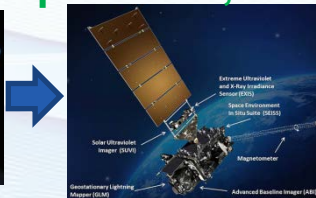
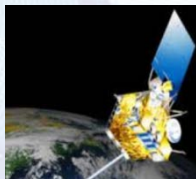
Capabilities Lost,



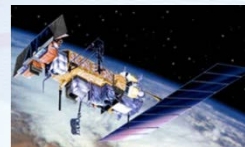
Capabilities on the way out,



Enhanced Capabilities,



GOES 13 to 16



POES to JPSS

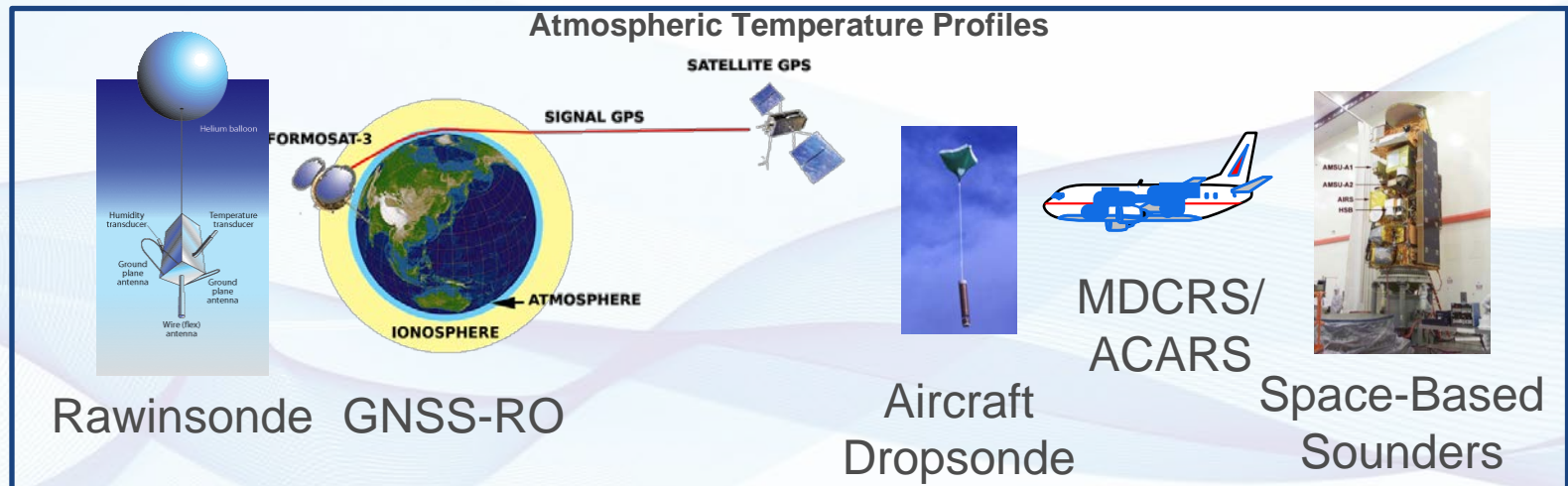
and New Capabilities.

- Phased Array Radar
- Three-Dimensional Tropospheric Winds from Space-Based Lidar
- Space-based multi-spectral Imager for Aurora
- Thermospheric composition and dynamics at high latitudes from space
- Coronagraph, Photospheric and Heliospheric Observations off Sun-Earth axis

Investment Optimization

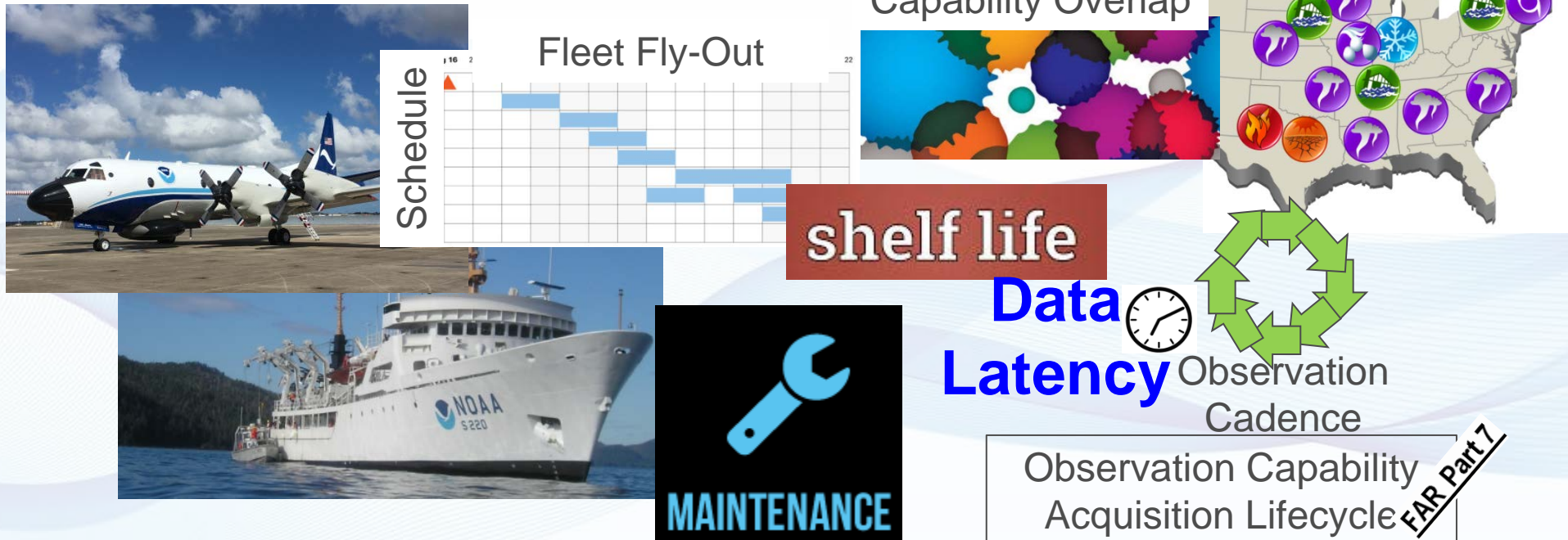
Optimize Investment

In Collection Method and Operating Domain Among Different Capabilities



Investment Optimization

Optimize Investment Under Temporal Variation in the Portfolio



Evolution of Portfolio Analysis

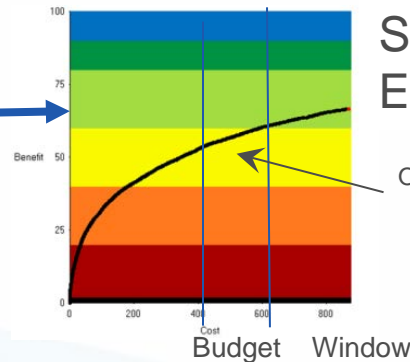
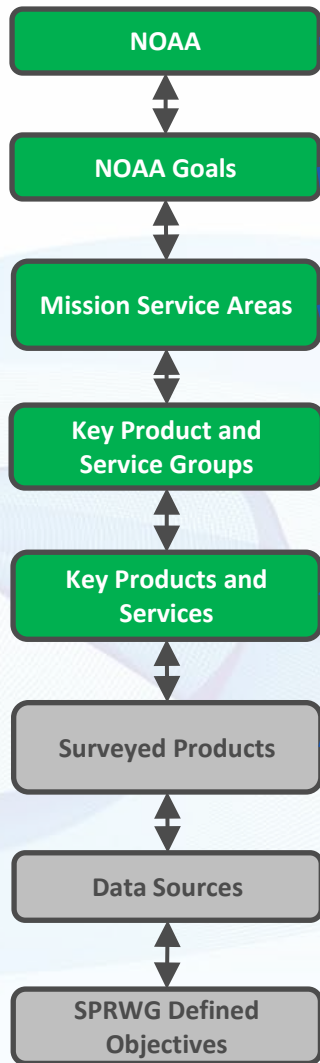
Attribute Level Trades Analysis (ALTA)

MULTI-SWING TABLE (MST)							Solve	
Parent SQ	0.55							
	geographic coverage	horizontal resolution	Accuracy (deg)	Forecast Interval (hr)	Model Update (hr)	Forecast Duration	Overall	
	0.2						0.010	min
	1						0.550	base
	1.2						0.860	full
	1.21						0.900	max
		0.3					0.650	max
		1					0.600	full
		3					0.550	base
		15					0.010	min
			1				0.680	max
			4.9				0.550	full
			5				0.550	base
			15				0.010	min
				1			0.650	max
				12			0.550	full
				24			0.550	base
				24.1			0.010	min
					5.9		0.600	max
					6		0.600	full
					24		0.550	base
					24.1		0.010	min
						72	0.010	min
						96	0.550	base
						96.1	0.550	full
						120	0.650	max
end	end	end	end	end	end	end		

New Survey Methodology in Development

- Assesses Observation Parameter Attributes (e.g. Horizontal Resolution)
- Trades capability among performance characteristics (e.g. more accuracy vs less Latency)
- Evaluates wide range of capabilities to meet a requirement
- Not specific to one observing system
- Explicitly links requirement satisfaction to system's value to meet mission
- Applicable to observation products or sensor data
- Models observation utility between minimum threshold and maximum utility

Evolution of Capabilities



Sampled Constellations

Efficient Frontier

Optimum Portfolio Within Budget

Mission Services



Measures of Effectiveness

“MoE”



Requirement Satisfaction Measures of Performance “MoP”

Sampled Constellations

###	169	379	###	058	###	###	###	###	406	###	738	###	###	080	363	578	324	199	260	388	383	331	584	###	514	210	
###	169	379	###	058	###	###	###	###	419	###	738	###	###	080	363	604	324	199	260	388	383	331	584	###	514	210	
###	192	386	###	072	###	###	###	###	495	###	738	###	026	06	086	426	717	359	326	413	435	428	814	###	514	247	
112	356	606	128	167	###	024	037	056	444	###	761	005	120	141	555	801	535	359	526	630	582	527	052	###	514	386	
###	224	443	###	071	###	###	###	###	480	###	749	###	012	094	526	674	538	276	381	472	507	524	797	###	514	409	
###	192	386	###	072	###	###	###	###	528	###	738	###	026	06	086	426	761	359	326	413	435	428	814	###	514	247	
130	373	585	133	170	###	042	050	672	###	672	764	090	139	137	690	960	684	540	636	657	679	742	991	###	514	560	
462	526	726	356	372	###	143	163	405	849	###	783	174	412	209	779	###	768	835	###	871	807	909	###	###	514	866	
###	###	###	###	###	###	###	###	###	###	###	793	###	###	807	971	###	###	925	###	###	###	946	###	###	514	888	
###	###	###	###	###	###	###	###	###	###	###	793	###	###	812	###	###	###	###	###	###	###	###	###	###	###	514	999
###	069	352	###	###	###	###	###	###	227	###	742	###	###	###	318	595	294	036	212	401	359	326	540	###	###	514	227
###	069	352	###	###	###	###	###	###	259	###	742	###	###	###	318	636	294	036	212	401	359	326	540	###	###	514	227
###	095	360	###	###	###	###	###	###	333	###	743	###	###	###	379	753	308	166	254	430	413	347	562	###	###	514	239
###	124	416	###	###	###	###	###	###	379	###	754	###	###	004	881	710	509	112	334	485	488	519	755	###	###	514	227
###	095	360	###	###	###	###	###	###	365	###	743	###	###	###	379	796	308	166	254	430	413	347	562	###	###	514	239
###	150	424	###	###	###	###	###	###	519	###	754	###	###	011	542	912	522	423	376	514	537	540	776	###	###	514	439
###	175	430	###	###	###	###	###	###	546	###	755	###	###	018	614	930	581	384	451	541	595	680	832	###	###	514	459
###	###	###	###	###	###	###	###	###	###	###	793	###	###	###	807	968	###	###	916	###	###	###	963	###	###	514	893
###	###	###	###	###	###	###	###	###	###	###	793	###	###	###	812	###	###	###	###	###	###	###	###	###	###	514	999
###	177	447	###	###	###	###	###	###	283	###	750	###	###	015	462	701	407	212	341	492	487	476	639	###	###	514	099
###	204	455	###	###	###	###	###	###	392	###	751	###	###	022	530	859	432	354	396	522	545	537	666	###	###	514	335
###	171	379	###	058	###	###	###	###	331	###	738	###	###	080	375	560	337	221	287	390	392	408	583	###	###	514	236
###	171	379	###	058	###	###	###	###	363	###	738	###	###	080	375	604	337	221	287	390	392	408	583	###	###	514	236
###	220	450	###	###	###	###	###	###	416	###	751	###	###	024	599	873	526	472	511	539	594	858	730	###	###	514	441
068	401	638	158	150	###	037	041	181	653	###	760	137	066	147	727	###	689	632	594	623	712	933	951	###	###	514	546
###	275	522	###	###	###	###	###	###	602	###	763	###	###	038	763	###	742	590	634	623	719	###	946	###	###	514	641
525	630	823	437	396	###	165	199	426	910	###	791	230	442	230	932	###	940	997	###	955	931	###	###	###	###	514	847
###	###	###	###	###	###	###	###	###	###	###	793	###	###	811	###	###	###	###	###	###	###	###	###	###	###	514	998
156	298	516	264	018	###	###	###	###	441	###	764	###	###	064	541	747	386	502	861	595	522	574	941	###	###	514	337
372	421	626	255	301	###	097	118	244	570	###	768	046	334	172	519	804	486	560	893	686	589	595	###	###	514	404	
388	476	690	281	315	###	105	127	256	631	###	780	054	360	186	838	920	702	638	###	771	714	788	###	###	514	604	
422	500	697	307	328	###	130	147	267	738	###	781	142	382	192	465	###	737	769	###	798	766	886	###	###	514	641	
###	323	614	065	87	###	###	###	###	364	###	759	###	###	126	537	871	570	176	306	602	549	417	860	###	###	514	385
###	382	678	113	124	###	###	###	###	621	###	770	###	028	145	667	971	737	273	452	695	658	580	###	###	514	555	

Thank You and Contact Information

NOAA Technical Report NESDIS

doi:10.7289/V52V2D1H



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Methodology Report**

Washington, D.C.
December 2015



U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Environmental Satellite, Data, and Information Service

TECHNOLOGY, PLANNING, AND INTEGRATION FOR OBSERVATION
TPIO

Louis.Cantrell@NOAA.gov

David.Helms@NOAA.gov

Technology, Planning, and Integration for
Observations



<https://nosc.noaa.gov>