



NASA Earth Science Decadal Survey Implementation

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Agenda



☞ NASA Earth Science Mission Portfolio

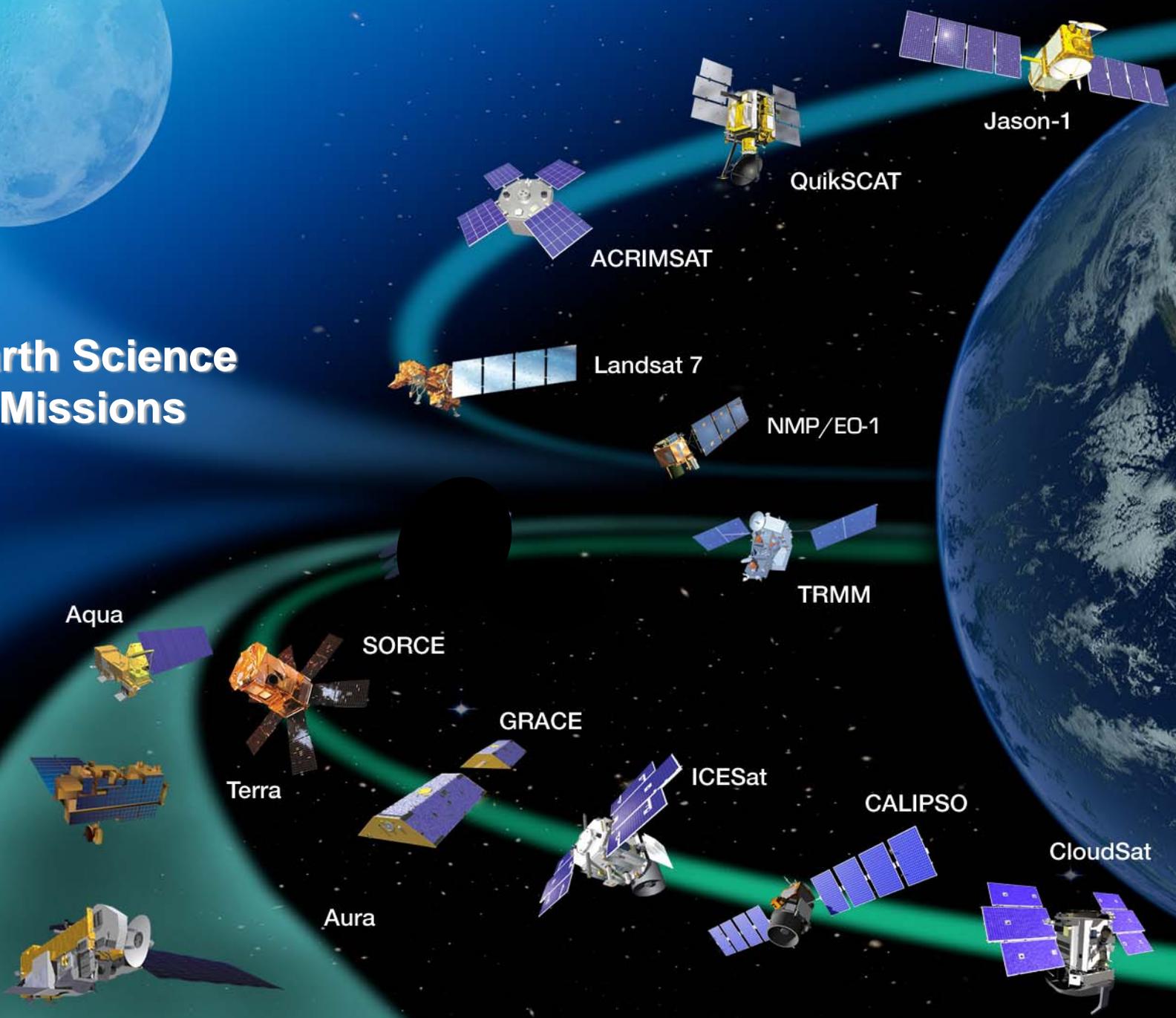
- ☐ *Missions on orbit*
- ☐ *Missions in development*
- ☐ *Other NASA Earth Science commitments*

☞ Where are we going?

- ☐ *Current NASA and Earth Science Budget*
- ☐ *Strategic planning and the Decadal Survey*

☞ Near term activities

Earth Science Missions



Jason-1

QuikSCAT

ACRIMSAT

Landsat 7

NMP/EO-1

TRMM

Aqua

SORCE

GRACE

ICESat

CALIPSO

CloudSat

Terra

Aura



Earth Science Missions in Development and Formulation



NPOESS Preparatory Project[^] Strategic mission - Systematic measurement	Required for continuity of several key climate measurements between EOS and NPOESS
Landsat Data Continuity Mission Strategic mission - Systematic measurement	Required for continuity of long-term global land cover change data; plan for post-LDCM acquisition operational agency in work
Ocean Surface Topography Mission^{*^} Strategic mission - Systematic measurement	Required for continuity ocean altimetry; planned as part of a transition to operational agencies
Glory Strategic mission - Initiate New Measurement and Continue Systematic Measurement	Addresses high priority objective of the US Climate Change Science Program and provide continuity for total solar irradiance
Orbiting Carbon Observatory Competed mission - Earth System Science Pathfinder	First dedicated global measurement of CO ₂ from space
Aquarius[*] Competed mission - Earth System Science Pathfinder	First dedicated global measurement of sea surface salinity from space
Global Precipitation Measurement[*] Initializes a systematic measurement	Extend spatial coverage to global and temporal coverage to every 3 hours with constellation

* Represents International Partnership

[^] Represents Interagency Partnership

NRC Recommended Missions - Early/Mid



Decadal Survey Mission	Mission Description	Orbit	Instruments	\$ Estimate
Timeframe 2010 – 2013, Missions listed by cost				
CLARREO (NASA portion)	Solar and Earth radiation: spectrally resolved forcing and response of the climate system	LEO, Precessing	Absolute, spectrally-resolved interferometer	\$200 M
SMAP	Soil moisture and freeze/thaw for weather and water cycle processes	LEO, SSO	L-band radar L-band radiometer	\$300 M
ICESat-II	Ice sheet height changes for climate change diagnosis	LEO, Non-SSO	Laser altimeter	\$300 M
DESDynI	Surface and ice sheet deformation for understanding natural hazards and climate; vegetation structure for ecosystem health	LEO, SSO	L-band InSAR Laser altimeter	\$700 M
Timeframe: 2013 – 2016, Missions listed by cost				
HypIRI	Land surface composition for agriculture and mineral characterization; vegetation types for ecosystem health	LEO, SSO	Hyperspectral spectrometer	\$300 M
ASCENDS	Day/night, all-latitude, all-season CO ₂ column integrals for climate emissions	LEO, SSO	Multifrequency laser	\$400 M
SWOT	Ocean, lake, and river water levels for ocean and inland water dynamics	LEO, SSO	Ka-band wide swath radar C-band radar	\$450 M
GEO-CAPE	Atmospheric gas columns for air quality forecasts; ocean color for coastal ecosystem health and climate emissions	GEO	High and low spatial resolution hyperspectral imagers	\$550 M
ACE	Aerosol and cloud profiles for climate and water cycle; ocean color for open ocean biogeochemistry	LEO, SSO	Backscatter lidar Multiangle polarimeter Doppler radar	\$800 M



NRC Recommended Missions - Late



Timeframe: 2016 -2020, Missions listed by cost				
LIST	Land surface topography for landslide hazards and water runoff	LEO, SSO	Laser altimeter	\$300 M
PATH	High frequency, all-weather temperature and humidity soundings for weather forecasting and SST*	GEO	MW array spectrometer	\$450 M
GRACE-II	High temporal resolution gravity fields for tracking large-scale water movement	LEO, SSO	Microwave or laser ranging system	\$450 M
SCLP	Snow accumulation for fresh water availability	LEO, SSO	Ku and X-band radars K and Ka-band radiometers	\$500 M
GACM	Ozone and related gases for intercontinental air quality and stratospheric ozone layer prediction	LEO, SSO	UV spectrometer IR spectrometer Microwave limb sounder	\$600 M
3D-Winds (Demo)	Tropospheric winds for weather forecasting and pollution transport	LEO, SSO	Doppler lidar	\$650 M



Budget & Planning



Major FY09 Budget Changes



- ☞ Increased commitment to Earth Science over 5 years, primarily at the expense on other SMD divisions
 - ☐ *Net effect was to stem the tide of previously planned Earth Science budget reductions*
- ☞ Initiated seven new FY09 mission starts: more than in the past four budgets combined; at least one per SMD science area:
 - ☐ *Earth Science: SMAP and ICESat II (2012, 2015 launches)*
 - ☐ *Astrophysics: JDEM (launch in 2014/2015)*
 - ☐ *Heliophysics: Solar Probe Plus (launch in 2015)*
 - ☐ *Planetary: Outer Planets Flagship (launch by 2017) small lunar science orbiter (launch by 2011), and lunar mini-landers (launch by 2014).*

	* FY2007	* FY2008	FY2009	FY2010	FY2011	FY2012	FY2013
<u>Total NASA</u>	<u>\$16,231.0</u>	<u>\$17,300.5</u>	<u>\$17,610.7</u>	<u>\$18,022.9</u>	<u>\$18,457.0</u>	<u>\$18,901.6</u>	<u>\$19,355.4</u>
<u>Science</u>	<u>\$4,609.9</u>	<u>\$4,706.2</u>	<u>\$4,441.5</u>	<u>\$4,482.0</u>	<u>\$4,534.9</u>	<u>\$4,643.4</u>	<u>\$4,761.6</u>
Earth Science	\$1,198.5	\$1,280.3	\$1,367.5	\$1,350.7	\$1,250.9	\$1,264.4	\$1,290.3
Planetary Science	\$1,215.6	\$1,247.5	\$1,334.2	\$1,410.1	\$1,537.5	\$1,570.0	\$1,608.7
Astrophysics	\$1,365.0	\$1,337.5	\$1,164.5	\$1,122.4	\$1,057.1	\$1,067.7	\$1,116.0
Heliophysics	\$583.7	\$590.9	\$575.3	\$598.9	\$689.4	\$741.2	\$746.6
DSN / Ground Network	\$247.2	\$250.0					



NASA Earth Science Budget



- ☞ All new activities come out of the single Decadal Survey mission line over the next five years

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

	FY07	FY08	FY09	FY10	FY11	FY12	FY13
Decadal Survey Missions (\$M)	0.6	33.0	103.2	116.2	150.0	250.2	290.7

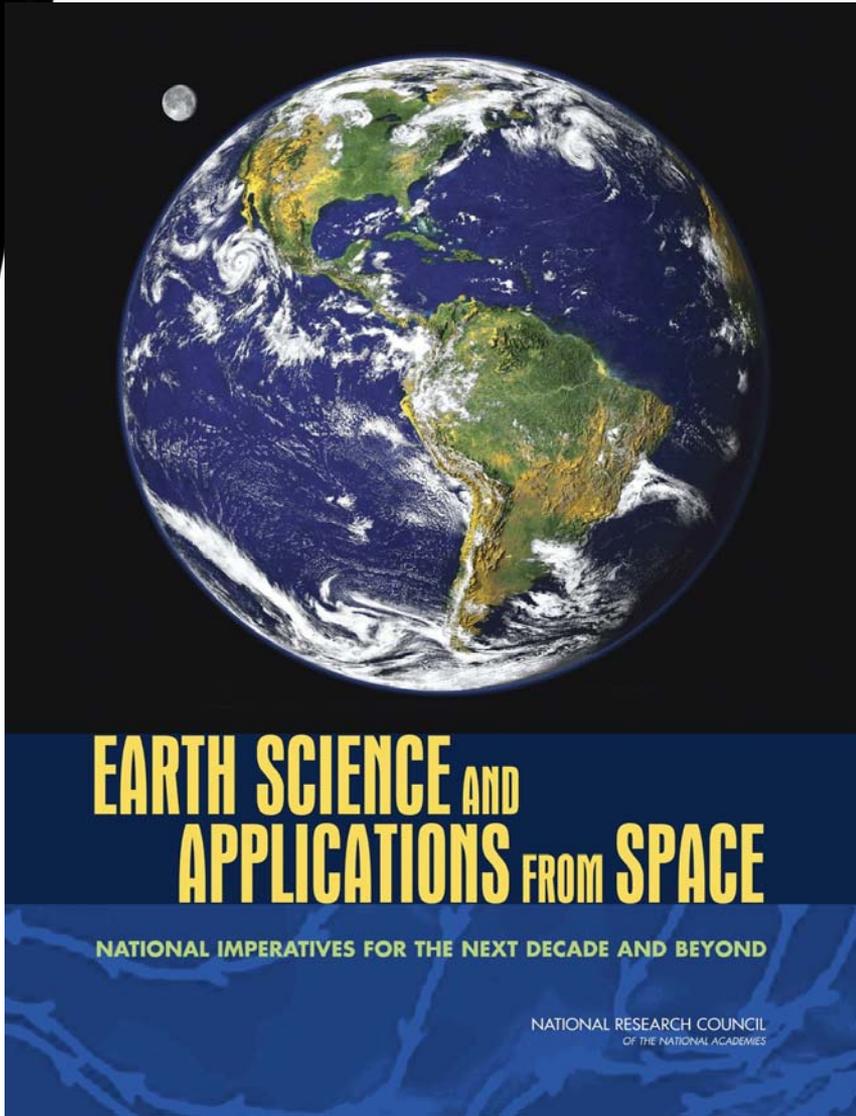


Two things primarily influence our planning



NRC Decadal Survey

NPOESS Nunn-McCurdy Response



EARTH SCIENCE AND APPLICATIONS FROM SPACE

NATIONAL IMPERATIVES FOR THE NEXT DECADE AND BEYOND

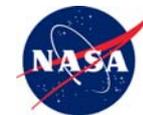
NATIONAL RESEARCH COUNCIL OF THE NATIONAL ACADEMIES

IMPACTS OF NPOESS NUNN-McCURDY CERTIFICATION ON JOINT NASA-NOAA CLIMATE GOALS

A Joint Document of
The National Aeronautics and Space Administration (NASA)
And
The National Oceanic and Atmospheric Administration (NOAA)

Prepared by the Earth Science Division
Science Mission Directorate
NASA Headquarters
And
The Climate Observations and Analysis Program
NOAA Climate Program Office

Mission Studies conducted vs. Decadal Survey Missions



Mission Study	Decadal Survey Equivalent	Study or Workshop	Lead	Support	Completion Date
Advanced Altimeter	SWOT	S	JPL		Oct-06
InSAR Mission	part DESDynI	S	JPL		Nov-06
Vegetation 3-D	part DESDynI	S	GSFC	JPL	Dec-06
Soil Moisture	SMAP	S	JPL		Dec-06
LEO-MAC	GACM	S	GSFC	JPL	Dec-06
CEIC	ICESat-II	S	GSFC		Dec-06
GWOS - Global Wind Observer Sounder	3D - WINDS	S	GSFC		Dec-06
GOCECP - Global Ocean, Carbon, Ecosystem ...	part ACE	S	GSFC		Dec-06
Soil Moisture + SST Combined Mission	-	S	JPL		Jan-07
Geo-MAC	GEO-CAPE	S	GSFC		Feb-07
InSAR + LIDAR Combined Missions	DESDynI	S	JPL	GSFC	Apr-07
Plant Physiology & Functional Types	part HypsIRI	S	JPL		Apr-07
GRACE Follow-on	GRACE-II	S	JPL		Apr-07
	ICESat-II	WS	HQ		Jun-07
	CLARREO	WS	HQ		Jul-07
	DESDYNI	WS	HQ		Jul-07
	SMAP	WS	HQ		Jul-07
PATH	PATH	S	JPL		Jul-07
SCLP	SCLP	S	JPL		Aug-07
HypsIRI Thermal Imager, Full Mission	HypsIRI	S	JPL		Aug-07
ACE - A	ACE	S	GSFC	JPL	Aug-07
ACE S B	ACE	S	JPL	GSFC	Aug-07
LIST	LIST	S	GSFC		Sep-07
ASCENDS	ASCENDS	S	LaRC	JPL	Oct-07

First four Decadal Survey missions concepts were vetted with the broad science community at open Science Workshops.



Mission Study Results



* Updated to FY07 \$

Missions	NASA ESD Study Costs*	Decadal Survey Cost*	Delta (%)
CLARREO	437.0	206.4	112%
SMAP	393.5	309.6	27%
ICESat-II	607.0	309.6	96%
DESDynI	760.0	722.4	5%
HyspIRI	452.0	309.6	46%
ASCENDS	473.0	412.8	15%
SWOT	698.0	464.4	50%
GEO-CAPE	1276.2	567.6	125%
ACE	1627.9	825.6	97%
LIST	609.9	309.6	97%
PATH	521.0	464.4	12%
GRACE-II	471.4	464.4	2%
SCLP	512.0	516.0	-1%
GACM	1036.9	619.2	67%
3D-WINDS	797.7	670.8	19%
Total:	10673.5	7172.4	49%

NASA Earth Science analyses and the Decadal Survey assessments used very different input assumptions



Observations & Assessments



- ☞ The studies produced point solutions only, certainly not optimal
- ☞ Missions were analyzed on individual bases only
 - ☐ *We clearly understand the need for integrated solutions, recognizing and harvesting the complementary and cooperative nature of the missions*
- ☞ Schedules developed according to NASA Center guidelines
 - ☐ *Schedules used primarily to pinpoint developmental technologies or extreme long lead items*
- ☞ Costs were based on Center internal pricing guidelines
- ☞ Formal acquisition approach to be determined during FY08 and FY09
 - ☐ *High costs indicate clear need for systematic trade studies*



Decadal Survey Program Activities



- ☞ Consider all missions as part of an integrated program, with various degrees of integrated science and observations

- ☞ Conduct cross mission analyses investigating potential common mission activities
 - ☐ *Technologies, such as lidars, radars, hyperspectral*
 - ☐ *Launch vehicle interfaces, including dual manifest possibilities*
 - ☐ *Spacecraft bus, possibly even a bulk buy for several spacecraft*

- ☞ International partnership discussions
 - ☐ *For all or part of instruments, and possibly shared or “traded” missions*

- ☞ Technology development primarily through the ESTO Instrument Incubator Program
 - ☐ *Current IIP call was focused on the Decadal Survey missions, selections in late March 2008*



FY08 - FY09 DS Mission Activities



- ☞ All missions to be managed through the Earth Systematic Missions Program Office, but with direct Science and Programmatic leadership from NASA Earth Science Division

- ☞ SMAP and ICESat II identified as the first two missions for development
 - ☐ *Will move into implementation as soon as they complete necessary mission milestones*

- ☞ Pre-Formulation science and mission development will continue for DESDynI and CLARREO
 - ☐ *Identify and conduct highest priority activities recommended by Science & programmatic team, based on Science workshop reports, community input, and workshops such as this*
 - ☐ *Mission configuration trade studies, technology investigations, science algorithm studies, cost and schedule assessments*

- ☞ Refine mission definition for 2nd & 3rd Tier missions, at a slower pace

