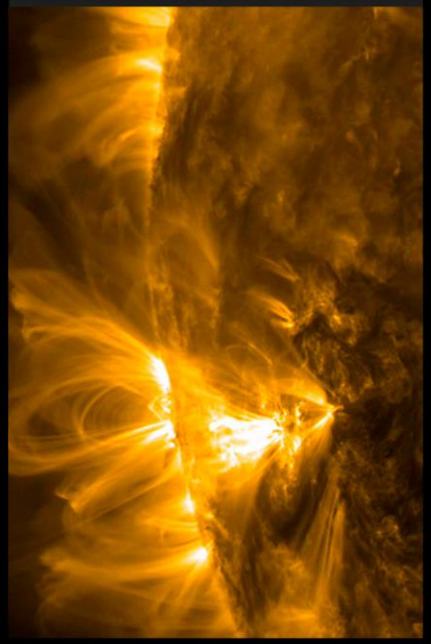
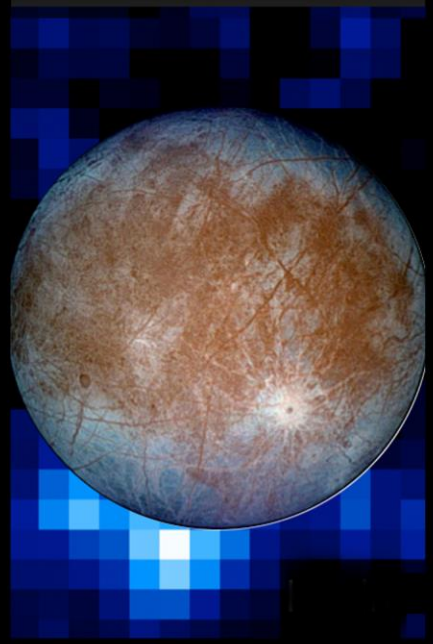
National Aeronautics and Space Administration



HELIOPHYSICS

EARTH SCIENCE



PLANETARY SCIENCE

ASTROPHYSICS

SCIENCE MISSION DIRECTORATE

FY 2016 Budget Overview to the NAC Science Committee

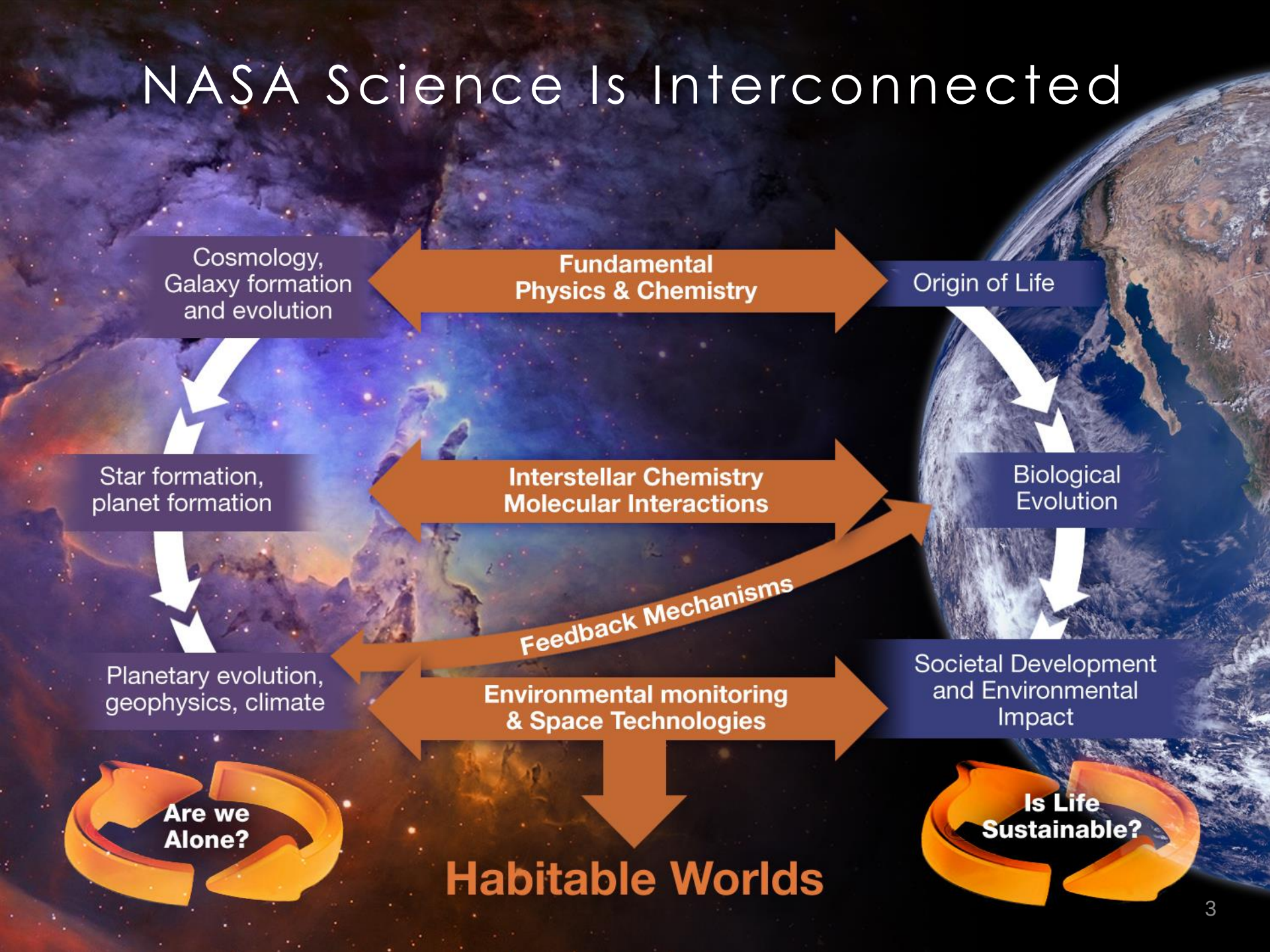
Craig Tupper, Resource Management Director

April 6, 2015

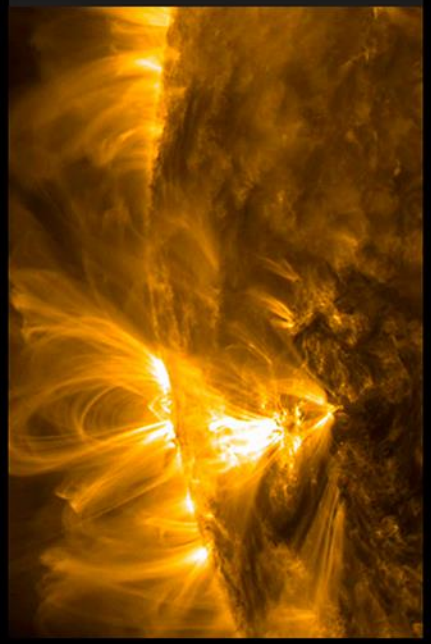
Science @ NASA executes:

- 97 missions
- 124 spacecraft
- 8 Balloon launches (FY 2014)
- 12 Sounding rockets (FY 2014)
- 4,600 Airborne hours (FY 2014)

NASA Science Is Interconnected

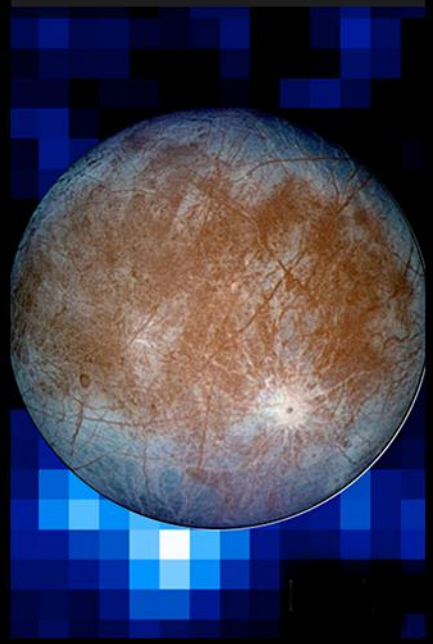


Science Mission Directorate



HELIOPHYSICS

EARTH SCIENCE



PLANETARY SCIENCE

ASTROPHYSICS

An Integrated Program of Science

FY 2016 Program/Budget Strategy

- Provide the most productive Earth & space science program for the available resources
  - Guided by national priorities
  - Informed by NRC Decadal Surveys recommendations
  - Incorporating new ideas and partnerships
  - Increase cross-directorate collaboration on strategic projects (ISS, Mars 2020, NEOs…)
- Responsibly manage the national investment in robotic space missions
  - Confirm new missions only after sufficient technology maturation, and budget at an appropriate confidence level
  - Take aggressive steps with missions that do not stay within budget
  - Proactively manage JWST to the cost and schedule baseline
- Increase cadence of competed PI-led flight missions

FY16 Program Highlights

- Provides for a sustained land imaging capability beyond Landsat 8
- Includes budget for TSIS-1, and altimetry missions after Jason-3 (formerly NOAA responsibilities)
- Supports Mars 2020 mission and formulation of a potential Europa mission
- Increases efforts to detect and study NEOs
- Enables release of a New Frontiers AO in FY16
- Restores SOFIA budget; to enter Senior Review in 2016
- Supports Pre-formulation of WFIRST/AFTA
- Increases collaboration with NASA's Space Technology Mission Directorate
- Implements the revised and competed STEM education program to ensure that the most meritorious activities within SMD are supported

Astrophysics | Earth Science
Heliophysics | Planetary Science
Joint Agency Satellite Division (JASD)

Total Missions / Spacecraft 97 / 124

18-Mar-2015

Formulation 12 / 12

JPL 5
- *OCO-3* 7/2016
- SWOT 10/2020
- **Mars 2020** 2020
- NISAR Late 2020/2021
- *ECOSTRESS* 2018 (TBR)

LaRC 2
- *TEMPO* 11/2018
- *RBI* 11/2021

GSFC 4
- **TSIS-1** TBD
- *GOLD* 9/2017
- **JPSS-2** 11/2021
- *GEDI* 2019 (TBR)

MSFC 1
- *JUICE* 2022

Implementation 25 / 39

JPL 6/7
- SMAP 1/31/15
- *ST-7* NET CY2015
- Jason-3 NET 7/22/2015
- *Euclid* 3/2020
- InSight 3/2016
- GRACE FO (1/2) 8/2017

GSFC 16/22
- **MMS** (1/4): 3/12/2015
- DSCOVR: 2/11/2015
- *Astro-H:* 11/2015
- *SET-1:* 9/2015
- **GOES-R (1/4)** 3/2016
- **ICESat-2**: 10/2017
- **OSIRIS-REx:** 9/3/2016
- **JPSS-1:** 11/15/2016
- *Solar Orbiter Collaboration:* 7/2017
- *MetOp-C:* 10/2018
- **JWST:** 10/31/2018
- *NICER:* 10/2016
- **Solar Probe Plus:** 7/31/2018
- *MOMA-MS:* 2018
- TESS: 8/2017
- ICON: NET 6/2017

MSFC 1
- *Strofio* 8/16/2015

LaRC 2/9
- *SAGE III-ISS* 3/2015
- CYGNSS (1/8) 10/2016

Primary Ops 14 / 15

AFRC 1
- **SOFIA**

MSFC 1
- New Horizons

JPL 4
- *Rosetta*
- Dawn
- Juno
- OCO-2

GSFC 8 / 9
- SDO
- Suomi NPP~
- Van Allen Probes (1/2)
- Aquarius
- Landsat 8~
- IRIS
- MAVEN
- GPM

Extended Ops 46 / 58

ARC 1
- Kepler

JPL 14/16
- Spitzer
- CloudSat
- GRACE (1/2)
- OSTM/Jason-2~
- QuikSCAT
- Voyager (1/2)
- *Mars Express*
- Mars Odyssey
- MER Opportunity
- Cassini
- MRO
- NEOWISE
- NuSTAR
- MSL Curiosity

MSFC 3
- Chandra
- *Hinode*
- MESSE-NGER

GSFC 27/37
- HST
- *Suzaku*
- EO-1
- *XMM-Newton*
- Swift
- Aqua
- SORCE
- IBEX
- Terra
- TRMM
- Landsat 7~
- THEMIS (1/5)
- STEREO (1/2)
- Geotail
- *Cluster II (1/4)*
- TWINS-A & B (1/2)

LaRC 1
- *CALIPSO*
- Fermi
- CINDI
- ACE
- AIM
- Aura
- RHESSI
- SOHO
- TIMED
- Wind
- LRO
- LAGEOS (1/2)

Div	Form	Imp	Pri Ops	Ext Ops	Total
Astro	0	6	1	9	**16**
Earth	7	5	5	13	**30**
Planet	2	4	5	9	**20**
Helio	1	5	3	15	**24**
JASD	2	5	0	NA	**7**
Total	**12**	**25**	**14**	**46**	**97**

Italics = NASA instruments on commercial, DOD, or international spacecraft X / Y = # of missions / # of spacecraft
~ Operated by another agency
Updates: (1) Note that SMAP, DSCOVR, and MMS have launched but not moved to Primary Operations.
(2) Updated Jason-3 LRD to NET 7/22/2015

12 font: LCC > $1B
10 font: $250M < LCC < $1B
8 font: LCC < $250M
} for projects in formulation & implementation

Science Budget Request Summary

	Op Plan	Enacted		Notional			
	FY14	FY15	FY16	FY17	FY18	FY19	FY20
Science	**5148.2**	**5244.7**	**5288.6**	**5367.9**	**5448.4**	**5530.2**	**5613.1**
Earth Science	**1824.9**	**1772.5**	**1947.3**	**1966.7**	**1988.0**	**2009.3**	**2027.4**
Earth Science Research	456.7		485.3	471.0	480.4	475.2	470.6
Earth Systematic Missions	837.2		895.2	919.7	948.6	994.1	1004.8
Earth System Science Pathfinder	257.4		267.7	272.8	255.4	238.7	244.8
Earth Science Multi-Mission Operations	179.0		190.7	192.5	193.7	192.4	195.8
Earth Science Technology	59.6		60.7	62.1	61.5	61.2	62.7
Applied Sciences	35.0		47.6	48.7	48.4	47.6	48.8
Planetary Science	**1345.7**	**1437.8**	**1361.2**	**1420.2**	**1458.1**	**1502.4**	**1527.8**
Planetary Science Research	221.8	255.8	276.3	282.0	292.0	291.7	285.7
Lunar Quest Program	11.4						
Discovery	297.4	255.0	156.1	201.6	277.2	337.4	344.9
New Frontiers	231.6	286.0	259.0	124.0	81.5	85.7	137.8
Mars Exploration	288.0	305.0	411.9	539.3	561.3	531.5	464.2
Outer Planets	152.4	181.0	116.2	117.7	81.6	87.6	110.5
Technology	143.1	155.0	141.7	155.5	164.4	168.5	184.7
James Webb Space Telescope	**658.2**	**645.4**	**620.0**	**569.4**	**534.9**	**305.0**	**197.5**
Astrophysics	**678.3**	**726.8**	**709.1**	**726.5**	**769.5**	**1005.5**	**1138.3**
Astrophysics Research	145.2		187.7	228.1	226.9	229.1	253.2
Cosmic Origins	224.2		199.3	200.4	199.1	207.9	244.5
Physics of the Cosmos	112.6		107.6	81.9	86.9	96.0	106.6
Exoplanet Exploration	106.7		64.2	67.8	148.4	302.2	365.7
Astrophysics Explorer	89.6		150.3	148.2	108.1	170.4	168.3
Heliophysics	**641.0**	**662.2**	**651.0**	**685.2**	**697.9**	**708.1**	**722.1**
Heliophysics Research	185.1		158.5	168.5	202.1	207.6	208.4
Living with a Star	212.5		343.0	387.3	399.9	212.6	103.3
Solar Terrestrial Probes	143.3		50.5	37.6	41.8	133.3	189.2
Heliophysics Explorer Program	100.2	123.6	98.9	91.9	54.1	154.5	221.3

Cost and Schedule Performance

	Original Baseline			Revised Baseline			Q1 FY15 Actual/Current		Change From Latest Baseline	
	Estab.	LRD	Dev $	Estab.	LRD	Dev $	LRD	Dev $	LRD	Dev Cost
Juno	Aug-08	Aug-11	742				8/5/11	709	--	-4%
GRAIL	Jan-09	Sep-11	427				9/10/11	398	--	-7%
Suomi NPP	Feb-06	Apr-08	593	Jan-11	Feb-12	815	10/25/11	765	- 4 mos	-6%
Curiosity	Aug-06	Sep-09	1069	Oct-09	Nov-11	1720	11/26/11	1769	--	3%
NuSTAR	Aug-09	Jan-12	110				6/13/12	116	+ 5 mos	5%
Van Allen	Dec-09	May-12	534				8/30/12	504	+ 3 mos	-6%
Landsat 8	Dec-09	Jun-13	583				2/11/13	503	- 4 mos	-14%
IRIS	Oct-10	Jun-13	141				6/27/13	143	--	1%
LADEE	Aug-10	Nov-13	168				9/6/13	191	- 2 mos	14%
MAVEN	Oct-10	Nov-13	567				11/18/13	472	--	-17%
GPM	Dec-09	Jul-13	555	Oct-11	Jun-14	519	2/27/14	484	- 4 mos	-7%
OCO-2	Sep-10	Feb-13	249	Jan-13	Feb-15	372	7/2/14	320	- 7 mos	-14%
SMAP	Jun-12	Mar-15	486				1/31/15	479	- 2 mos	-1%
MMS	Jun-09	Mar-15	857				4/1/15	884	--	3%
Astro-H	Nov-13	Mar-16	81				Mar-16	81	--	0%
InSight	Dec-13	Mar-16	542				Mar-16	542	--	0%
SAGE-III	Jul-13	Mar-16	81				Mar-16	93	--	14.9%
Euclid *	Sep-13	May-16	77				May-16	80	--	4%
OSIRIS-REx	May-13	Oct-16	779				Oct-16	710	--	-9%
CYGNSS	Feb-14	May-17	151				May-17	151	--	0%
ICON	Oct-14	Oct-17	196				Oct-17	196	--	0%
GRACE-FO	Feb-14	Feb-18	264				Feb-18	263	--	0%
ICESat-2	Dec-12	May-17	559	May-14	Jun-18	764	Jun-18	764	--	0%
TESS	Oct-14	Jun-18	323				Jun-18	296	--	-8%
SPP	Mar-14	Aug-18	1056				Aug-18	1056	--	0%
SOC	Mar-13	Oct-18	377				Oct-18	320	--	-15%
JWST	Aug-09	Jun-14	2581	Sep-11	Oct-18	6198	Oct-18	6190	--	0%

Recent Cost Performance

NASA Science is providing reliable cost estimates for its missions, contributing to program stability

	Original Baseline	Current/ Actual	Actual vs. Original	
Juno	742.0	708.8	-4%	
GRAIL	427.0	398.0	-7%	
Suomi NPP	593.0	765.2	29%	
Curiosity	1069.0	1769.0	65%	
NuSTAR	110.0	116.0	5%	
Van Allen	534.0	504.0	-6%	
Landsat 8	583.4	502.8	-14%	
IRIS	141.0	143.0	1%	
LADEE	168.0	191.4	14%	
MAVEN	567.0	472.0	-17%	
GPM	555.0	484.3	-13%	
OCO-2	249.0	320.3	29%	
SMAP	485.7	479.0	-1%	final costs TBD after commissioning
MMS	857.3	884.5	3%	final costs TBD after commissioning
	7081.4	7738.4	9%	

The total cost to develop 14 Science missions launched in the last 3.5 years exceeds the sum of our *original* estimates by 9%. Excluding Curiosity from that list, the figure becomes -1% (a slight underrun in total).

SMD Solicitations

	RELEASE DATE	PROPOSAL DUE DATE	TARGET SELECT DATE
CLOSED SOLICITATIONS			
AO: Europa Instrument Investigation (SALMON-2) NNH12ZDA006O-EUROPA	7/15/14	10/17/14	April 2015
AO: Astrophysics 2014 Small Explorer NNH14ZDA013O	9/17/14	12/18/14	Summer 2015
AO: Astrophysics Explorer Mission of Opportunity (PEA N for SALMON-2) NNH12ZDA006O-APEXMO2	9/17/14	12/18/14	Summer 2015
AO: Discovery Program 2014 NNH14ZDA014O	11/5/14	2/18/15	Summer 2015
OPEN SOLICITATIONS			
NRA: RESEARCH OPPORTUNITIES IN SPACE AND EARTH SCIENCES – 2014 (ROSES-2014) NNH14ZDA001N	2/18/15	4/30/15	Goal: ≤ 150 d after due date
SMD Science Education Cooperative Agreement Notice (CAN) NNH15ZDA004C	2/4/15	5/4/15	Goal: ≤ 120 d after due date
NRA: RESEARCH OPPORTUNITIES IN SPACE AND EARTH SCIENCES – 2015 (ROSES-2015) NNH15ZDA001N	2/14/14	4/30/16	Goal: ≤ 150 d after due date

http://soma.larc.nasa.gov/StandardAO/

Anticipated Future Mission Opportunities
(Based on Notional Outyear Budgets)

ASTROPHYSICS: SOFIA 3rd-Generation Instrument FY 2015

EARTH: Venture Class 2015 AO EVI-3 Instruments

EARTH: Venture Class 2015 AO EVM-2 Mission

HELIOPHYSICS: Explorer Mission AO NET 2016 for Mission and Mission of Opportunity

PLANETARY: New Frontiers 4 Mission AO in 2016 for launch ~2024

EARTH: Venture Class 2017 AO EVI-4 Instruments

EARTH: Venture Class 2017 ROSES PEA EVS-3 Suborbital

PLANETARY: Discovery Mission AO in 2017 for launch ~2023

HELIOPHYSICS: Solar Terrestrial Probes Mission AO NET 2017

ASTROPHYSICS: Medium-class Explorer (MIDEX) Mission FY2017 AO for Mission and Mission of Opportunity