



# NASA's Flight Program Mission Development & Planning Update

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# Outline of Presentation



- ◆ Guiding Program Documents
- ◆ Flight Program Overview
- ◆ Pre-Formulation Mission Study Activities

# Guiding Recommendation Documents



## 2007 DECADAL SURVEY



### EARTH SCIENCE AND APPLICATIONS FROM SPACE

NATIONAL IMPERATIVES FOR THE NEXT DECADE AND BEYOND

NATIONAL RESEARCH COUNCIL OF THE NATIONAL ACADEMIES

- Research/Applications priorities
- No realistic budget constraint
- Shopping list of missions & activities
- Assumed Legacy missions completed

National Aeronautics and Space Administration

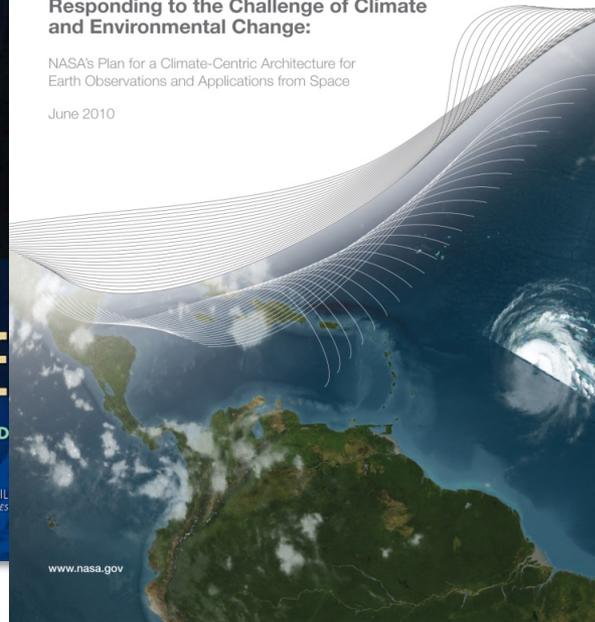


## 2010 NASA RESPONSE TO CLIMATE PLAN

Responding to the Challenge of Climate and Environmental Change:

NASA's Plan for a Climate-Centric Architecture for Earth Observations and Applications from Space

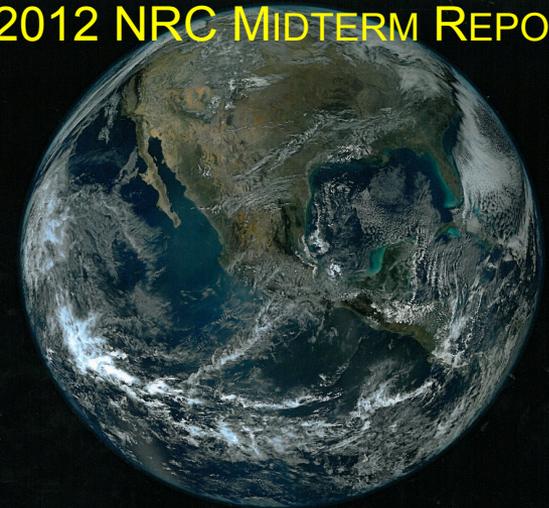
June 2010



www.nasa.gov

- Identified new Climate Measurements
- Matched against President's budget
- Vetted w/OSTP, OMB & Admin

## 2012 NRC MIDTERM REPORT



### EARTH SCIENCE AND APPLICATIONS FROM SPACE

A Midterm Assessment of NASA's Implementation of the Decadal Survey

NATIONAL RESEARCH COUNCIL OF THE NATIONAL ACADEMIES

- Endorsed NASA's implementation
- "Encouraged" more rigorous cost control
- Endorsed additional Venture calls



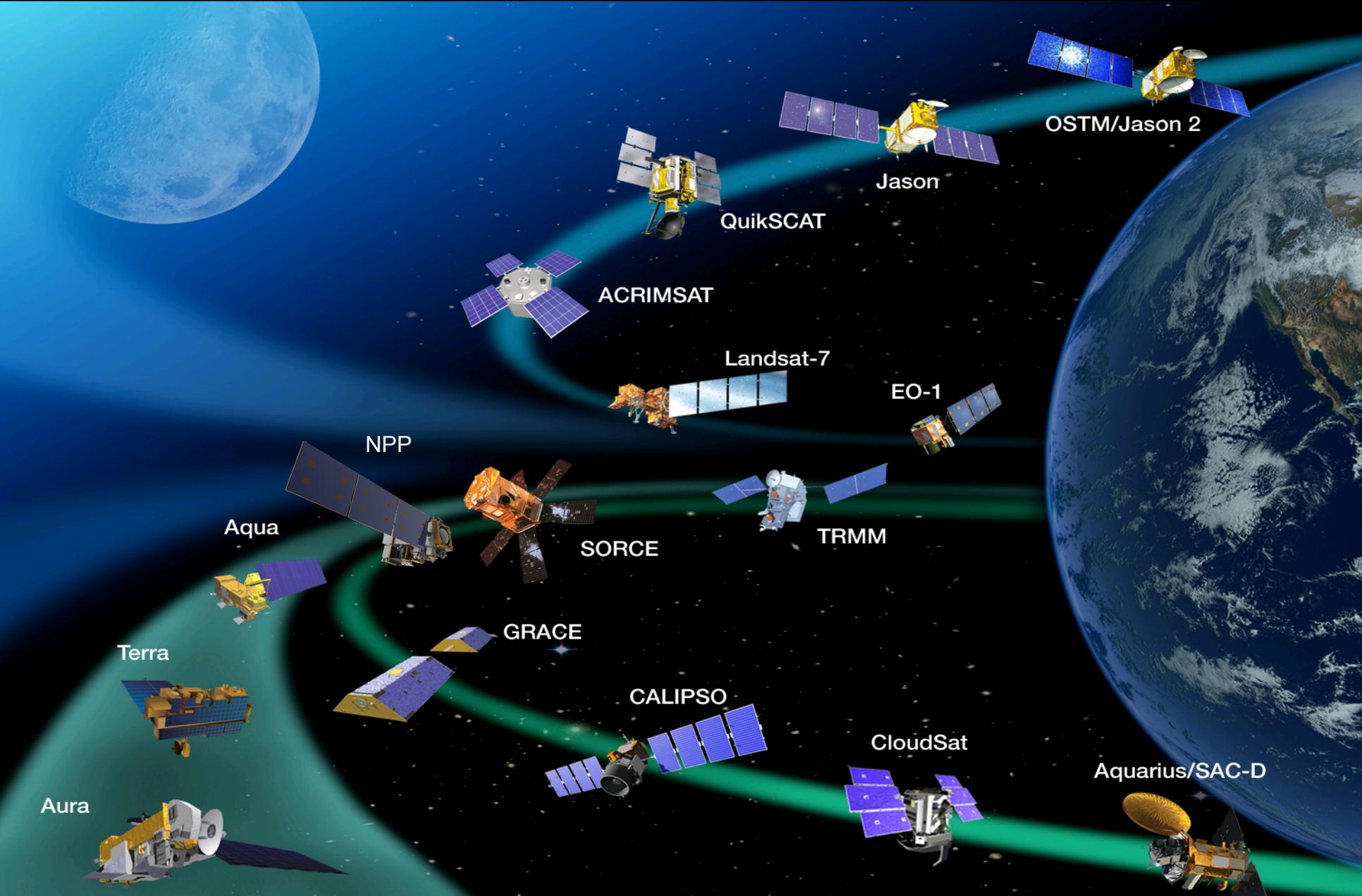
## ◆ For Missions in Operation

- ❑ Continue to operate safely and efficiently
- ❑ Ensure maximum return from measurements already taken

## ◆ For Missions in Development & Formulation

- ❑ Ensure timely maturation of any technology elements
- ❑ Maintain rigor on requirements implementation (no mission creep!)
- ❑ Ensure projects stay within their defined budget parameters and stay on schedule

# NASA Operating Missions



OSTM/Jason 2

Jason

QuikSCAT

ACRIMSAT

Landsat-7

EO-1

NPP

Aqua

SORCE

TRMM

Terra

GRACE

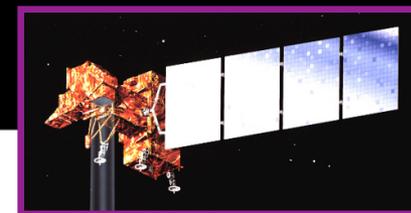
CALIPSO

CloudSat

Aura

Aquarius/SAC-D

# Missions In Development



LDCM  
w/USGS, VIS & TIR

## ◆ LDCM

- ❑ Completed integration of OLI and TIRS instruments to spacecraft
- ❑ On schedule for a launch on an Atlas V Feb 11, 2013

## ◆ GPM

- ❑ Delivered all instruments to the spacecraft for system testing
- ❑ Preparing now for Observatory thermal vacuum testing
- ❑ On schedule for a launch on a JAXA H-IIA in Feb 2014



GPM  
w/ JAXA; Precip

## ◆ OCO-2

- ❑ Completed instrument delivery to the spacecraft
- ❑ Launch vehicle selected for the mission
- ❑ On schedule for a launch on a Delta II in July 2014



OCO-2  
Global CO<sub>2</sub>

## ◆ SMAP

- ❑ Completed KDP-C confirmation review
- ❑ Launch vehicle selected for the mission
- ❑ On schedule for a launch on a Delta II in October 2014



SMAP  
w/CSA  
Soil Moist., Frz/Thaw

## ◆ SAGE III

- ❑ Proceeding on an accelerated development path, completed KDP-A, -B, and -C gate reviews in FY2012
- ❑ On schedule for a launch to the ISS on a Falcon-9 in Jul 2014



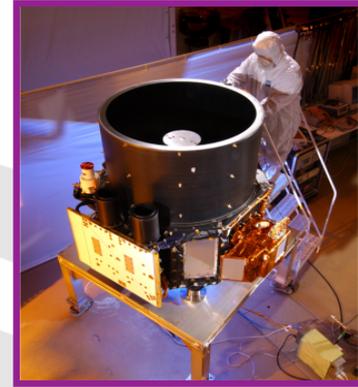
SAGE III  
Ozone & Trace Gases

# Missions In Formulation



## ◆ ICESat-2

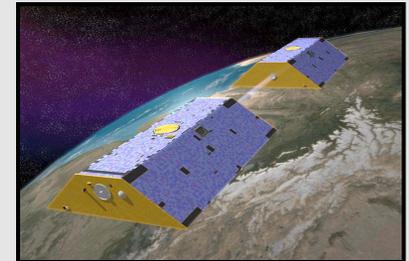
- ❑ Completed instrument and spacecraft PDR
- ❑ Initial dual manifest approach with DMSP-20 discontinued
- ❑ Draft launch vehicle announcement on the street
- ❑ Preparing for 2012 Confirmation review and Jul 2016 Launch



ICESat-2  
Ice Dynamics

## ◆ GRACE Follow-On

- ❑ Completed Phase A and KDP-B
- ❑ Partnership with GFZ being developed
- ❑ Partner pursuing Launch Vehicle
- ❑ Working to an Aug 2017 launch date



GRACE FO  
w/Germany; Global Mass  
& Water Variation

## ◆ CYGNSS (CYclone Global Navigation Satellite System)

- ❑ Selected winner of Earth Venture 2 Small Satellite announcement
- ❑ Targeting a launch in 2016/2017



CYGNSS  
Cyclone  
Generation 7

# Missions Distributed by NASA Flight Project Life Cycle

Project Life Cycle						
Project Pre-Formulation	Project Formulation		Approval (For Implementation)	Project Implementation		
Pre-Phase A	Phase A	Phase B	Phase C	Phase D	Phase E	Phase F
<p><u>NASA:</u>                      DESDynI                      L-Band SAR                      CLARREO                      SWOT                      OCO-3                      ASCENDS                      PACE                      ACE                      GEO-CAPE                      HypIRI                      QuikSCAT FO</p> <p style="text-align: right; color: red; font-size: 2em;">7</p>	<p><u>NASA:</u>                      CYGNSS                      SWOT (2012)                      OCO-3 (2012)</p> <p style="text-align: right; color: red; font-size: 2em;">3</p>	<p><u>NASA:</u>                      GRACE FO                      ICESat-2</p> <p style="text-align: right; color: red; font-size: 2em;">2</p>	<p><u>NASA:</u>                      GPM                      LDCM                      OCO-2                      SMAP                      SAGE III                      EV-1</p> <p style="text-align: right; color: red; font-size: 2em;">6</p>	<p><u>NASA Prime:</u>                      NPP                      Aquarius                      Extended:                      Aura                      OSTM                      Aqua                      Terra                      TRMM                      Jason                      EO-1                      QuikSCAT                      SORCE                      Acrimsat                      CALIPSO                      CloudSat                      GRACE</p> <p style="text-align: right; color: red; font-size: 2em;">15</p>		

Legacy Missions
Decadal Survey Missions
Climate Plan Missions

# NASA Approach to Pre-Formulation Mission Development



- ◆ For strategic missions, our objective is to ensure the complete mission concept is mature before proceeding into formulation and development
- ◆ This includes:
  - Investments in Technology to ensure the critical measurement and mission technologies are at the right level of maturity
  - Development of community consensus to define an achievable scientific scope
  - Investigation of mission concepts to see that the measurement approach is well founded and can meet science objectives
  - Development of cost and schedule assessments for missions that fit within the programmatic constraints

# Technology Program Overview



The Earth Science Technology Office (ESTO) is a **targeted, science-driven, competed, actively managed, and dynamically communicated technology program** and serves as a model for technology development.

Competitive, peer-reviewed proposals enable selection of best-of-class technology investments that **retire risk** before major dollars are invested: a cost-effective approach to technology development and validation. ESTO investment elements include:



## Instrument Incubator Program (IIP)

provides robust new instruments and measurement techniques  
*16 new projects added in FY11 (total funding approximately \$67M over 3 years)*



## Advanced Component Technologies (ACT)

provides development of critical components and subsystems for instruments and platforms  
*15 new projects added in FY11 (total funding approximately \$16M over 3 years)*



## Advanced Information Systems Technology (AIST)

provides innovative on-orbit and ground capabilities for communication, processing, and management of remotely sensed data and the efficient generation of data products  
*18 new projects added in FY12 (total funding approximately \$23M over 3-4 years)*



## In-Space Validation of Earth Science Technologies (InVEST)

provides in-space, orbital technology validation and risk reduction for components and systems that could not otherwise be fully tested on the ground or in airborne systems  
*First Solicitation expected in FY12-13*

Observation

Information

Validation

# Earth Science Technology: New Investments Enabling the Decadal Survey



Upon publication of the Earth Science Decadal Survey in 2007, ESTO investments **already supported all 18 of the recommended mission concepts**. Since then, ESTO has awarded **74 additional technology projects** representing an investment of **over \$172M directly related to the Earth Science priorities outlined by the Decadal Survey**.

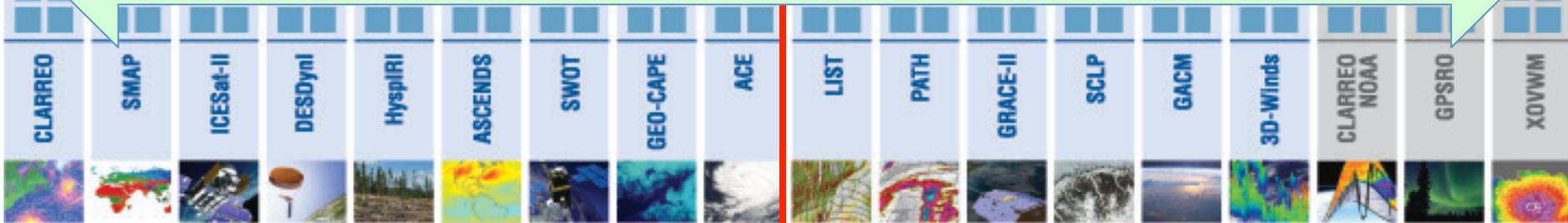
Technology Addressed by Flight & ESTO

Technology Addressed by ESTO Only

2010

2007 - 2009

All mission science objectives are accessible to the Earth Venture opportunities



NASA Earth Science Missions

NOAA Missions

Tier I

Tier II

Tier III

- Instrument Technology Investments
- ✈ planned airborne testing
- 🎈 planned balloon testing
- Component Technology Investments

- Information Systems Investments with Direct Applicability
- Information Systems Investments with Secondary Applicability

# Decadal Survey Venture Line



**EV-1:**  
Sustained  
Sub-Orbital  
Investigations

**EV-2:**  
Complete,  
self-  
contained,  
small  
missions

**EV-Instrument:**  
Full function, facility-  
class instruments  
Missions of  
Opportunity (MoO)

EV Schedule	Type	Solicitation	Selection	Launch/Delivery
EV-1	Suborbital	2009	2010	
EV-2	Full Orbital	2011	2012	LRD ~ <del>2017</del> 2016
EV-I1	Instrument Only	<del>2011</del> 2012	2012	Del ~2016
EV-I2	Instrument Only	<del>2012</del> 2013	<del>2013</del> 2014	Del ~2018
EV-3	Suborbital	2013	2014	
EV-I3	Instrument Only	<del>2013</del> 2014	<del>2014</del> 2015	Del ~ <del>2018</del> 2019
EV-I4	Instrument Only	<del>2014</del> 2015	<del>2015</del> 2016	Del ~ <del>2019</del> 2020
EV-4	Full Orbital	2015	2016	LRD ~2021
EV-I5	Instrument Only	<del>2015</del> 2016	<del>2016</del> 2017	Del ~ <del>2020</del> 2021
EV-I6	Instrument Only	<del>2016</del> 2017	<del>2017</del> 2018	Del ~ <del>2021</del> 2022

## *Fall 2012 Earth Venture Mission Schedule*



# NASA Planned New Missions (2011-2023)

**~4 Earth  
Venture  
Instruments  
for Flights of  
Opportunity**



ICESat II

GPM

SWOT

LDCM

PACE

SMAP

OCO-3

L-Band SAR

ASCENDS

OCO-2

EV-4

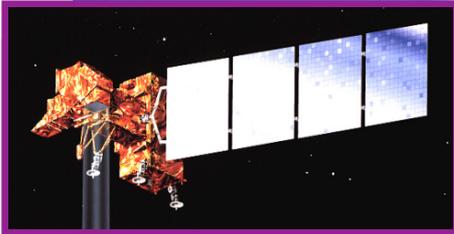
SAGE-III

GRACE-FO

NPP

CYGNSS

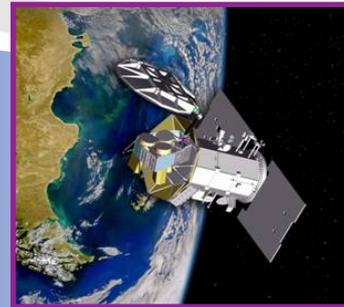
# Near Term Mission Plans



LDCM  
Jan 2013  
w/USGS; TIRS  
**Atlas V**



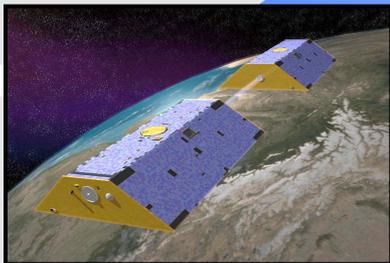
GPM  
Feb 2014  
w/ JAXA; Precip  
**H-IIA**



SAGE III  
Aug 2014  
Ozone & Trace Gases  
**Falcon-9**



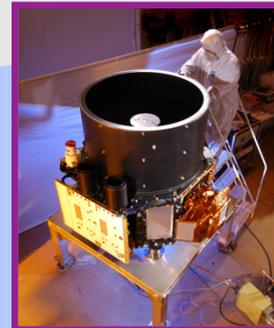
OCO-2  
July 2014  
Global CO<sub>2</sub>  
**Delta II**



GRACE FO  
Aug 2017  
w/Germany; Global Mass  
& Water Variation  
**TBD**



CYGNSS  
2016  
Cyclone  
Generation  
**TBD**



ICESat-2  
Jul 2016  
Ice Dynamics  
**TBD**



SMAP  
Oct 2014  
w/CSA  
Soil Moist., Frz/Thaw  
**Delta II**