

National Aeronautics and Space Administration



# Current and Future NASA Earth Observing Satellites

Hal Maring  
14 September 2011

# Earth Science Division Overview

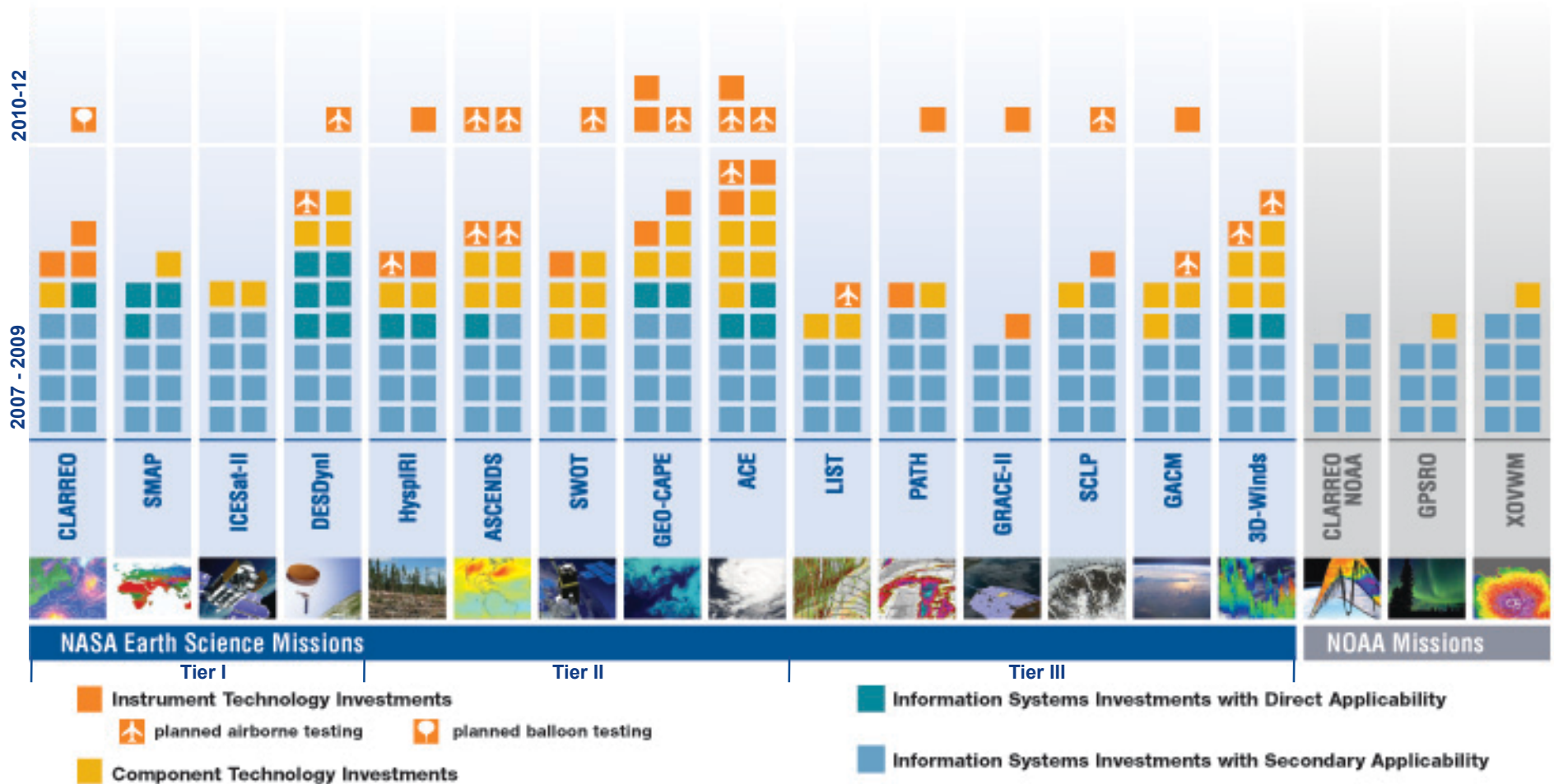


- Overarching goal: to advance Earth System science, including climate studies, through space-borne data acquisition, research and analysis, and predictive modeling
- Six major activities:
  - Building and operating Earth observing satellite missions, many with international and interagency partners
  - Making high-quality data products available to the broad science community
  - Conducting and sponsoring cutting-edge research
    - Field campaigns to complement satellite measurements
    - Ground networks (e.g., AERONET – with international partners)
    - Analyses of NASA and non-NASA mission and in-situ data
    - Modeling
  - Applied Science
  - Developing technologies to improve Earth observation capabilities
  - Education and Public Outreach

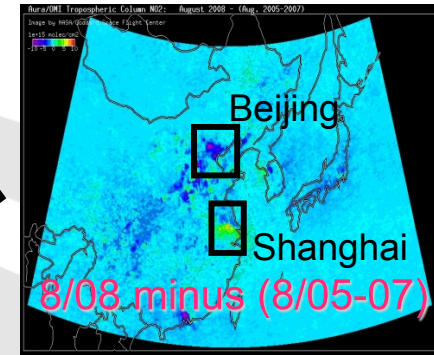
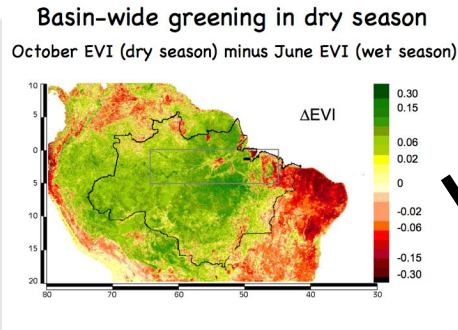
# Earth Science Technology: New Investments Enabling the Decadal Survey



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**.



# Earth SCIENCE Division Focus Areas



Atmospheric Composition

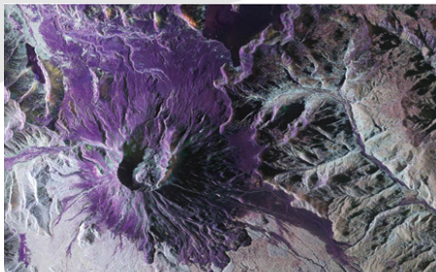
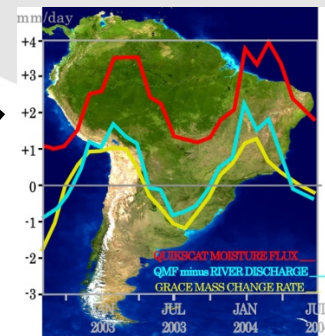
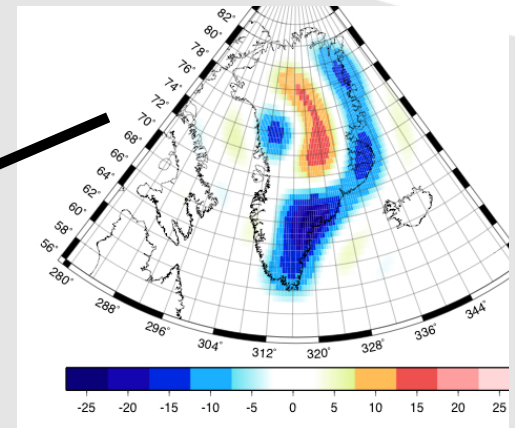
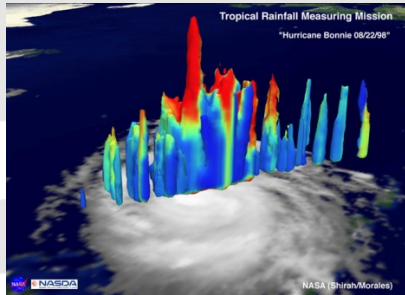
Carbon Cycle and Ecosystems

Climate Variability and Change

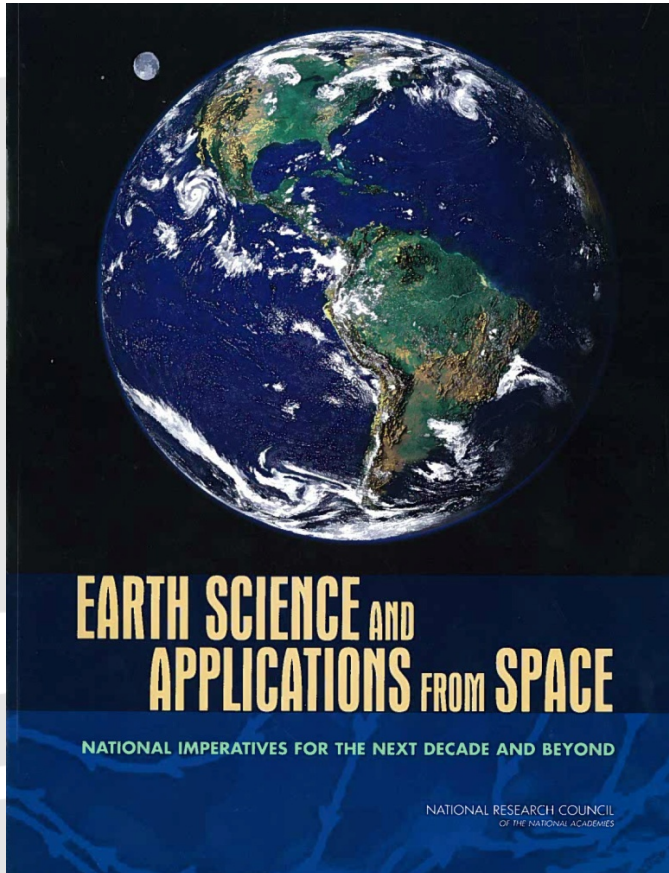
Weather

Water and Energy Cycle

Earth Surface and Interior



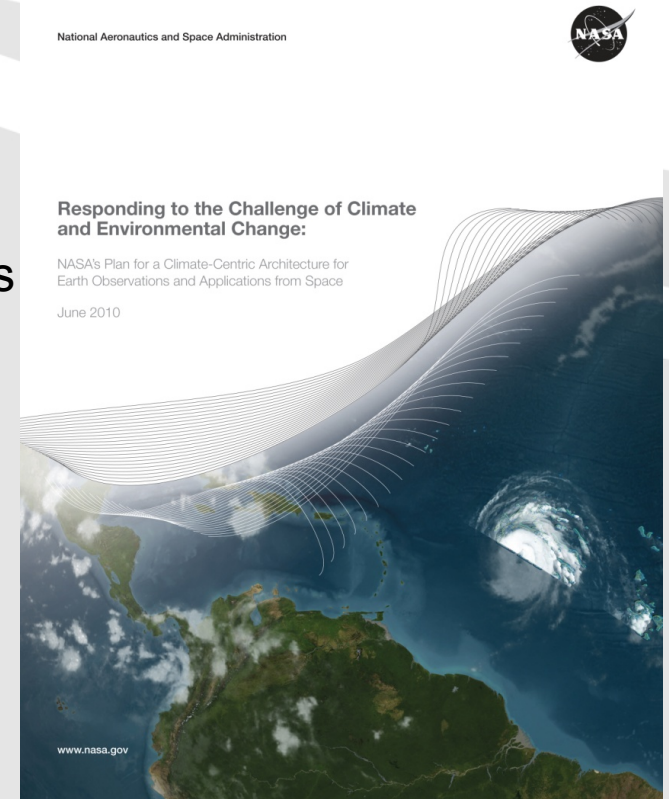
# Guiding Recommendation Documents



Administration priorities  
and constraints



Decadal survey,  
OCO-2,  
climate continuity  
missions,  
balanced program  
***Integrated Program***



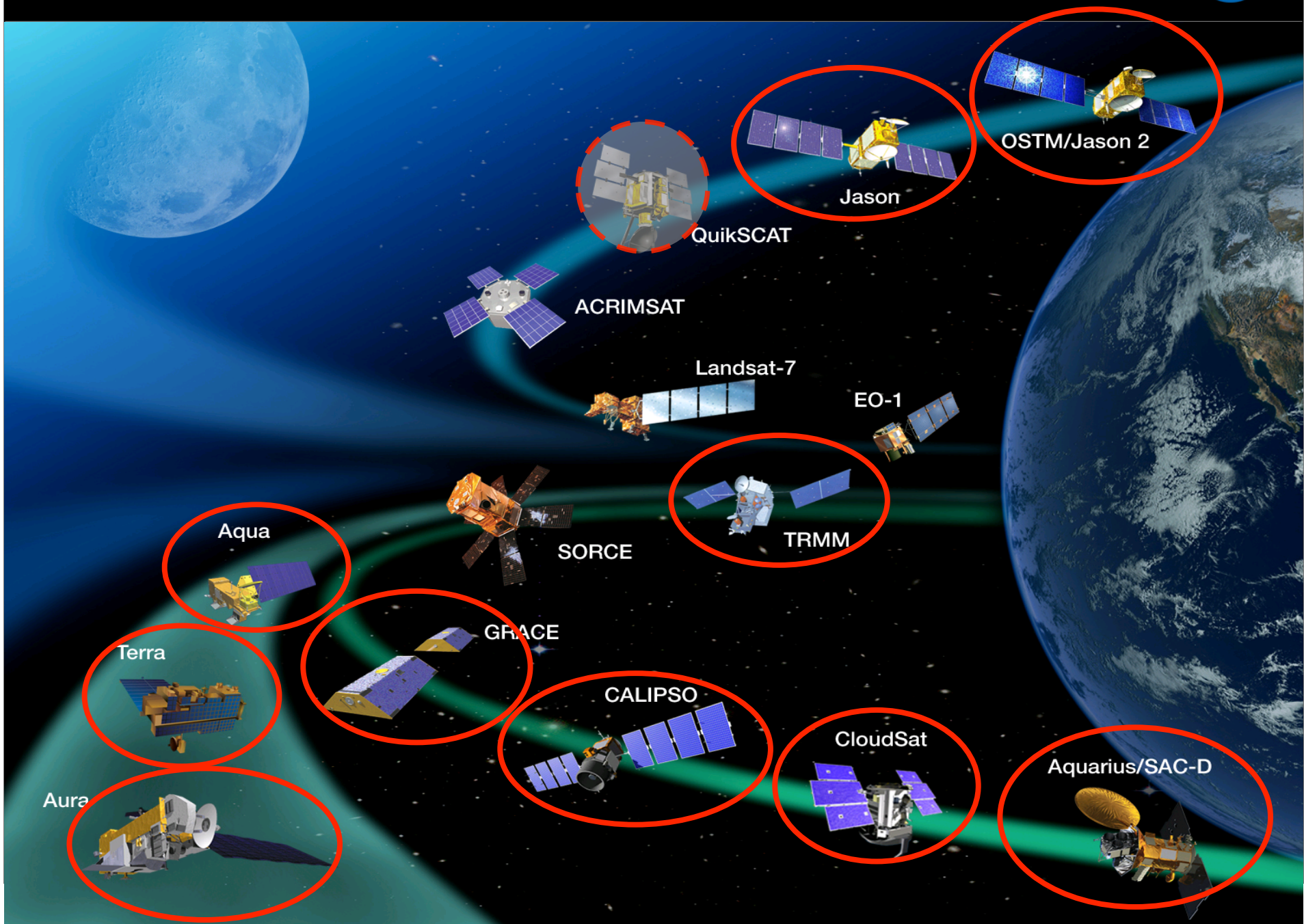
## 2007 Decadal Survey

- Research and Applications communities priorities
- No realistic budget constraint (calls for \$2B funding [FY06 constant \$\$ beginning in FY10])

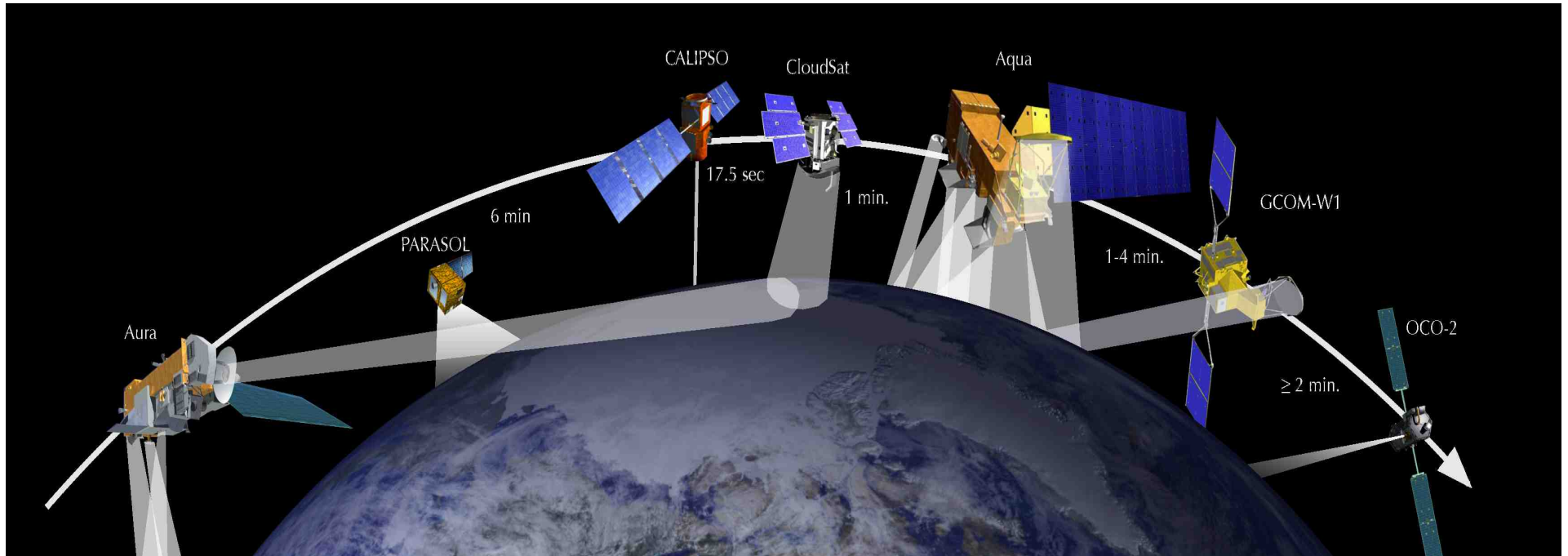
[http://science.nasa.gov/media/medialibrary/2010/07/01/Climate\\_Architecture\\_Final.pdf](http://science.nasa.gov/media/medialibrary/2010/07/01/Climate_Architecture_Final.pdf)

- Dec Surv + Administration priorities
- Executable for FY11 Pres. Bud.
- OSTP, USGCRP, OMB approval

# NASA Operating Missions (International Collaboration)

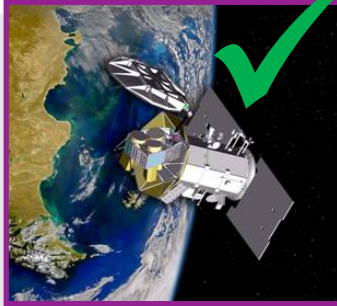


# Mission Update – Afternoon Constellation



- PARASOL to lower orbit additional 10km, per their Space Ops safety process
- CloudSat has moved 2.6 km below A-Train while continuing recovery effort
- JAXA GCOM-W1 to join the A-Train (LRD: November 2011 – March 2012)
- OCO-2 to join the A-Train (LRD: ~2013)

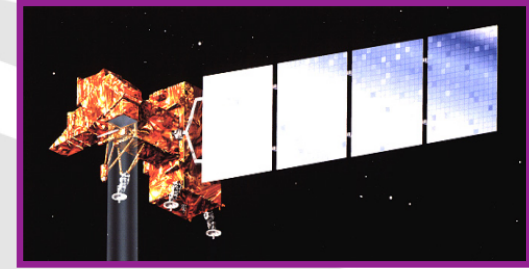
# Missions in Formulation and Implementation – 9/2011



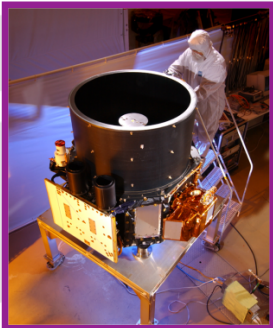
**AQUARIUS**  
**6/10/2011**  
w/CONAE; SSS



**NPP**  
**10/25/2011**  
w/NOAA  
EOS cont., Op Met.



**LDCM**  
**12/2012**  
w/USGS; TIRS



**ICESat-II**  
**Likely 2016**  
Ice Dynamics



**SMAP**  
**Early CY2015**  
w/CSA  
Soil Moist., Frz/Thaw

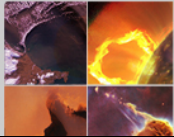


**GPM**  
**7/2013**  
w/ JAXA; Precip

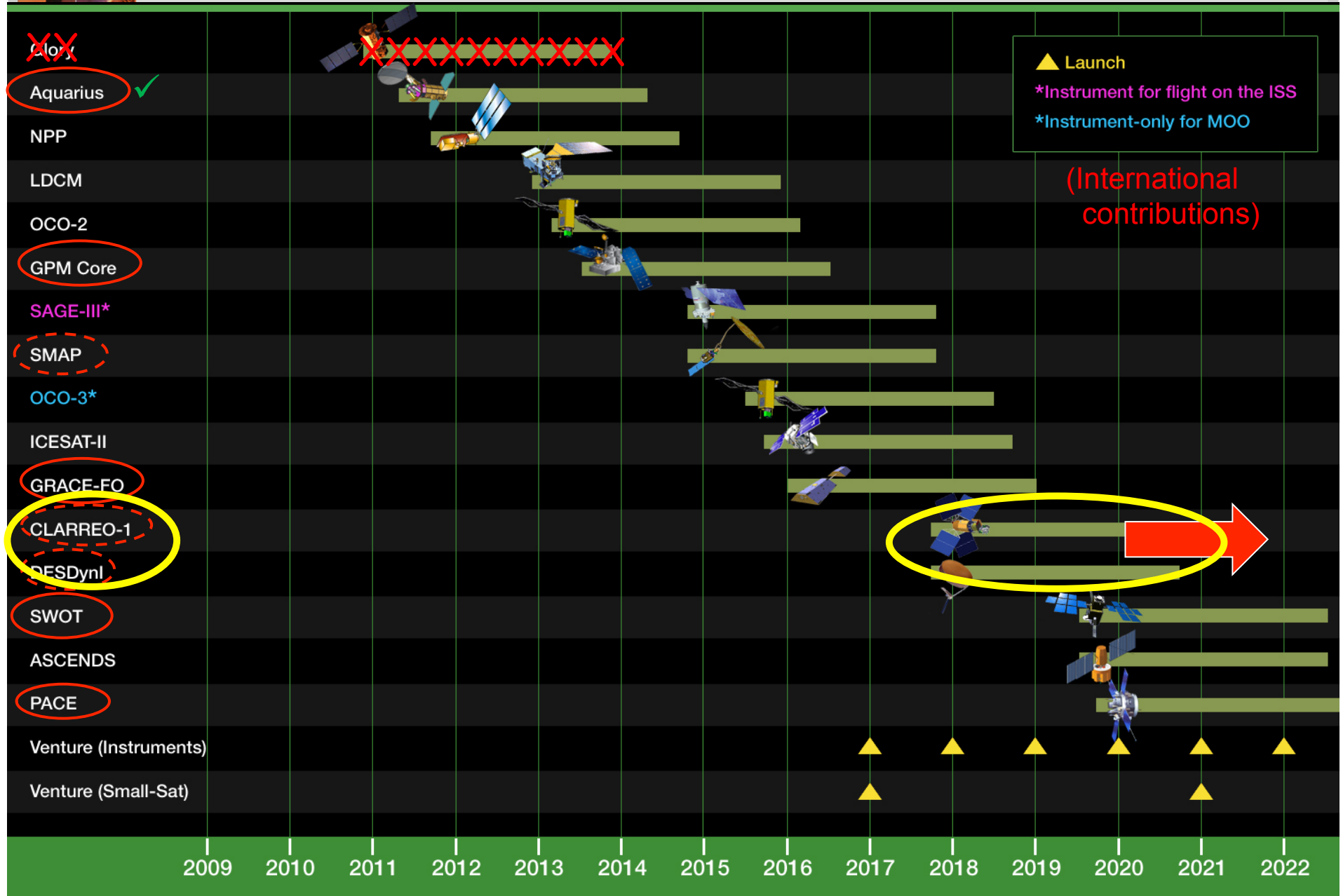


**OCO-2**  
**2013**  
Global CO<sub>2</sub>





# Future Orbital Flight Missions – 2011 – 2022



# VENTURE-CLASS UPDATE/STATUS



- **Venture-Class is a Tier-I Decadal Survey recommendation**
  - Science-driven, PI-led, competitively selected, cost- and schedule-constrained, regularly solicited, orbital and suborbital
  - Venture-class investigations complement the systematic missions identified in the Decadal Survey, and provide flexibility to accommodate scientific advances and new implementation approaches
- **Venture-Class is fully funded, with 3 “strands”**
  - EV-1: suborbital/airborne investigations (5 years duration)
    - Solicited in FY09 (selections in FY10) **and every 4 years**
    - 5 investigations selected; flights beginning in FY11
  - EV-2: small complete missions (5 years duration)
    - Solicited in FY11 (selections in FY12) **and every 4 years**
    - Small-sat or stand-alone payload for MoO; \$150M total development cost
    - Final AO released 17 June 2011, proposals due 22 Sept 2011
  - EV-Instrument: Space-borne instruments for flight on MoO (5 years dev.)
    - Solicited in FY11 (selections in FY12) **and annually (or bi-annually) thereafter**
    - Final AO release in 2<sup>nd</sup> half of FY11
    - ~\$90M development costs, accommodation costs budgeted separately
    - Common Instrument Interface specs being developed

# INTERNATIONAL COLLABORATIONS (1 of 2)



- **European Space Agency**

- NASA-ESA Earth Science collaboration framework signed September 2010 (Weiler-Liebig)
- Field Campaigns/Cal-Val; Ground systems, data products, mission “interoperability”; Flight missions

- **ISRO (India)**

- Oceansat-2 scatterometer, ocean color instrument data exchange, validation
- QuikSCAT re-orientation to allow use as transfer standard
- GPM/Megha-Tropiques partnership
- AERONET (with Technical Institutes)
- GLOBE (with Ministry of Environment)

- **CNES (France)**

- GPM/Megha-Tropiques partnership
- SWOT (72%/28%\$\$ NASA/CNES work package agreed upon)
- Polder-FO (polarimeter) for PACE under discussion

- **JAXA (Japan)**

- TRMM, ASTER, AMSR-E extended missions
- GOSAT/ACOS/OCO-2 (validation, OCO-2 algorithm refinement)
- GPM



- **DLR/GFZ (Germany)**
  - GRACE extended mission
  - GRACE-FO under discussion
  - DESDynI Radar (possible)
- **CONAE (Argentina)**
  - COSMIC real-time data provision (w/ NOAA)
  - SAC-D/Aquarius full mission collaboration
- **CSA (Canada)**
  - SMAP (Flight components, ground station under discussion; validation)
  - SWOT (Flight components; science participation)

# ESD/SMD/NASA Launch Vehicle Crisis



***ESD/SMD/NASA is losing reliable, predictable, access to space via affordable, proven launch vehicles***

***After 2 consecutive failures of the Taurus-XL LV, there is no certified U.S. LV with capacity between the Pegasus (440kg to LEO) and the Atlas-V (9750-29,240 kg to LEO)***

***LV availability and reliability problems are causing launch delays and cost increases **now**, and will have greater impacts on the Earth and Space science programs in the coming decade***

# U.S. Launch Vehicles



- **Pegasus (440 kg) Cat 2**
- **Taurus-XL (1350 kg) Cat 2 (3 of last 4 launches failed)**
- **Delta-II (2700-6100 kg) Cat 3**
  - Production discontinued; Aquarius (6/11) and NPP (10/11) are manifested on 2 of the last 3 Delta-IIs;
  - ~5 more “white tails” may be available, but not on NLS-2 list
- **Atlas-5 (9750-29,240 kg) Cat 3**
  - No proven DSS for multiple-spacecraft launch
  - Exceptionally costly (\$250M-500M)
  - Crowded manifest with low SMD priority
- **Minotaur-IV (up to 1735 kg) Unrated**
  - Non-commercial
  - Possible fairing commonality with Taurus-XL
- **Falcon-9 (up to 10,450 kg) Unrated**
- **Taurus-II (up to 7000 kg) Unrated**