



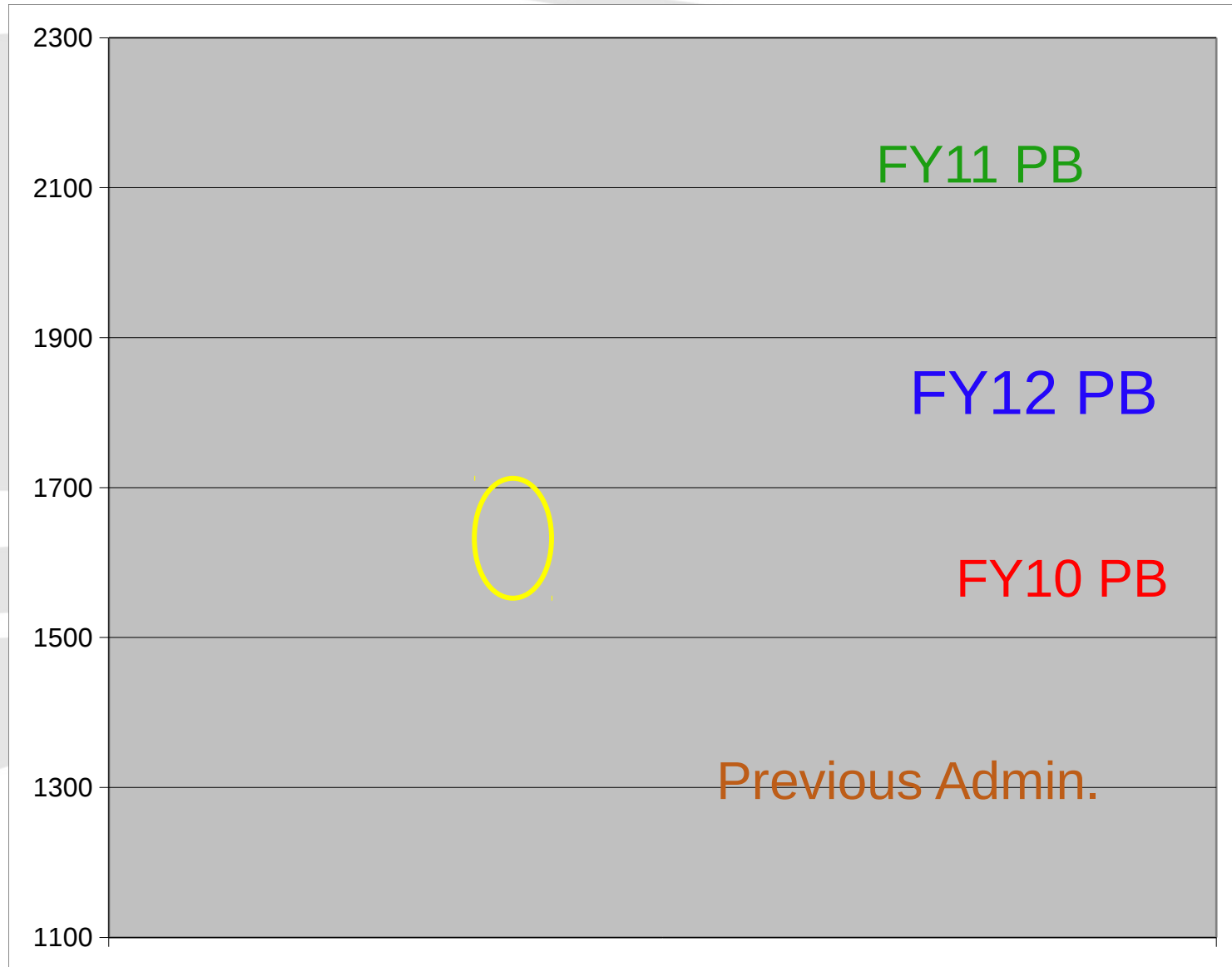
NASA's Earth Science Division Bureaucratic Overview for OVWST

9 May 2011



- ESD budget and activity status (on-orbit missions, launches, Venture-class)
- Scatterometry and NASA
- Glory launch vehicle failure – plans and NASA's launch vehicle challenges

BUDGET OUTLOOK (incl. FY11 Appropriation)

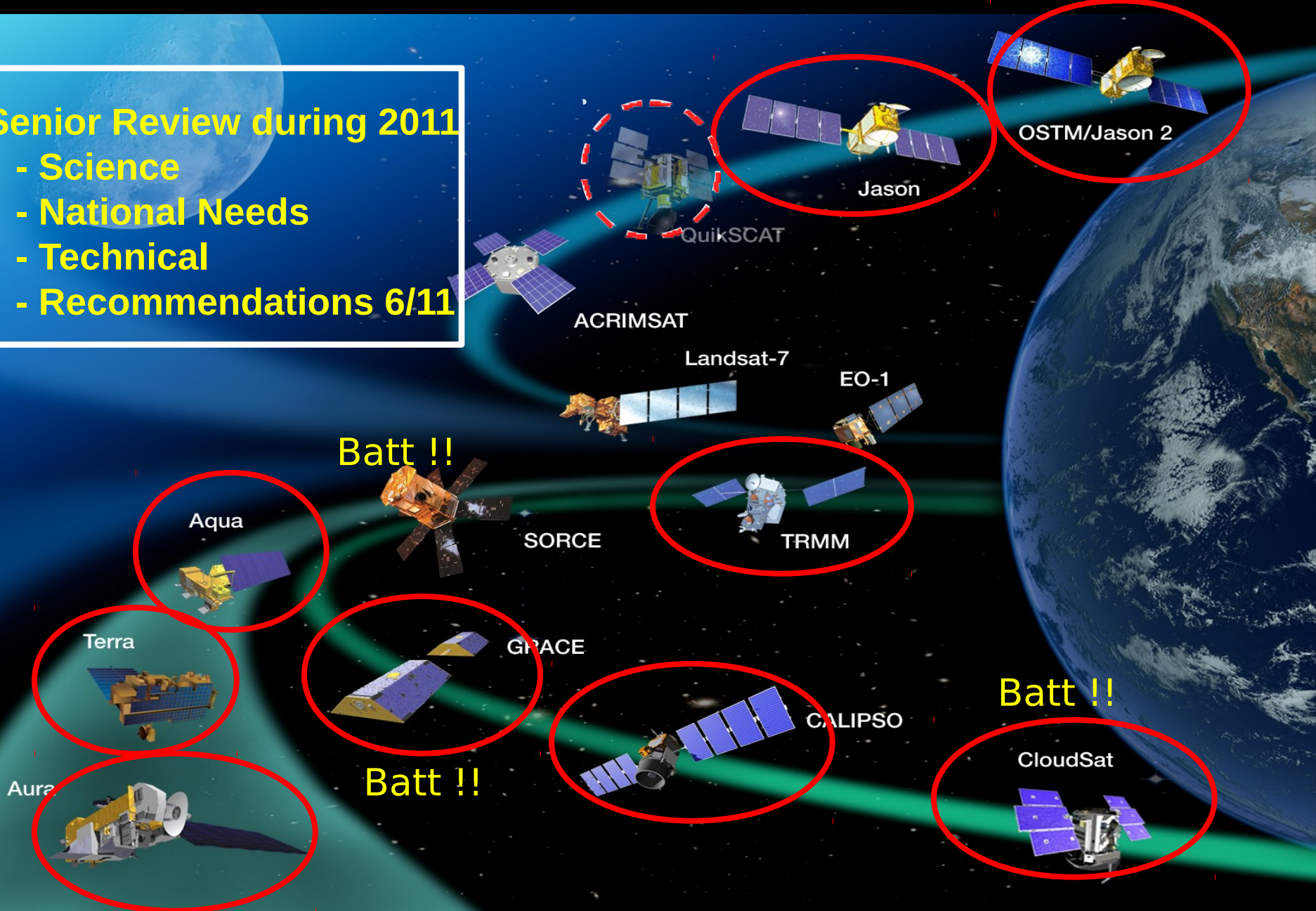


NASA Operating Missions (International Collaboration)

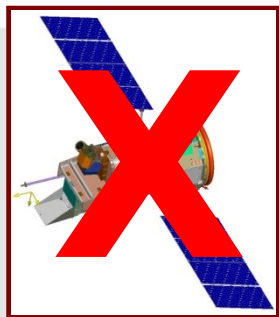


Senior Review during 2011

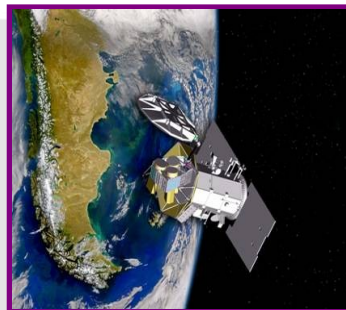
- Science
- National Needs
- Technical
- Recommendations 6/11



Missions in Formulation and Implementation – 5/2011



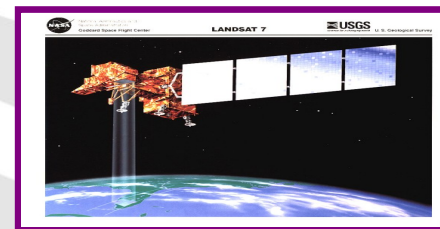
GLORY
3/4/2011
Aerosols, TSI



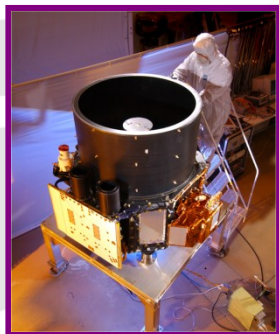
AQUARIUS
6/9/2011
w/CONAE; SSS



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

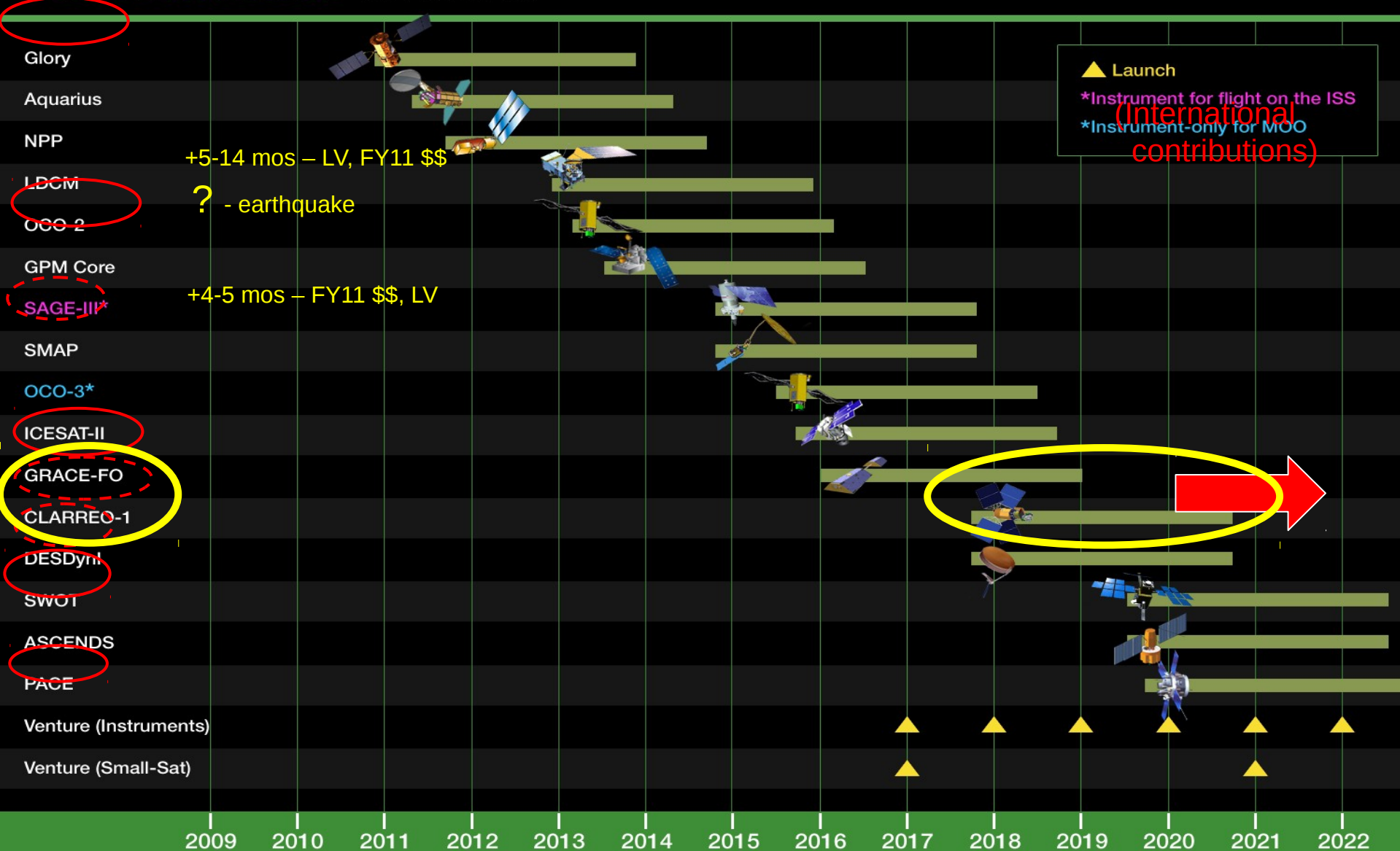


OCO-2
2013 ???
Global CO2

Future Orbital Flight Missions – 2011 – 2022



Future Missions timeline





- **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 release in May, 2011
- EV-Instrument: Spaceborne instruments for flight on MoO (5 years dev.)
 - Solicited in FY11 (selections in FY12) **and annually thereafter**
 - Final AO release in 2nd half of FY11
 - ~\$90M development costs, accommodation costs budgeted separately
 - Common Instrument Interface specs being developed

Summaries

Airborne Microwave Observatory of Subcanopy and Subsurface (AirMOSS) - Univ Mich/JPL

North American ecosystems are critical components of the global exchange of the greenhouse gas carbon dioxide and other gases within the atmosphere. To better understand the size of this exchange on a continental scale, this investigation addresses the uncertainties in existing estimates by measuring soil moisture in the root zone of representative regions of major North American ecosystems. Investigators will use NASA's Gulfstream-III aircraft to fly synthetic aperture radar that can penetrate vegetation and soil to depths of several feet.

Airborne Tropical Tropopause Experiment (ATTREX) - ARC

Water vapor in the stratosphere has a large impact on Earth's climate, the ozone layer and how much solar energy the Earth retains. To improve our understanding of the processes that control the flow of atmospheric gases into this region, investigators will launch four airborne campaigns with NASA's Global Hawk remotely piloted aerial systems. The flights will study chemical and physical processes at different times of year from bases in California, Guam, Hawaii and Australia.

Carbon in Arctic Reservoirs Vulnerability Experiment (CARVE) - JPL

This investigation will collect an integrated set of data that will provide unprecedented experimental insights into Arctic carbon cycling, especially the release of the important greenhouse gases such as carbon dioxide and methane. Instruments will be flown on a Twin Otter aircraft to produce the first simultaneous measurements of surface characteristics that control carbon emissions and key atmospheric gases.

Deriving Information on Surface Conditions from Column and VERTically Resolved Observations Relevant to Air Quality (DISCOVER-AQ) - LaRC

The overarching objective of the DISCOVER-AQ investigation is to improve the interpretation of satellite observations to diagnose near-surface conditions relating to air quality. NASA's B-200 and P-3B research aircraft will fly together to sample a column of the atmosphere over instrumented ground stations.

Hurricane and Severe Storm Sentinel (HS3) – GSFC/ARC

The prediction of the intensity of hurricanes is not as reliable as predictions of the location of hurricane landfall, in large part because of our poor understanding of the processes involved in intensity change. This investigation focuses on studying hurricanes in the Atlantic Ocean basin using two NASA Global Hawks flying high above the storms for up to 30 hours. The Hawks will deploy from NASA's Wallops Flight Facility in Virginia during the 2012-14 Atlantic hurricane seasons.

The Ocean Vector Winds Science Team and NASA's strong commitment to fund analyses of scatterometer data will continue

- QuikSCAT backscatter measurements ongoing
 - ASCAT and OSCAT measurements are valuable
 - Lindstrom/Hacker are actively managing “uncosted” funding as part of a Division-wide push to reduce the chance of a rescission
- NOAA/NESDIS has informed NASA/ESD of NOAA's inability to fund a follow-on scatterometer for the foreseeable future
- Discussions on a NASA scatterometer have started with OSTP and OMB (flight on GCOM-W2, or ISS, or free-flyer)
 - Decadal Survey recommendation (for NOAA), NASA direction from Administration to consider continuity are both favorable
 - NOAA recognizes that NASA will continue to be sensitive to NOAA desires
 - Study funding for JPL and design team will continue from NASA
 - Launch NET 2017; this process may take some time

- **Glory mission was lost - LV failure (fairing non-sep) on 4 March**
- Total Irradiance Monitor (TIM) and Aerosol Polarimetry Sensor (APS) + Cloud Cameras
- Refurbished Vegetation Canopy Lidar satellite bus
- Taurus-XL failure has similar manifestations to OCO loss (24 Feb 2009)
- **Way forward: Glory**
- Carbon-copy Glory recovery mission will **not** be developed – VCL bus obsolete
- **Way forward: TIM**
- SORCE, ACRIMSAT missions continuing through at least 2016
- TSIS instrument development passed KDP-C in 1/2011 (reimbursable, NOAA-funding to NASA SMD/JASD)
- Instrument delivery planned late CY2012; no s/c or LV yet identified
- **Way forward: APS**
- Science viability study – 90-days (due late June)
 - Utility of flight of APS-capability sensor in 3-5 years
 - Possible NRC (or ESS) review
- Implementation study for APS replacement mission – 120 days (late July)
 - Cost, schedule, instrument approach, satellite approach, LV
- No recovery mission without top-line ESD budget augmentation
 - Same programmatic approach as for OCO-2

ESD Near-term Upcoming Launches



- **Aquarius** **6/2011** **Delta-II**
- **NPP** **10/2011** **Delta-II**
- **LDCM** **12/2012** **Atlas-V (NLS-1 contract)**
- **OCO-2** **2/2013 !!** **Taurus-XL !! (contract)**
- **GPM Core** **7/2013** **H-IIA (JAXA)**
- **[Jason-3 / NOAA 2014 ??] ?? (Taurus-XL was possible, LSTO in process)**
- **SMAP** **3/2015** **?? (LSTO in process)**
- **SAGE-III** **2015** **SOMD – ATV, HTV to ISS**
- **ICESAT-2** **2016** **Atlas-V rideshare ??**
- **GRACE-FO** **2016** **Int'l Partnership**
- **[JPSS-1 / NOAA 2016/17 ??] ??**

OCO-3 (avail. 2015) is instrument for MoO, possibly ISS

BACKUP



Airborne Microwave Observatory of Subcanopy and Subsurface (AirMOSS) Moghaddam – U Mich

University of Michigan – Ann Arbor, Oregon State University, Massachusetts Institute of Technology, Harvard University, Purdue University, USDA Agricultural Research Service, USDA – Forest Service, NASA Goddard Space Flight Center, NASA Jet Propulsion Laboratory

Airborne Tropical Tropopause Experiment (ATTREX) Jensen – NASA Ames Research Center

University of Colorado – Boulder, National Center for Atmospheric Research, University of Maryland - Baltimore, Harvard University, University of Miami – Key Biscayne, NOAA Oceanic & Atmospheric Research, Northwest Research Associates Inc., Park Stratton Engineering Co. Inc., University of California - Los Angeles, University of Heidelberg, NASA Ames Research Center, NASA Goddard Space Flight Center, NASA Jet Propulsion Laboratory, NASA Langley Research Center,

Carbon in Arctic Reservoirs Vulnerability Experiment (CARVE) Miller – Jet Propulsion Laboratory

NOAA Oceanic & Atmospheric Research, University of Colorado – Boulder, San Diego State University, University Of California – Irvine, California Institute of Technology, Harvard University, University of California – Berkeley, University Of California - Santa Barbara, Commissariat A L'Energie Atomique, NASA Jet Propulsion Laboratory

Deriving Information on Surface Conditions from COLUMN and VERTically Resolved Observations Relevant to Air Quality (DISCOVER-AQ) Crawford – Langley Research Center

University Of Maryland – Baltimore, University of California - Berkeley, National Center for Atmospheric Research, Pennsylvania State University, Leopold Franzens Universitaet Innsbruck, Howard University, NASA Ames Research Center, NASA Goddard Space Flight Center, NASA Langley Research Center

Hurricane and Severe Storm Sentinel (HS3) Braun – Goddard Space Flight Center

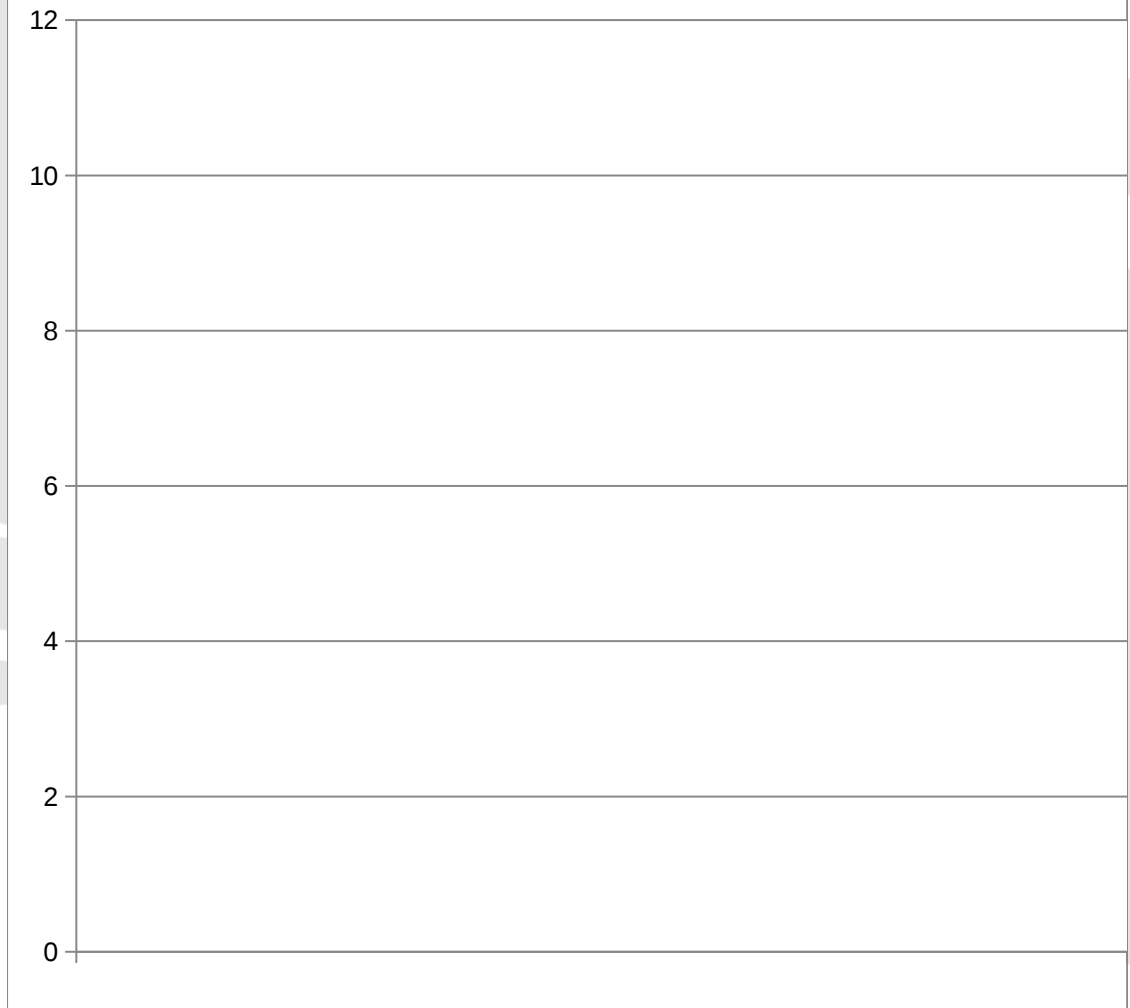
NOAA National Environmental Satellite Data And Information Service, University Of Maryland - Baltimore, Naval Postgraduate School, University Of Wisconsin – Madison, State University Of New York - Albany, University Of Utah - Salt Lake City, Northrop Grumman Inc., Naval Research Laboratory, NOAA National Center for Environmental Prediction, NASA Dryden Flight Research Center, NASA Goddard Space Flight Center, NASA Jet Propulsion Laboratory, NASA Marshall Space Flight Center

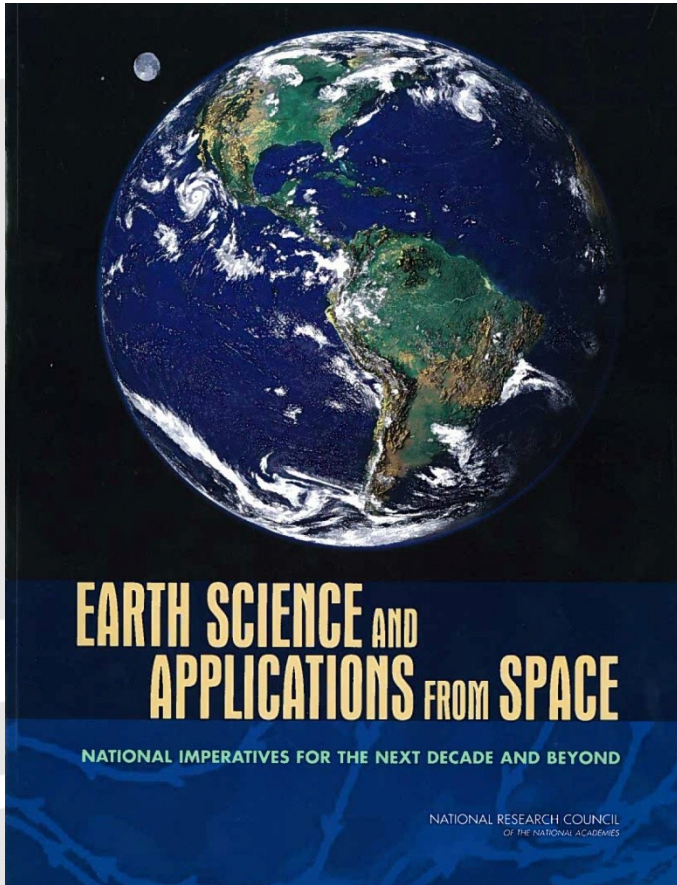
Airborne Science Program DS Missions



INTEX-B	2006
CC-VEX	2006
Arctic Sea Ice	2006
INTEX-B	2006
MILAGRO	2006
WRAP	2006-2009
Arctic Ice 2007	2007
CLASIC	2007
TC-4	2007
ARCTAS	2008
Calipso Caribbean	2008
CASIE	2009
ASCENDS test flights	2009
Racoro	2009
GloPac	2010
ABACATE	2010
GLEAM	2010
ASCENDS test flights	2010
AID for ASCENDS	2010
SIMPL	2010
MACPEX	2011
CAR	2011
4Star	2012
DC-3	2012
HEX	2012
SEAC4RS	2012
AVIRIS CONUS	2006-2012
UAVSAR	2006-2012
CLPX II	2007-2008
SMAPVEX	2008, 2010-11
OIB	2009-2015
Earth Venture 1	2011-2014

ASP Flight Hours supporting DS Missions





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])

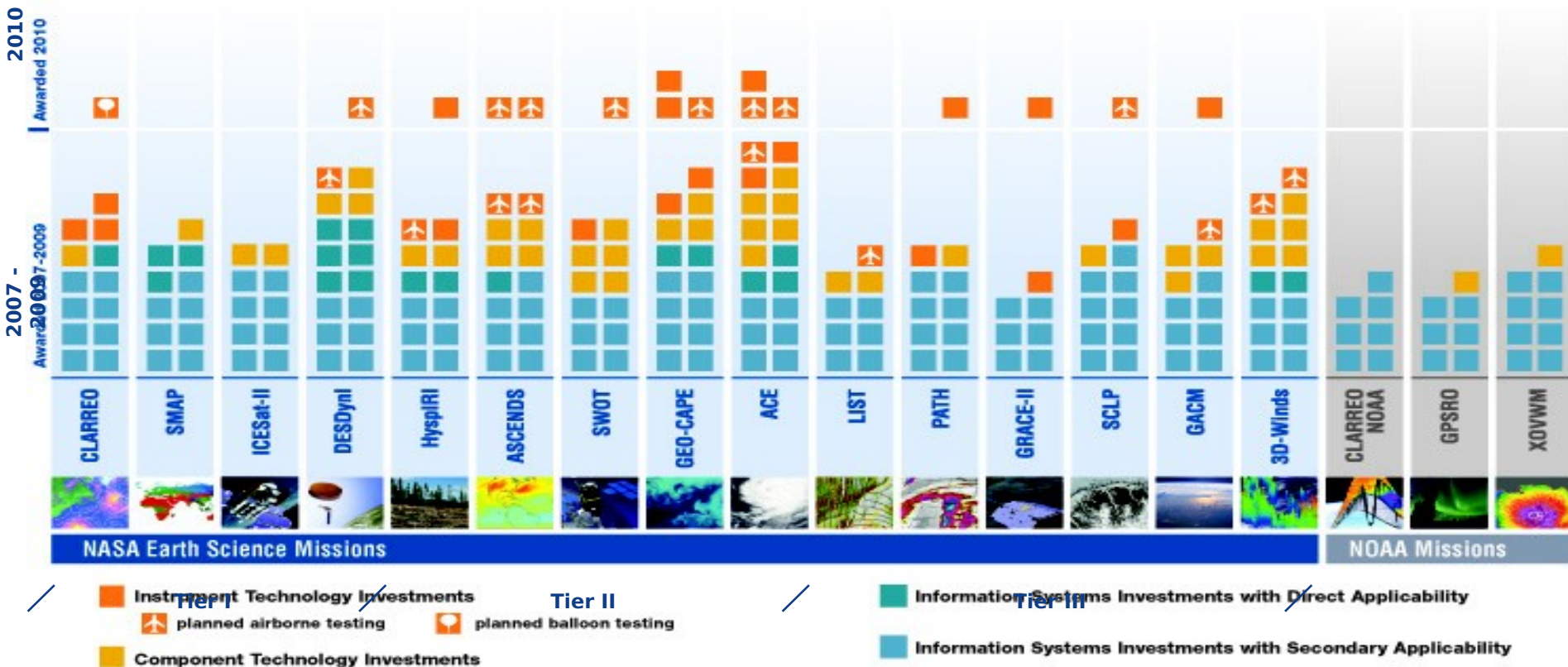
http://science.nasa.gov/media/medialibrary/2010/07/01/Climate_Architecture_Final.pdf

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

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**.





ESD/SMD/NASA is a space organization without 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)

There is little evidence that the agency is confronting this challenge in a realistic and urgent way

- **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**

- Total Irradiance Monitor (TIM) and Aerosol Polarimetry Sensor (APS) + Cloud Cameras
- Refurbished Vegetation Canopy Lidar satellite bus
- Taurus-XL failure has similar manifestations to OCO loss (24 Feb 2009)
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} No VAFB Polar Orbit
Launch Pad