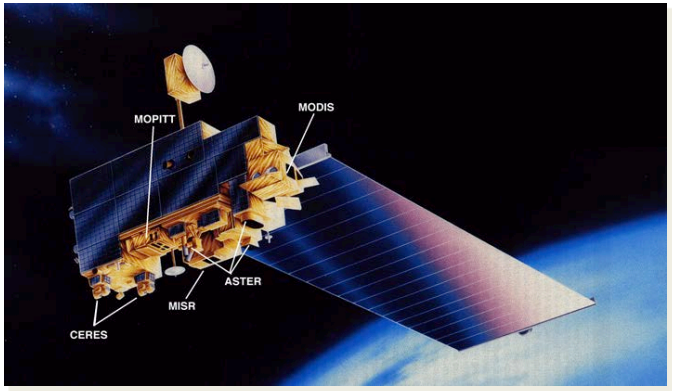
CSPP/IMAPP Users' Group Meeting
May 21-23, 2013



EOS Terra and Aqua Status

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Why Fly Constellations?

Science is key!

Constellations form single "virtual" platforms which enable near-coincident observations, thus providing enhanced science

Terra Status Summary

- Spacecraft Status - GREEN
- Instrument Status – GREEN
  - ASTER (VNIR and TIR), CERES, MISR, MODIS, and MOPITT: Producing Great Science
- Data Capture/L0 Processing Status – GREEN
  - SSR Data Capture to 04/30/2013: 99.91%
- Data Latency – Excellent
- Ground Systems – GREEN
  - Responding to new security requirements and upgrades to obsolete hardware or COTS systems, as required

Terra Status (details)

- **Spacecraft Bus – Nominal Operations (<u>Very Good Health</u>):**

  All Components remain on primary hardware with te following exception:

  - Direct Access Modulator (X-Band) primary side failed in 2008. No impact to Nominal Operations
  - Battery Cell Failure (1 of 108). No impact to Nominal Operations
  - Battery Heater Control failure (affects 4 of 18 Heater Groups). No impact to Nominal Operations
  - Solar Array Panel Failure (1 of 24) in Sept 2000. No impact to Nominal Operations
  - Solid State Recorder Print Wire Assembly Anomalies (9 of 59 are offline)
    - Operationally able to manage by reducing ASTER data captured and increasing playback opportunities
    - Recycle of Memory Unit likely to recover all PWAs currently offline; not warranted at this time

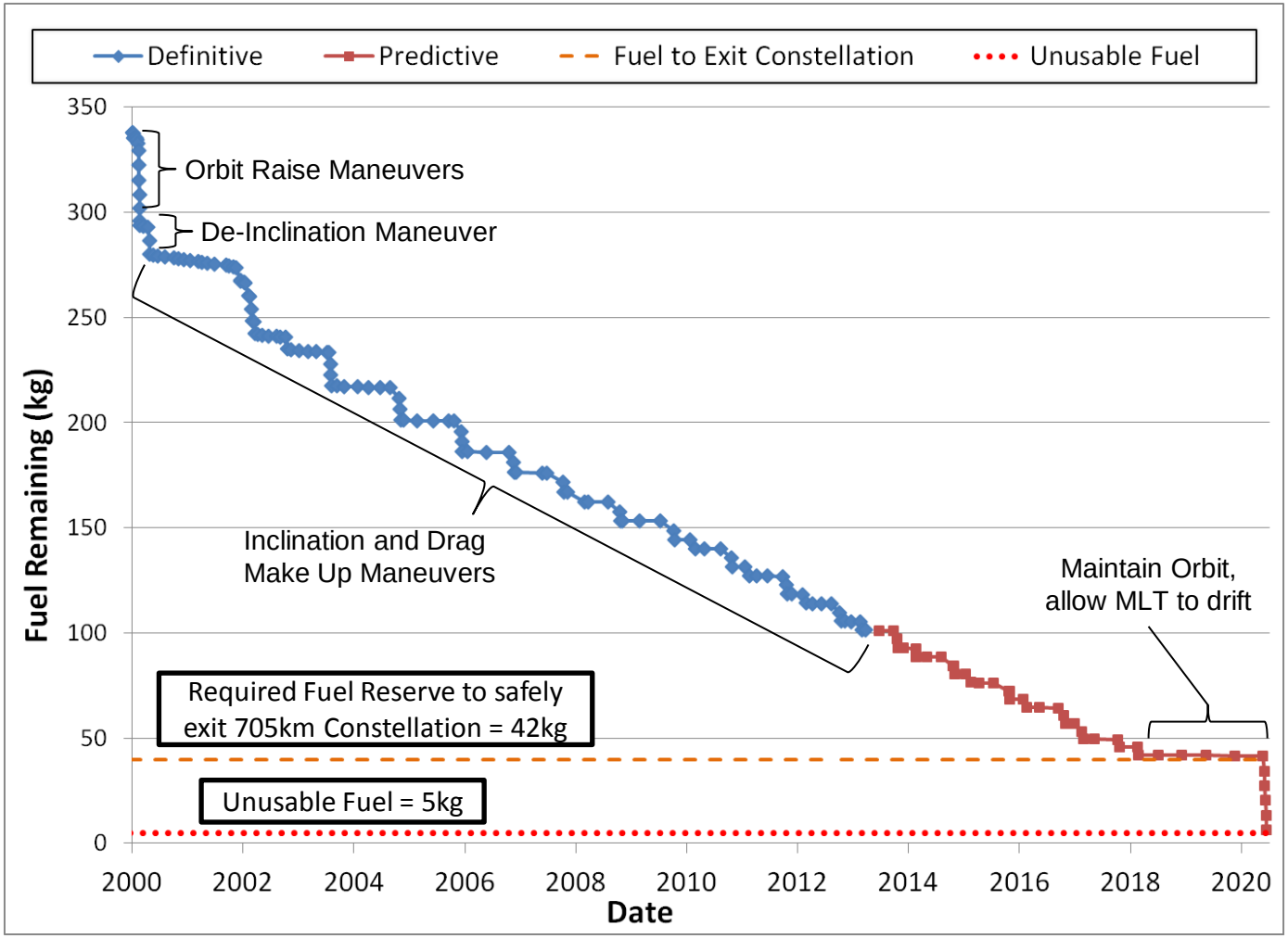
- **MODIS – Nominal Operations (<u>Very Good Health – some loss of redundancy</u>)**
  - All voltages, currents, and temperatures as expected
  - Power Supply Failure (June 2001). Switched to redundant. Formatter Degradation (Sept 2002). Switched to redundant.
  - Solar Diffuser Screen Door Failed to Close (May 6th, 2003); configured to remain open indefinitely in July 2003
  - Current configuration allows for Nominal Science

Terra Status (additional details)

- **MISR – Nominal Operations – (<u>Excellent Health</u>)**
  - All voltages, currents, and temperatures as expected
- **ASTER – Nominal Operations (TIR and VNIR – <u>Excellent Health</u>, SWIR – <u>Failed</u>)**
  - All voltages, currents, and temperatures as expected.
  - SWIR – Compressor unable to maintain detector temperature after April 2008. No Science Data
  - VNIR – Nominal Operation
  - TIR – Nominal Operation
- **CERES-FORE and AFT (FM-1 & FM-2) – Nominal Operations (<u>Excellent Health</u>)**
  - All voltages, currents, and temperatures as expected.
  - Cross-Track and Biaxial Modes fully functioning.
  - All channels remain operational.
- **MOPITT – Nominal Operations. (<u>Good Health – loss of redundancy; some blockage)</u>**
  - All voltages, currents, and temperatures as expected
  - Displacer-B Failure (May 2001). Operating Compressor B at reduced speed to minimize spacecraft disturbance
  - Chopper motor failure resulting in ~3% blockage (August 2001)

Terra Fuel Usage: Actual & Predicted

(Updated April 2013)



Based on predicted fuel usage, Terra can continue to perform propulsive maneuvers (to maintain the orbit) to support the science requirements into 2020. Mean Local Time (MLT) will drift from 10:30am to 10:15am.

Terra Spacecraft Anomalies

- **Current Status of Battery**
  - **Power Module Battery (PBAT)** has performed superbly throughout mission (No Issues)
  - **Hex Bay Battery (BBAT)** has experienced one (1) cell failure out of 54 cells and damage to the BBAT heater control
  - Likely caused by a Micro-Meteor or Orbital Debris (MMOD) 10/09
  - The heater groups that are working are keeping the cell temperatures above -13 ºC
  - Since the anomaly BBAT has been reconfigured to maintain a temperature margin and reduce the stress on the batteries

Note: There is significant redundancy that only in the event of a catastrophic failure (multiple anomalies) would we lose an entire battery. More likely scenario would be a continuing decrease in capacity (loss of cells) over a period of time.

Terra Battery Life Capability is projected through May 2020

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Terra Spacecraft Anomalies

Direct Access System Modulator (DASM) Side 1 failed (February 25th, 2012)

- Not required for prime mission objectives
- Attempt to power cycle on 6/4/08 was unsuccessful. On 6/13/08, Switched to DASM-2 cross-strapped with Up-Converter-1 and Solid State Power Amplifier-1.
- Continuing with Direct Broadcast normal operations.

SFE Anomaly (typically 1-2 per year)

- The Science Formatting Equipment (SFE) is turned off when part of its electronics "hangs" or stops operating properly
- Probably due to an Single Event Upset (SEU)
- All science recording stops when the SFE is off
- Has occurred 28 times since launch
- So far, the fix has been to turn the SFE back on

Thank you to the DB users who have provided feedback on data quality after recovery.

Terra MODIS Instrument Status

- **Terra MODIS continues to operate nominally**
- **All voltages, currents, and temperatures are as expected**

Note: MODIS has full redundancy with the following exceptions:

- **MODIS Power Supply 2 Failure** (June 15th, 2001)
  - Power supply shutdown caused by a thermal runaway condition in one of the two Down Regulator FETs
  - Suspected high energy particle as root cause
  - Switch to power supply 1

- **MODIS Formatter A Timing Errors** (Sept. 10th, 2002)
  - Formatter A exhibited several problems resulting in processing errors
  - Likely cause was an incorrectly terminated clock signal
  - On Sept. 10th, 2002 MODIS science data was affected.
  - **Switched to B side on Sept. 17th, 2002, with no further issues**

- **MODIS Solar Diffuser Screen Door Failed to Close** (May 6th, 2003)
  - Thermal stress is the most likely cause
  - Solar Diffuser Door was configured to remain open indefinitely in July 2003
  - Some calibration activities still possible

EOS Aqua Status

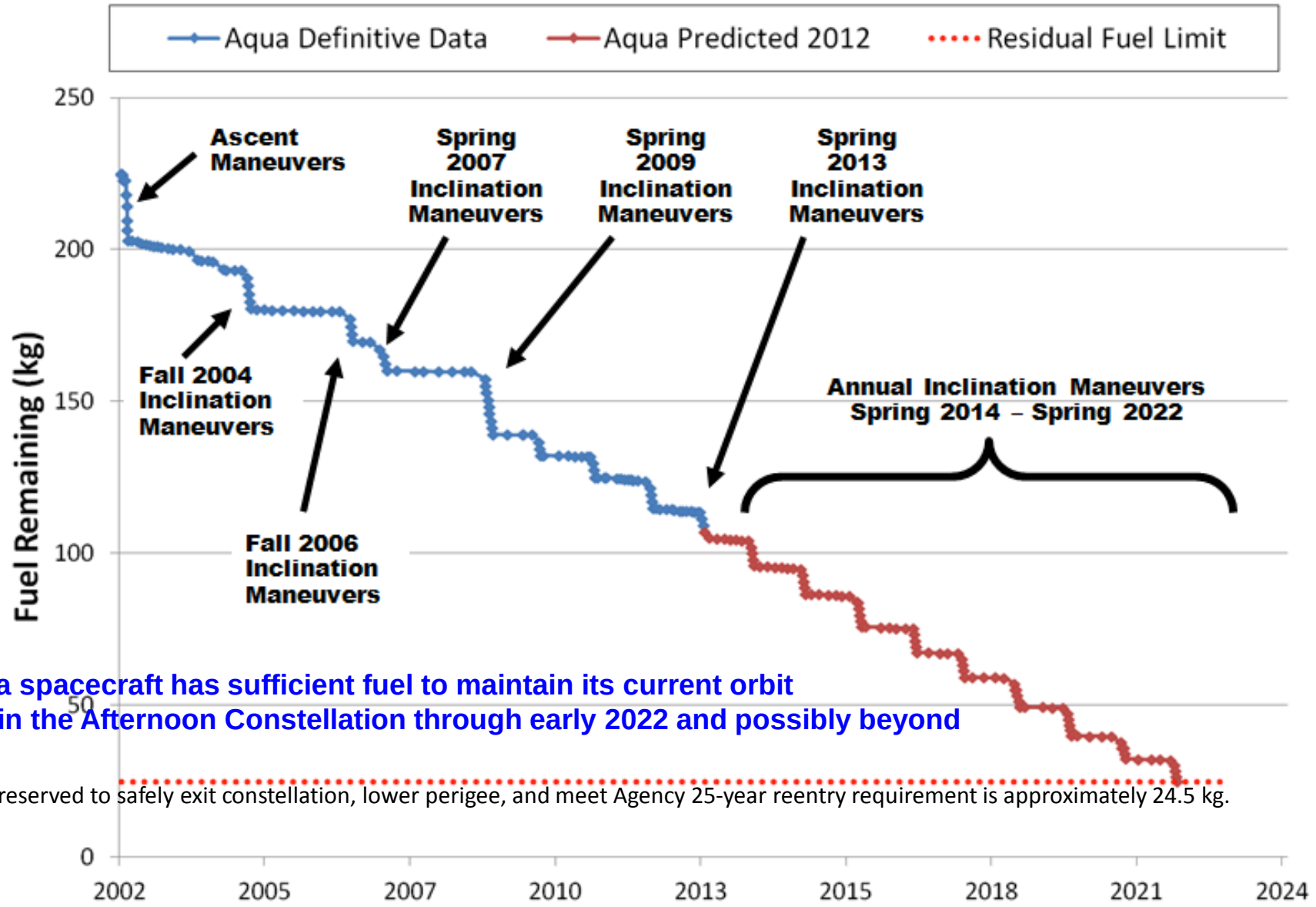
Aqua Status Summary

- Spacecraft Status - GREEN
- Instrument Status - GREEN
  - AIRS, AMSU, CERES & MODIS: Producing Great Science
  - HSB: Survival Mode since 2/5/2003
  - AMSR-E: Antenna Anomaly & Spin Down to 0 RPM on 10/04/2011
    - Spin-Up to ~2 RPM on 12/04/2012; operating at 2 rpm (no science data
    - 2 rpm data will be usedfor calibration with AMSR2 on GCOM-W1
- Data Capture/L0 Processing Status – GREEN
  - SSR Data Capture to 04/30/2013: 99.97352898%
- Data Latency – Excellent
- Ground Systems – GREEN
  - Responding to new security requirements and upgrades to obsolete hardware or COTS systems, as required

Aqua Summary Details

- **Spacecraft Bus – Nominal Operations (Excellent Health)**
  - **All Components remain on primary hardware.**
- **MODIS – Nominal Operations (Excellent Health)**
  - **All voltages, currents, and temperatures as expected.**
  - **All Components remain on primary hardware.**
- **AIRS – Nominal Operations (<5% of Channels degraded) – (Excellent Health)**
  - **All voltages, currents, and temperatures as expected.**
  - **~200 of 2378 channels are degraded due to radiation, however they are still useful.**
- **AMSU-A – Nominal Operations for 12 of 15 Channels (Good Health)**
  - **All voltages, currents, and temperatures as expected.**
  - **3 of 15 channels have been removed from Level 2 processing.**
- **CERES-AFT (FM-3) – Nominal Operations (Excellent Health)**
  - **All voltages, currents, and temperatures as expected.**
  - **Cross-Track and Biaxial Modes fully functioning.**
  - **All channels remain operational.**
- **CERES-FORE (FM-4) – Nominal Operations (Good Health)**
  - **All voltages, currents, and temperatures as expected.**
  - **Cross-Track is Nominal. Biaxial Mode is Nominal when used.**
  - **The Shortwave channel failed on March 30, 2005; the other two channels remain operational.**
- **AMSR-E – Operating at 2 rpm; No Science – Calibration Only (Poor Health)**
  - **All voltages, currents, and temperatures as expected.**
  - **Operating at reduced rotation rate for calibration purposes only.**
- **HSB – Non-operational since February 2003 anomaly**

Aqua Fuel Usage: Actual & Predicted
(Updated April 2013)



Aqua spacecraft has sufficient fuel to maintain its current orbit within the Afternoon Constellation through early 2022 and possibly beyond

Fuel reserved to safely exit constellation, lower perigee, and meet Agency 25-year reentry requirement is approximately 24.5 kg.

Aqua MODIS Instrument Status

- All voltages, currents, and temperatures are as expected.
- There are no disturbing trends in any engineering parameter.
- Aqua MODIS continues to operate on prime equipment.
  - Full redundancy exists except for 10 W Lamps used for calibration
    - Lamps #2 and #3 failed prematurely
    - Able to use remaining lamps for calibration purpose

Life Limiting Items	Designed	5/4/2002	4/12/2013
SRCA 10 W Lamp #1 (Hours of use)	500	200.2	306.6
SRCA 10 W Lamp #2 [1] (Hours of use)	500	175.7	188.0
SRCA 10 W Lamp #3 [1] (Hours of use)	500	178.5	205.7
SRCA 10 W Lamp #4 (Hours of use)	500	57.7	114.8
SRCA 1 W Lamp #1 (Hours of use)	5000	499.5	528.2
SRCA 1 W Lamp #2 (Hours of use)	5000	269.8	274.9
Solar Diffuser Door Movements (Open or Close)	3022	1630	**3072** [2]
Nadir Aperture Door Movements (Open or Close)	1316	1046	1053
Space View Door Movements (Open or Close)	1316	624	632

1. Spectroradiometric Calibration Assembly (SRCA) 10 W Lamp #2 and Lamp #3 are no longer functional. Modified mode of operation to reduce the risk that Lamp #1 and #4 will fail prematurely.
2. Solar Diffuser Door Movements have exceeded design. Use of Door has been reduced from once per week to once every 6 weeks. Use of Screen was reduced from once per week to once every three weeks. Modified calibration is possible if door fails.

Aqua MODIS is in Excellent Health

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Aqua MODIS is in Excellent Health

Maneuvers

- **Drag Makeup Maneuvers (DMU) --** maintain nominal spacecraft altitude of 705 km

- **Inclination Adjust Maneuvers --** maintain nominal spacecraft mean local time (descending node) of 10:30 AM.

  -- Current predictions indicate need to perform 3 Inclination Burns per year (1 in Spring, 2 in Fall) to maintain 10:30am +/- 1 min goal.

- **Calibration Maneuvers**

  -- MODIS Roll Maneuvers are performed approximately once/month to calibrate MODIS sensors on lunar illumination

  -- MODIS Lunar Calibration is performed ~4 days after full moon.

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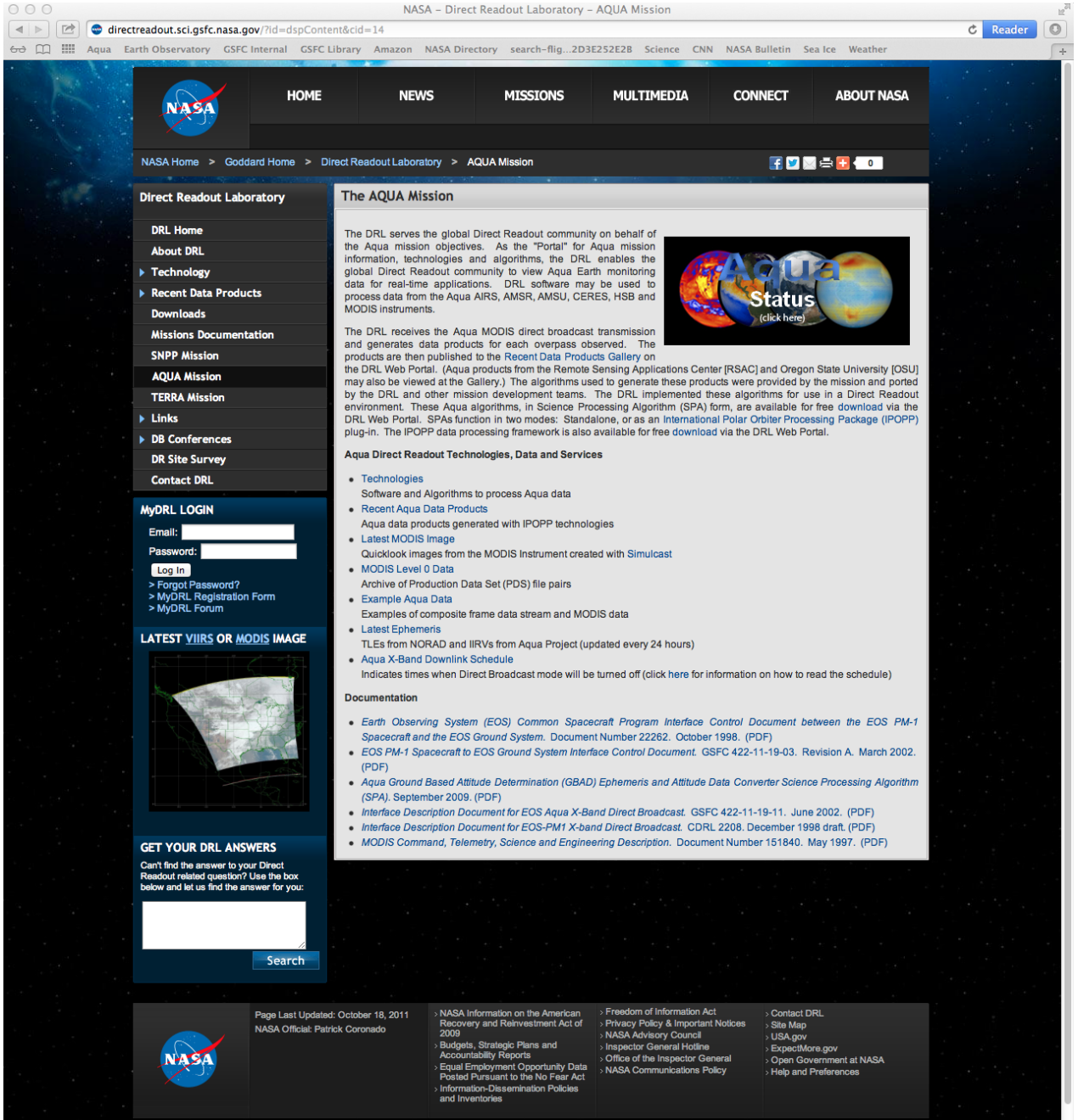
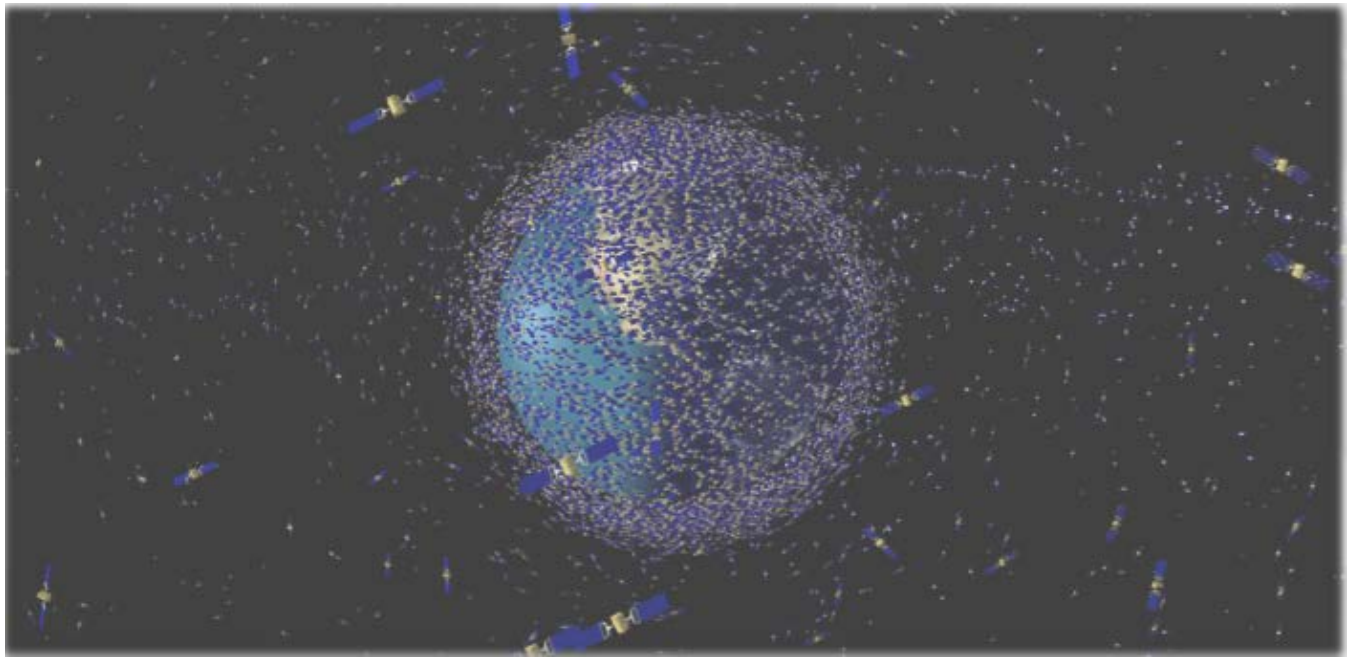
DRL/DB Website

Screen shot from the DRL/DB website after the addition of a link to the aqua.nasa.gov website for the Aqua status



Orbital Debris Monitoring

- Orbital debris is a cause for concern by all space missions.
- Increased number of high interest events for the past 6 months
- NASA has an agreement with the US Air Force to provide notification of predicted conjunctions between Constellation satellites and other maneuverable and non-maneuverable space objects (e.g., orbital debris).
- This is implemented by the *Robotic Systems Protection Program* at Goddard.



SUMMARY

- **Both EOS Terra and Aqua are operating nominally**
- **Both satellites have exceeded their design life (6 years)**
  - **Terra is on its 14th year**
  - **Aqua is on its 11th year**
- **Both satellites are producing excellent science**
- **Realtime operational application is valued**
- **Terra is projected to operate through ~2020**
- **Aqua is projected to operate through 2022 and even beyond**