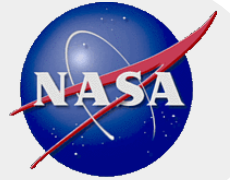


USA Space Debris Environment, Operations, and Policy Updates

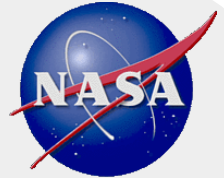
**Presentation to the 48th Session of the
Scientific and Technical Subcommittee
Committee on the Peaceful Uses of Outer Space
United Nations**

7-18 February 2011



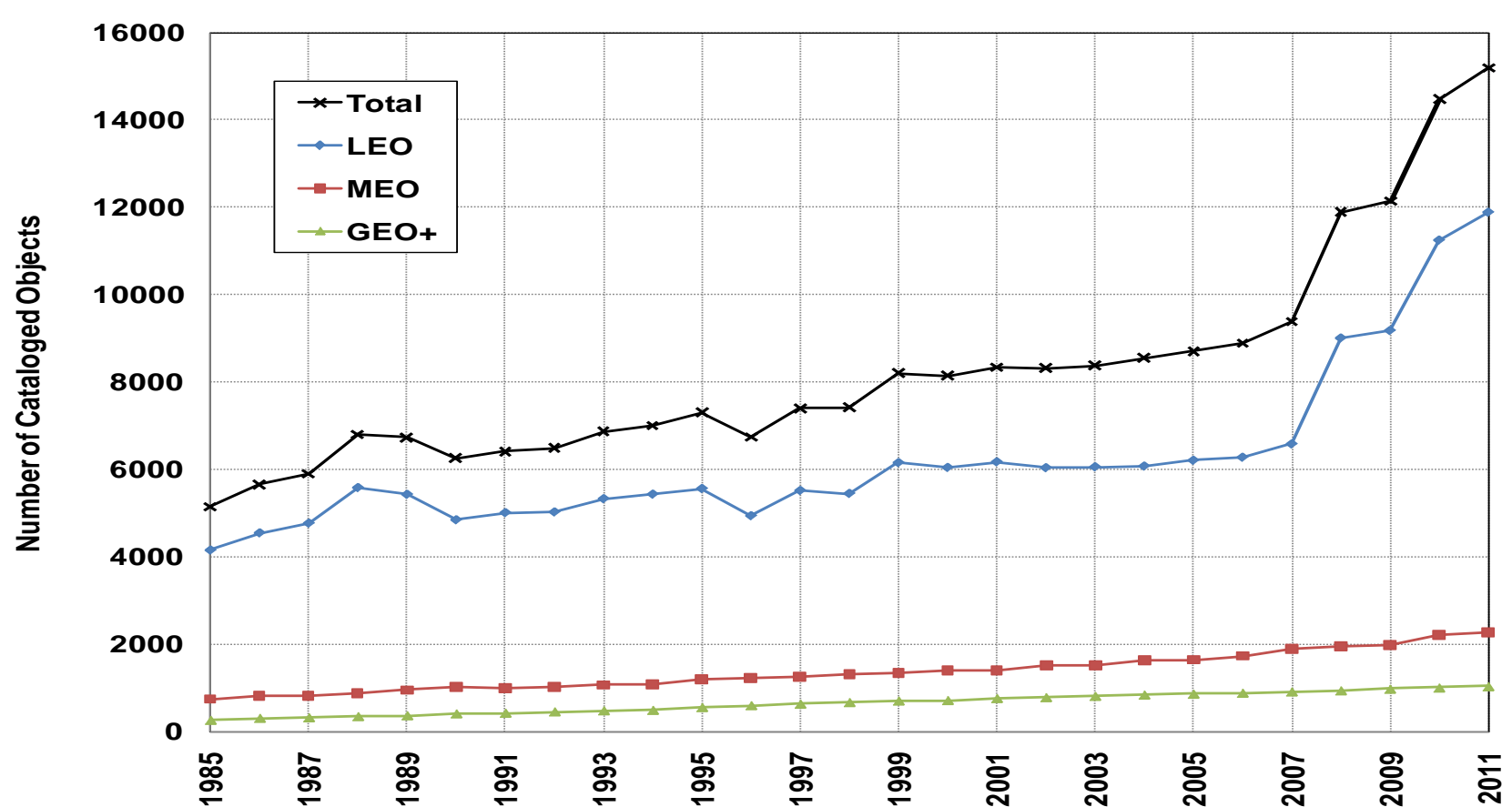
Presentation Outline

- **Earth Satellite Population**
- **Satellite Reentries in 2010**
- **Collision Avoidance Maneuvers in 2010**
- **Satellite Fragmentations**
- **Disposal of U.S. Spacecraft in 2010**
- **New U.S. National Space Policy**

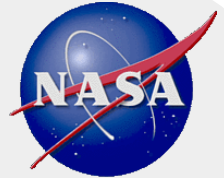


Growth of the Cataloged Satellite Population

- The number of cataloged objects in Earth orbit by orbit type, as assessed by the U.S. Space Surveillance System.

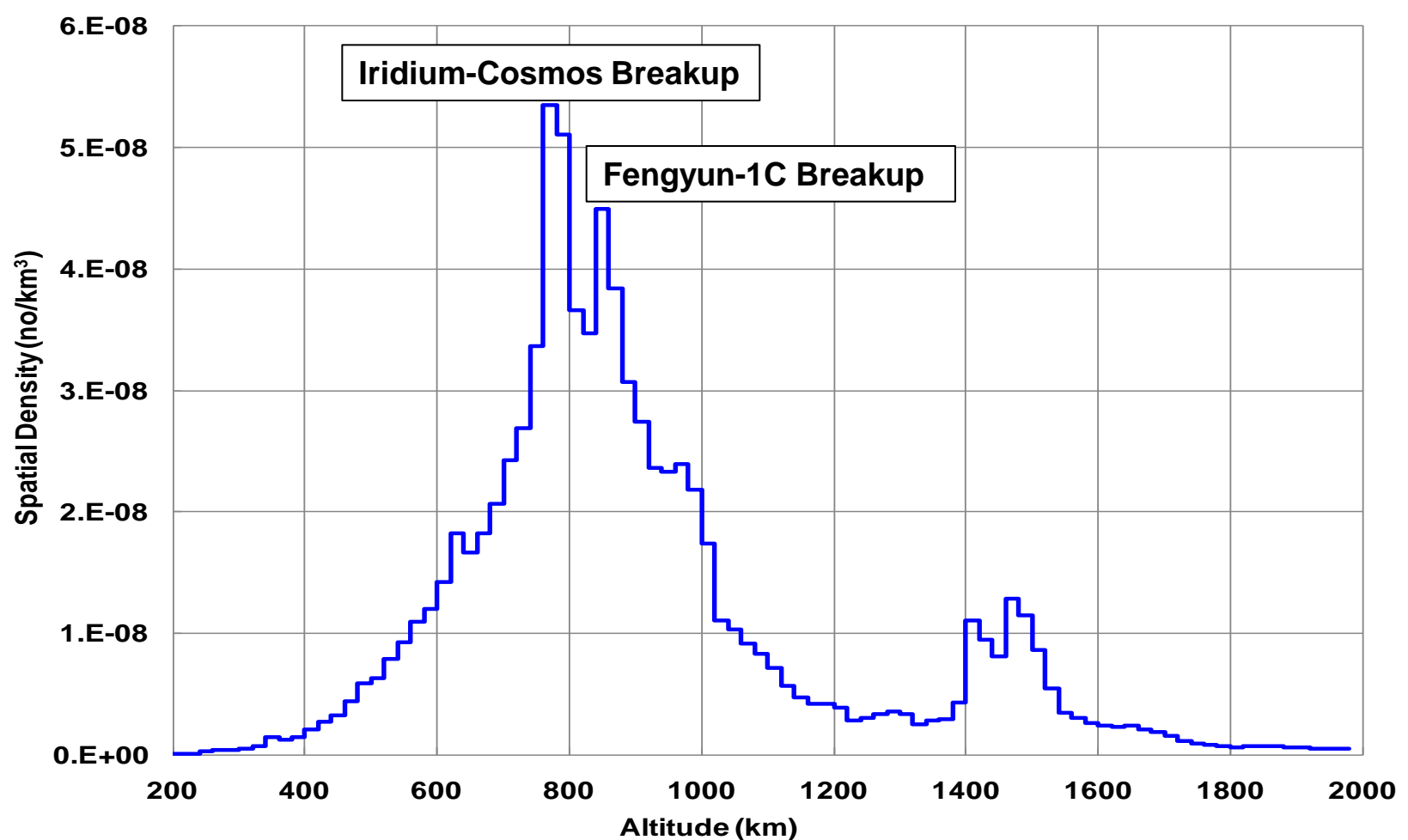


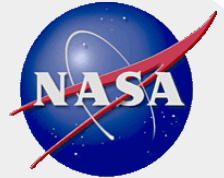
Graphic compiled from publicly available orbital data at www.space-track.org



Satellite Distribution in Low Earth Orbit

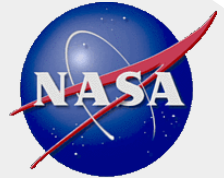
- The highest levels of cataloged object concentration in LEO remain near the sites of the Fengyun-1C, Cosmos 2251, and Iridium 33 breakups.





Satellite Reentries in 2010

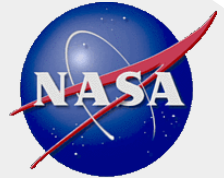
- **The U.S. Space Surveillance Network recorded 382 reentries during 2010.**
 - 369 uncontrolled reentries
 - 13 controlled reentries
- **The uncontrolled reentries accounted for a total mass of ~60 metric tons from 22 payloads and 27 rocket bodies.**
- **No accounts of personal injury or significant property damage were reported.**
- **The overall rate of uncontrolled reentries is expected to increase during the next several years due to the approach of solar maximum; however, the vast majority of these reentries will represent small debris which do not pose hazards to people and property on Earth.**



Controlling the Reentry of Upper Stages

- **NASA conducted two new missions to GEO during 2010 and utilized high perigee geosynchronous transfer orbits (1) to avoid leaving stages in low Earth orbit and (2) to prevent the stages from posing reentry risks to people and property on Earth.**
- **Both stages were left in disposal orbits above LEO and below the GEO operational regime.**

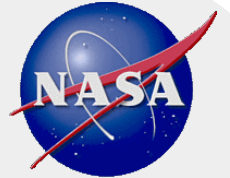
Spacecraft	Orbital Stage	Stage Perigee	Stage Apogee
Solar Dynamics Observatory	Atlas 5 second stage	2370 km	33515 km
GOES 15	Delta 4 second stage	6595 km	35165 km



Orbital Debris Collision Avoidance

- **Since 2007 NASA has required frequent satellite conjunction assessments for all of its maneuverable spacecraft in LEO or GEO to avoid accidental collisions with resident space objects.**
- **During 2010 NASA robotic satellites conducted 7 collision avoidance maneuvers.**

Spacecraft	Maneuver Date	Object Avoided
Terra	22 January	Iridium 33 debris
Cloudsat	17/18 August	Unidentified debris
Landsat 5	24 August	Cosmos 2251 debris
Cloudsat	11 October	Zenit rocket body debris
Cloudsat	13 October	Cosmos 2251 debris
Aura	22 November	Cosmos 2251 debris
Landsat 7	21 December	USA 26 debris

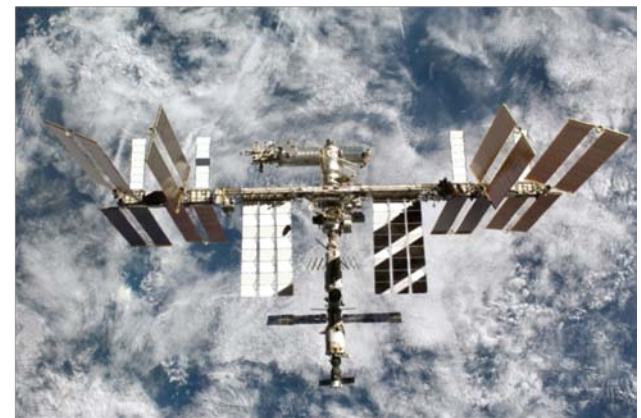


ISS Collision Avoidance Maneuver

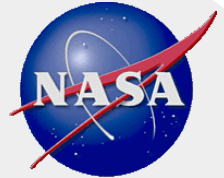
- **After a 14-year mission, NASA's Upper Atmospheric Research Satellite (UARS) was decommissioned in late 2005 and maneuvered into a lower altitude disposal orbit from which reentry will occur during 2011.**
- **In September 2010, a small fragment unexpectedly separated from UARS.**
- **Although the fragment remained in orbit only six weeks, the object was predicted to pass close by the International Space Station on 26 October, posing a collision threat of greater than 1 in 10,000.**
- **Using the Progress M-07M logistics vehicle, a small collision avoidance maneuver (+0.4 m/s) was conducted a little more than two hours before the predicted time of closest approach.**



UARS being deployed by Space Shuttle Discovery in 1991.



International Space Station



Satellite Fragmentations in 2010

- **Six satellite fragmentations were detected by the U.S. Space Surveillance Network during 2010.**
- **Fortunately, none of the events have been assessed as contributing large numbers of long-lived debris to the near-Earth environment.**
- **The causes of four of the events have yet to be determined.**

Common Name	International Designator	Fragmentation Date	Perigee	Apogee	Cataloged / Assessed Debris	Cause
Yaogan 1	2006-015A	4 February	625 km	630 km	8 / 8	Unknown
Briz-M Tank	2009-042C	21 June	90 km	1490 km	89 / 400 ⁺	Aerodynamic
Briz-M Stage	2008-011B	13 October	645 km	26565 km	9 / 30 ⁺	Propellants
CZ-3C Third Stage	2010-057B	1 November	160 km	35780 km	1 / 50 ⁺	Unknown
NOAA 11	1988-089A	24 November	835 km	850 km	2 / 2	Unknown
H-2A Debris	2007-005E	23 December	430 km	440 km	3 / 6	Unknown

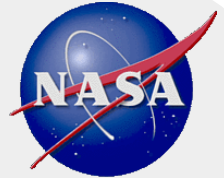


Status of Fengyun-1C, Cosmos 2251, and Iridium 33 Debris

- The intentional destruction of the Fengyun-1C spacecraft in 2007 and the accidental collision of the Cosmos 2251 and the Iridium 33 spacecraft in 2009 remain the worst known debris generation events in Earth orbit.

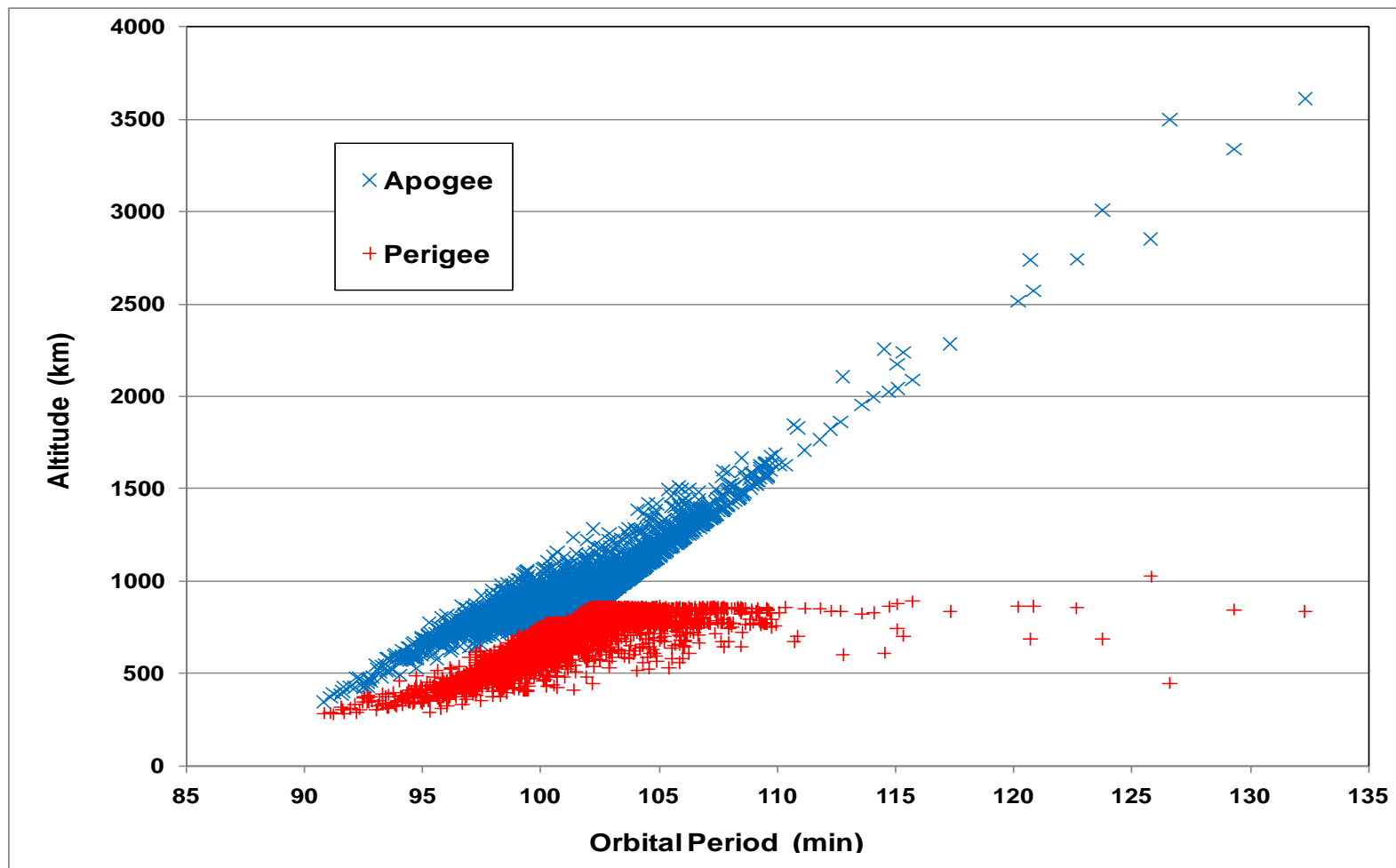
	<u>Cataloged Debris</u>	<u>Cataloged Debris in Orbit 1 Jan 2011</u>
Fengyun-1C	3037	2932 (97%)
Cosmos 2251	1347	1273 (94%)
Iridium 33	528	492 (93%)

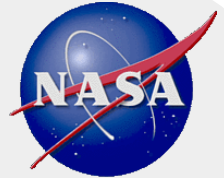
- All together, the two events account for 36% of the total number of cataloged objects residing in or traversing low Earth orbit.
- The rate of reentry of the debris will increase as solar activity increases.



Debris Distribution

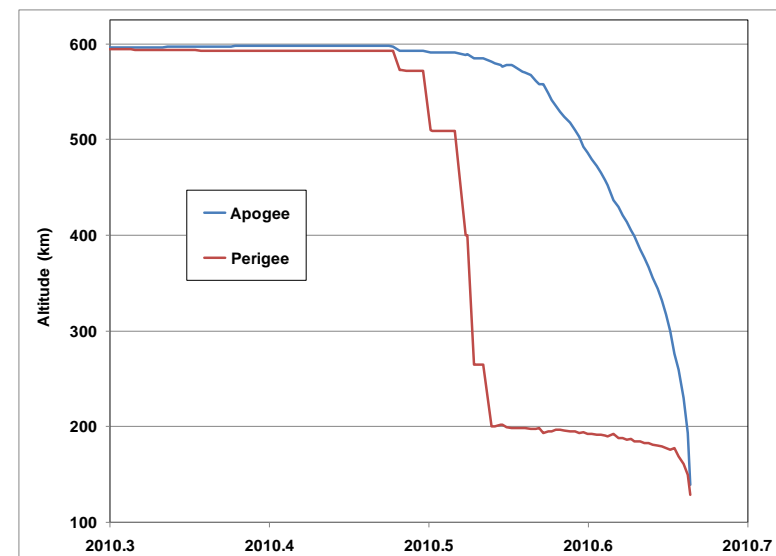
- The debris from Fengyun-1C, Cosmos 2251, and Iridium 33 span the entire region of low Earth orbit with the highest concentrations near 750-900 km.

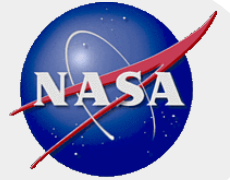




Disposal of ICESAT

- **NASA's Ice, Cloud, and land Elevation Satellite (ICESAT) concluded a highly successful, 7-year environmental monitoring mission in February 2010.**
- **In compliance with U.S. and UN orbital debris mitigation guidelines, during June and July the 900-kg ICESAT was maneuvered 20 times to bring the spacecraft from an operational altitude of approximately 600 km to a disposal orbit of only 200 km by 580 km. ICESAT was then passivated.**
- **Reentry occurred without incident six weeks later on 30 August over the Barents Sea.**



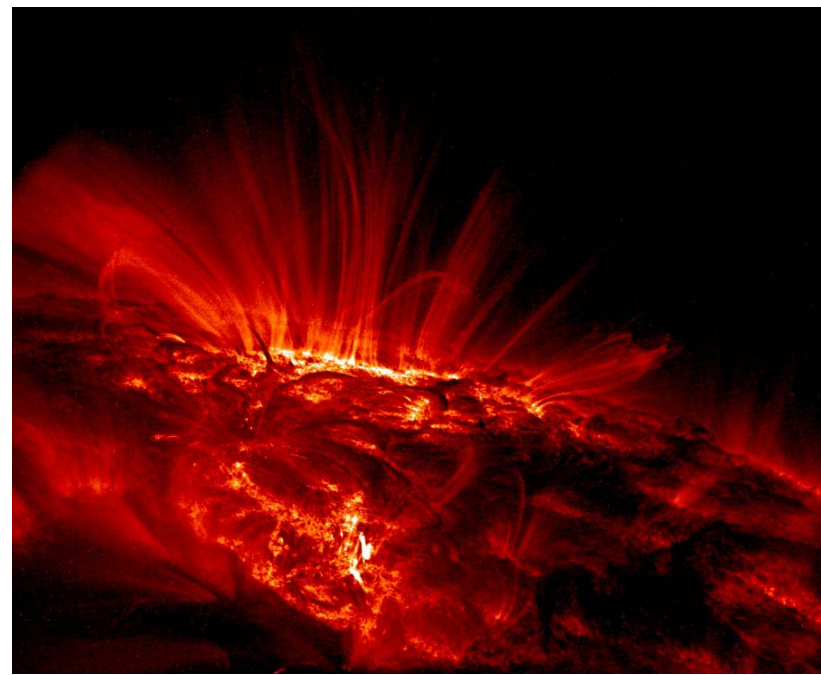


TRACE End of Mission

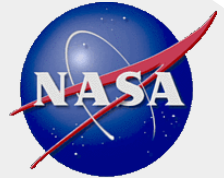
- **NASA's Transition Region and Coronal Explorer (TRACE) spacecraft completed a successful 12-year, solar observation mission in June 2010 and was passivated in September at a mean altitude of 570 km.**
- **The spacecraft is expected to reenter the atmosphere within 13 years of decommissioning, in accordance with U.S. and UN guidelines.**



TRACE spacecraft

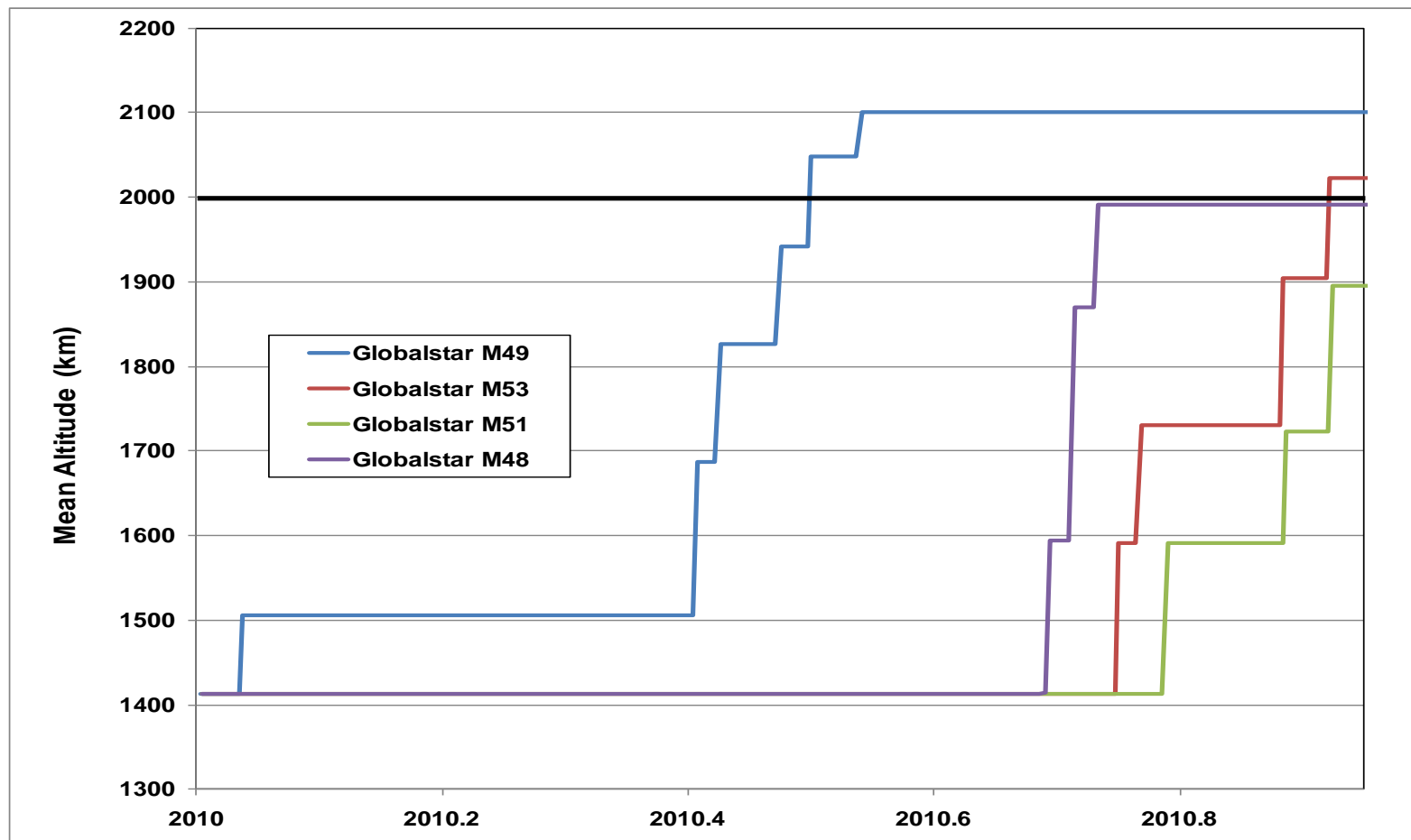


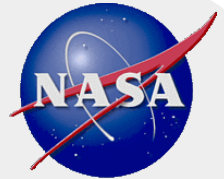
TRACE image of solar eruption



Disposal of Globalstar Satellites in 2010

- **Globalstar communications satellites operate near 1415 km. At mission completion, the objective is to maneuver each satellite to a higher disposal orbit, preferably above LEO, *i.e.*, above 2000 km.**



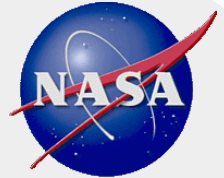


Disposal of TDRS 1

- **NASA's first Tracking and Data Relay Satellite (TDRS) completed more than 26 years of valuable service in October 2009.**
- **During June 2010 the spacecraft conducted 12 separate maneuvers over an 8-day period to reach a disposal orbit with a perigee more than 300 km above GEO, in accordance with U.S. and UN guidelines.**
- **After reaching the disposal orbit, TDRS 1 still possessed more than 120 kg of hydrazine. This propellant was expended during 20 more hours of small thruster burns over a period of 10 days.**
 - To accomplish the depletion burns, the spacecraft was placed in a special spin-stable attitude, which had never before been used by TDRS 1.
- **TDRS 1 completed passivation actions on 27 June in an orbit 345 km by 525 km above GEO.**

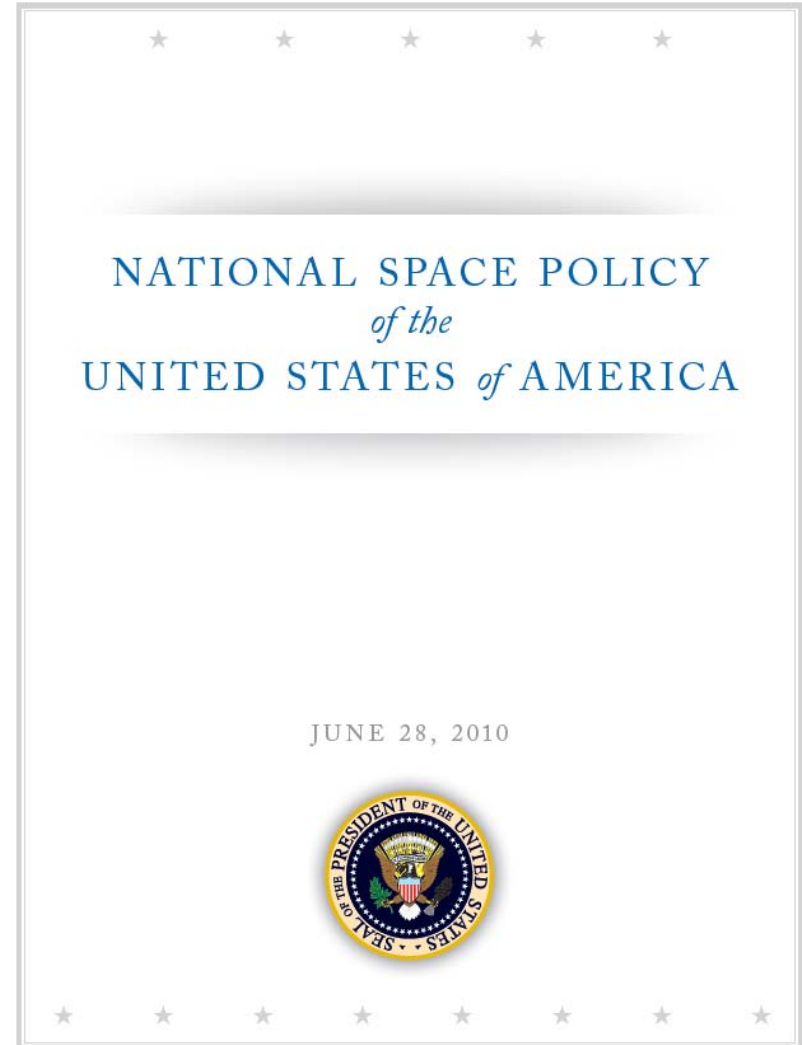


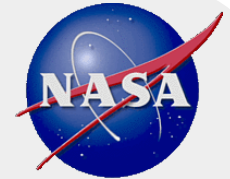
TDRS 1 spacecraft



U.S. National Space Policy and Orbital Debris

- **Orbital debris mitigation has been addressed in all U.S. National Space Policies since 1988.**
- **On 28 June 2010, President Barack Obama issued the latest U.S. National Space Policy.**
- **One of the six principal goals of the new National Space Policy was to strengthen stability in space, including “strengthening measures to mitigate orbital debris”.**
- **A section of the new National Space Policy was devoted to “Preserving the Space Environment and the Responsible Use of Space”.**





U.S. National Space Policy and Orbital Debris

“Preserve the Space Environment. For the purposes of minimizing debris and preserving the space environment for the responsible, peaceful, and safe use of all users, the United States shall:

- Lead the continued development and adoption of international and industry standards and policies to minimize debris, such as the United Nations Space Debris Mitigation Guidelines;
- Develop, maintain, and use space situational awareness (SSA) information from commercial, civil, and national security sources to detect, identify, and attribute actions in space that are contrary to responsible use and the long-term sustainability of the space environment;
- Continue to follow the United States Government Orbital Debris Mitigation Standard Practices, consistent with mission requirements and cost effectiveness, in the procurement and operation of spacecraft, launch services, and the conduct of tests and experiments in space;
- Pursue research and development of technologies and techniques, through the Administrator of the National Aeronautics and Space Administration (NASA) and the Secretary of Defense, to mitigate and remove on-orbit debris, reduce hazards, and increase understanding of the current and future debris environment; and
- Require the head of the sponsoring department or agency to approve exceptions to the United States Government Orbital Debris Mitigation Standard Practices and notify the Secretary of State.”