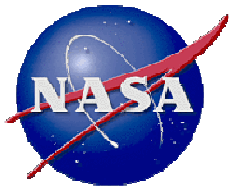
National Aeronautics and Space Administration

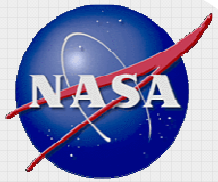


USA Space Debris Environment, Operations, and Modeling Updates

Presentation to the 51st Session of the
Scientific and Technical Subcommittee
Committee on the Peaceful Uses of Outer Space
United Nations

10-21 February 2014

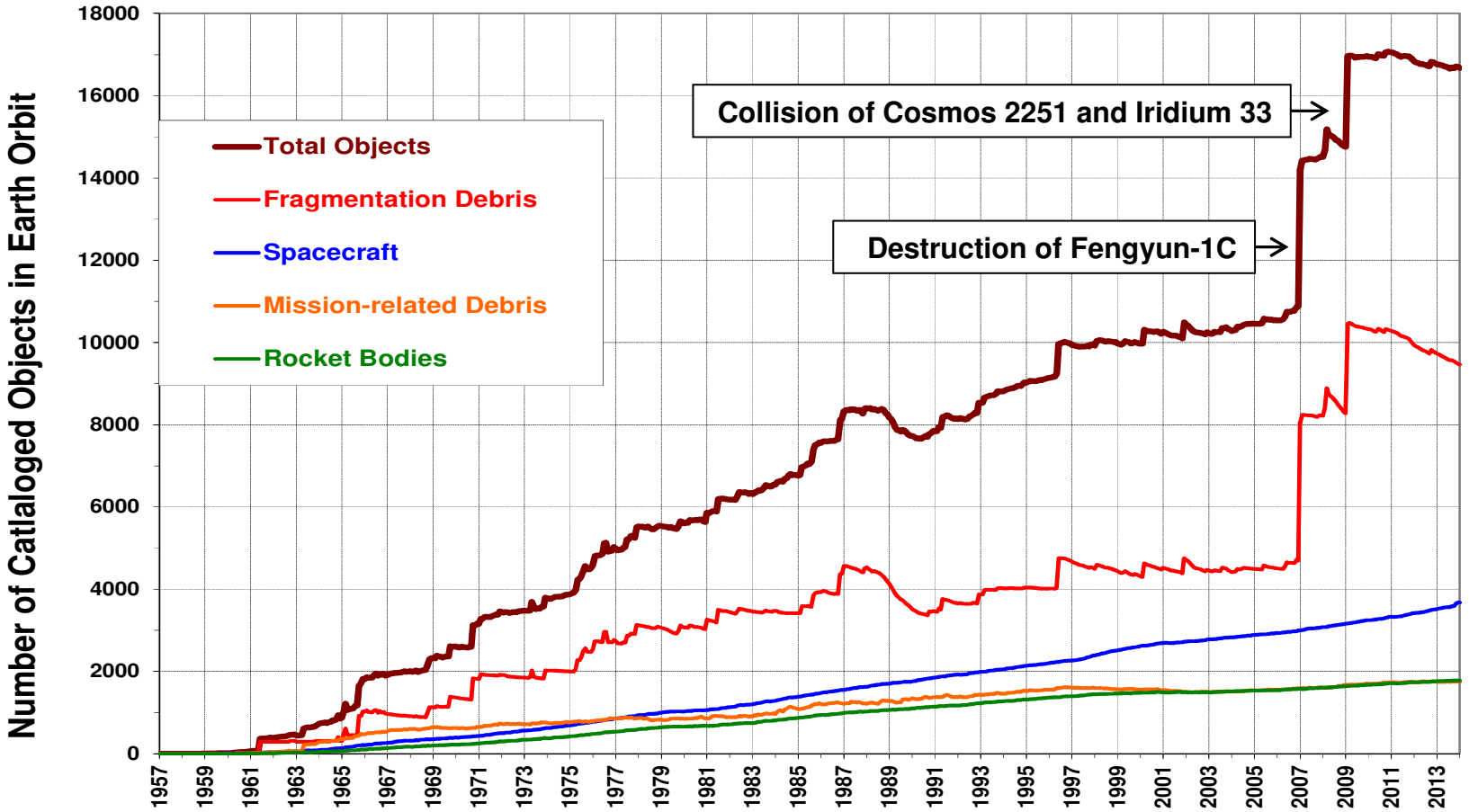
Presentation Outline



- **Earth Satellite Population**
- **Space Missions in 2013**
- **Spacecraft Disposals**
- **Satellite Fragmentations**
- **Collision Avoidance Maneuvers**
- **Satellite Reentries**
- **Update to NASA Orbital Debris Engineering Model**

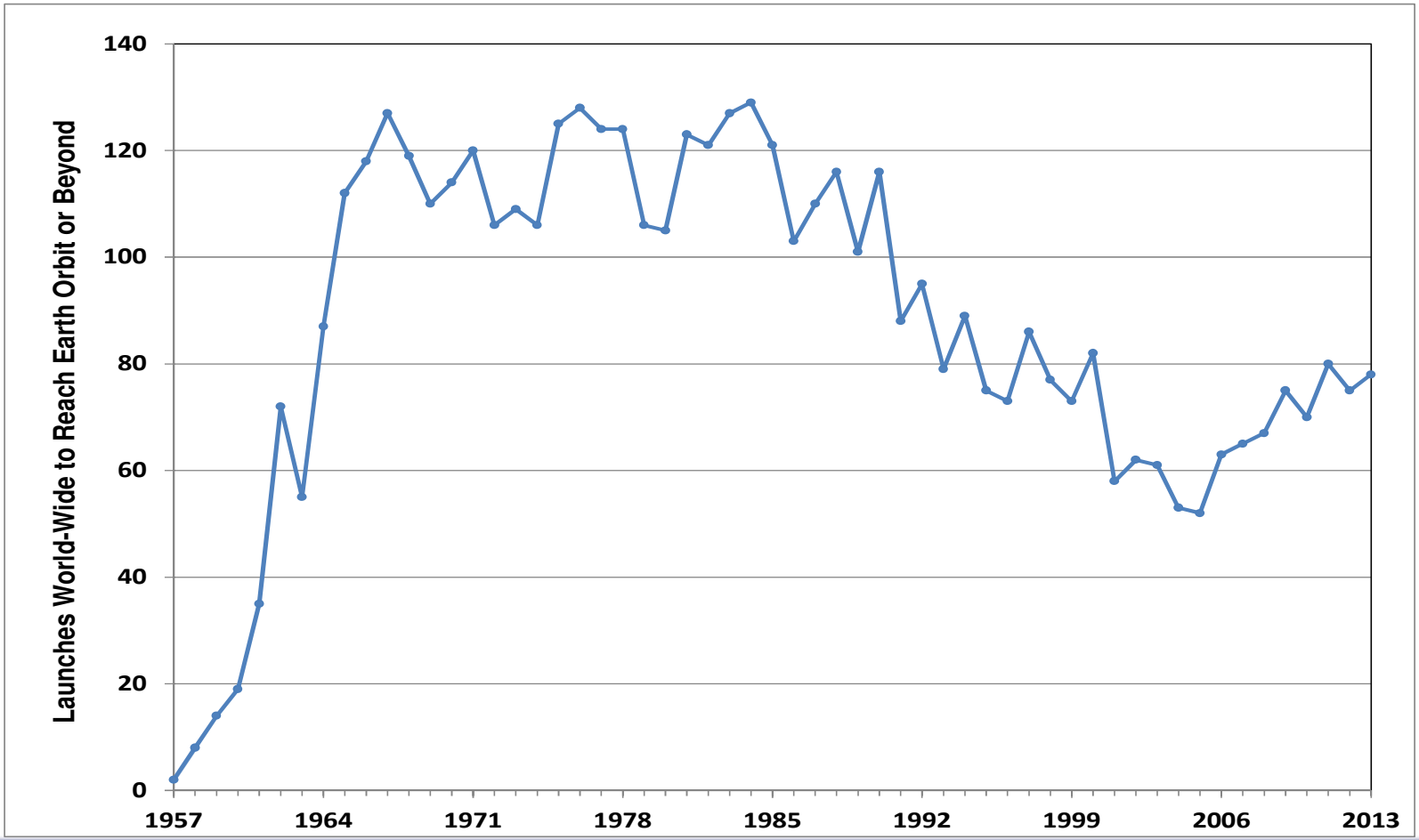
Evolution of the Cataloged Satellite Population

- **According to the U.S. Satellite Catalog, the number of 10 cm and greater objects in Earth orbit remained essentially unchanged during 2013.**

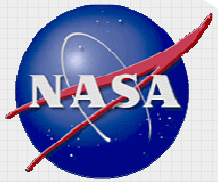


World-Wide Space Activity in 2013

- **A total of 78 space launches placed nearly 200 spacecraft into Earth orbits during 2013.**
  - An increasing number of small spacecraft (mass less than 10 kg) are being launched.



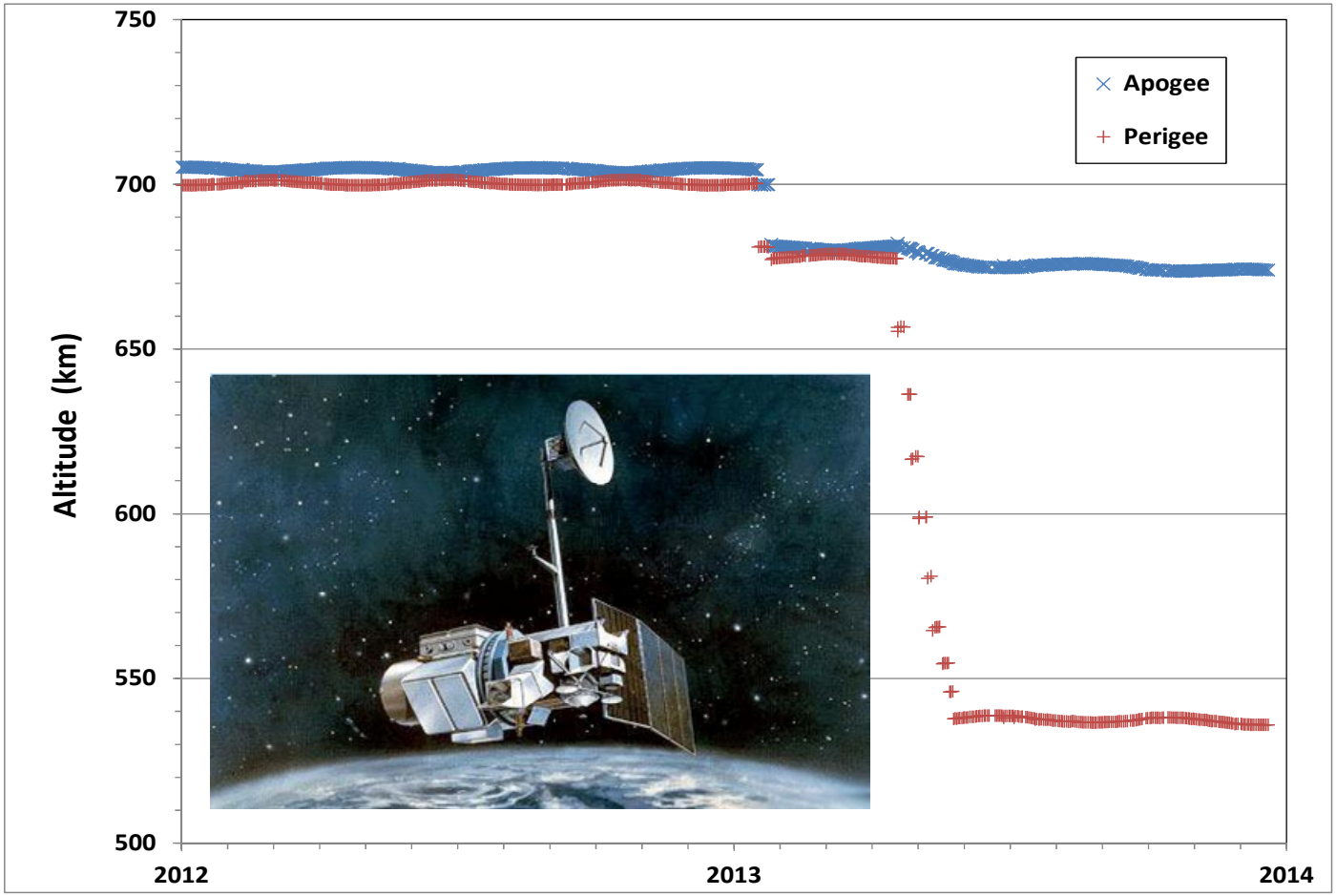
NASA Space Missions in 2013



- **Eight primary NASA or NASA-sponsored spacecraft were launched in 2013, along with 9 orbital stages.**
  - All spacecraft and rocket bodies with perigees within LEO, except one, have reentered or will reenter within 25 years.
  - One small (185 kg) upper stage will likely remain in LEO for ~30 years.
- **Under NASA's Educational Launch of Nanosatellites (ELaNa) program, 16 small satellites (each less than 5 kg) were carried into orbit as secondary payloads.**
  - All were inserted into low Earth orbits and will reenter within 25 years.

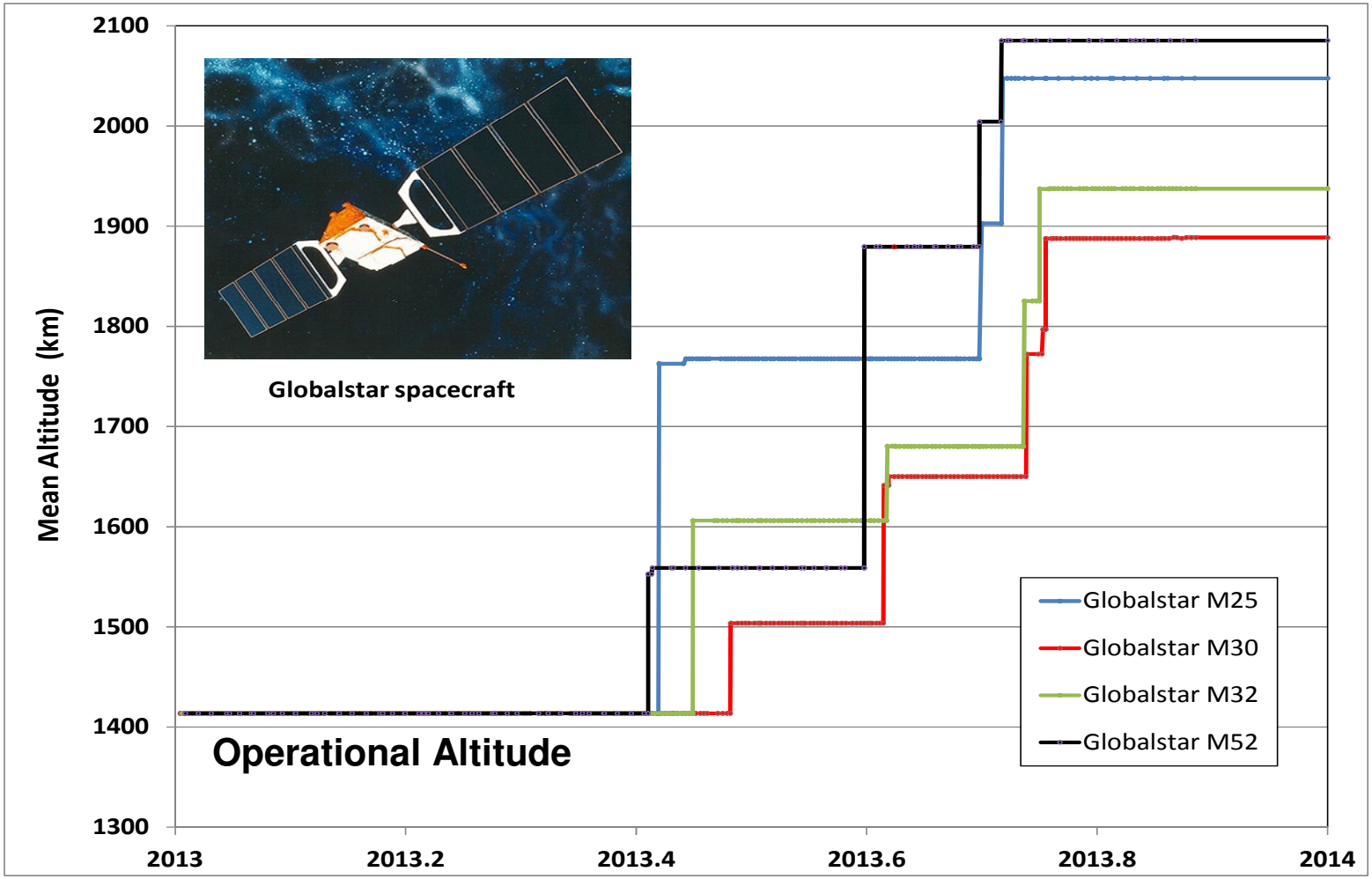
Disposal of Landsat 5 Spacecraft

- **After a highly successful 29-year mission, the Landsat 5 spacecraft (1984-021A) was moved to a disposal orbit with a remaining lifetime of less than 25 years.**



Disposal of Globalstar Spacecraft

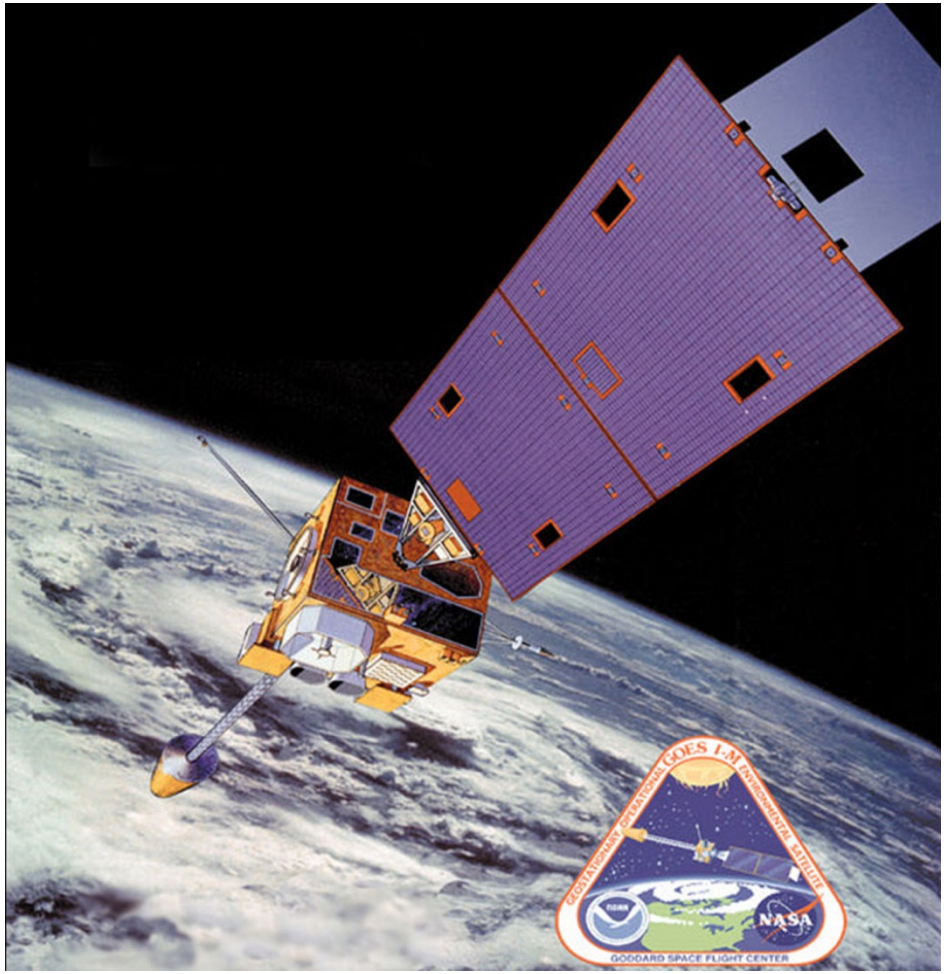
- **During 2013 four Globalstar commercial communications spacecraft reached end of mission and were maneuvered into high altitude disposal orbits.**



Disposal of GOES 12 Spacecraft

- **The GOES 12 meteorological spacecraft (2001-031A) was launched into a geosynchronous orbit in 2001.**

- **The spacecraft completed its mission in August 2013 and was maneuvered into a disposal orbit more than 300 km above the GEO altitude, in accordance with U.S., ITU, and UN COPUOS recommendations.**



Satellite Fragmentations During 2013

- **The U.S. Space Surveillance Network detected only two, minor satellite fragmentations during 2013.**

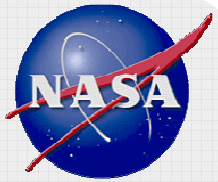
- **A U.S. Falcon 9 launch vehicle released 15 unplanned debris during its 29 September mission due to a second stage malfunction.**

  – The debris were initially in low altitude elliptical orbits.

  – All but one debris had reentered by the end of the year.

- **The Russian BLITS calibration satellite also released a fragment during an anomalous event.**

Robotic Spacecraft Collision Avoidance Maneuvers



- **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.**

- **NASA also assists other U.S. government and foreign spacecraft owners with conjunction assessments and subsequent maneuvers.**

- **During 2013 NASA executed or assisted in the execution of a record 29 collision avoidance maneuvers by robotic spacecraft.**

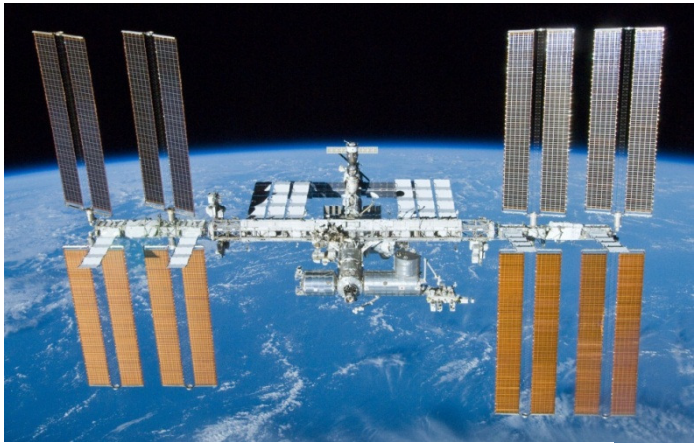
  – 6 maneuvers were needed to avoid debris from Fengyun-1C

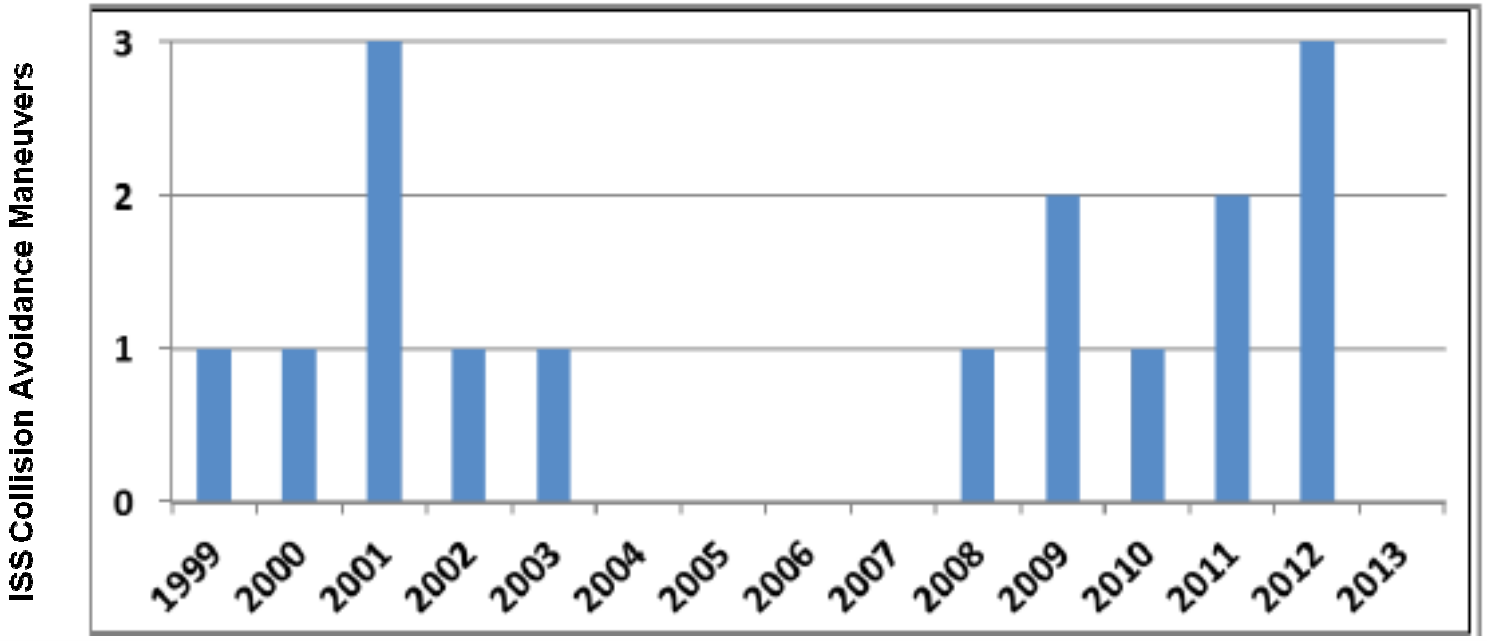
  – 6 maneuvers were needed to avoid debris from the collision of Cosmos 2251 and Iridium 33

ISS Collision Avoidance Maneuvers

- **The International Space Station has conducted 16 collision avoidance maneuvers since 1999.**

- **During 2013, no collision avoidance maneuvers were necessary.**





Satellite Reentries in 2013

- **More than 400 spacecraft, launch vehicle stage, and other debris reentries were recorded by the U.S. Space Surveillance Network during 2013.**

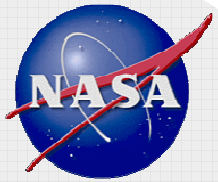
- **Uncontrolled reentries accounted for a total mass of >100 metric tons from 66 payloads and launch vehicle stages.**

- **An additional 19 spacecraft and stages executed controlled reentries.**

- **A 38-year-old U.S. upper stage tank fell on Zimbabwe in July, 2013.**

- **No one was injured.**

Update to NASA Orbital Debris Engineering Model



- **For 30 years NASA has developed orbital debris engineering models to characterize the current and near-term Earth satellite population.**

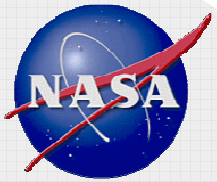
- **Orbital debris engineering models are mathematical tools to assess orbital debris flux for specific orbits.**

  – They are created primarily for spacecraft designers to accurately assess spacecraft risk during the duration of the mission.

- **NASA's most recent orbital debris engineering model, ORDEM 3.0, was released in 2013 and incorporates:**

  – Changes in the environment, *e.g.*, satellite fragmentations
  – Additional observational data
  – Improved modeling techniques
  – Need for expanded capabilities

ORDEM 3.0 Characteristics



- **ORDEM 3.0 is principally an empirical model with historical- and physics-based extensions for the future environment to 2035.**

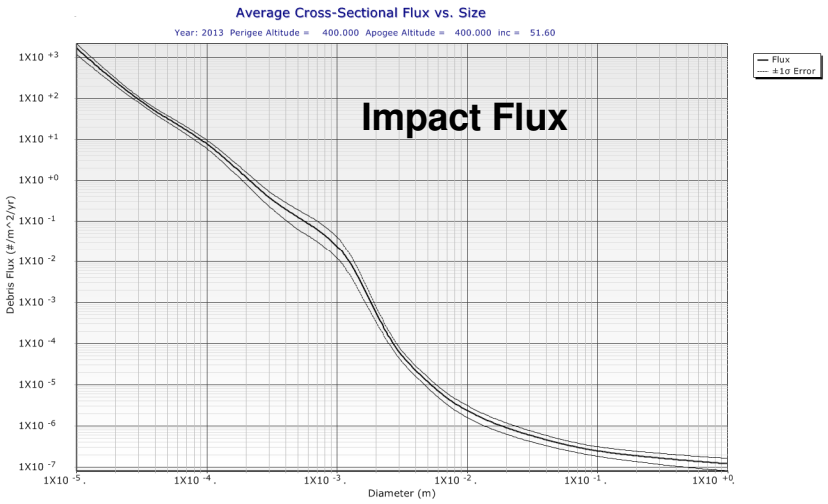
- **Data sources include radars and telescopes for debris 3 mm and larger and the examination of returned spacecraft surfaces for debris 1 mm and smaller.**

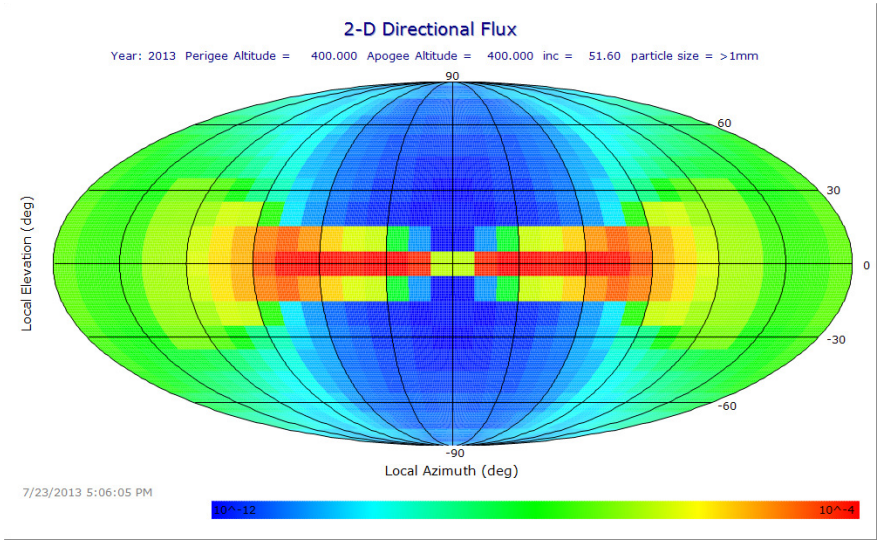
- **ORDEM 3.0 has significant new capabilities, including**

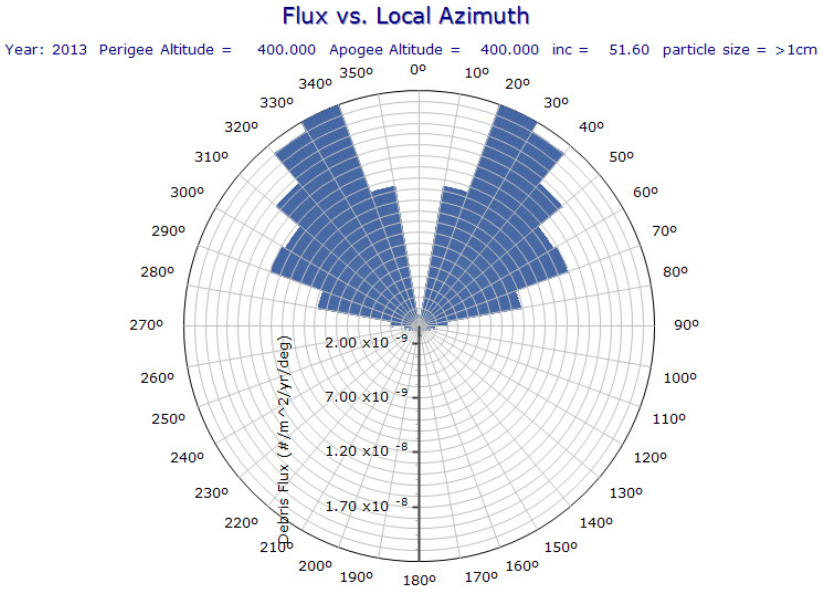
  - Explicit uncertainty values for particle fluxes
  - Debris material density categories
  - Coverage extended to GEO

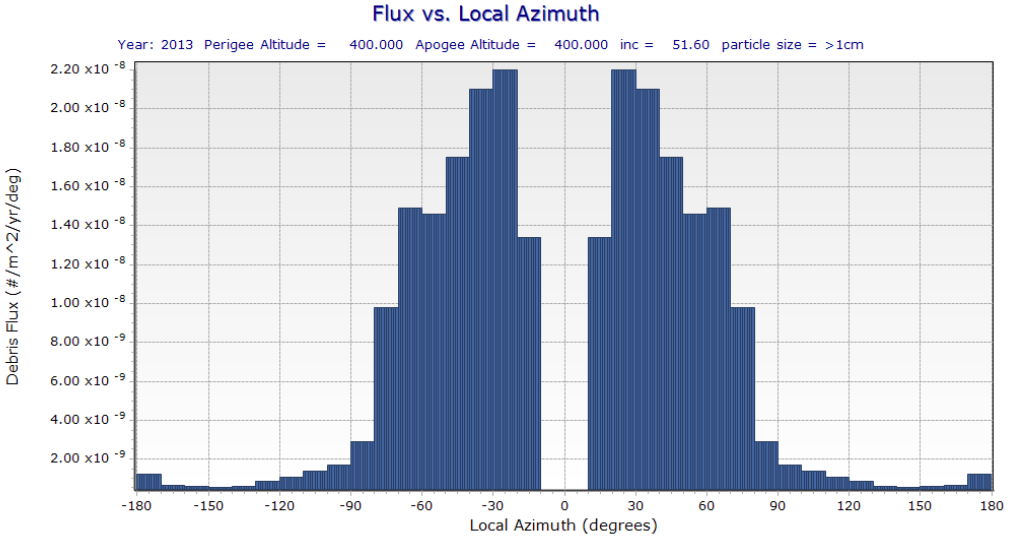
- **Directions for obtaining ORDEM 3.0 and its documentation can be found at http://orbitaldebris.jsc.nasa.gov/model/engrmodel.html.**

Graphical Output Options of ORDEM 3.0









ORDEM 3.0 Debris Flux for ISS Orbit: 400km