National Aeronautics and Space Administration

U.S. Space Debris Environment and Activity Updates

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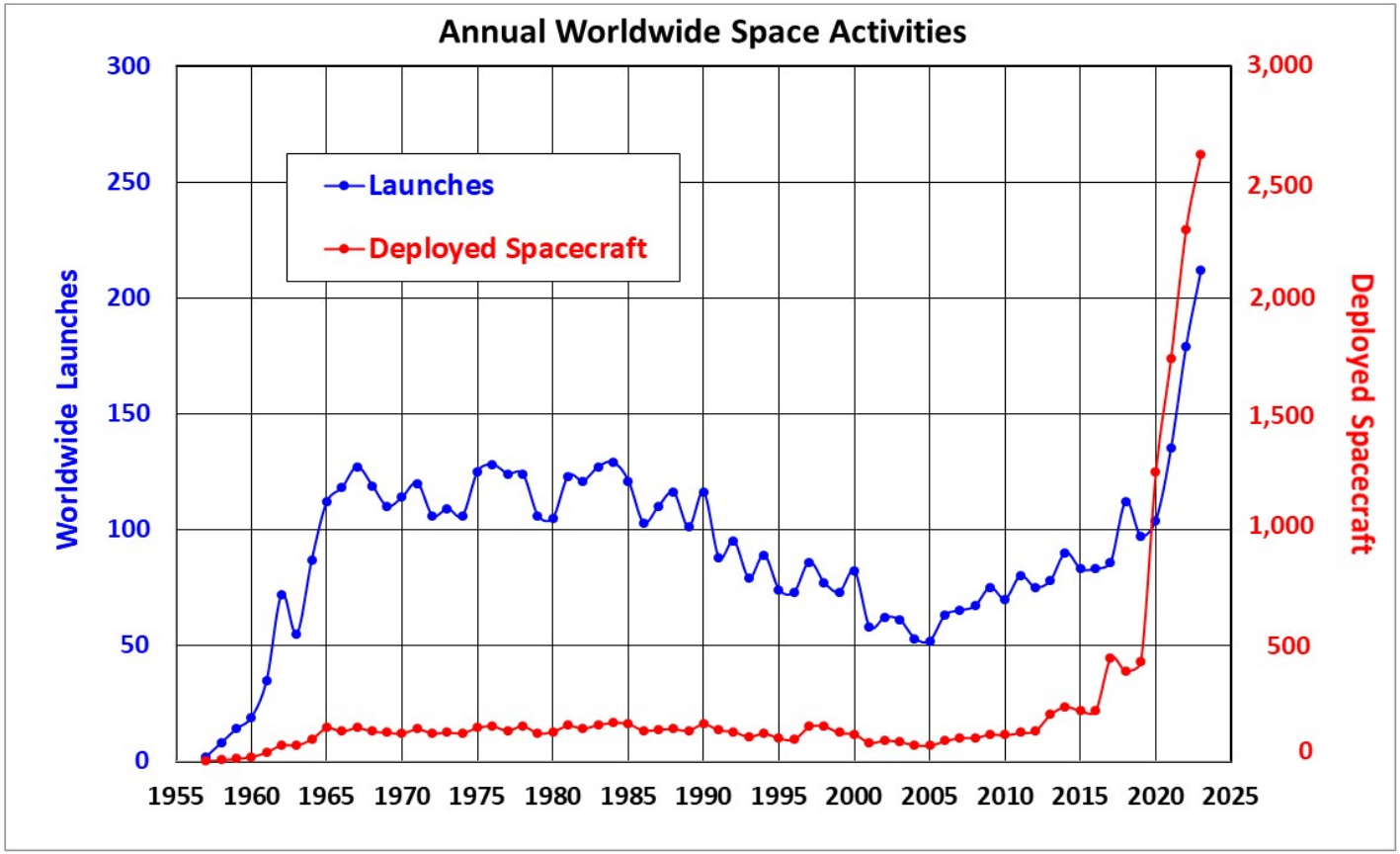
Presentation Outline

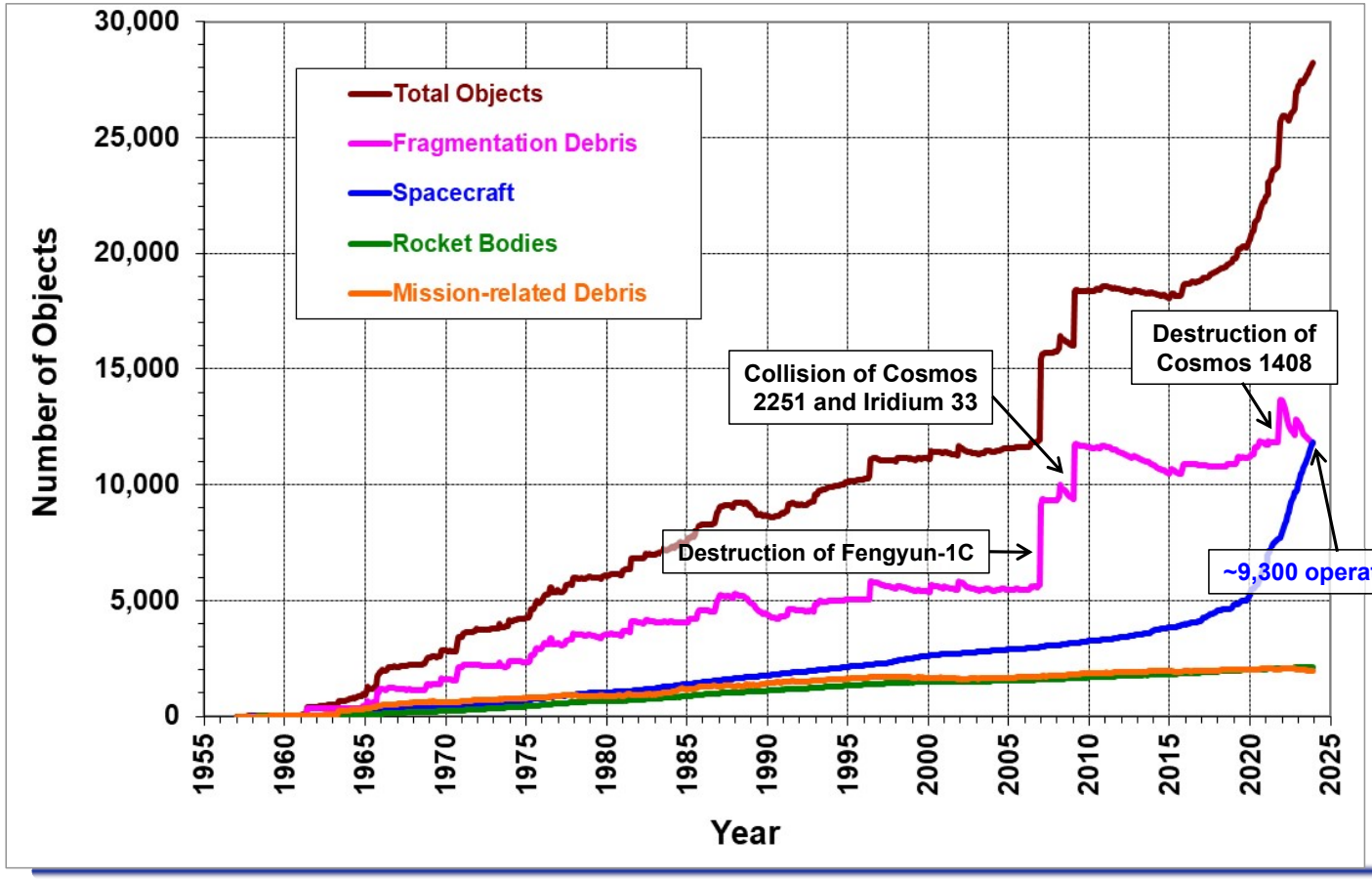
- **Worldwide Space Activity in 2023**
- **Population Increase (1957–2023)**
- **Satellite Fragmentations and Reentries in 2023**
- **Collision Avoidance Maneuvers**
- **Research and Technology Development**
- **The Second International Orbital Debris Conference**

Worldwide Space Activity in 2023



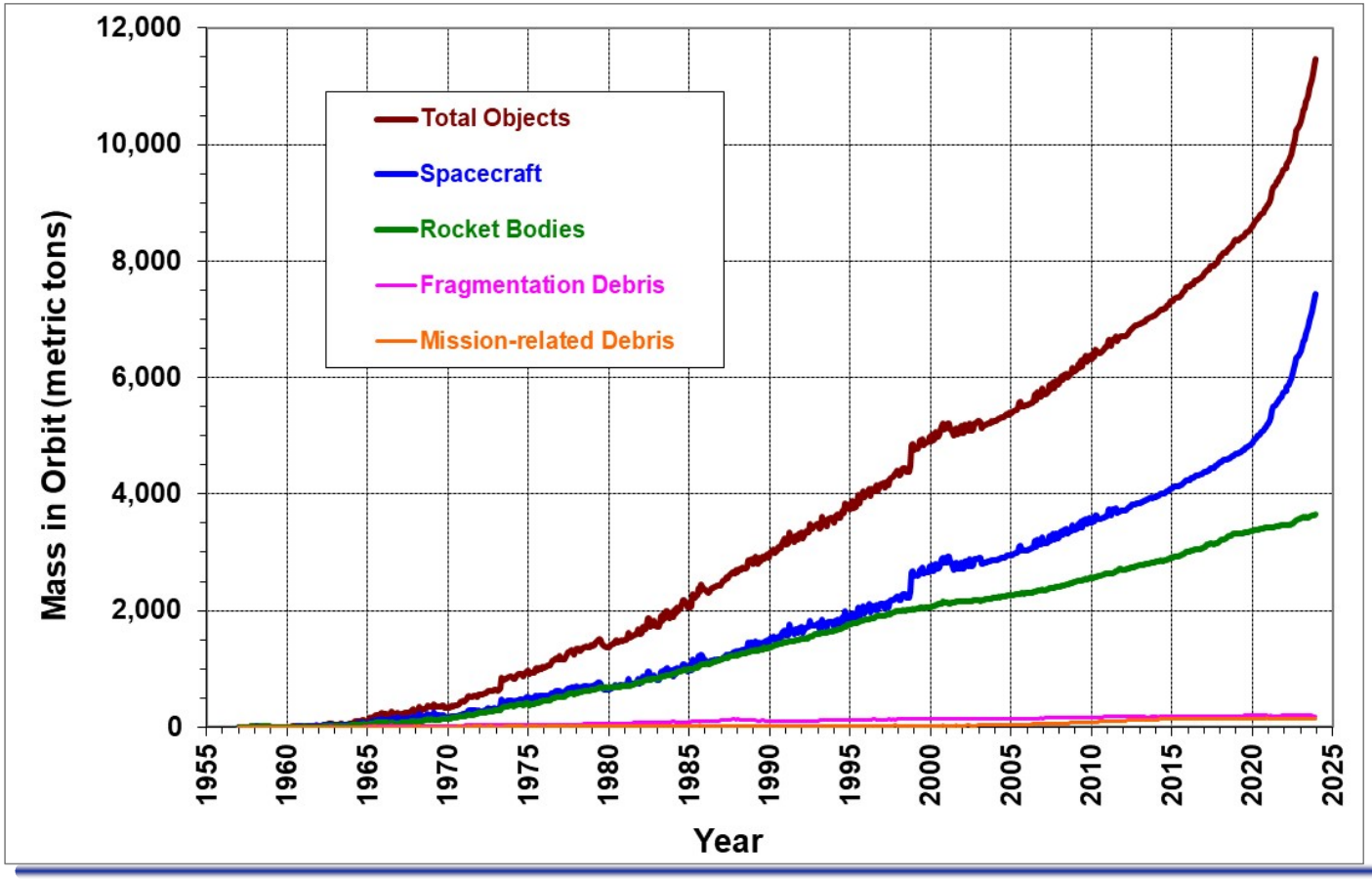
- **The year 2023 set two historical records for space activities**
- **For the first time in history, more than 200 launches were conducted world-wide in a year, with a record number of 2600+ spacecraft deployed**

Growth of the Cataloged Population



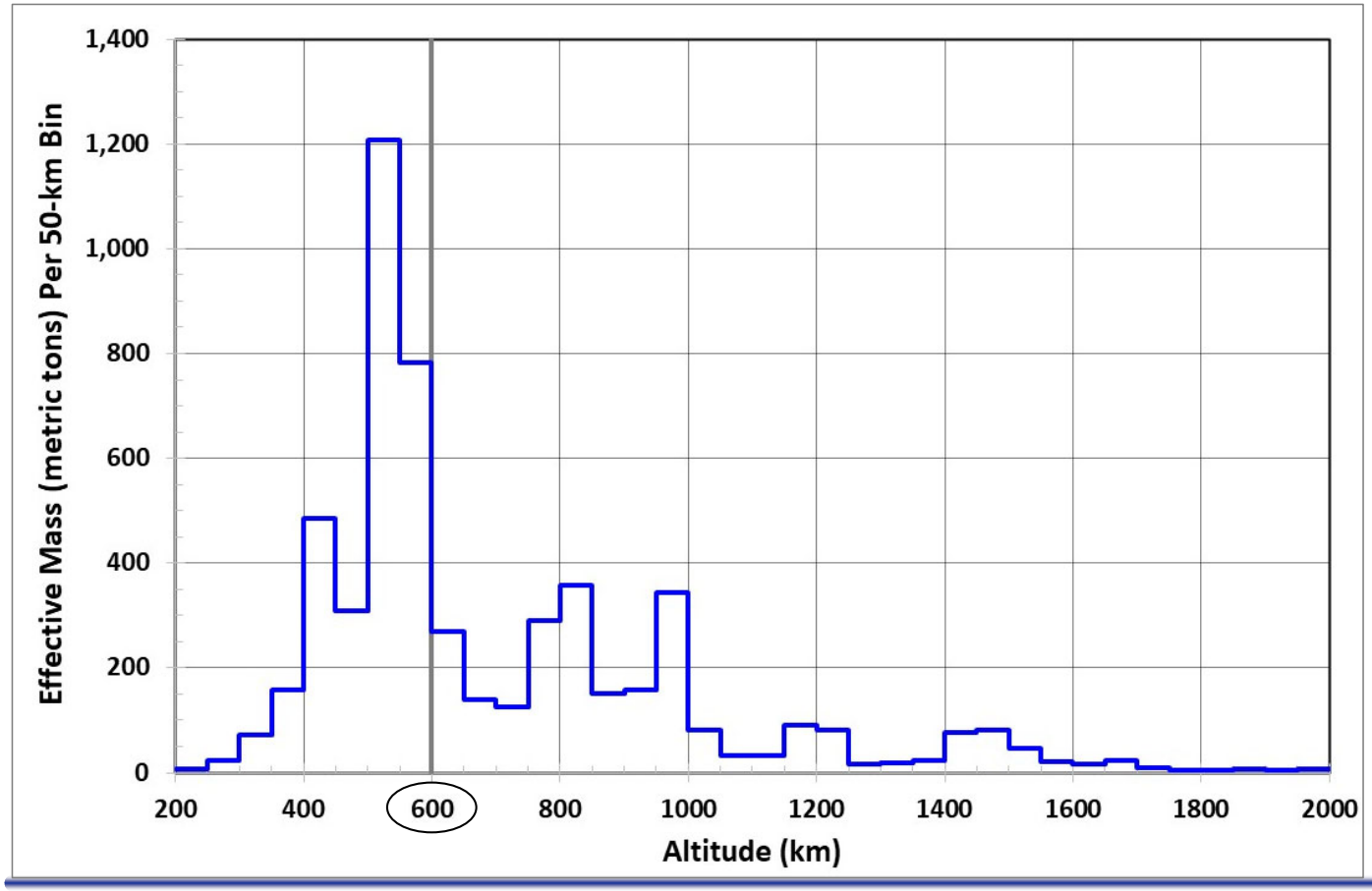
- **The cataloged objects continued to increase**
  - Such large objects only represent the tip of the iceberg for the orbital debris population
  - ~100,000,000 additional debris too small to be tracked but large enough to threaten missions exist in the environment
- **The rapid increase in spacecraft was due to CubeSats and large constellations**

Mass in Orbit



- **The mass in orbit also continued to increase**
- **At the end of 2023, the total mass in orbit exceeded 11,000 metric tons**
  - The mass was dominated by spacecraft (~65% of the total) and rocket bodies (~32% of the total)
  - Approximately half of the mass concentrated in low Earth orbit (LEO)

Mass Distribution in LEO



- **The mass below 600 km altitude was dominated by the Starlink large constellation and the ISS**
- **The mass above 600 km altitude was dominated by spent rocket bodies and retired spacecraft**

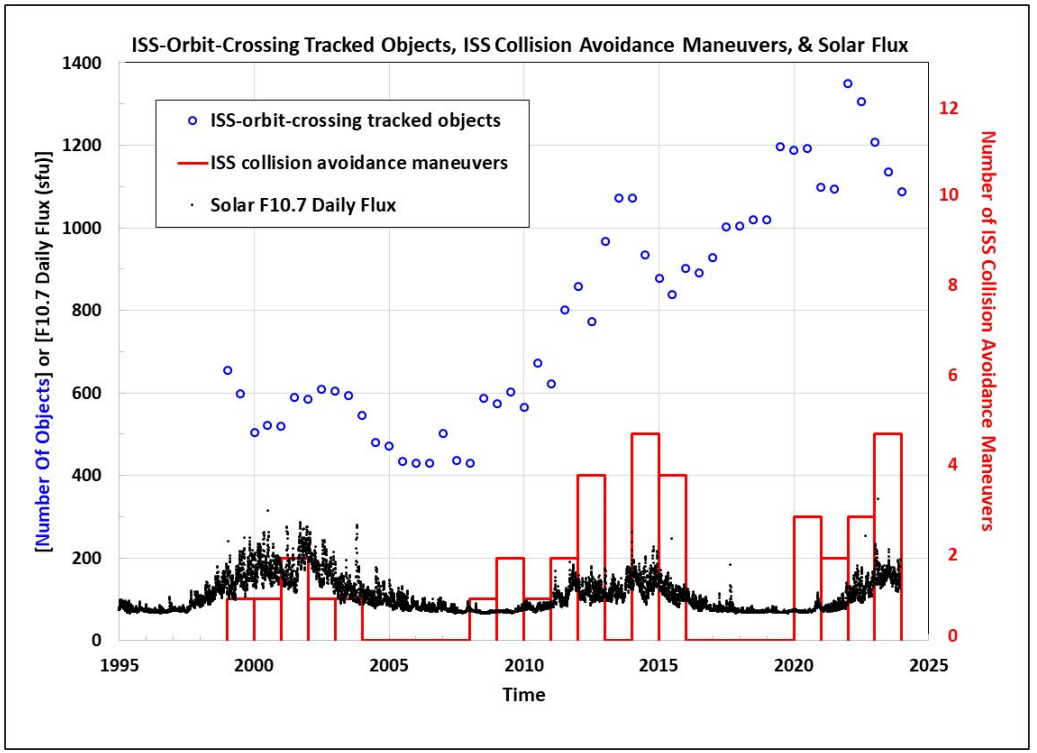
Reentries and Fragmentations in 2023

- **More than 1900 reentries of spacecraft, launch vehicle upper stages, and other cataloged debris were recorded by the U.S. Space Surveillance Network (SSN) during 2023**
  - Spacecraft: 630 (including 88 SpaceX Starlinks and several hundred CubeSats)
  - Upper stages: 92
  - The total mass of the 2023 reentries exceeded 375 metric tons
- **Four minor on-orbit breakups were documented by the U.S. Space Force**

Common Name	International Designator	Perigee Altitude (km)	Apogee Altitude (km)	Debris Cataloged
Cosmos 2499	2014-028E	1,163	1,537	37
SS3 Upper Stage	2023-019D	357	442	5
ORBCOMM FM 36	1999-065E	776	793	9
Cosmos 2143	1991-033A	1,398	1,416	6

NASA Mission Collision Avoidance Maneuvers

- **NASA has established conjunction assessment processes for missions to avoid accidental collisions with large objects tracked by the SSN**
- **The International Space Station (ISS) conducted 5 collision avoidance maneuvers in 2023**
  - Total avoidance maneuvers since 1999: 38
  - Frequency of the avoidance maneuvers depends on solar activity, number of objects crossing the ISS orbit, the SSN tracking capability, and other factors
- **NASA also executed or assisted in the execution of 20 collision avoidance maneuvers by robotic spacecraft during 2023**



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Orbital Debris Research and Technology Development

- **NASA continued to pursue research and technology development on key orbital debris challenges**
  - Collected measurement data to monitor the ever-changing environment and updated models for risk assessments and mission support
  - Advanced *in-situ* measurement sensor technology in preparation for addressing the key small debris data gap in low Earth orbit
  - Conducted cost-benefit analyses on mitigation versus remediation
  - Identified priority gaps to guide investments relevant to mitigation, collision avoidance, on-orbit servicing, remediation, and space sustainability
  - Provided grants to industry and academia on several research and technology development areas
  - Explored technology demonstration mission opportunities for environment characterization and on-orbit servicing

The Second International Orbital Debris Conference (IOC II)

- **NASA organized/hosted IOC II near Houston, Texas on 4-7 December 2023**
  - Held to promote orbital debris research activities in the United States, foster collaborations with the international community, and address the orbital debris problem for long-term sustainability of near-Earth space activities
  - Attracted about 250 participants from 14 countries, including representatives from ASI, CNES, DLR, ESA, ISRO, JAXA, KARI, UKSA, and NZ Space Agency
  - A total of 124 papers covering orbital debris measurements, modeling, hypervelocity impact protection, reentry, conjunction assessments, space situational awareness, mitigation, remediation, space traffic coordination, and policy were presented
  - Approximately half of the papers were contributions from international subject matter experts (governments, industry, and academia)