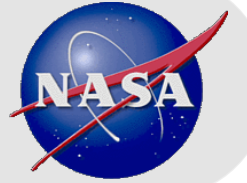




U.S. Space Debris Environment and Activity Updates

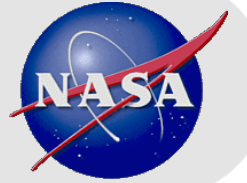
J.-C. Liou, Ph.D.
Chief Scientist for Orbital Debris
National Aeronautics and Space Administration
United States

62nd Session of the Scientific and Technical Subcommittee
Committee on the Peaceful Uses of Outer Space, United Nations
3-14 February 2025



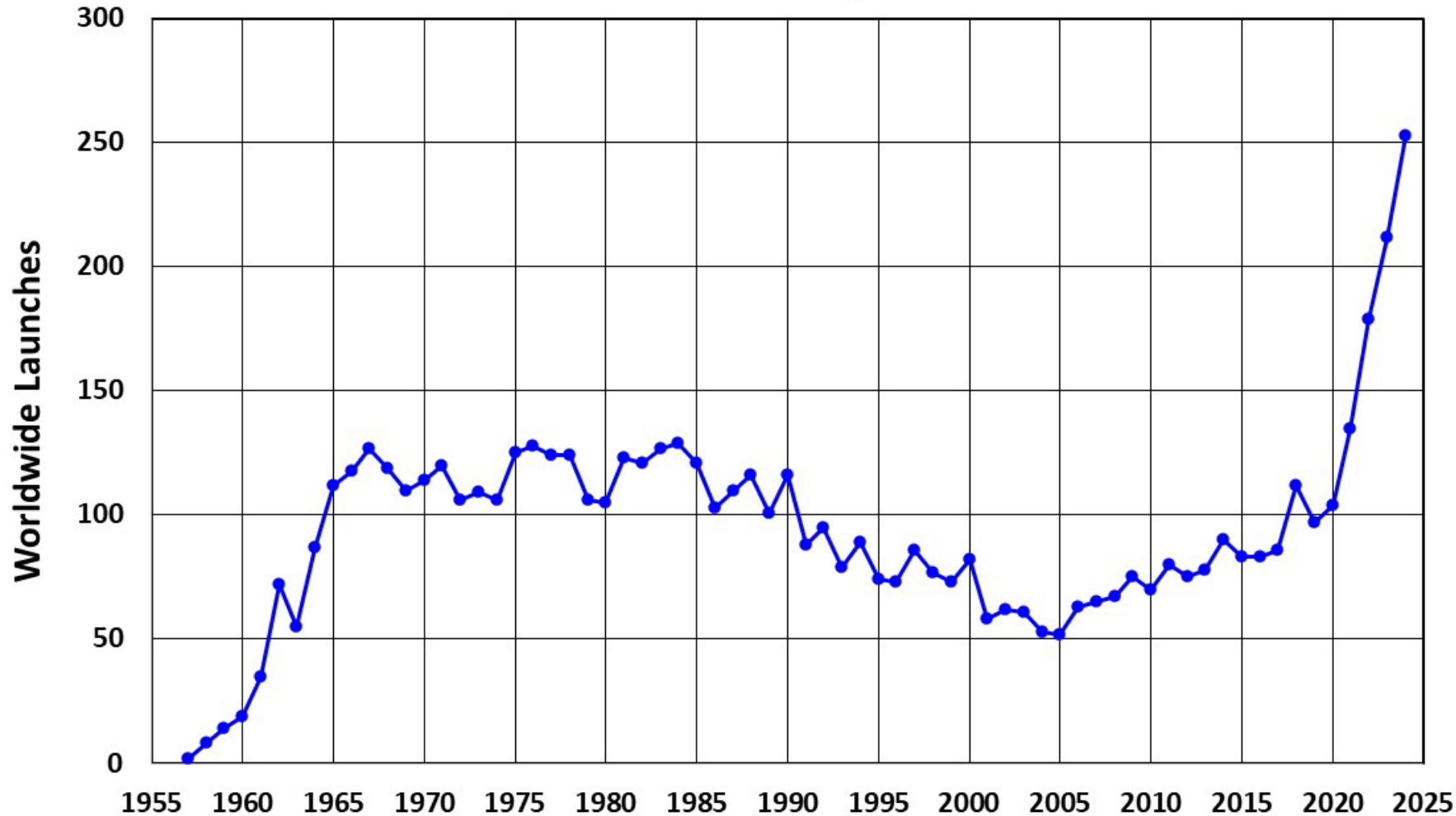
Presentation Outline

- **Worldwide Space Activity in 2024**
- **Population Increase (1957–2024)**
- **Reentries and On-orbit Fragmentations**
- **NASA Mission Collision Avoidance Maneuvers**
- **NASA's Space Sustainability Strategy**
- **U.S. National Cislunar Science & Technology Action Plan**



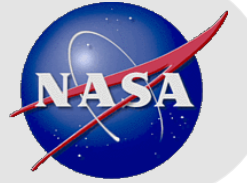
Worldwide Space Activity in 2024

Annual Worldwide Space Activities

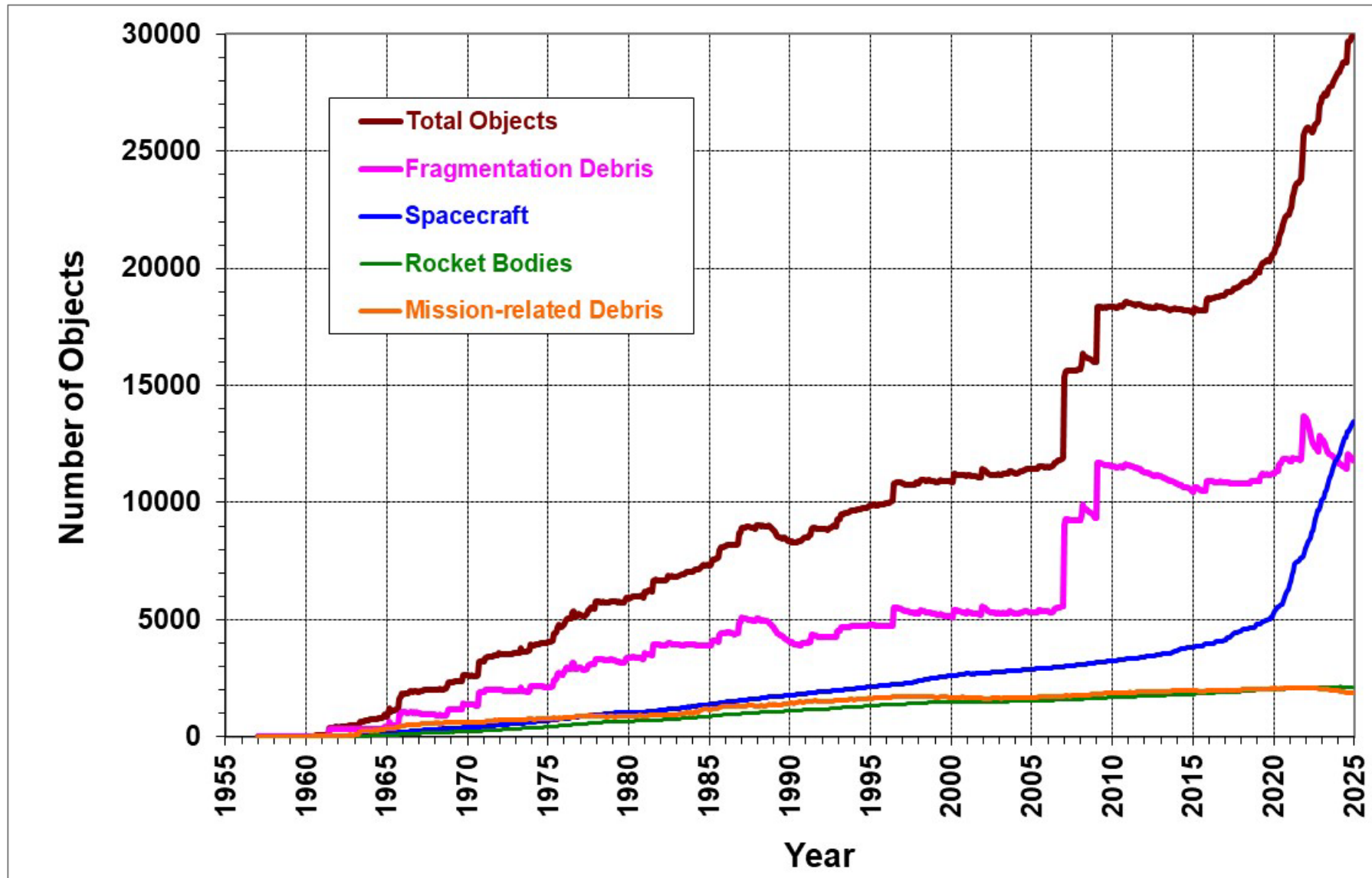


- **The year 2024 set another record of global space activities with more than 250 launches**

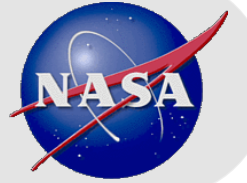
- Close to 2500 spacecraft were deployed to the near-Earth space environment, from low Earth orbit (LEO) to Geosynchronous Earth Orbit (GEO)



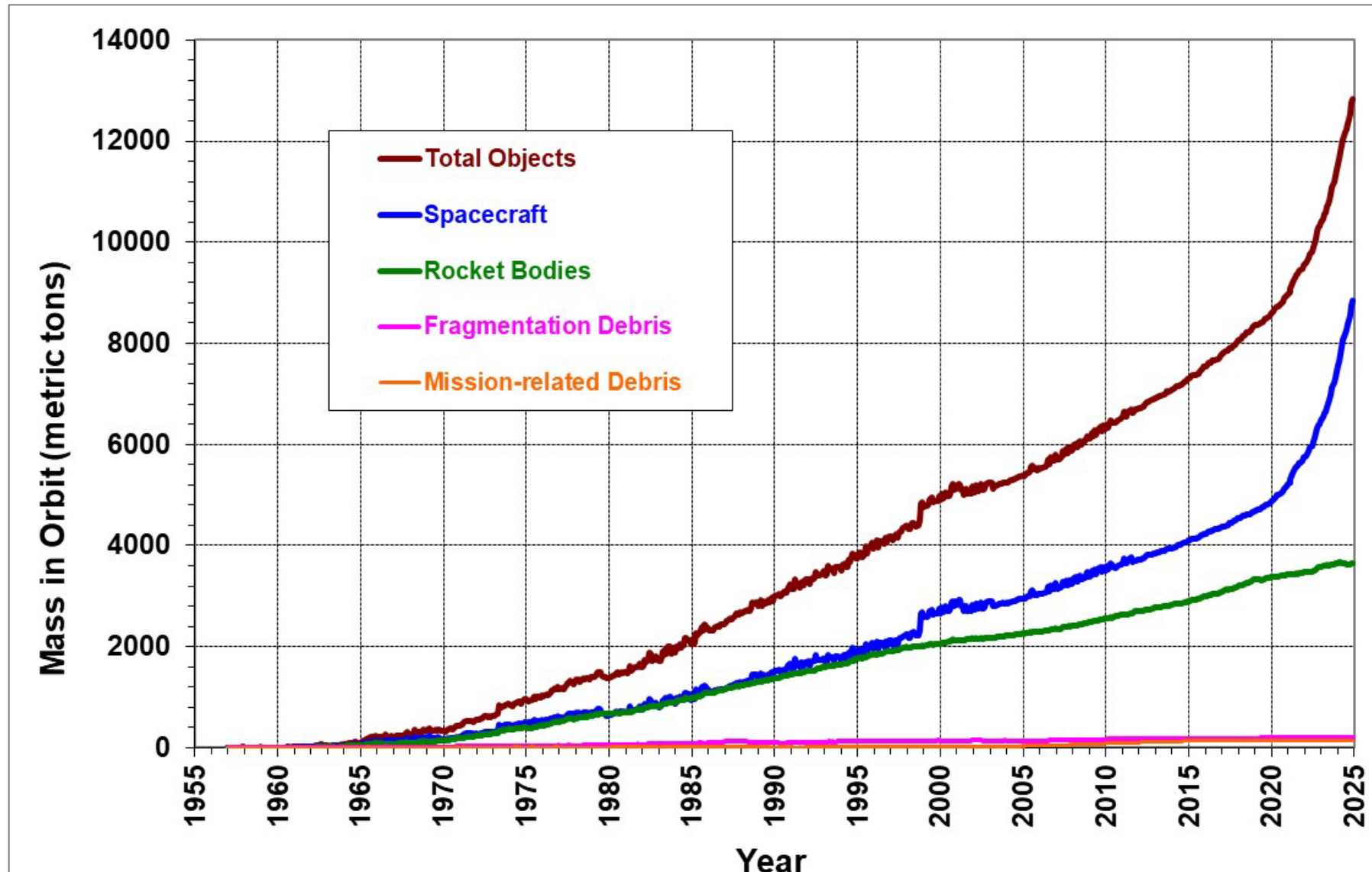
Growth of the Cataloged Population



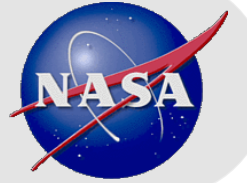
- **The cataloged objects continued to increase**
 - Spacecraft, including ~11,000 active and 2500 defunct, have significantly surpassed fragmentation debris.
 - The rapid increase in spacecraft was due to CubeSats and large constellations.
 - Many more debris too small to be cataloged exist in the environment. Mission-ending risk is driven by such small debris.



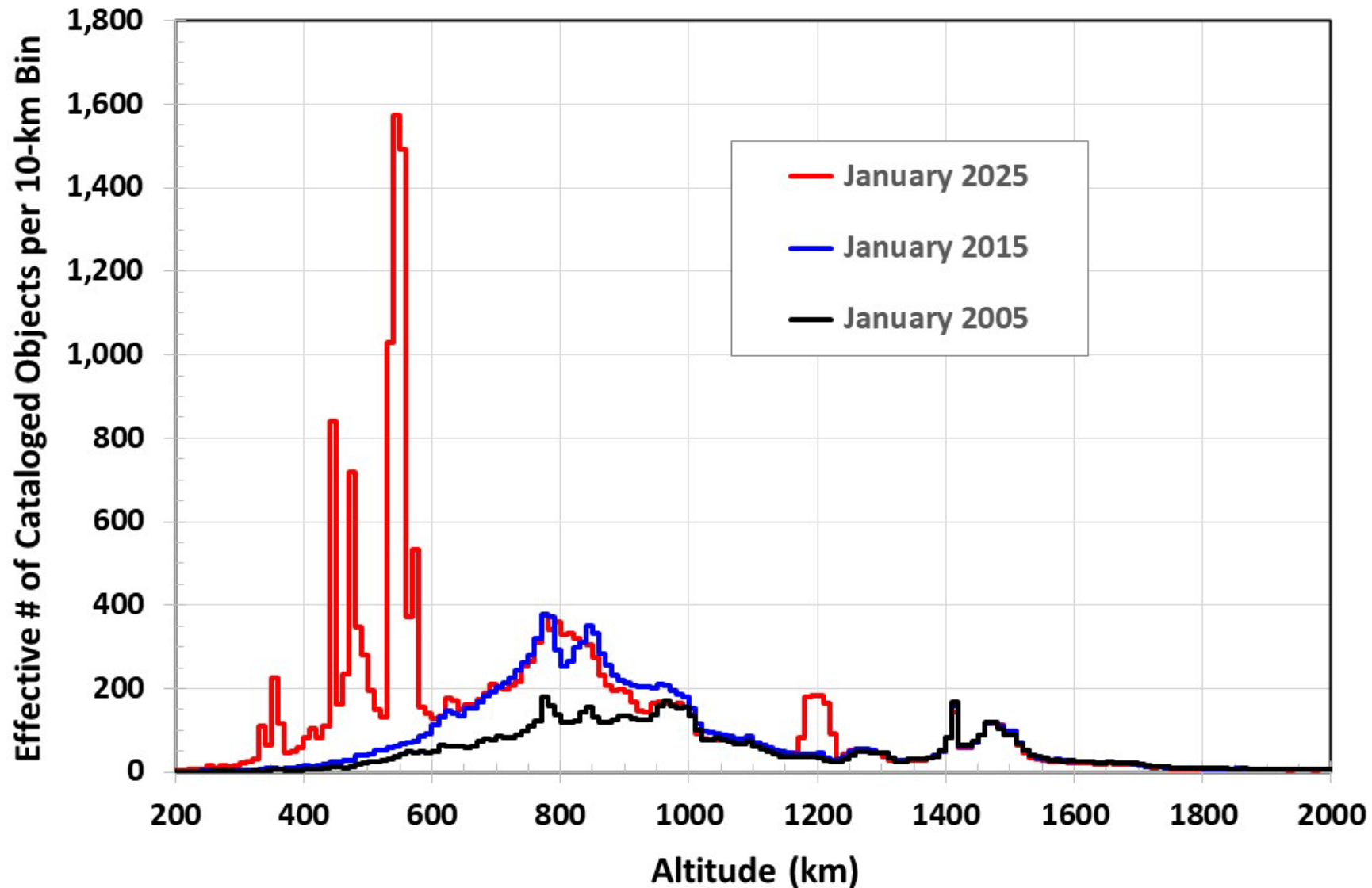
Mass in Orbit



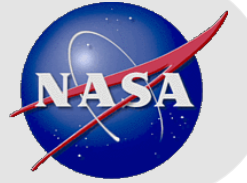
- **The mass in orbit also continued to increase**
 - The total mass in orbit has exceeded 12,000 metric tons
 - The mass was dominated by spacecraft (~69% of the total) and rocket bodies (~28% of the total)
 - More than half of the mass was concentrated in LEO



Changes in LEO Environment: 2005 to 2025

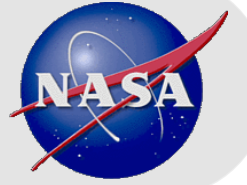


- The landscape of the LEO environment has dramatically changed over the past two decades
- Changes below 1000 km altitude were driven by
 - 2005 to 2015: two major breakup events
 - 2015 to 2025: proliferation of CubeSats and the deployments of large constellations



Reentries

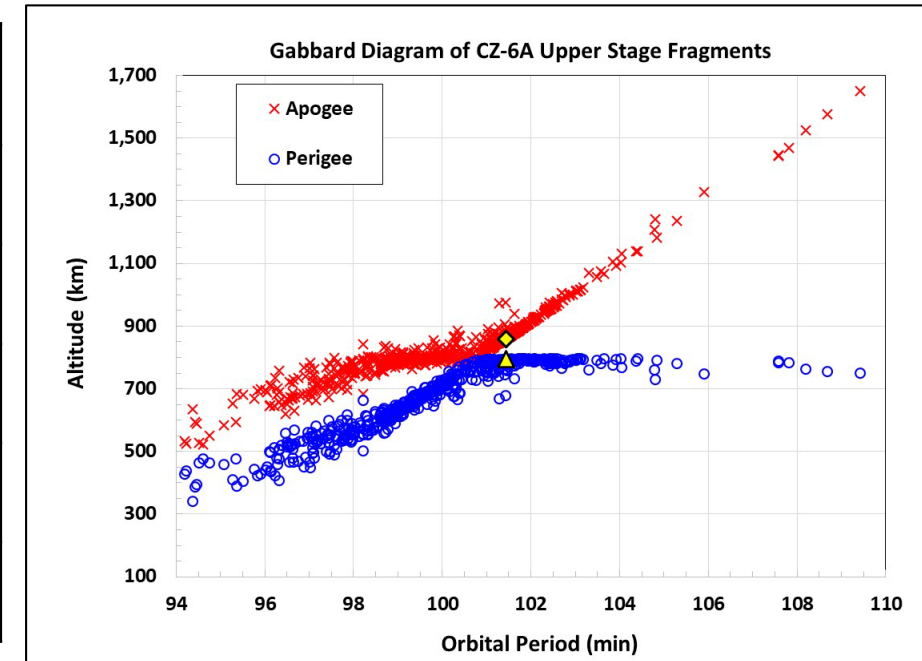
- **More than 2000 reentries of spacecraft, launch vehicle upper stages, and other cataloged debris were recorded by the U.S. Space Surveillance Network (SSN) during 2024**
 - Spacecraft: 947 (including 334 SpaceX Starlinks and several hundred CubeSats)
 - Upper stages: 112
 - The total mass of the 2024 reentries exceeded 550 metric tons
 - The oldest spacecraft reentered in 2024 was Hitchhiker 1, an 80-kg radiation research satellite launched in 1963
 - The oldest upper stage reentered in 2024 was associated with the deployment of a meteorological satellite in 1970

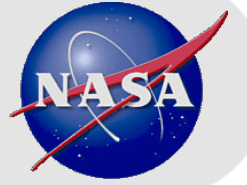


On-orbit Fragmentations

- **The U.S. Space Force documented one major and several minor breakups during 2024**
 - Fragments generated above ~700 km altitude have long-term negative effects to the environment and to current and future missions
 - Limiting the generation of new, long-lived debris is key to space sustainability

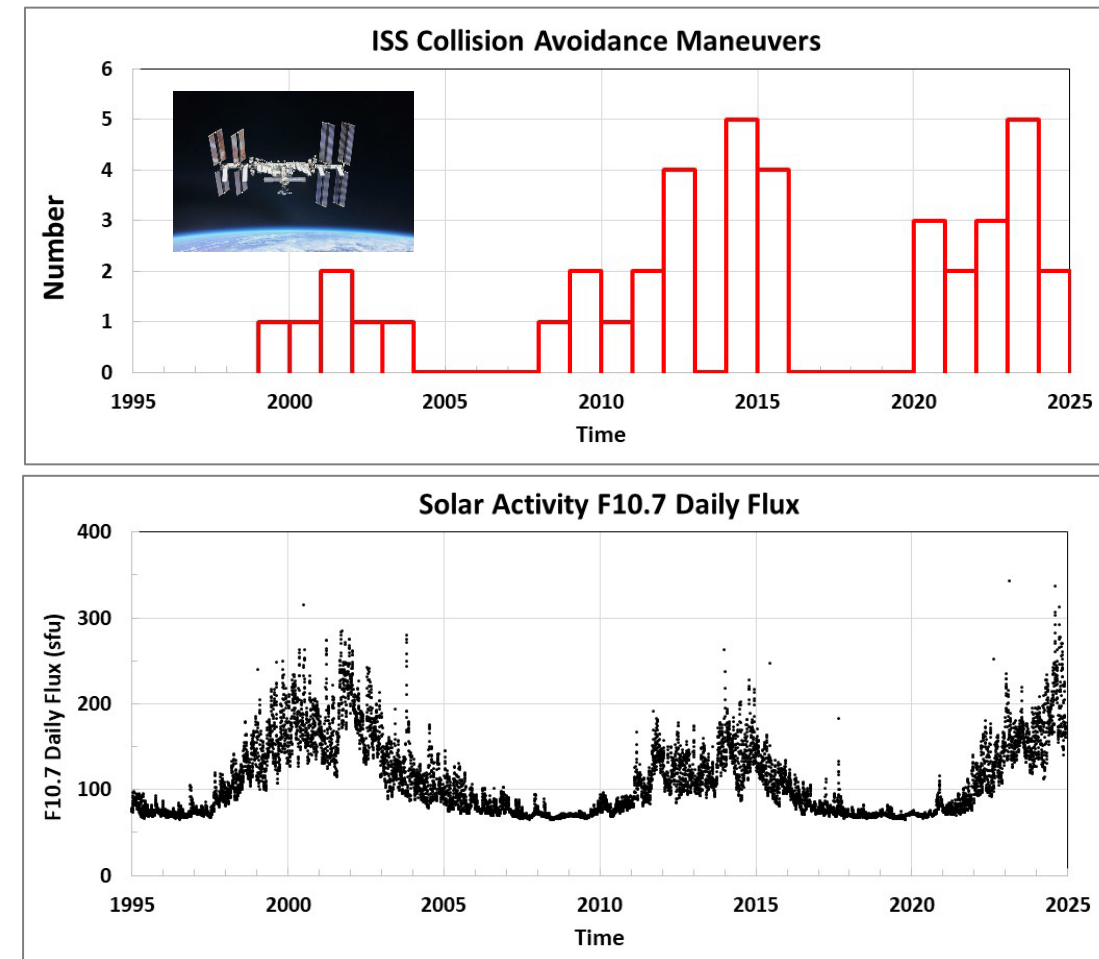
Common Name	International Designator	Perigee Altitude (km)	Apogee Altitude (km)	Debris Cataloged
COSMOS 2428	2007-029A	847	853	5
RESURS P1	2013-030A	353	388	18
DMSP 5D-2 F8	1987-053A	818	837	4
CZ-6A Upper Stage	2024-140U	755	828	664
Intelsat 33E	2016-053B	35,774	35,798	18





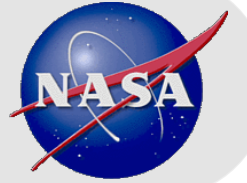
NASA Mission Collision Avoidance Maneuvers

- **NASA has established conjunction assessment processes for missions to avoid accidental collisions with large objects tracked by the SSN**
- **The International Space Station (ISS) has conducted 40 collision avoidance maneuvers since 1999**
 - Twice in 2024. The avoided objects were (1) a fragment generated from the 2007 *Fengyun-1C* ASAT test and (2) a fragment from the breakup of a DMSP 5D-2 F13 spacecraft in 2015
 - There is a strong correlation between solar activity and the ISS maneuver frequency
- **NASA also executed or assisted in the execution of 8 collision avoidance maneuvers by robotic spacecraft during 2024**



NASA's Space Sustainability Strategy

Volume 1: Earth Orbit



- **Purpose**

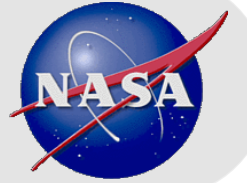
- Focus on advancements the Agency can make that address the mounting space sustainability challenges posed by the rapidly changing space environment and that are aligned with NASA's mission as a science and technology organization

- **Goals**

1. Develop a framework for assessing space sustainability at NASA
2. Prioritize the most efficient ways to minimize uncertainties about orbital debris and operations in the space environment
3. Lower barriers to space sustainability through developing and transferring technology
4. Update or develop policies that provide incentives to support space sustainability
5. Continue and improve coordination and collaboration outside of NASA
6. Improve NASA's internal organization to support space sustainability



U.S. National Cislunar Science & Technology Action Plan



- **The Action Plan aims to advance U.S. science and technology leadership in Cislunar space per the 2022 National Cislunar Science & Technology Strategy**
- **Many actions identified are related to orbital debris**
 - *“Develop technology to mitigate environmental impacts to Cislunar space that might harmfully limit future use. This research and development might include but is not limited to technologies that limit orbital and Lunar surface debris...”*
 - *“...develop and propose best practices for safe Cislunar operations across a range of domains including debris mitigation,...end-of-life operations,...collision avoidance...”*
 - *“Identify and prioritize research and development needed to support extension of U.S. SSA capabilities into Cislunar space, to include... improved debris population modeling, and detection, tracking, and characterization of satellites in the Cislunar volume...”*
 - *“Develop best practices for post-mission disposal, debris mitigation, and conjunction assessment and mitigation processes in Cislunar space.”*
 - *“Update the U.S. Orbital Debris Mitigation Standard Practices to incorporate both Cislunar and Lunar-surface considerations and subsequently update derived requirement and guidance documents at the Department and Agency level.”*

