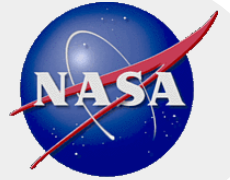


U.S. Space Debris Environment and Activity Updates

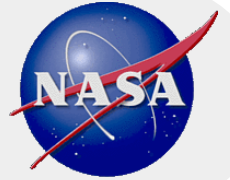
Dr. J.-C. Liou and Dr. Bhavya Lal
National Aeronautics and Space Administration
United States

59th Session of the Scientific and Technical Subcommittee
Committee on the Peaceful Uses of Outer Space, United Nations
8 February 2022



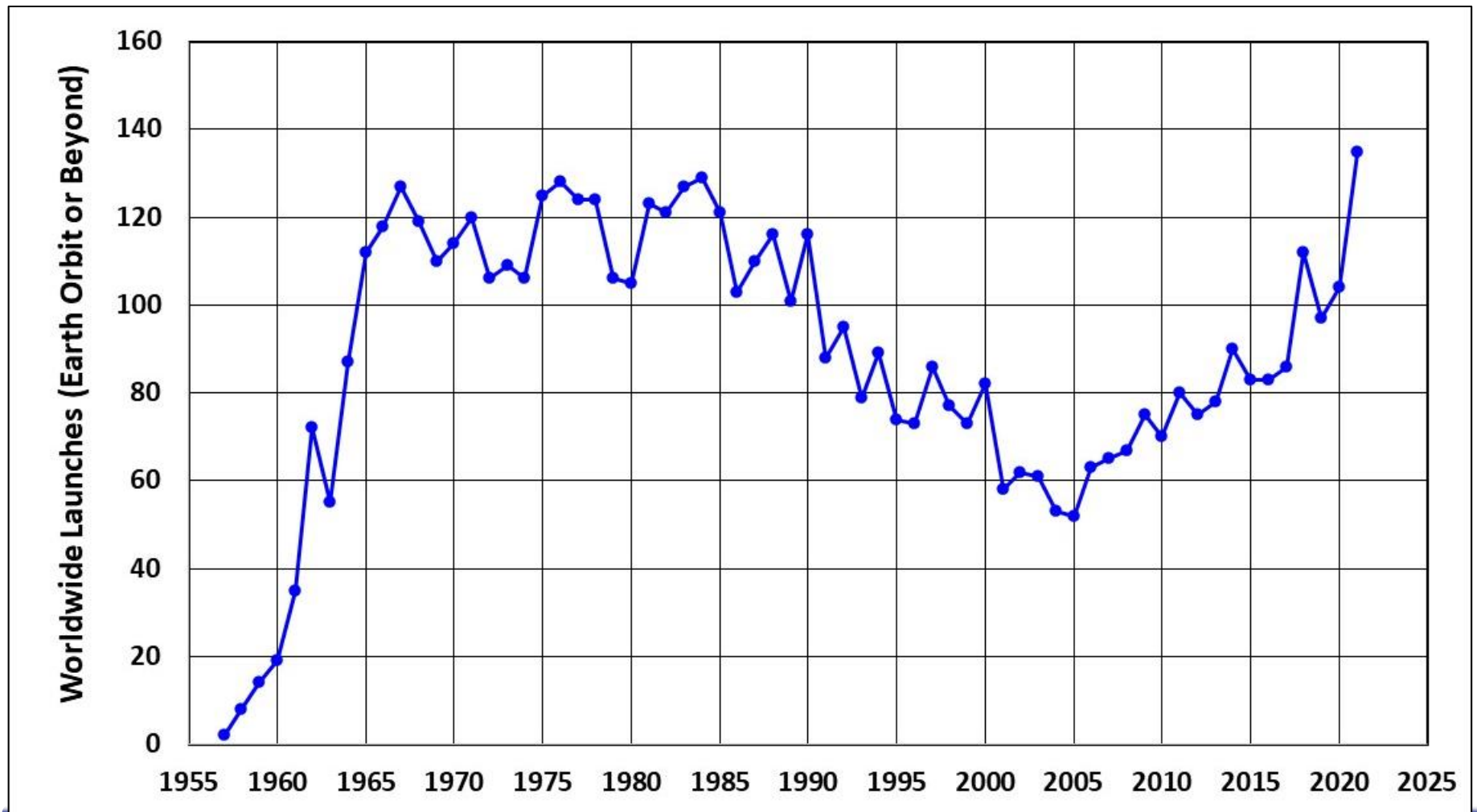
Presentation Outline

- **Worldwide Space Activity in 2021**
- **Earth Satellite Population (1957–2021)**
- **Satellite Fragmentations and Reentries in 2021**
- **Collision Avoidance Maneuvers**
- **The 2021 U.S. Space Priorities Framework**



Worldwide Space Activity in 2021

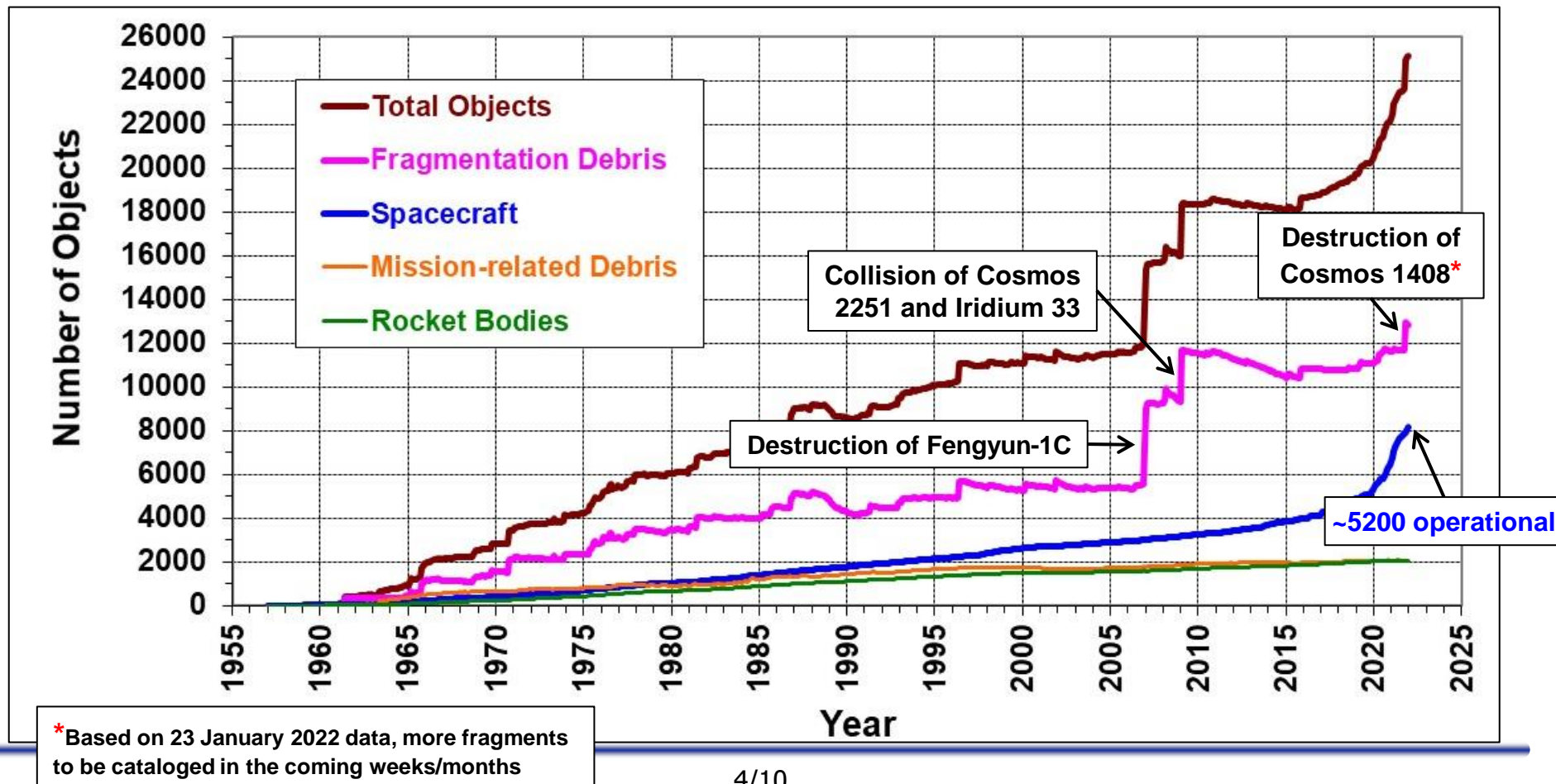
- A total of 135 space launches, **a historical record**, were conducted in 2021. The 135 launches placed more than 1800 spacecraft into Earth orbits.





Evolution of the Cataloged Satellite Population

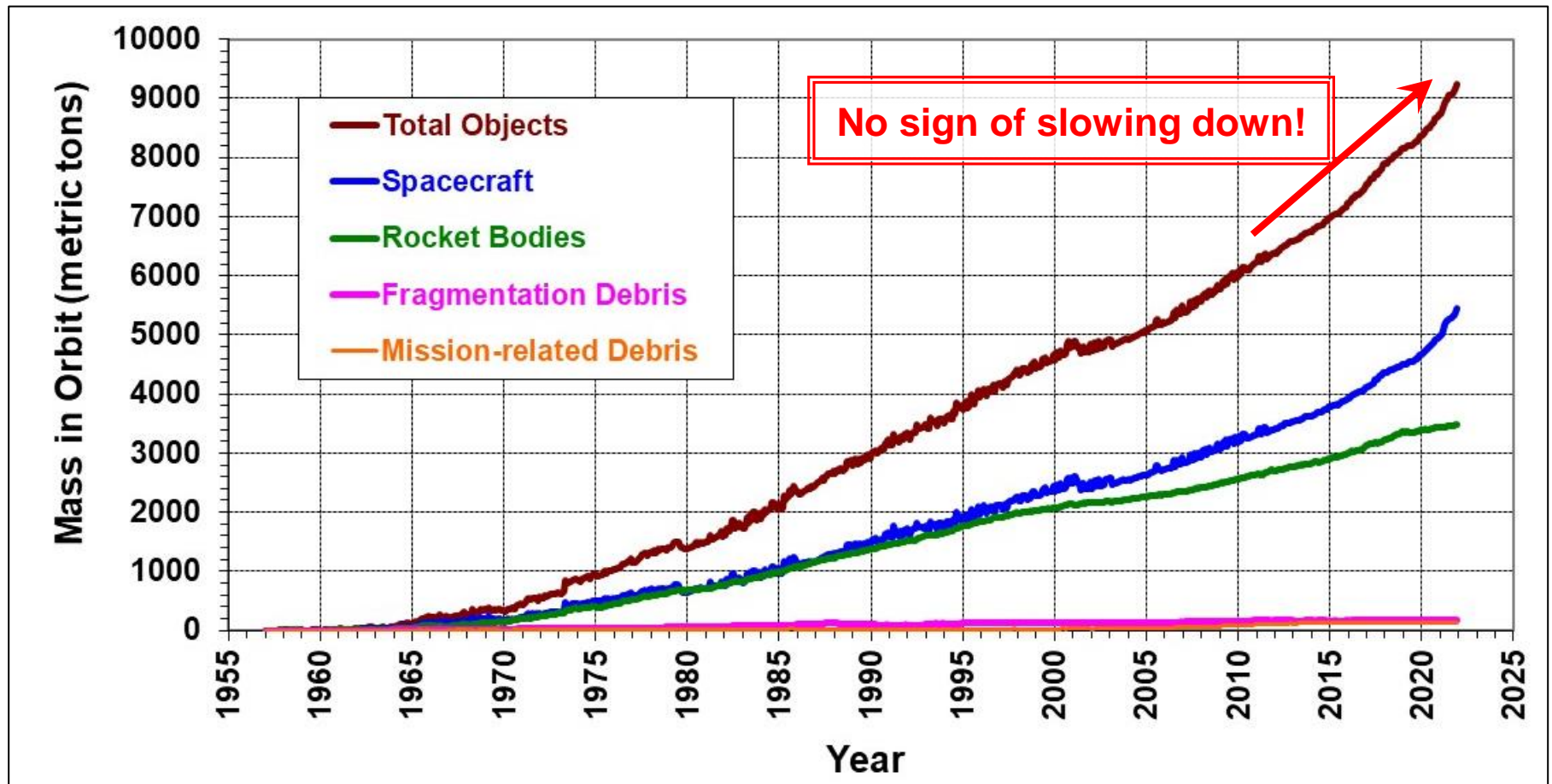
- According to the U.S. Satellite Catalog, the number of 10 cm and larger objects in Earth orbit continued to increase in 2021
 - About **100,000,000** additional debris too small to be tracked but large enough to threaten human spaceflight and robotic missions exist in the environment





Mass in Near-Earth Space Continued to Increase

- **The total mass of material exceeded 9000 metric tons in 2021**
 - About 3800 tons of material was in low Earth orbit (LEO, the region below 2000 km altitude)



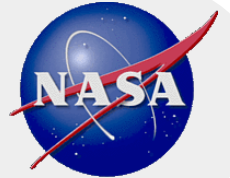


Satellite Fragmentation During 2021

- **The U.S. Space Surveillance Network (SSN) detected five satellite fragmentations during 2021. The five breakups generated**
 - more than 1600 fragments large enough to be tracked by the SSN and
 - millions of additional debris too small to be tracked by the SSN but large enough to threaten human spaceflight and robotic missions.

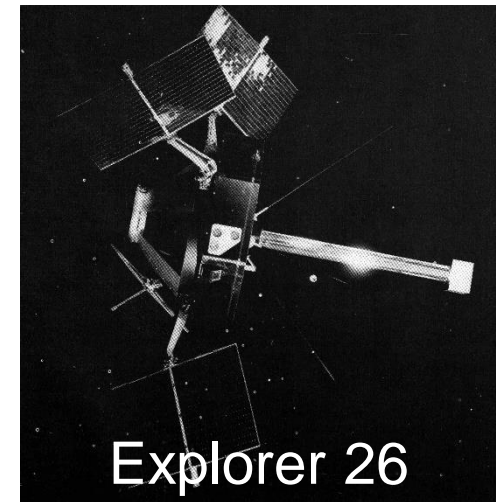
Common Name	International Designator	Perigee Altitude (km)	Apogee Altitude (km)	Debris Cataloged	Notes
NOAA-17 spacecraft	2002-032A	800	817	114	
YunHai 1-02 spacecraft	2019-063A	780	785	37	Accidental collision with debris 1996-051Q
Cosmos 2499 spacecraft	2014-028E	1507	1152	22	
Cosmos 1408 spacecraft	1982-092A	465	490	1251 ¹	ASAT intentional destruction
ORBCOMM FM 5 spacecraft	1997-084F	758	771	8	

¹As of 23 January 2022. Hundreds of additional fragments to be cataloged in the coming weeks/months. Shortly after the Cosmos 1408 destruction, the International Space Station crew had to shelter in place for some time to mitigate risks from small Cosmos 1408 fragments.



Satellite Reentries in 2021

- **More than 500 reentries of spacecraft, launch vehicle upper stages, and other cataloged debris were recorded by the U.S. Space Surveillance Network during 2021**
 - Spacecraft: 172 (including 90 SpaceX Starlinks)
 - Upper stages: 57
 - Other debris: 289
 - The oldest cataloged object reentered in 2021 was NASA's Explorer 26. The 46 kg spacecraft was launched in 1964 to measure the Earth's magnetic field for 3 years.
- **The total mass of the 2021 reentries was more than 200 metric tons**
- **No accounts of personal injury or significant property damage were reported**



International Space Station and NASA Robotic Spacecraft Collision Avoidance Maneuvers



- **NASA has established conjunction assessment processes for its human spaceflight and robotic missions to avoid accidental collisions with objects tracked by the SSN**
 - NASA also assists other U.S. government spacecraft owners with conjunction assessments and subsequent maneuvers
- **The International Space Station conducted two debris collision avoidance maneuvers in 2021**
 - The avoided objects were (1) a fragment generated from the 2007 Fengyun-1C ASAT test and (2) a fragment from the explosion of a Pegasus upper stage in 1996
- **During 2021 NASA also executed or assisted in the execution of 13 collision avoidance maneuvers by robotic spacecraft**





United States Policies Related to Space Sustainability

- **2018 Space Policy Directive-3**

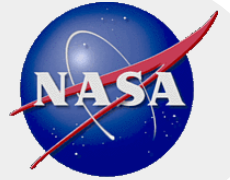
- *“Safety, stability, and operational sustainability are foundational to space activities, including commercial, civil, and national security activities. It is a shared interest and responsibility of all spacefaring nations to create the conditions for a safe, stable, and operationally sustainable space environment.”*
- *“The United States should pursue active debris removal as a necessary long-term approach to ensure the safety of flight operations in key orbital regimes. This effort should not detract from continuing to advance international protocols for debris mitigation associated with current programs.”*

- **2020 National Space Policy**

- *“Lead the enhancement of safety, stability, security, and long-term sustainability in space by promoting a framework for responsible behavior in outer space, including the pursuit and effective implementation of best practices, standards, and norms of behavior”*
- *“Evaluate and pursue, in coordination with allies and partners, active debris removal as a potential long-term approach to ensure the safety of flight in key orbital regimes.”*

- **2021 Orbital Debris R&D Plan**

- National plan of research and development in support of managing the risk posed by orbital debris
- Identifies three critical segments of debris R&D: limiting debris generation by design, tracking and characterizing debris, and remediating or repurposing debris



United States Policy Related to Space Sustainability (cont)

- **2021 U.S. Space Priorities Framework**

- *Maintaining a Robust and Responsible U.S. Space Enterprise*

- ***The United States will foster a policy and regulatory environment that enables a competitive and burgeoning U.S. commercial space sector.***

“...U.S. regulations must provide clarity and certainty for the authorization and continuing supervision of non-governmental space activities, including for novel activities such as on-orbit servicing, orbital debris removal, space-based manufacturing, commercial human spaceflight, and recovery and use of space resources...”

- *Preserving Space for Current and Future Generations*

- ***The United States will prioritize space sustainability and planetary protection.***

“The United States will increase efforts to mitigate, track, and remediate space debris. The United States will advance development and implementation of domestic and international best practices to mitigate the creation of space debris and will support efforts to evolve those practices to ensure continued safety of flight operations in the future...”