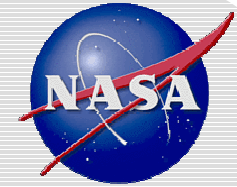


# **USA Space Debris Environment and Policy Updates**

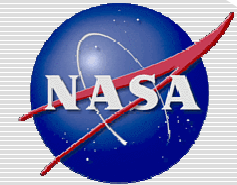
**Presentation to the 45<sup>th</sup> Session of the  
Scientific and Technical Subcommittee  
Committee on the Peaceful Uses of Outer Space  
United Nations**

**11-22 February 2008**



## Presentation Outline

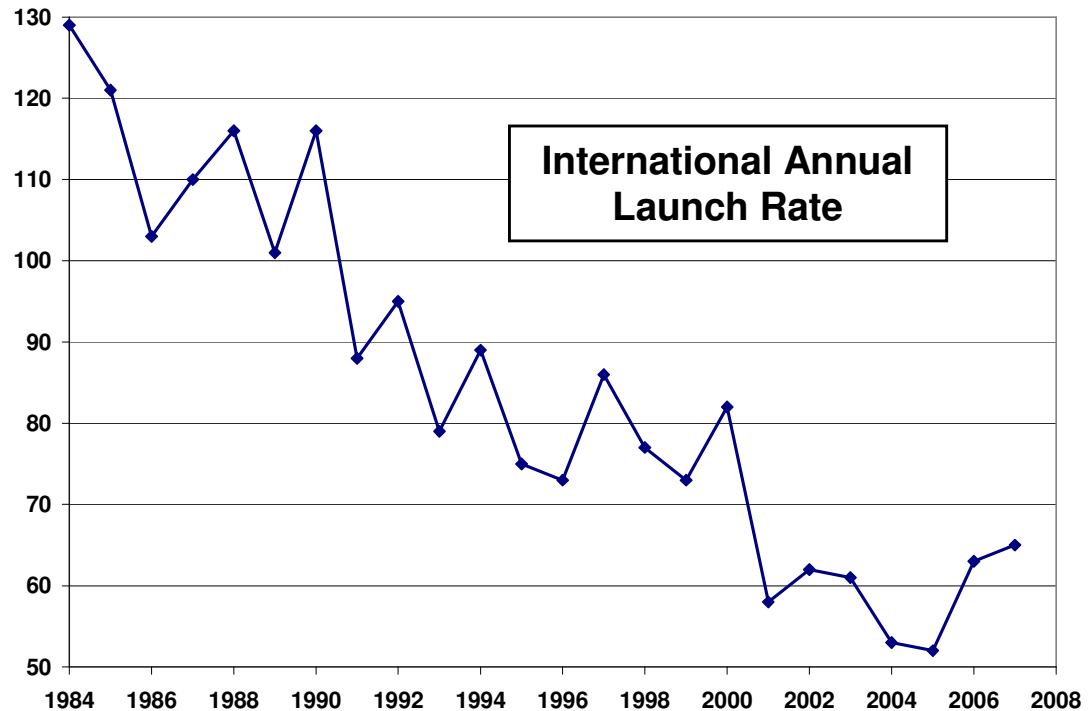
- **Satellite Launches and Reentries in 2007**
- **Change in LEO Environment**
- **Collision Avoidance**
- **Retirement of USA GEO Spacecraft in 2007**
- **Satellite Fragmentations in 2007**
- **New NASA Orbital Debris Mitigation Requirements and Standards**
- **New ISS Jettison Policy**



# Satellite Launch Traffic in 2007

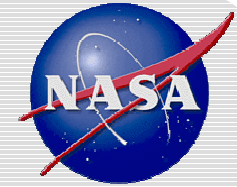
- The number of world-wide space launches in 2007 to reach Earth orbit or beyond was :

- Russian Federation 25
- USA 18
- China 10
- France 6
- India 3
- Japan 2
- Israel 1

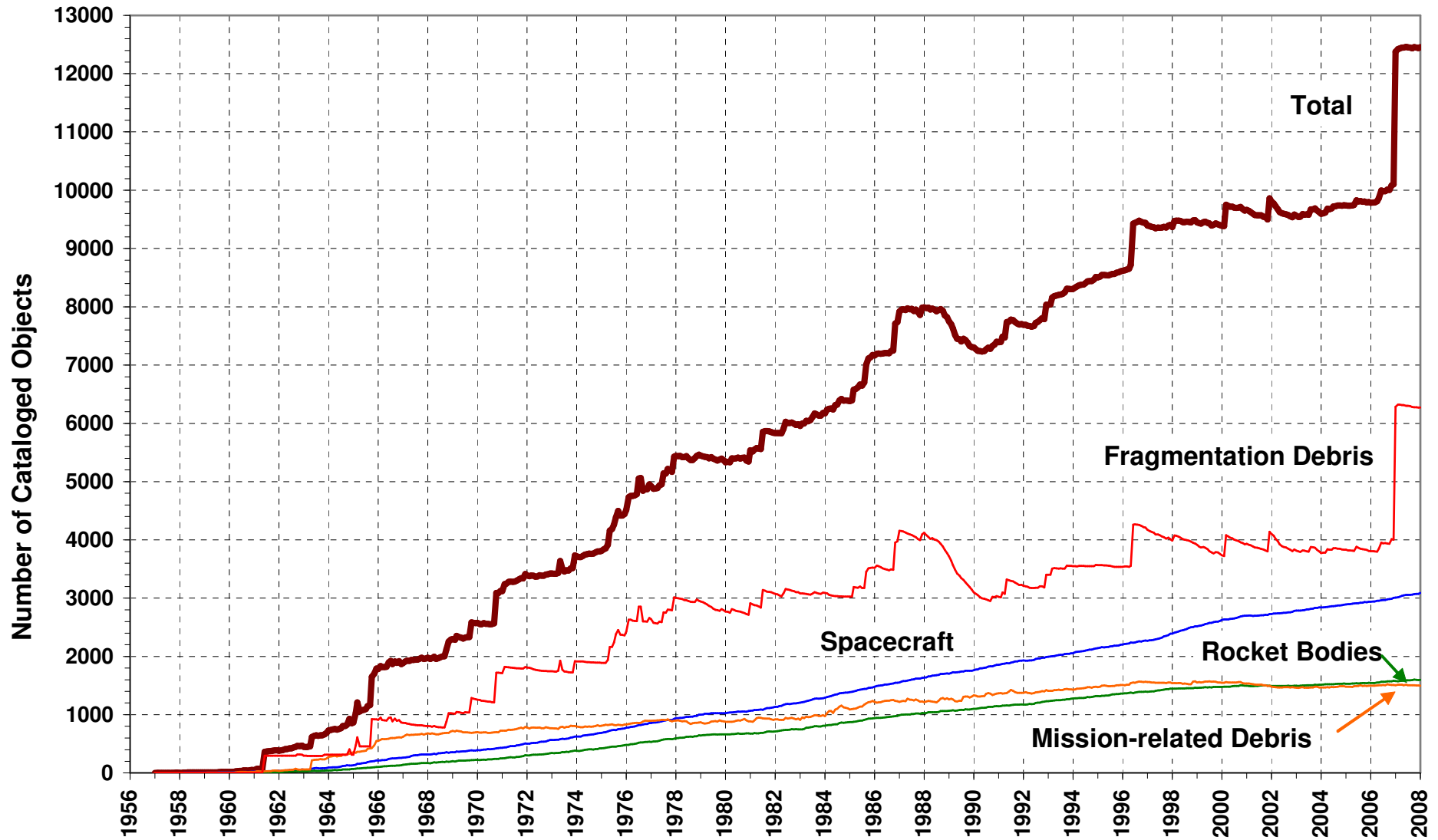


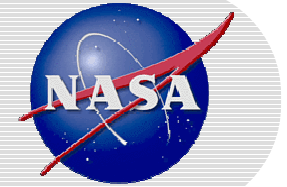
- Cataloged Objects in Earth Orbit (from USA Space Surveillance Network):

	<u>Total</u>	<u>USA</u>
1 January 2007	9944	4070
1 January 2008	12456	4200



# Historical Growth of the Large Earth-Satellite Population



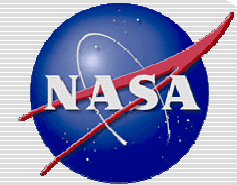


## NASA Space Missions of 2007

- **Seven NASA space missions were undertaken in 2007.**

<b>Mission</b>	<b>Launch Date</b>	<b>Destination</b>	<b>Other Objects Left in Earth Orbit</b>
THEMIS (5 probes)	17 February	Elliptical Earth Orbit	Two rocket bodies; one already reentered
AIM	25 April	LEO	One rocket body
STS-117	08 June	LEO (ISS)	No objects left in Earth orbit
Phoenix	04 August	Heliocentric Orbit	One rocket body
STS-118	08 August	LEO (ISS)	No objects left in Earth orbit
DAWN	27 September	Heliocentric Orbit	One rocket body
STS-120	23 October	LEO (ISS)	No objects left in Earth orbit

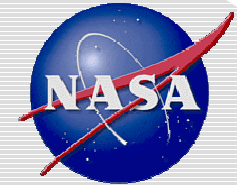
- **All spacecraft, rocket bodies, and mission-related debris residing in or passing through LEO have already reentered or will reenter within 25 years.**



## Reentry of Satellites in 2007

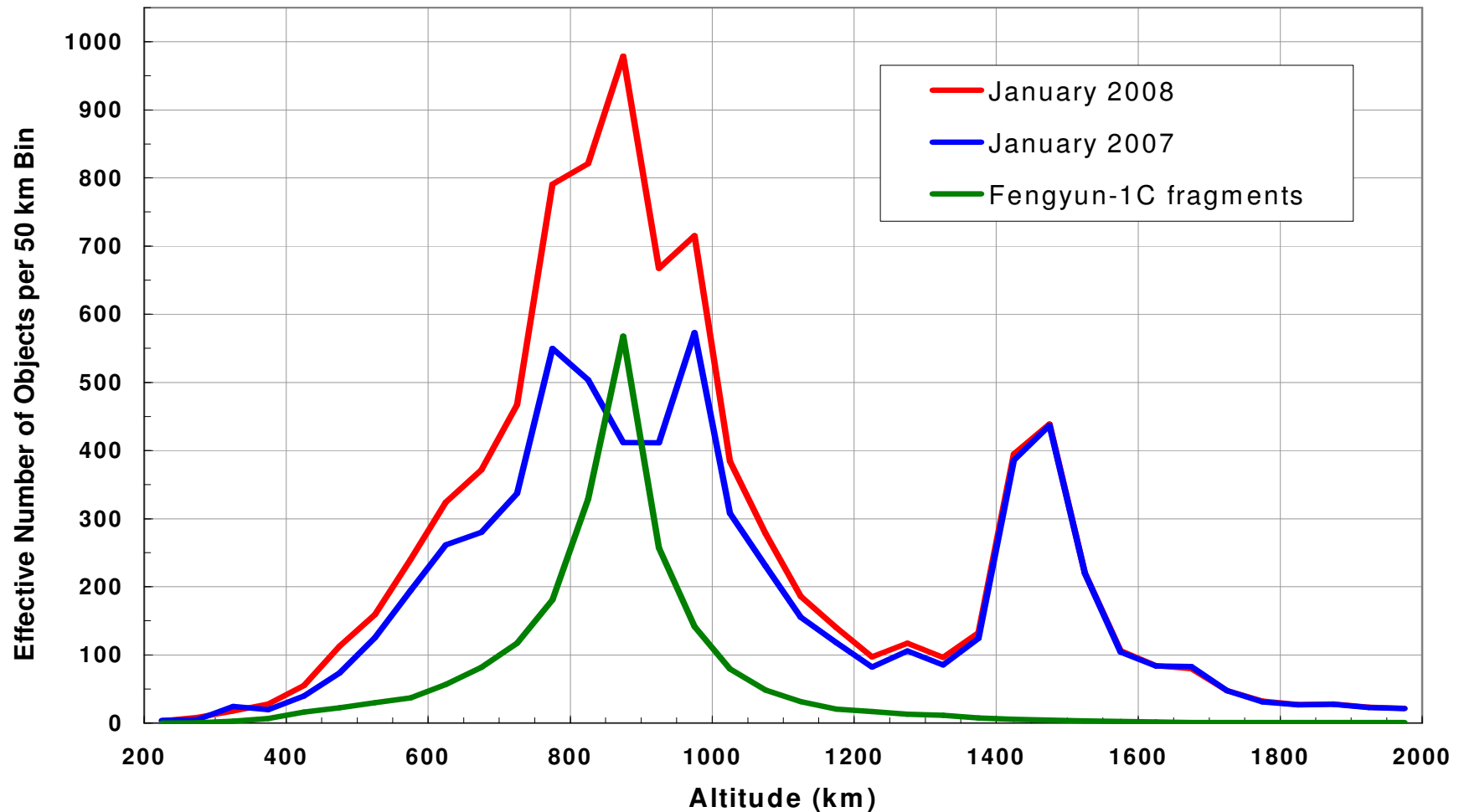
- Due to continued low solar activity, the number of known satellite reentries remained below average in 2007.
- A total of 171 spacecraft, launch vehicle orbital stages, and other cataloged debris reentered during the year.
- The total number of uncontrolled reentries was 159, including 13 payloads and 34 launch vehicle orbital stages with a total mass of about 70 metric tons.

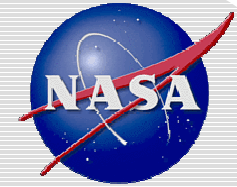
**No instances of injuries or property damage were reported.**



## Change in LEO Environment

- The destruction of the Fengyun-1C spacecraft in January 2007 has resulted in a major, long-term increase in the LEO satellite population.





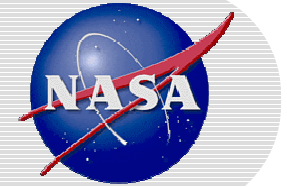
## Orbital Debris Collision Avoidance

- **NASA continues to conduct satellite conjunction assessments on a routine basis to avoid accidental collisions with resident space objects.**
- **Each of the eleven Earth Observation System (EOS) spacecraft (altitude 705 km) average 2 conjunctions per month within 1 km and nearly 1 conjunction per month within 500 m**
- **Four EOS collision avoidance maneuvers were conducted during 2007:**

Spacecraft	Maneuver Date	Object Avoided
<b>PARASOL</b> (France)	16-Jan-2007	Unknown debris
<b>SAC-C</b> (Argentina)	16-Feb-2007	Cosmos rocket body debris
<b>Terra</b> (USA)	22-Jun-2007	Fengyun-1C debris
<b>Cloudsat</b> (USA)	4-Jul-2007	Sinah 1 spacecraft







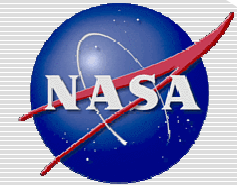
## Disposal of USA Satellites in 2007

- **Three former or current USA civil GEO spacecraft completed operations in 2007.**

Spacecraft	International Designator	Minimum Height above GEO	Maximum Height above GEO
SATCOM C-4 *	1992-057A	350 km	365 km
DIRECTV 2	1994-047A	430 km	500 km
GOES 9	1995-025A	410 km	430 km

\* Since 2006, SATCOM C-4 had been operated by SES Satellites Ltd (Gilbraltar)

**All spacecraft met USA, IADC, and United Nations recommendations for GEO disposal and will not come within GEO during the next 200 years.**

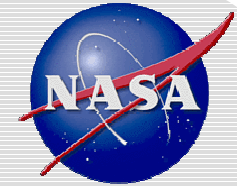


## Satellite Fragmentations in 2007

- **A total of 10 spacecraft and launch vehicle components experienced minor to severe fragmentations during 2007.**

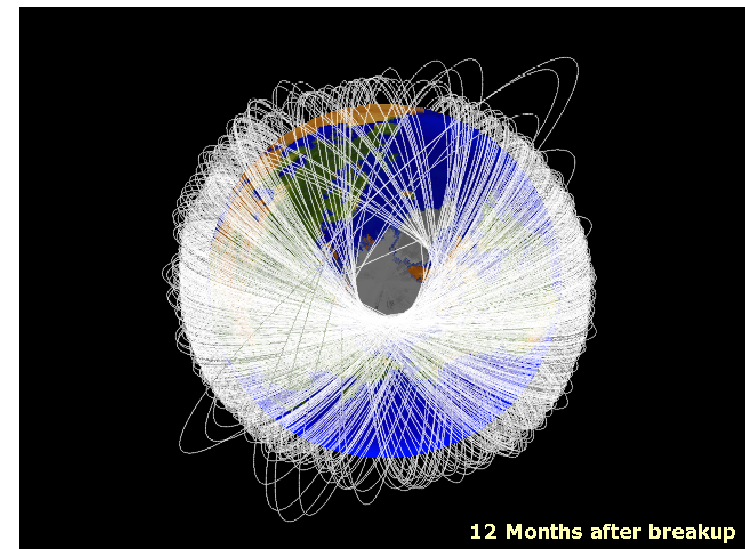
Type	Common Name	International Designator	Orbit Type	Debris Detected	Debris Lifetime
<b>Spacecraft</b>	ISIS 1	1969-009A	High, eccentric	1	Long
	Seasat	1978-064A	Low, circular	1	Short
	UARS	1991-063B	Low, circular	4	Short
	Fengyun-1C	1999-025A	Low, circular	~2600	Moderate-Long
	CBERS 1	1999-057A	Low, circular	~25	Moderate
	Beidou 2A	2007-003A	High, eccentric	70-100	Short
<b>Launch Vehicles</b>	Proton Ullage Motor	1997-070F	High, eccentric	~60	Short
	Briz-M Stage	2006-006B	High, eccentric	~1000	Long
	H-2A Second Stage	2006-037B	Low, circular	~15	Short
	Delta 4 Second Stage	2007-054B	Low, eccentric	~25	Short-Moderate

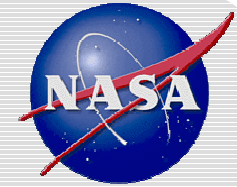
- **More than 3800 debris larger than 5 cm in diameter were detected, and more than half of these debris were in orbits with likely lifetimes of many years.**
  - 2007 was by far the worst year on record for the creation of large debris



## Destruction of Fengyun-1C

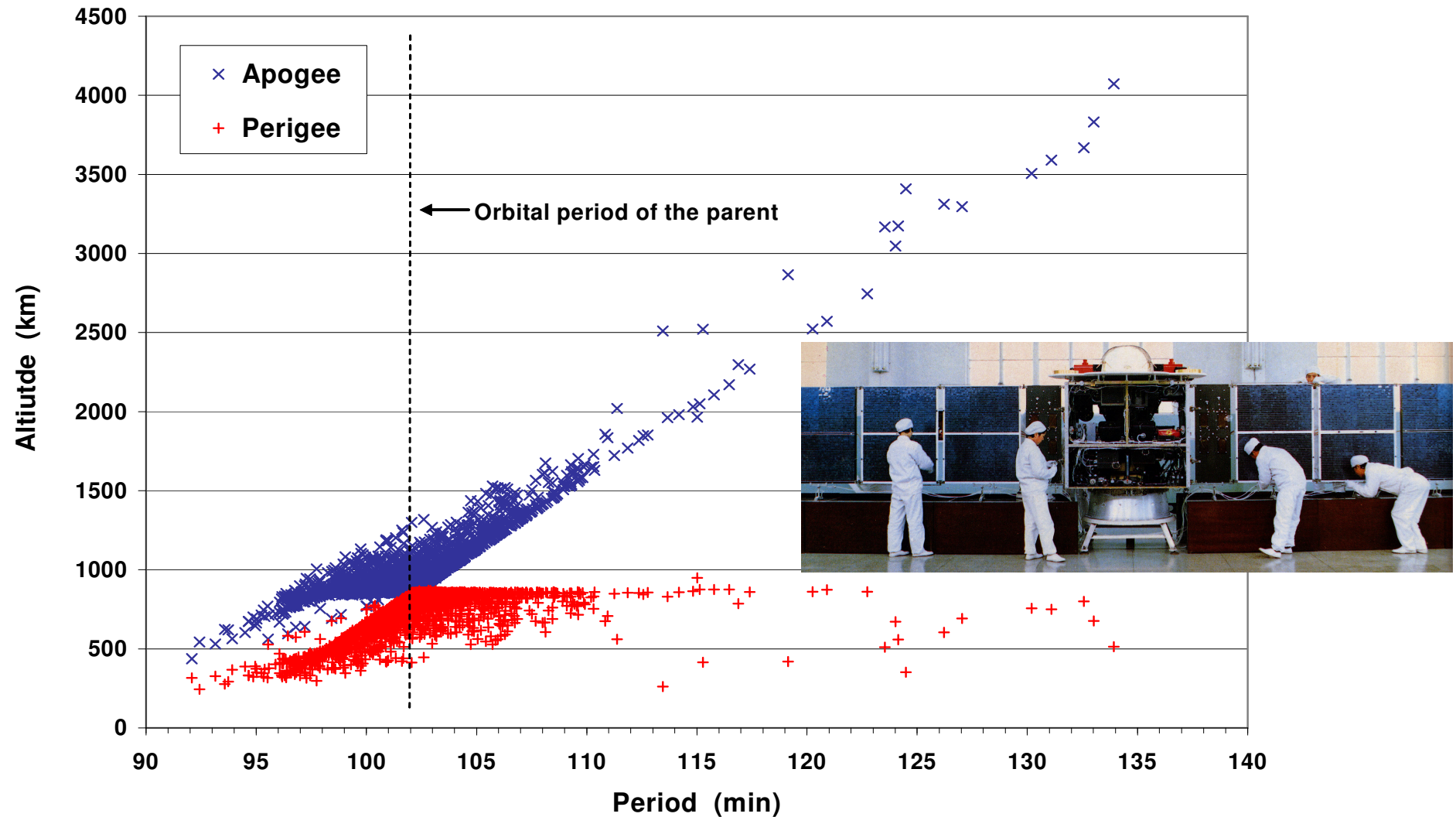
- **The destruction of the Fengyun-1C spacecraft by a ballistic interceptor on 11 January 2007 created the most severe orbital debris cloud in history.**
- **The USA Space Surveillance Network is currently tracking more than 2500 debris from this event.**
  - Only about 2 debris are reentering each month.
- **The assessed number of debris larger than 1 cm is currently ~125,000.**
- **At least two USA spacecraft conducted collision avoidance maneuvers in 2007 due to Fengyun-1C debris. A maneuver by the International Space Station was planned on one occasion to avoid debris from Fengyun-1C, but the maneuver was cancelled shortly before execution.**

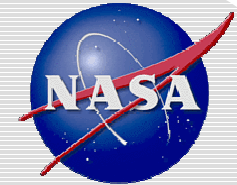




# Debris Distribution from Fengyun-1C

- Fengyun-1C debris is spread across the entire LEO region and beyond.





## Fragmentations of USA Satellites in 2007

- **Seasat (1978-064A)**

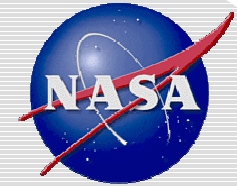
Since 1983 a small piece of debris has been released from Seasat (mission ended in 1978) on average every 1-2 years due to unknown reasons. A single piece of debris was released in April 2007. All debris are very short-lived.

- **UARS (1991-063B)**

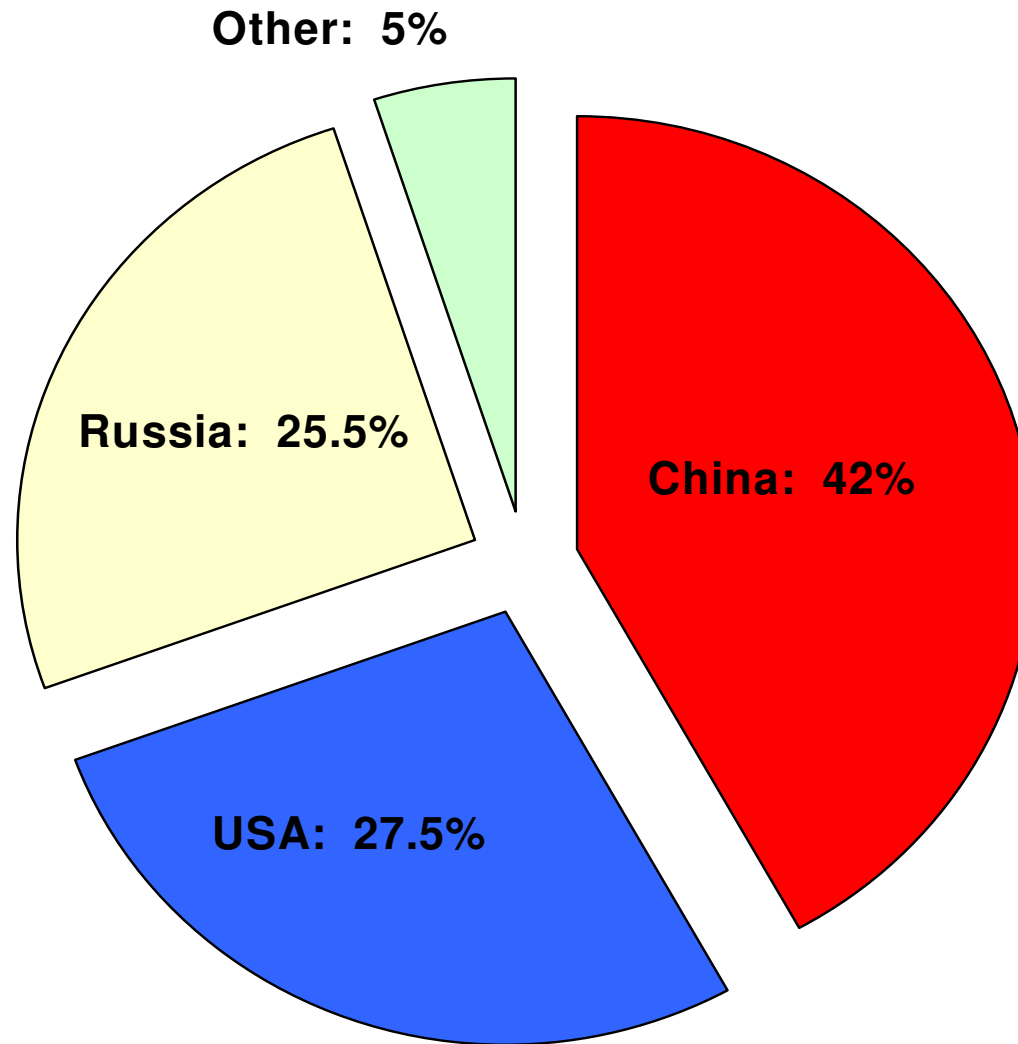
Four debris were released by UARS in November 2007, two years after the spacecraft had been passivated and shut-down. Two debris have already reentered, and the remaining two debris will be short-lived. Cause of debris release is unknown.

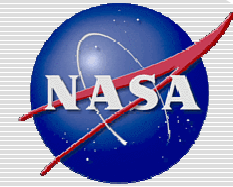
- **Delta IV second stage (2007-054B)**

Shortly after entering a low altitude parking orbit in November 2007, this Delta IV second stage released approximately two dozen debris. The event was similar to the previous Delta IV mission in November 2006. An investigation into the cause of the debris release is underway.



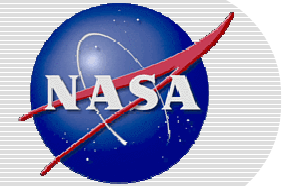
## On-Orbit Satellite Breakup Debris: 2008





# New NASA Orbital Debris Mitigation Requirements and Standards

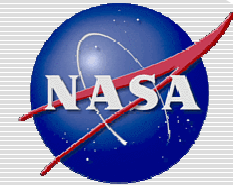
- **Effective 17 August 2007 a new NASA Procedural Requirements for Limiting Orbital Debris (NPR 8715.6) superseded NASA Policy Directive 8710.3B as the principal, top level agency guidance on orbital debris mitigation.**
- **NPR 8715.6 includes several new requirements:**
  - Formal End-of-Mission plans are required prior to launch and are to be up-dated during the mission as events warrant, e.g., in the case of spacecraft system degradations.
  - Prompt notifications are required in the event of intended or unintended generation of orbital debris.
  - Vehicles flying to the Moon, Mars, and Earth-Sun Lagrangian points are now addressed.
  - Routine conjunction assessments required for all maneuverable spacecraft in LEO and GEO.



## **New NASA Orbital Debris Mitigation Requirements and Standards (continued)**

- **Also in August 2007, NASA Standard 8719.14 replaced NASA Safety Standard 1740.14 as the source of detailed orbital debris mitigation requirements for each NASA space program or project.**
- **No major new requirements added, but noteworthy changes include**
  - Disposal orbits of GEO spacecraft must not come within GEO + 200 km for at least 100 years.
  - Spacecraft are limited to 25 years in LEO after mission termination but no more than a total of 30 years after launch.
  - Potentially injurious reentering debris defined as having kinetic energy of 15 Joules or greater.
  - Human casualty risk from reentering debris now evaluated by explicit probability of injury rather than debris casualty area. Desired limit of risk remains 1 in 10,000 per reentry event.





## New ISS Jettison Policy

- **In March 2007 the Program Manager for the International Space Station approved a new ISS Jettison Policy.**
- **The intentional jettisoning of objects from ISS is discouraged but will be considered if**
  - an object poses a safety issue for return onboard a visiting vehicle;
  - an object negatively impacts ISS utilization, return or on-orbit stowage manifests;
  - an object represents an Extra-vehicular Activity (EVA) timeline savings; or
  - an object is designed for jettison.
- **Jettisoned objects should**
  - be trackable by the USA Space Surveillance Network;
  - not pose a risk of fragmentation prior to reentry of greater than 1 in 10,000;
  - not pose a human casualty reentry risk of greater than 1 in 10,000; and
  - not pose a collision hazard risk to either ISS or any visiting vehicles.
- **Objects released from ISS normally reenter with a few weeks or months and pose no long-term threat to the space environment.**