

Space Debris

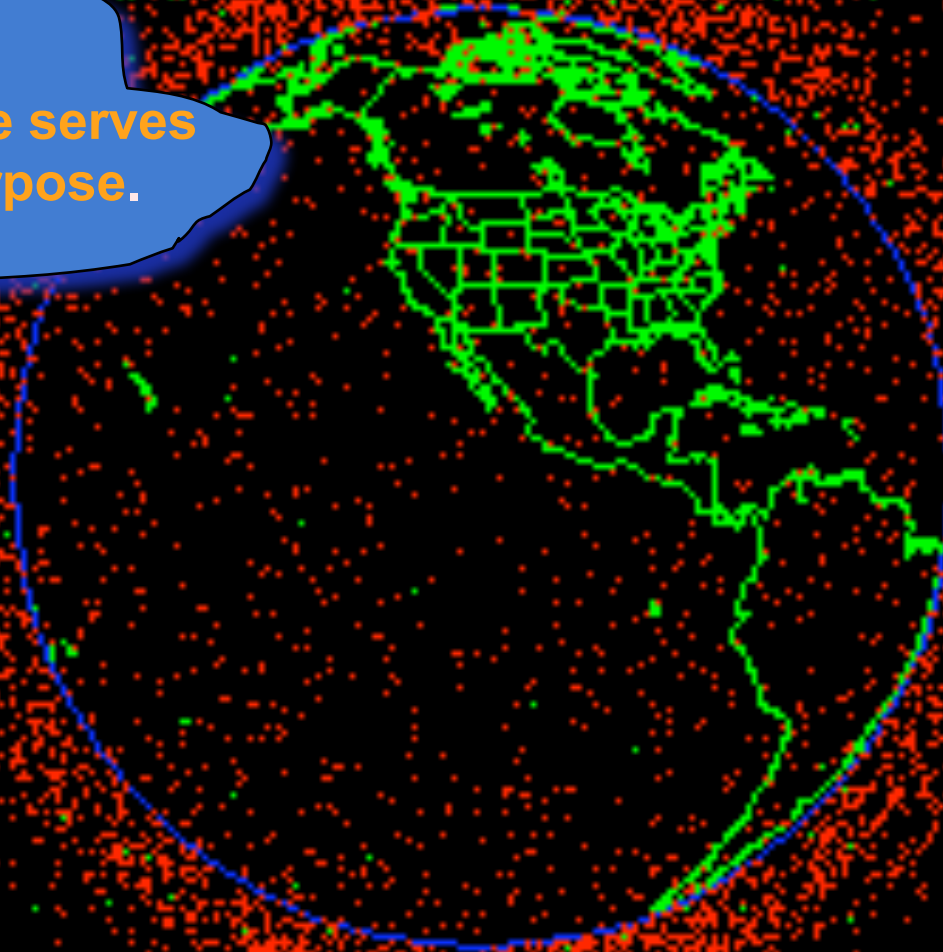
Jussi Markkanen EISCAT

Jyrki Manninen SGO

Talk given by J Manninen for a meeting of Military Attachès in Sodankylä, March 2008.

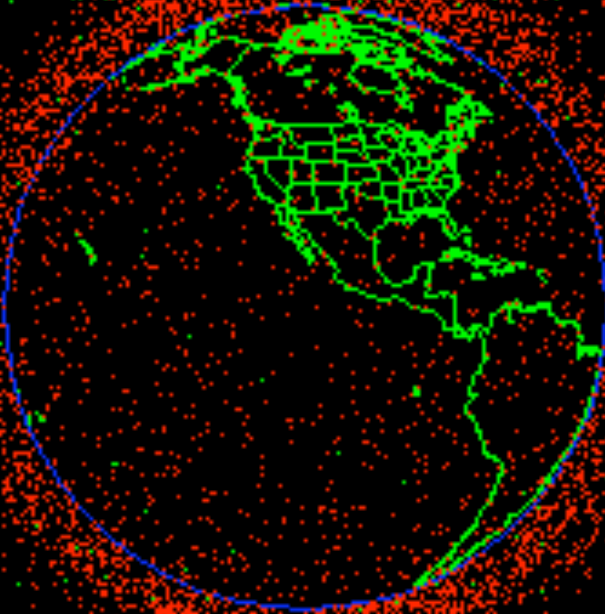
Space Debris

Space Debris
Orbiting stuff
which no more serves
any useful purpose.



Dec-1997

A global Environmental Problem



“Just 50 years ago there was nothing
but pristine, inky space ---
and now it’s messier than a freshman’s dorm room.”

Chris Kemp, CityBeat, Jun 2001

Where's the beef ?

KEW



LOSAT

Where's the beef ?

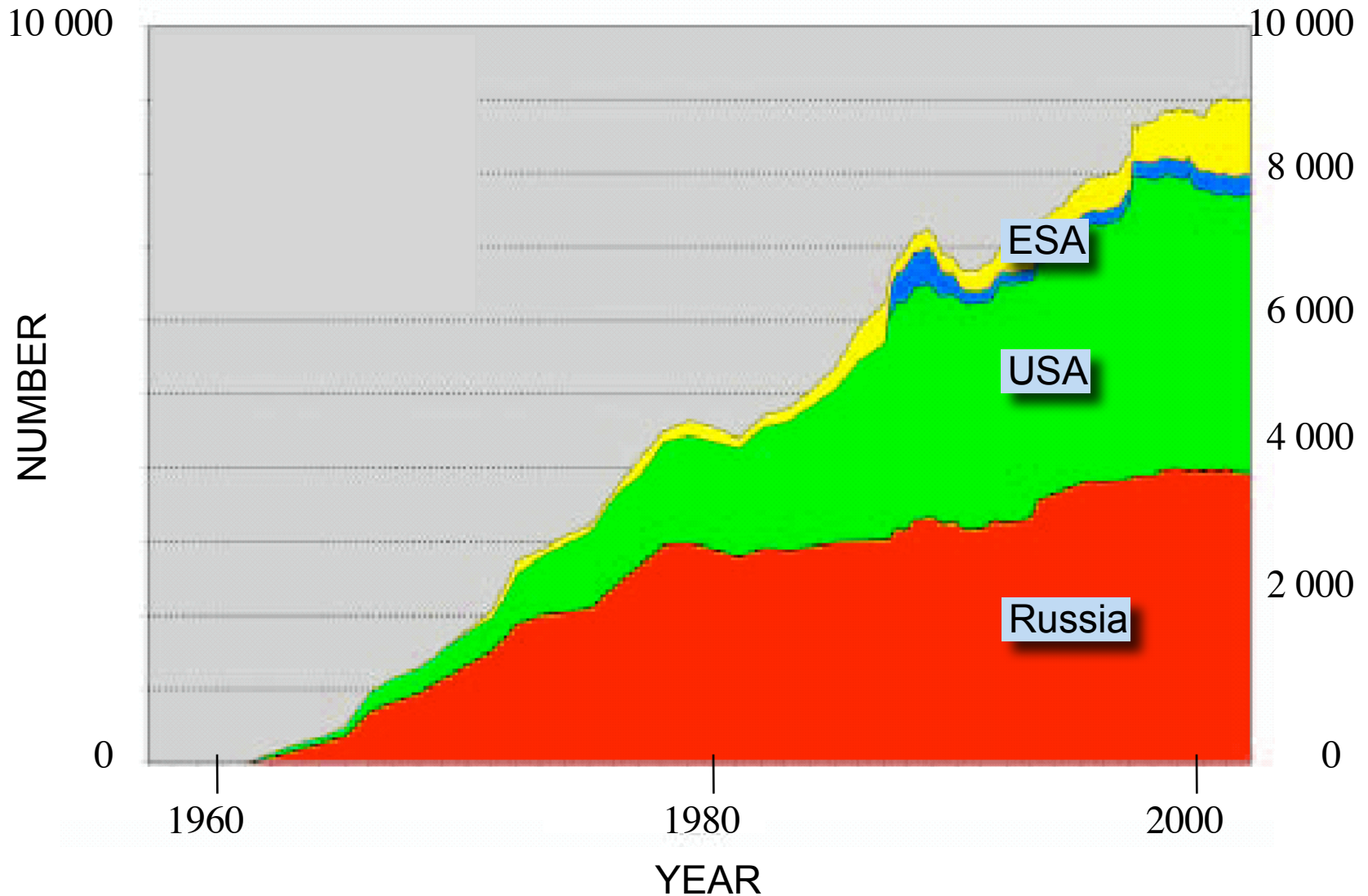


4g + 10 km/s = 50 kcal

Large-sized (>10 cm) space objects are routinely monitored and catalogued, among others, by USSTRATCOM.

At the end of 2007, their catalog contained about 12 500 objects. Only about 600 of these are functional satellites.

Number of catalogued objects in orbit

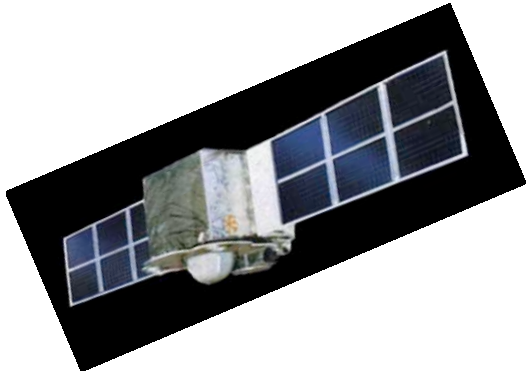


ESA Bulletin 109, Feb 2002

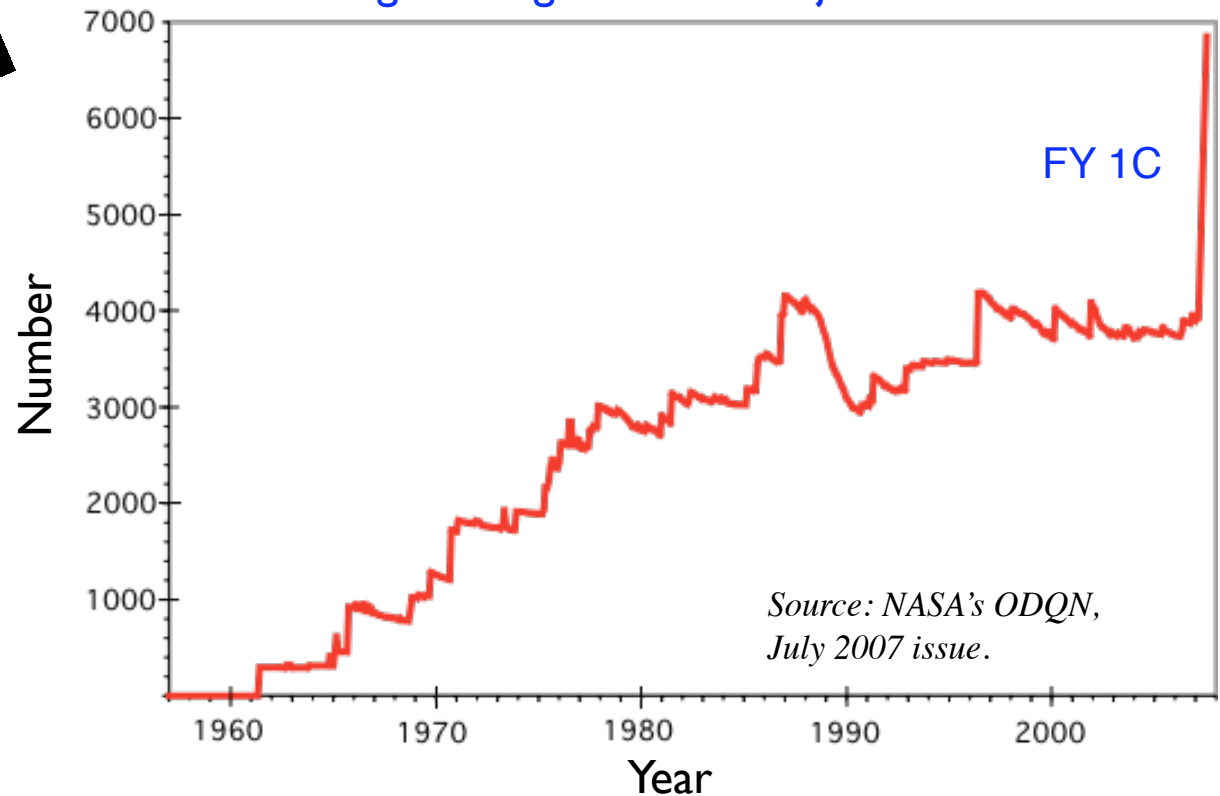
Year 2007 was
a catastrophic year
(also)
in terms of
space debris
production.

Chinese anti-satellite (ASAT) test on Jan 11, 2007

11 Jan 2007 22:26 UT China destroyed (kinetic kill) with a missile their aging FengYun 1C- polar-orbiting weather satellite at an altitude of 863 km. This resulted in the most serious space debris event in history, injecting about 2300 catalogued-sized objects and perhaps 40 000 - 50 000 cm-sized fragments into a heavily used orbital region. The FY 1C debris will take several hundred years to rain down.



Time development of the number of catalogued fragmentation objects 1957-2007



EISCAT has measured space debris with its Tromso (930 MHz) and Svalbard (500 MHz) radars occasionally since the year 2000, originally by ESA initiative and funding.

EISCAT's space debris measuring system was developed in Sodankylä, by Markku Lehtinen et al.

EISCAT Svalbard radar - monitoring space debris (almost) continuously during the International Polar Year



- ❖ The IPY debris measurement started 11 March 2007 and finished 28 Feb 2008.
- ❖ More than 5000 hours of measurement gave more than 200 000 target observations.
- ❖ Daily results summaries freely available in: <http://www.sgo.fi/~jussi/spade/ipy/>
- ❖ The FY 1C debris ring was very clearly visible throughout the campaign period.

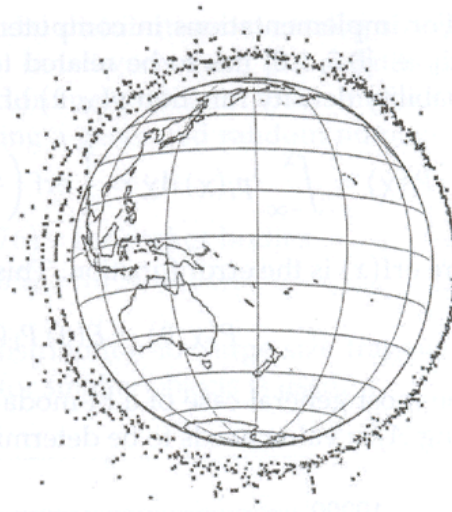
Spreading of debris after a typical fragmentation event (model calculation)

Assumed: Spherically symmetric breakup on an altitude 800 km, inclination 98.7° orbit.

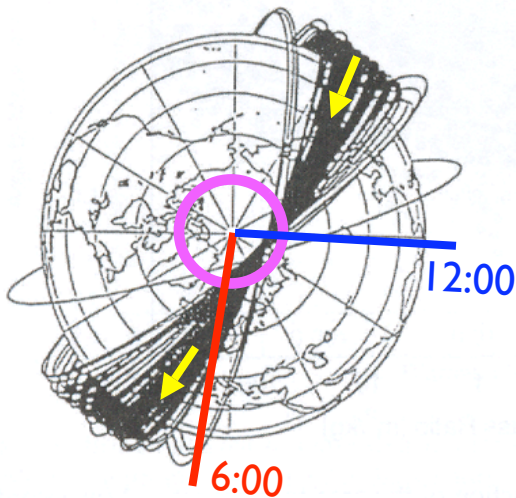
Source: H. Klinkrad, Space debris, Models and Risk Analysis, p. 72.



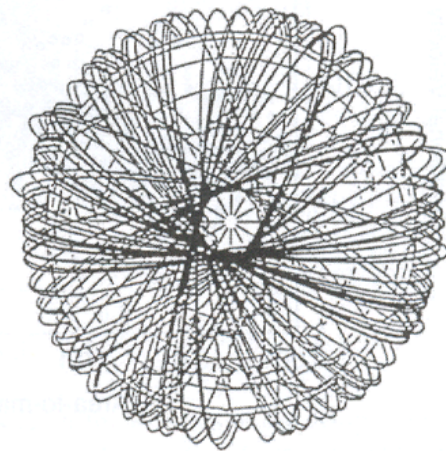
after 1 orbit



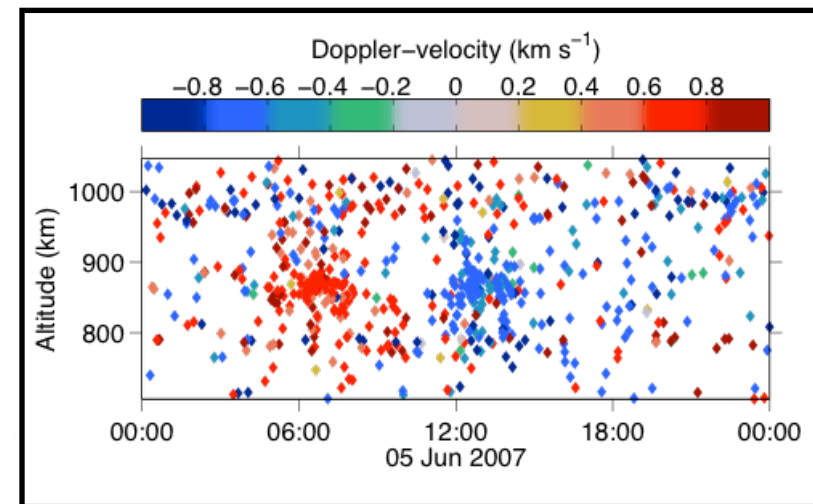
after 20 orbits



after 3 months

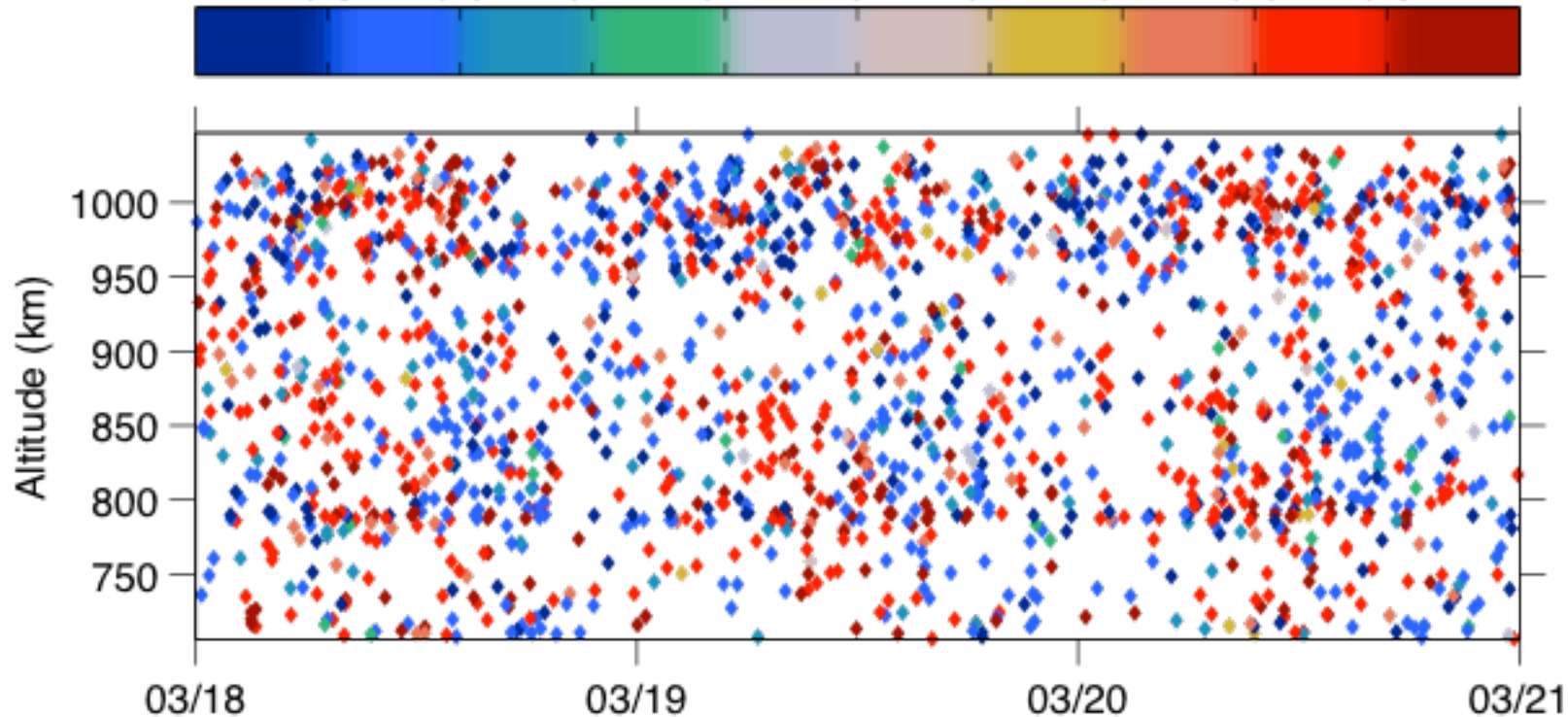


after 4 years

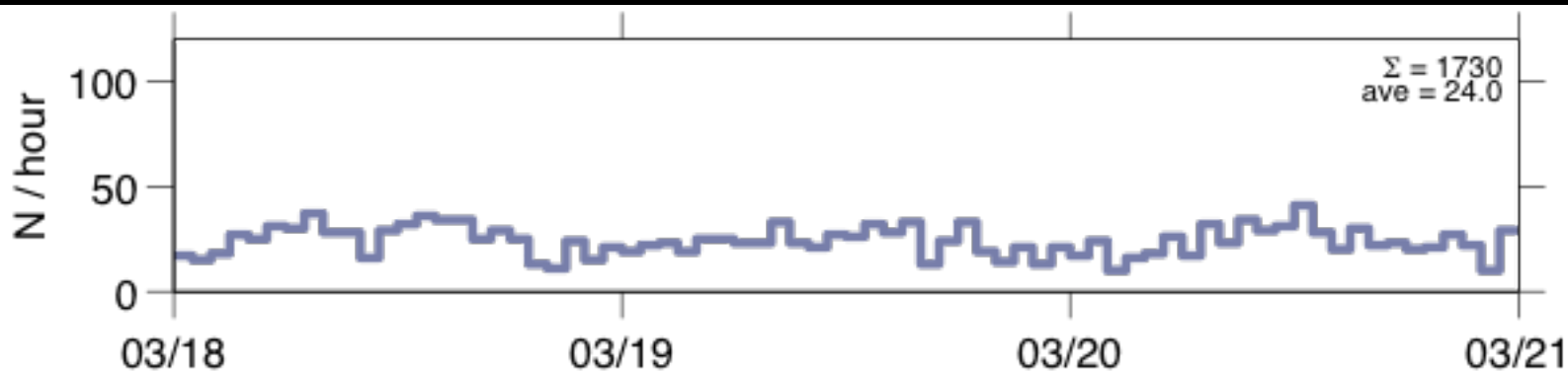


Doppler-velocity (km s^{-1})

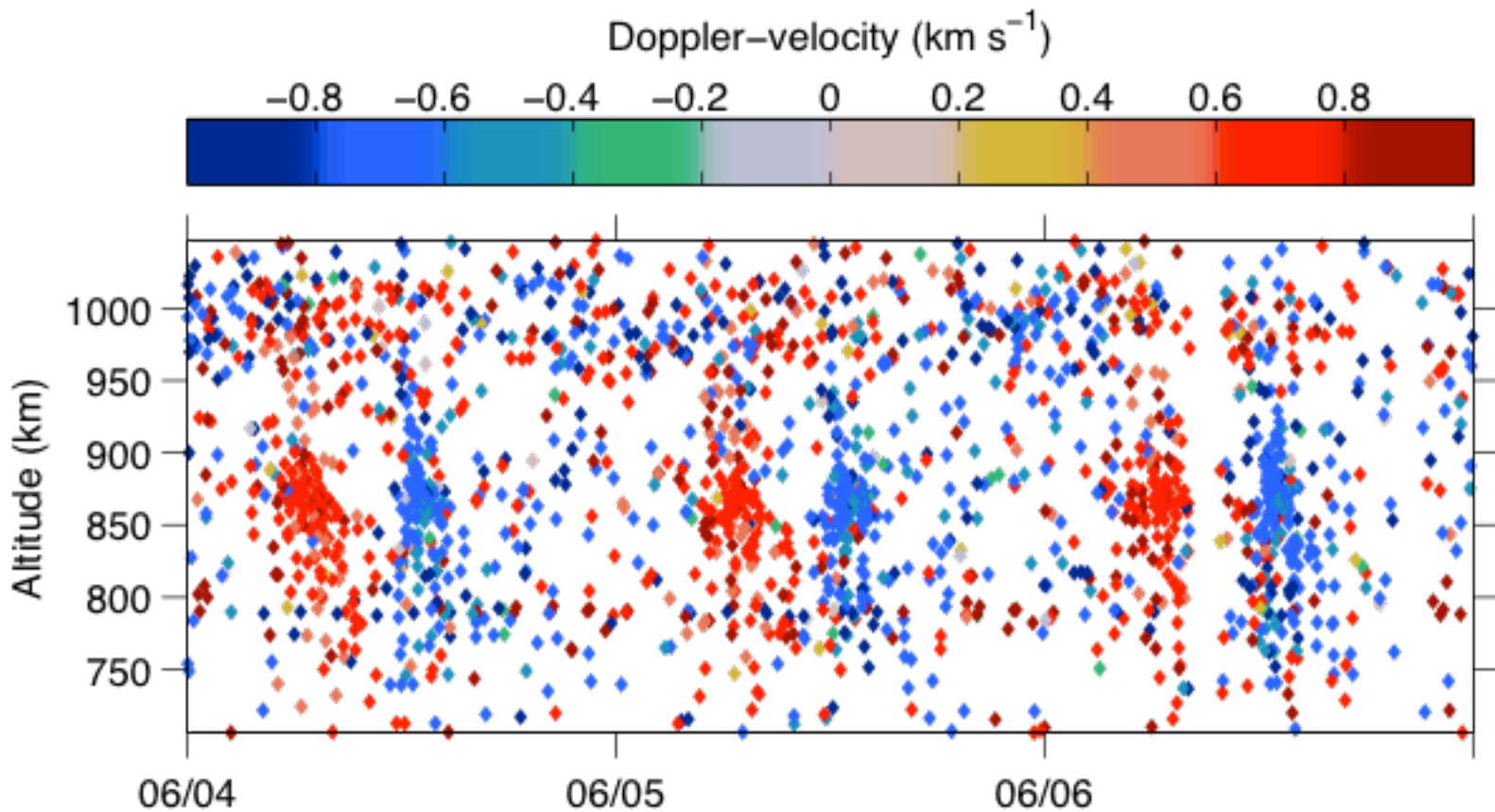
-0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6 0.8



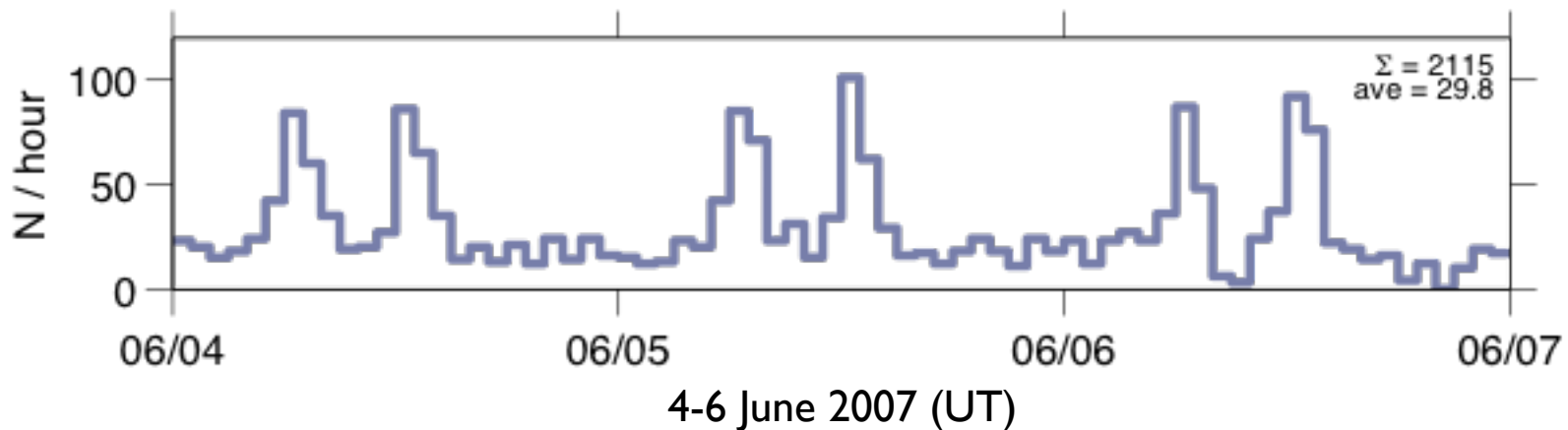
Three days of ESR observations before the FY IC ASAT



18-20 March 2006 (UT)

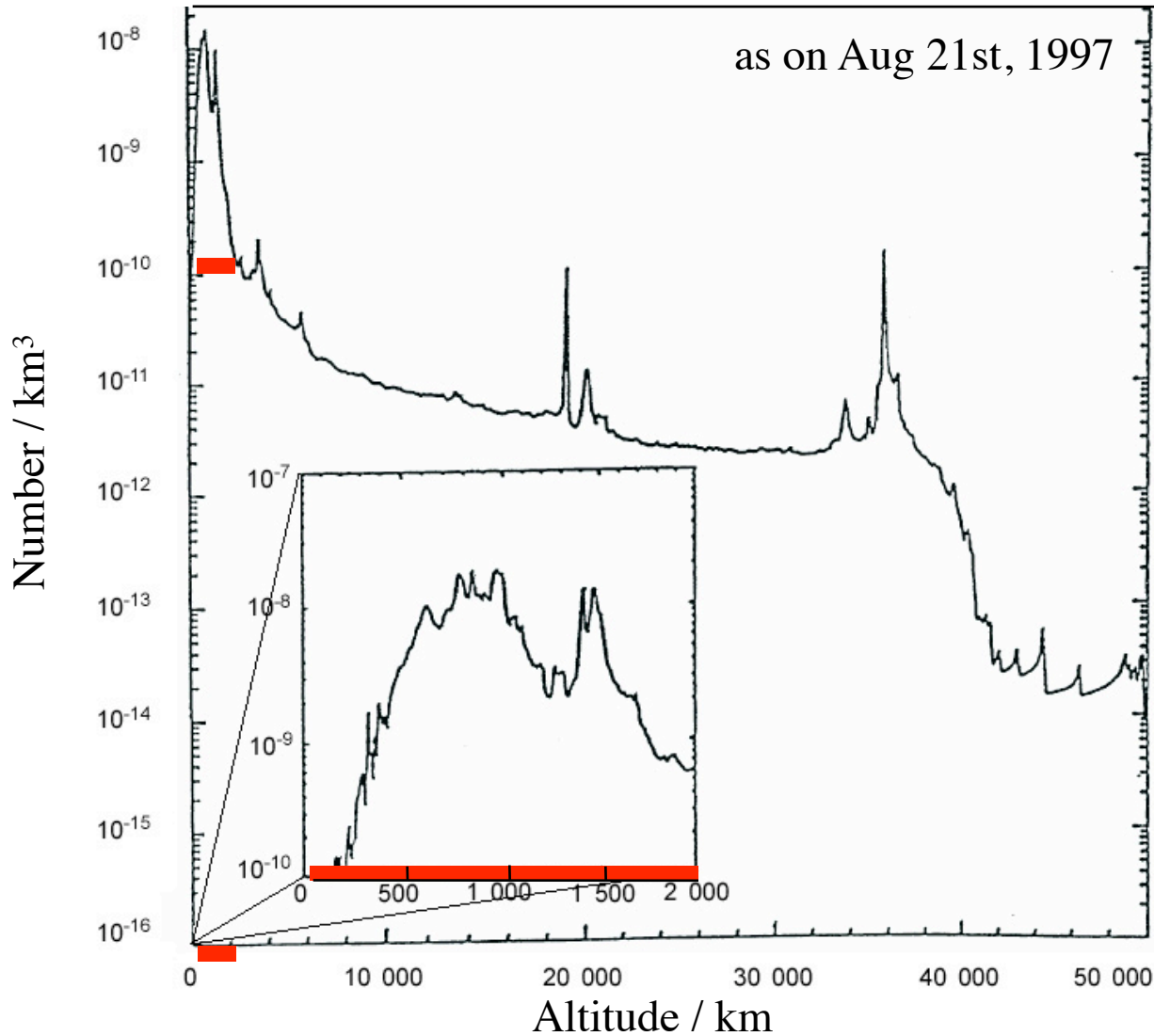


Three days of ESR observations after the FY IC ASAT



The FY IC fragmentation occurred in the most heavily used orbital region, which already contained a lot of debris.

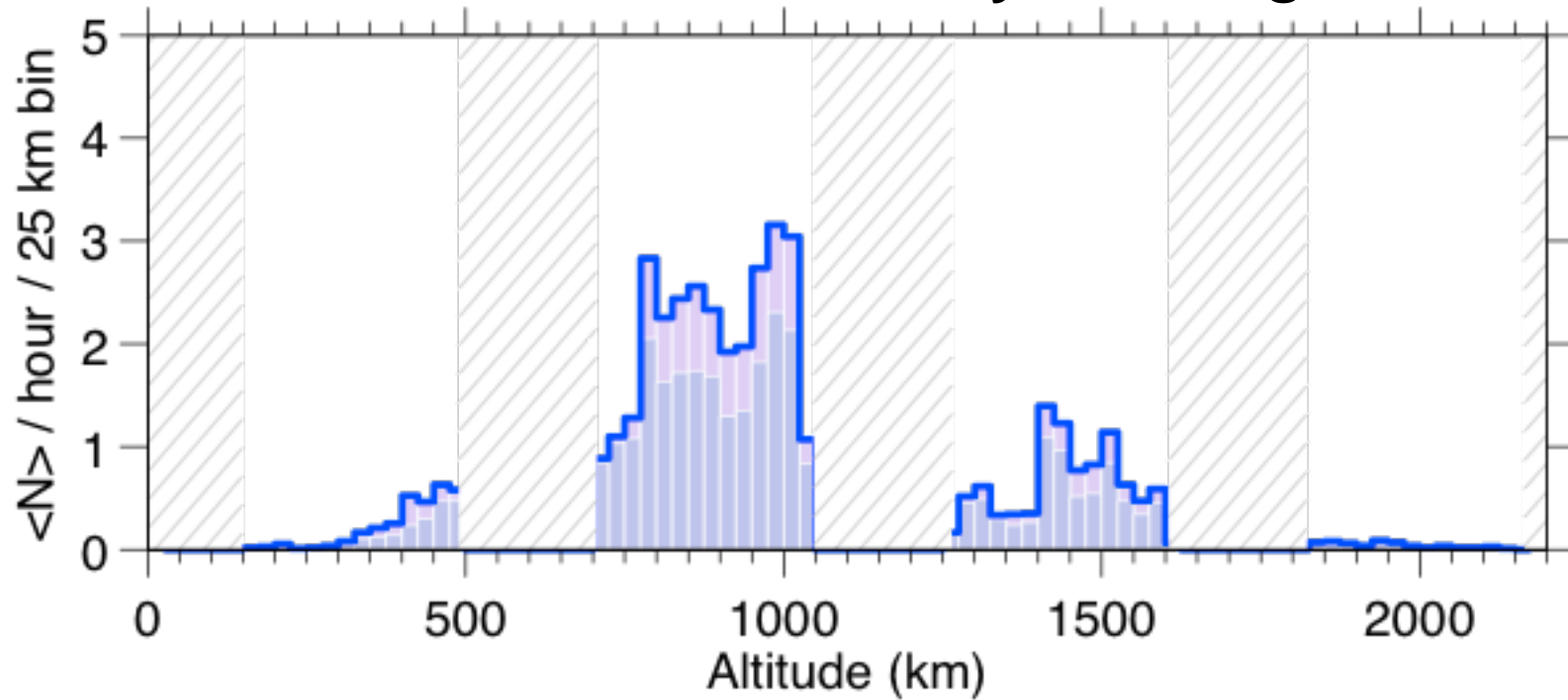
Altitude distribution of catalogued objects



Source:
UN, 1999

Mean event rate as function of altitude

ESR, 30 Jul - 5 Aug 2007



Given long enough time,
atmospheric drag slows down
orbital stuff, and the stuff will
ultimately fall down.

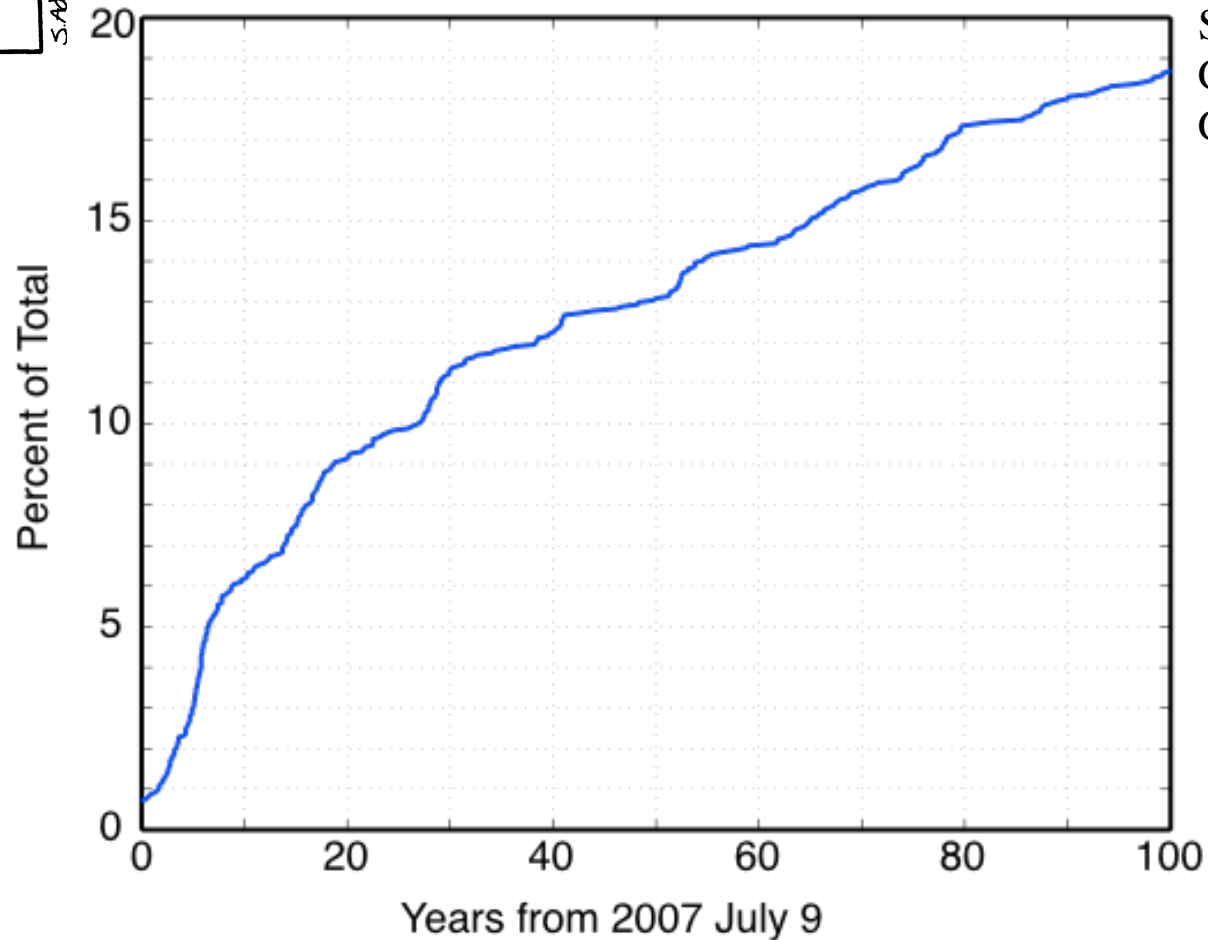
MOST PROBLEMS GO AWAY IF YOU WAIT LONG ENOUGH, ASOK.



S. Adams

How long is long enough ?

Lifetime Plot of FENGYUN 1C Debris
(1933 pieces)



Source:
CelesTrack/
CSSI