ΠΛΑΝΗΤΕΣ Could Be a True Story?
– Instability of the Current Debris Population in LEO –

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What is ΠΛΑΝΗΤΕΣ?

人類が宇宙で生活をするのが当たり前となった2075年。

長年にわたる宇宙開発で廃棄されてきた人工衛星などの「スペースデブリ(宇宙ごみ)」が、人間の生活を脅かすようになっていた。

星野八郎太（愛称ハチマキ）は、そんなデブリを拾い集める回収員の一人。姉御肌の船長フィー、失敗ばかりの新人タナベ、そして、寡黙な船員ユーリと共にデブリを回収する日々を送っていた。

ある時、ハチマキは仲間に心を閉ざし続けるユーリに苛立ちをおぼえ衝突する。

しかし、ユーリには仲間だからこそ打ち明けたくない秘密があったのだ。

７年前の高高度旅客機事故。ユーリの運命を大きく変えたのは、たった一つの小さな「スペースデブリ」だった。

Background

- A new WG2 study, “Benefits of Active Debris Removal on the LEO Debris Population,” was defined at the 26th Inter-Agency Space Debris Coordination Committee (IADC) meeting
- Possible activities
  - Reach a consensus on the stability/instability of the current debris population in LEO
  - Conduct parametric studies on the effectiveness of ADR
  - Compare results from different environment models
- The study is a new WG2 Internal Task, with the potential of converting it to an Action Item after 1 year
- Short-term goal: complete the LEO environment simulations and present the comparison results at the 27th IADC meeting

Participating Agencies and Models

Agency	NASA	ASI	BNSC	ESA	JAXA
POC	J.-C. Liou	A. Rossi	H. Lewis	H. Krag	T. Hanada
Model (version)	LEGEND (N/A)	SDM (4.0)	DAMAGE (N/A)	DELTA (3.01)	LEODEEM (1.1)

Schedule and Milestones

4 Nov 2008:	Provide input files to participating members
2 Feb 2009:	Provide simulation results to J.-C. Liou (NASA)
23 Feb 2009:	Provide the draft summary presentation to participating members for review
9 Mar 2009:	Provide the final summary presentation to participating members for review
26 Mar 2009:	Present the summary at the 27th IADC meeting

Inputs Files

(1) iadc_01012006.pop

Provided by: H. Krag (ESA)

Information: This file includes all 10 cm and larger LEO-crossing (perigee altitude below 2000 km) objects on 1 January 2006. The population is generated from the MASTER2005 model. Each object is individually listed in the file. The parameters are explained in the first 5 lines of the file.

(2) solar_flux_f107 HL 20081020.dat

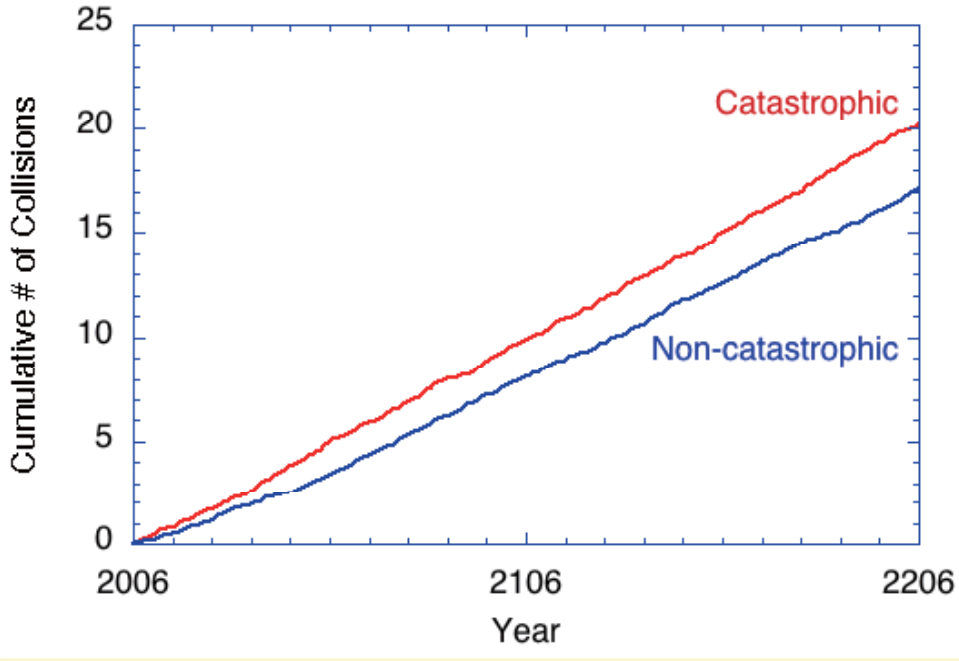
Provided by: H. Lewis (BNSC)

Information: This is the solar flux F10.7 table between January 2005 and December 2207.

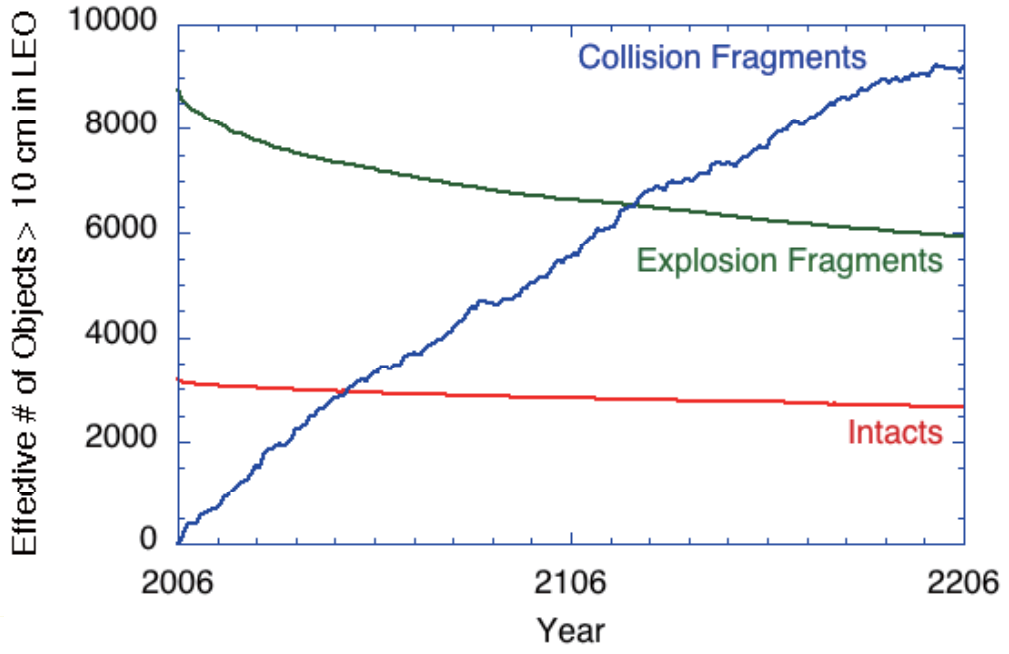
Test Scenario

- Use objects in iadc_01012006.pop as the initial population for future projection
- Set the initial epoch to 1 January 2006
- Carry out future projection for 200 years
- Use BNSC's solar flux table for drag calculation
- Allow no new launches beyond 1 January 2006
- Set future explosion to 0
- Allow no station keeping
- Include objects 10 cm and larger in collision consideration
- Use the NASA standard breakup model to predict the outcome of collisions
- Run as many Monte Carlo (MC) simulations as possible

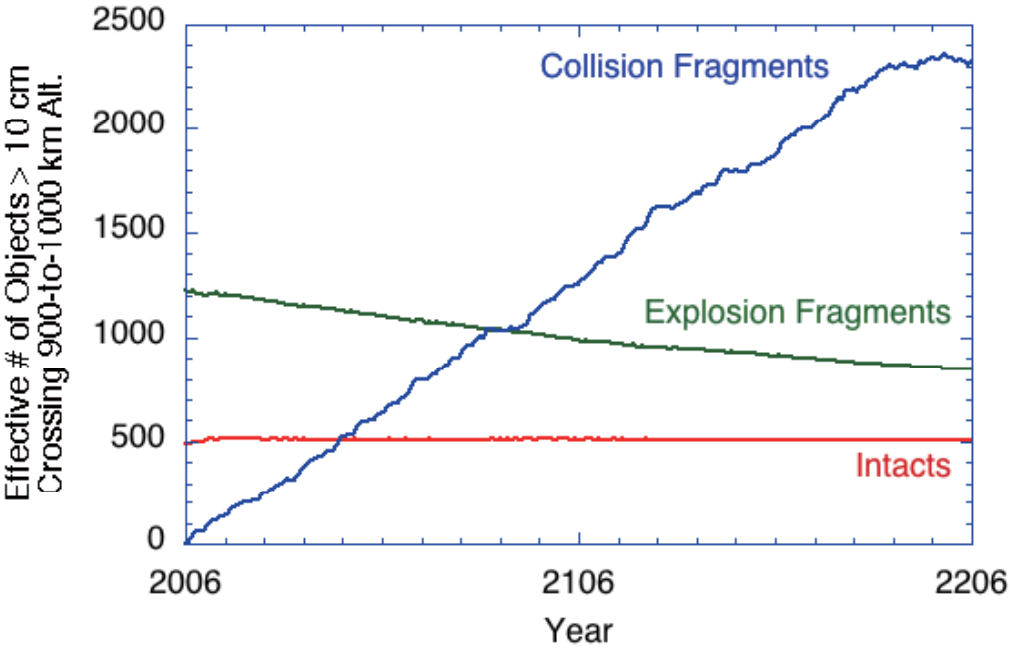
LEO Collision Activities



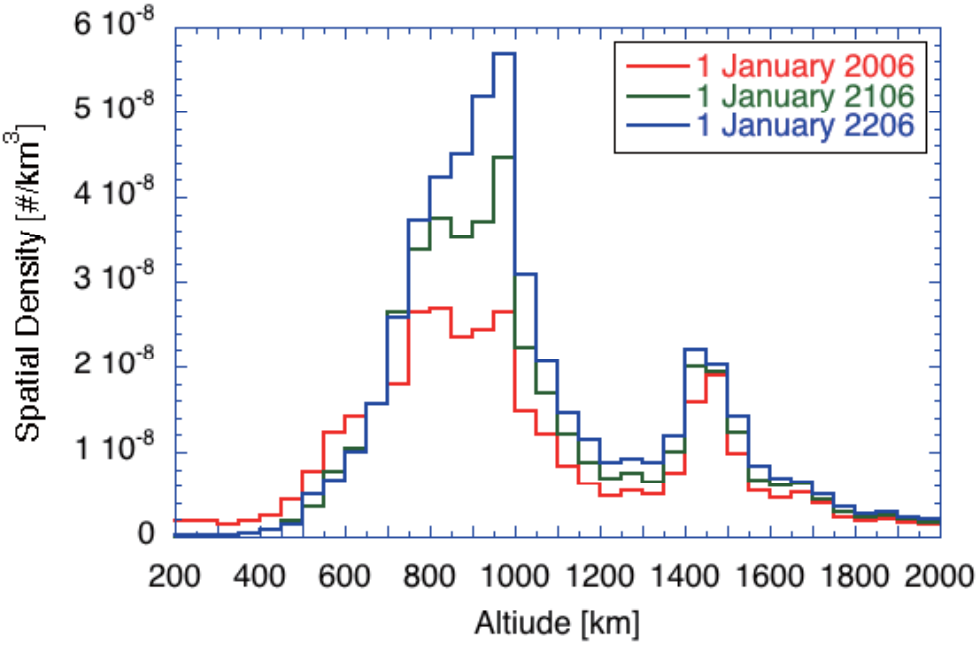
LEO Population Growth



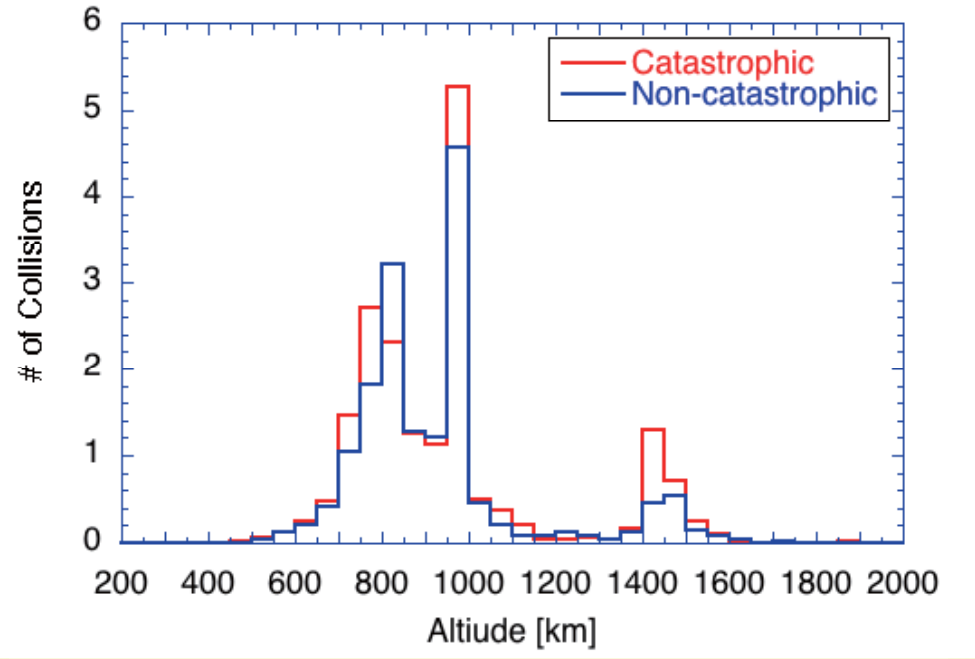
Population Between 900 and 1000 km



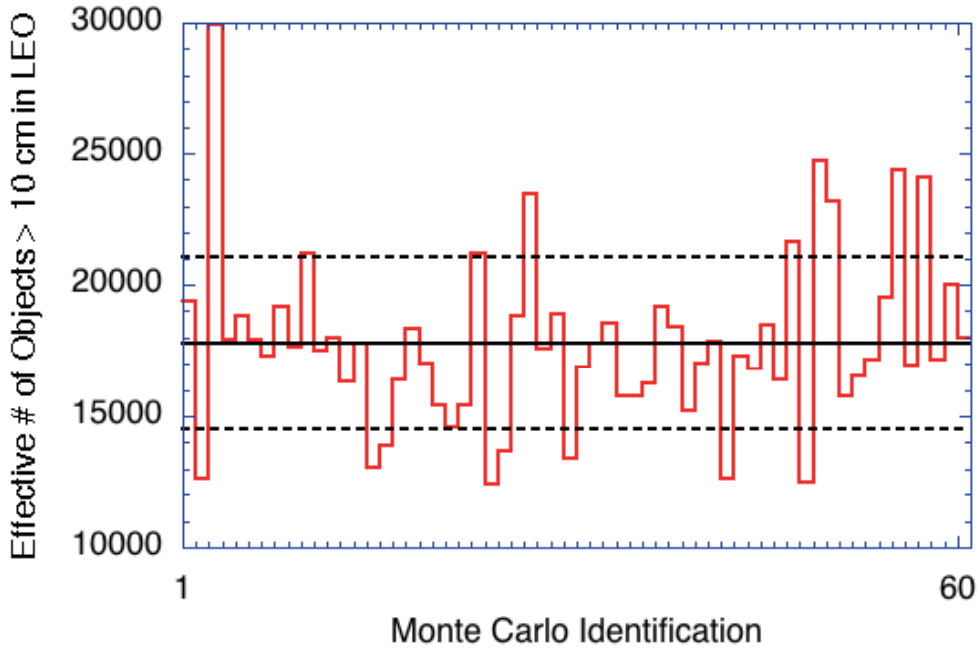
LEO Spatial Density



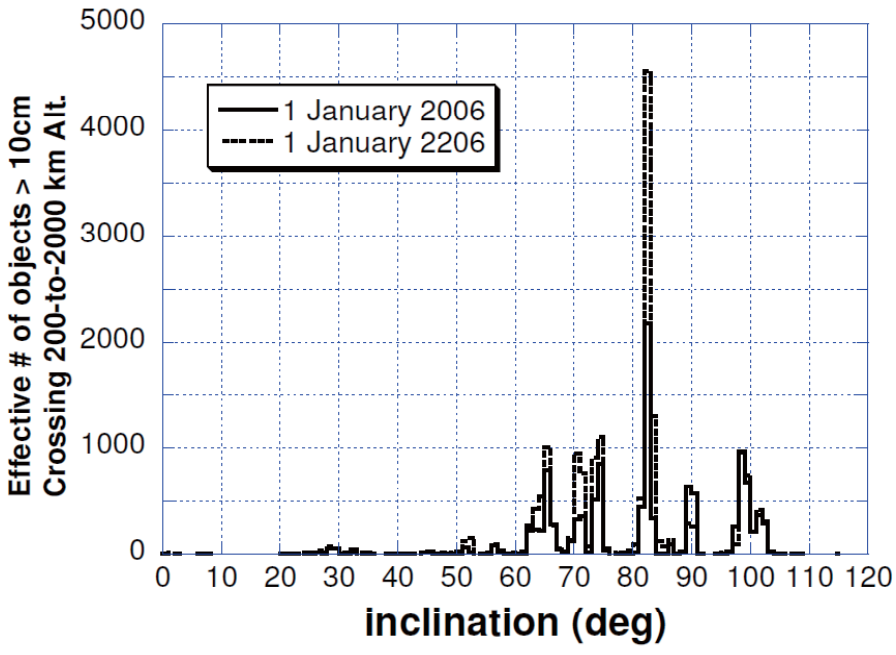
Collision Locations



Predictions by Individual MC Runs



Effective Number of Objects per 1 deg. Bin



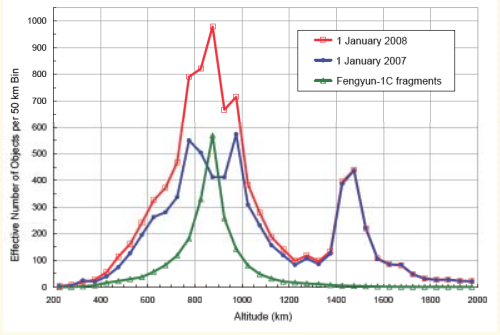
Summary

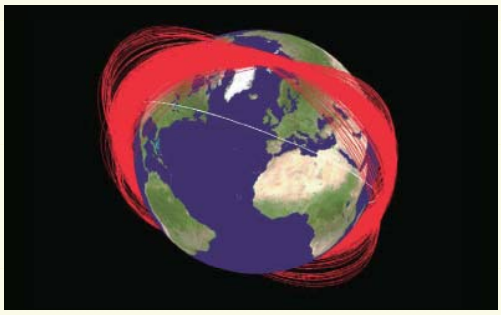
- The current debris population in LEO would continue to increase even with a good implementation of the commonly-adopted mitigation measures
- The present study (using the 2006 population as the initial condition and the “no future launches” assumption) represents an ideal best-case scenario
- In reality
  - more satellites have been launched since 2006 and will continue to be launched in the future
  - major breakups have added thousands of 10 cm and larger fragments to the environment since 2006
- It is recommended to
  - use the 1 January 2009 population as the initial condition,
  - repeat a reasonable 8-year launch traffic cycle in the future, and
  - implement the 25-year rule at the end of mission

Backup Slides

Chinese Anti-satellite Test

- Fengyun-1C spacecraft was used as a target on 11 January 2007 for the test of an anti-satellite (ASAT) system by China.
- Impacted by a direct-ascent interceptor at a speed of approximately 9 km/s at an altitude near 850 km, the spacecraft disintegrated, spreading debris throughout low Earth orbit (LEO) and beyond.
- By the end of the year 2007, the United States Space Surveillance Network (SSN) had officially catalogued 2,317 debris, of which only 22 had reentered the atmosphere.
- Figure at upper right compares the catalogued populations in January 2007 and January 2008.





IRIDIUM and COSMOS Accidental Collision

- IRIDIUM 33 (commercial communication satellite) and COSMOS 2251 (defunct communications rely station) ran into each other above northern Siberia on 10 February 2009
- They were traveling at a relative velocity of 11.6 km/sec
- Initial radar tracking detected some 600 pieces of debris
- Estimated number of fragments > 1 cm in diameter are > 62,000