Inter-Agency Space Debris Coordination Committee

Stability of the Future LEO Environment

Report of an IADC Study

50th Session of the Scientific and Technical Subcommittee

United Nations Committee on the Peaceful Uses of Outer Space

11-22 February 2013

Overview of IADC

The primary purpose of the IADC is

- to exchange information on space debris research activities between member space agencies,
- to facilitate opportunities for cooperation in space debris research,
- to review the progress of on-going cooperative activities and
- to identify debris mitigation options.

(IADC Terms of Reference, see http://www.iadc-online.org)

Study Objectives

- Since 2005 some IADC members have been studying the evolution of the far-term LEO satellite population under a variety of space debris mitigation scenarios.

- At its 27th meeting in 2009, the IADC adopted a new Action Item (AI 27.1) to assess
  - (1) the stability of the LEO space object population and
  - (2) the need to use active debris removal (ADR) to stabilize the future LEO environment.

- The Action Item was undertaken by IADC Working Group 2 (Environment and Data Bases). The principal participants in the study were ASI, ESA, ISRO, JAXA, NASA, and UKSA.

Environment Evolution Models Employed

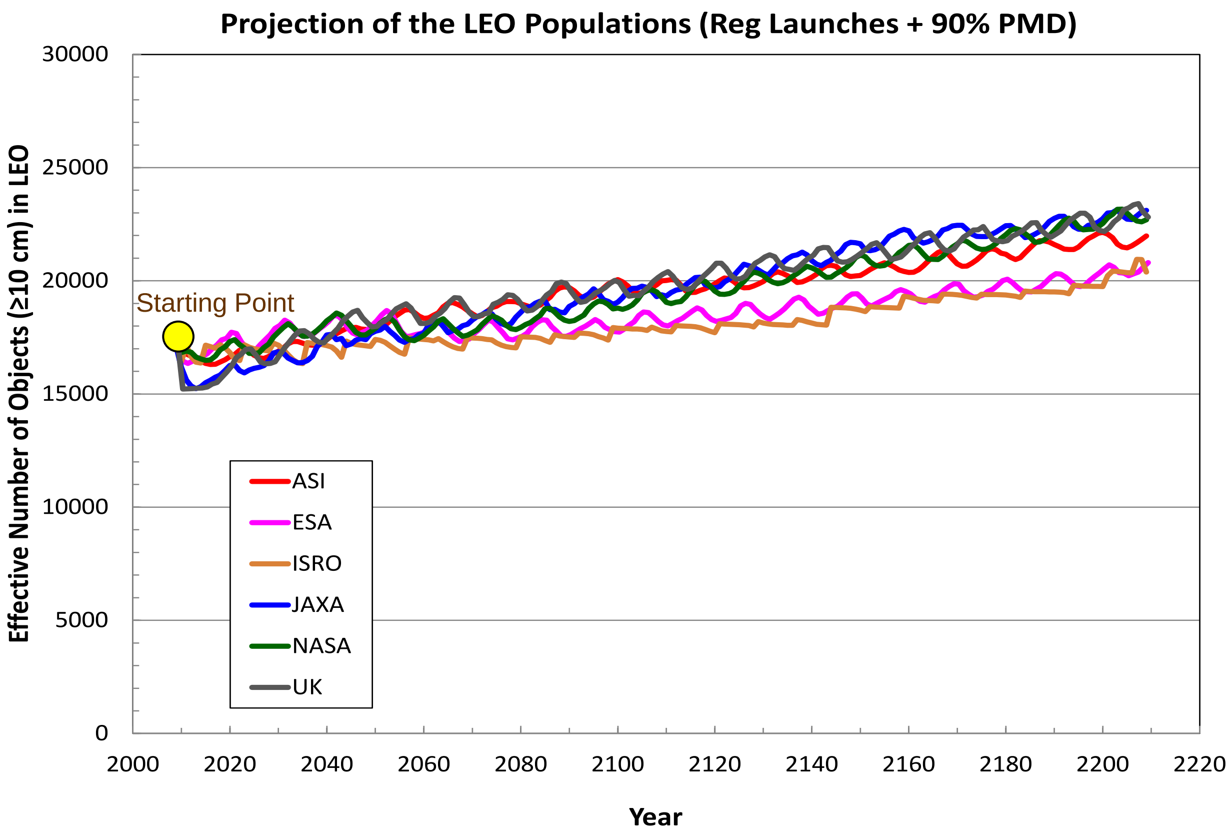
- ASI: Space Debris Mitigation long-term analysis program (SDM)
- ESA: Debris Environment Long-Term Analysis model (DELTA)
- ISRO: KS Canonical Propagation model (KSCPROP)
- JAXA: LEO Debris Evolutionary Model (LEODEEM)
- NASA: LEO-to-GEO Environment Debris model (LEGEND)
- UKSA: Debris Analysis and Monitoring Architecture for the Geosynchronous Environment (DAMAGE)

Initial Conditions and Assumptions

- A 2009 baseline environment for debris 10 cm and larger was provided by ESA's MASTER model.
- The future space traffic model was based on a repetition of the historic 2001-2009 space traffic.
- Each participating member used its own solar flux projection model.
- A catastrophic collision was defined as one characterized by an impactor kinetic energy to target mass ratio of 40 J/g or greater.
- A future post-mission disposal (PMD) compliance level of 90% was assumed for both spacecraft and launch vehicle stages.

Primary Study Results

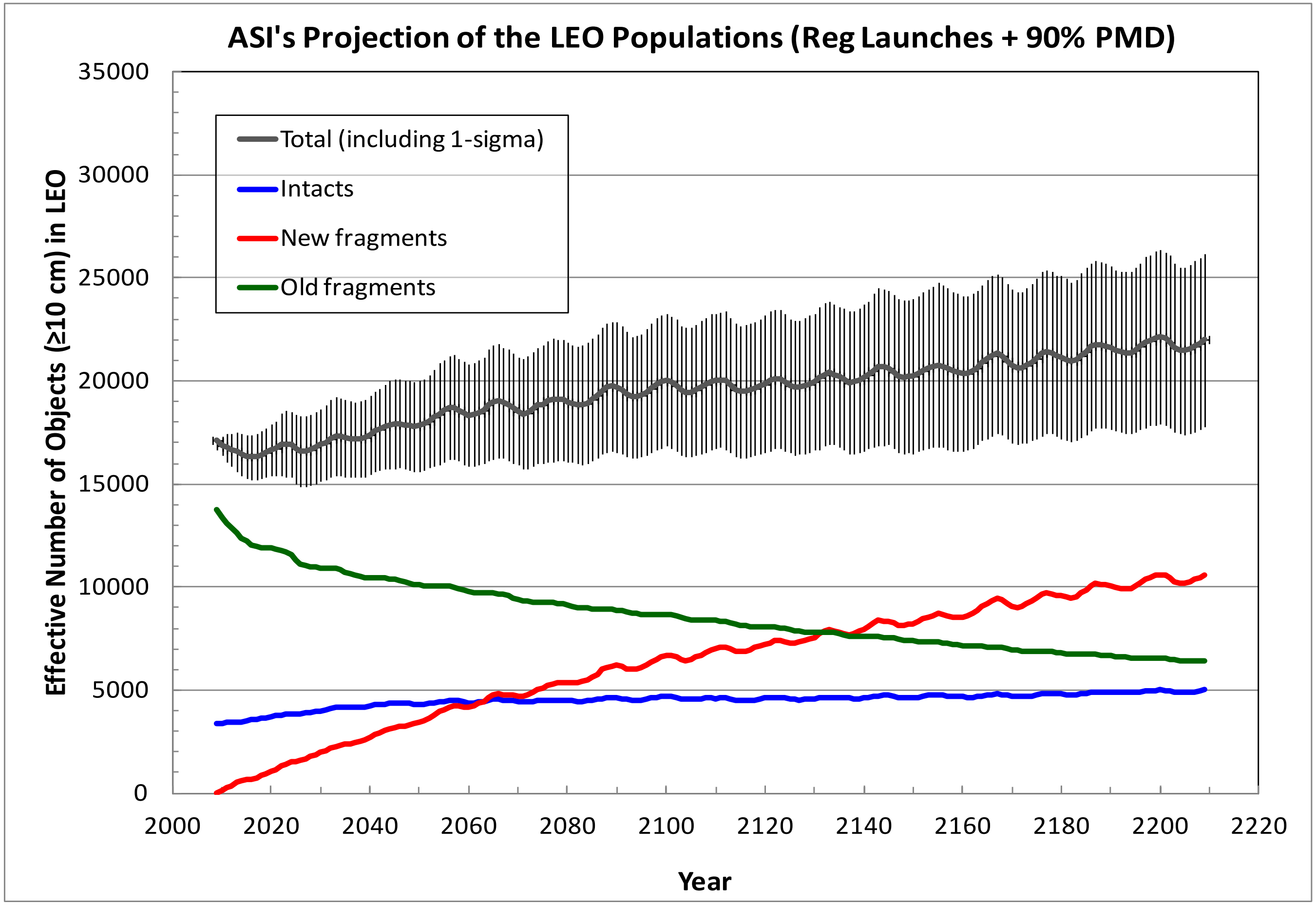
- All six member models revealed a steady increase in the 10 cm and greater population, despite an assumed global PMD level of 90%.



Population Prediction Results

- All six models yielded comparable populations in 200-year forecasts.

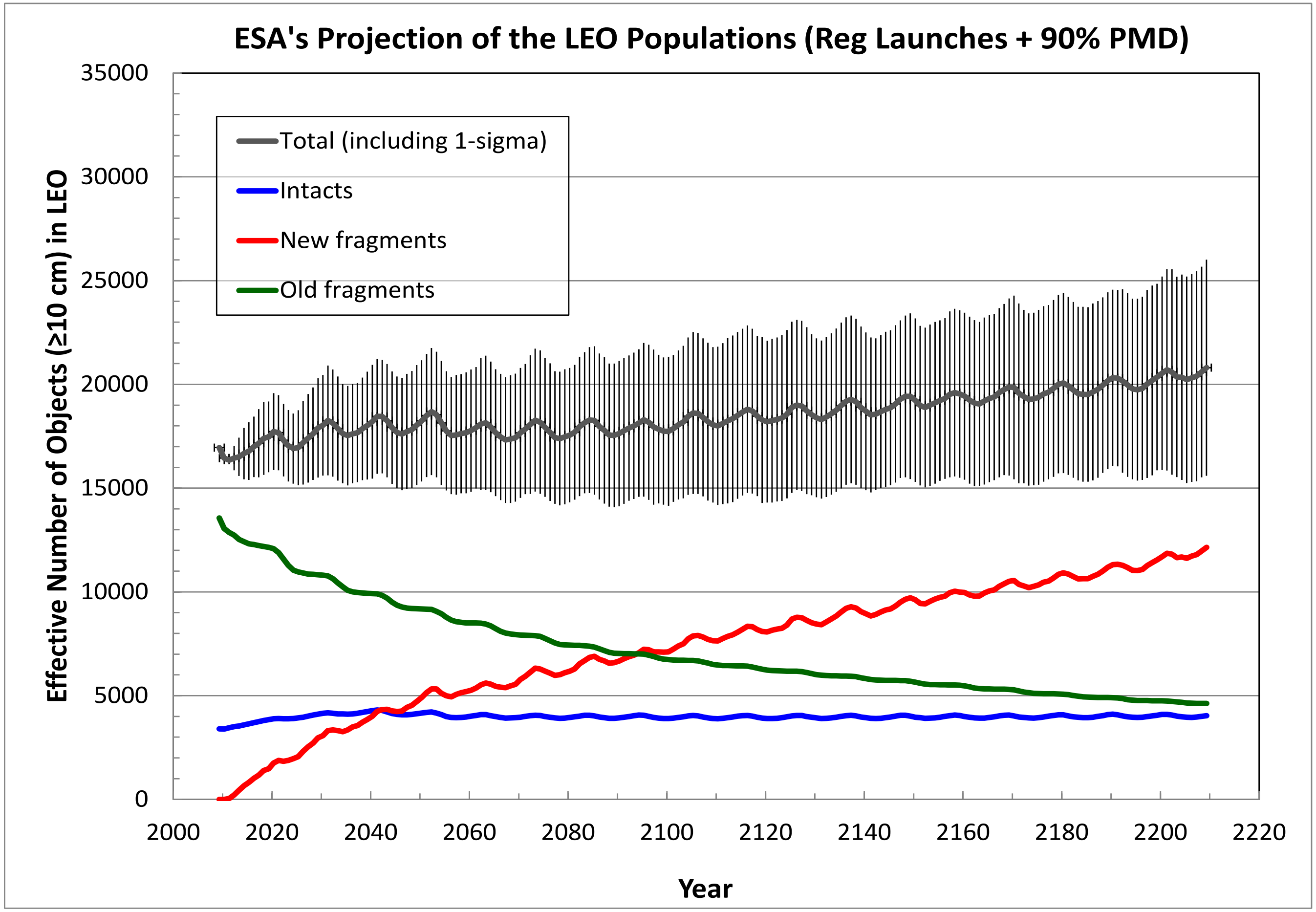
ASI



Population Prediction Results

- All six models yielded comparable populations in 200-year forecasts.

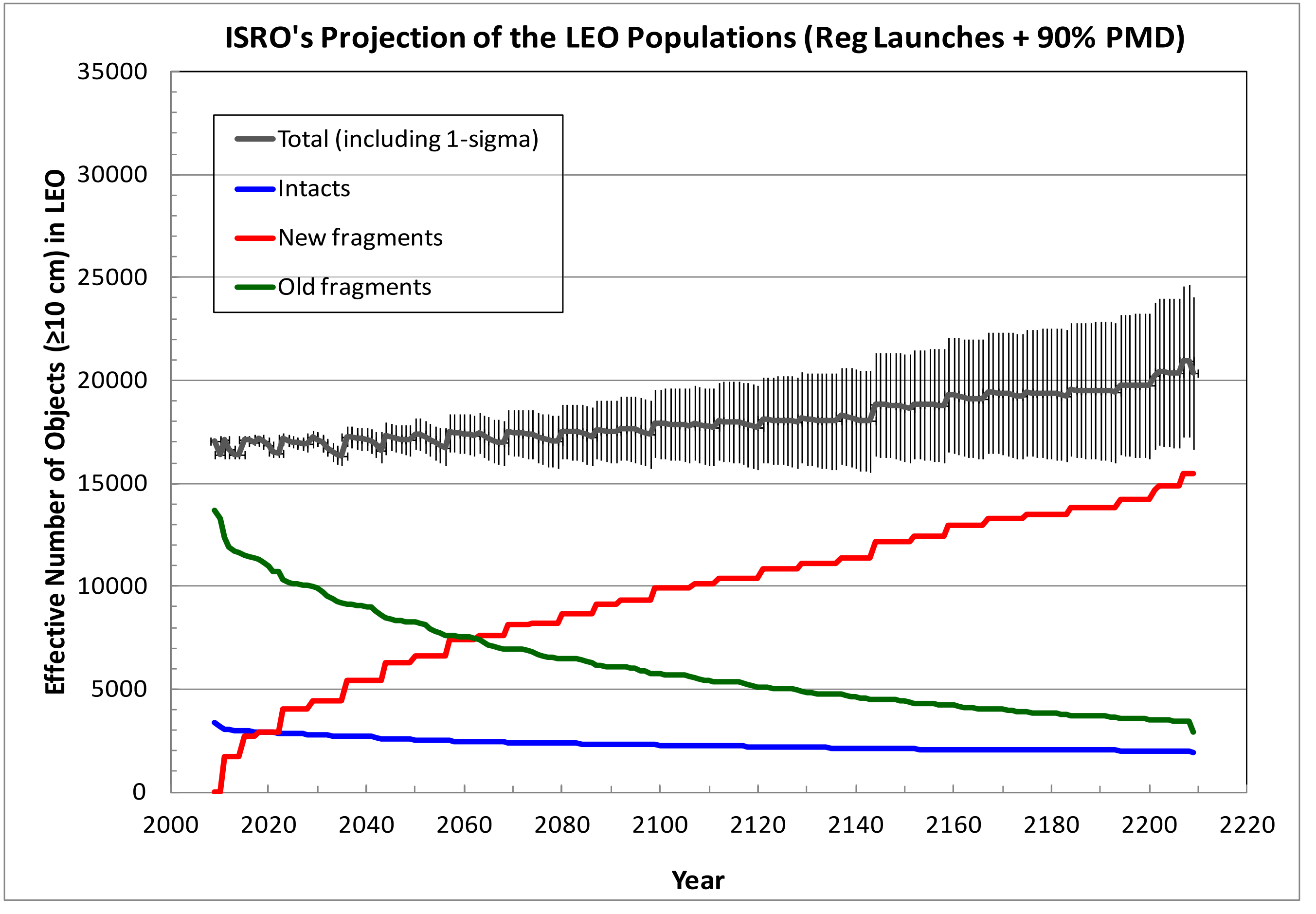
ESA



Population Prediction Results

- All six models yielded comparable populations in 200-year forecasts.

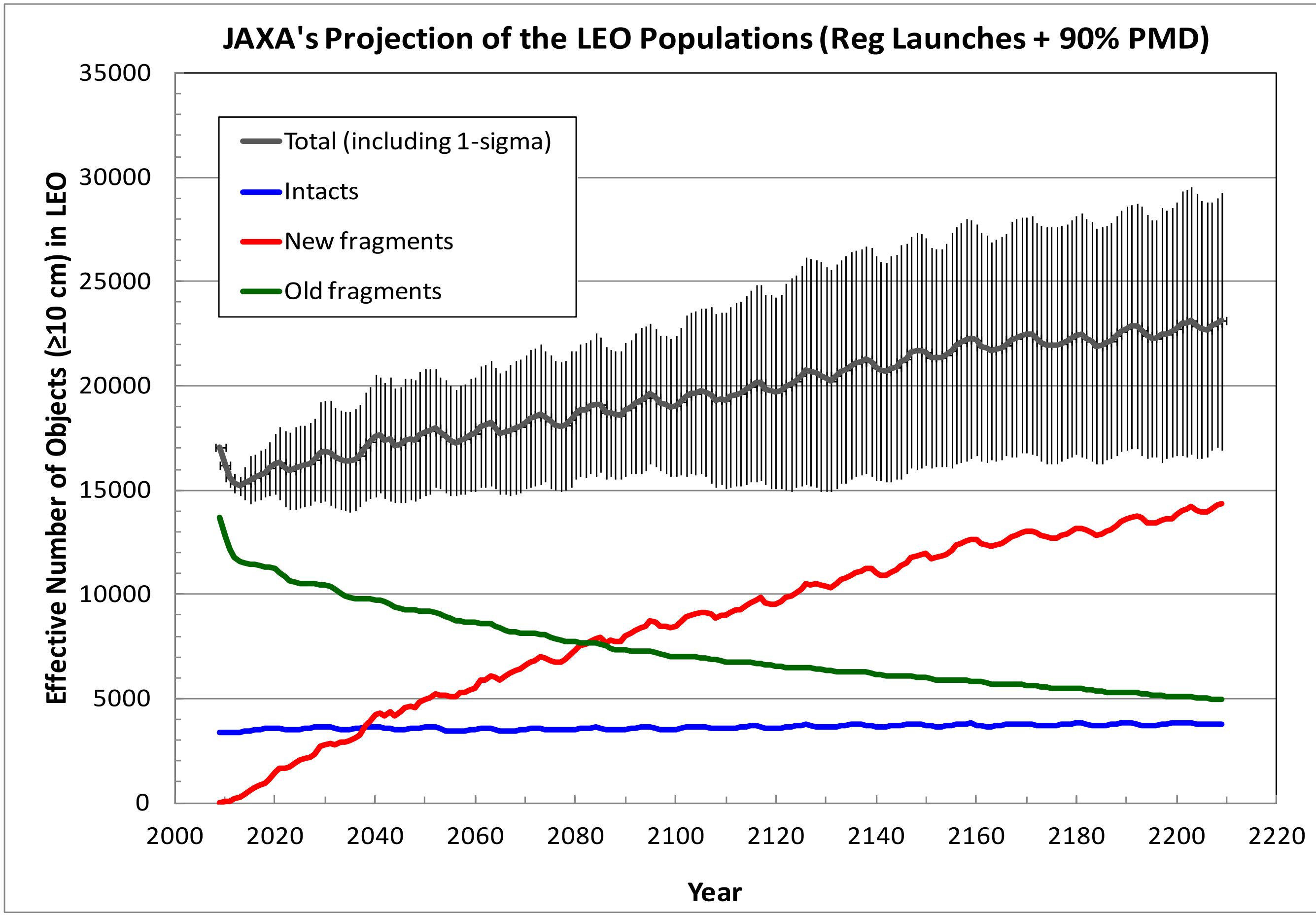
ISRO



Population Prediction Results

- All six models yielded comparable populations in 200-year forecasts.

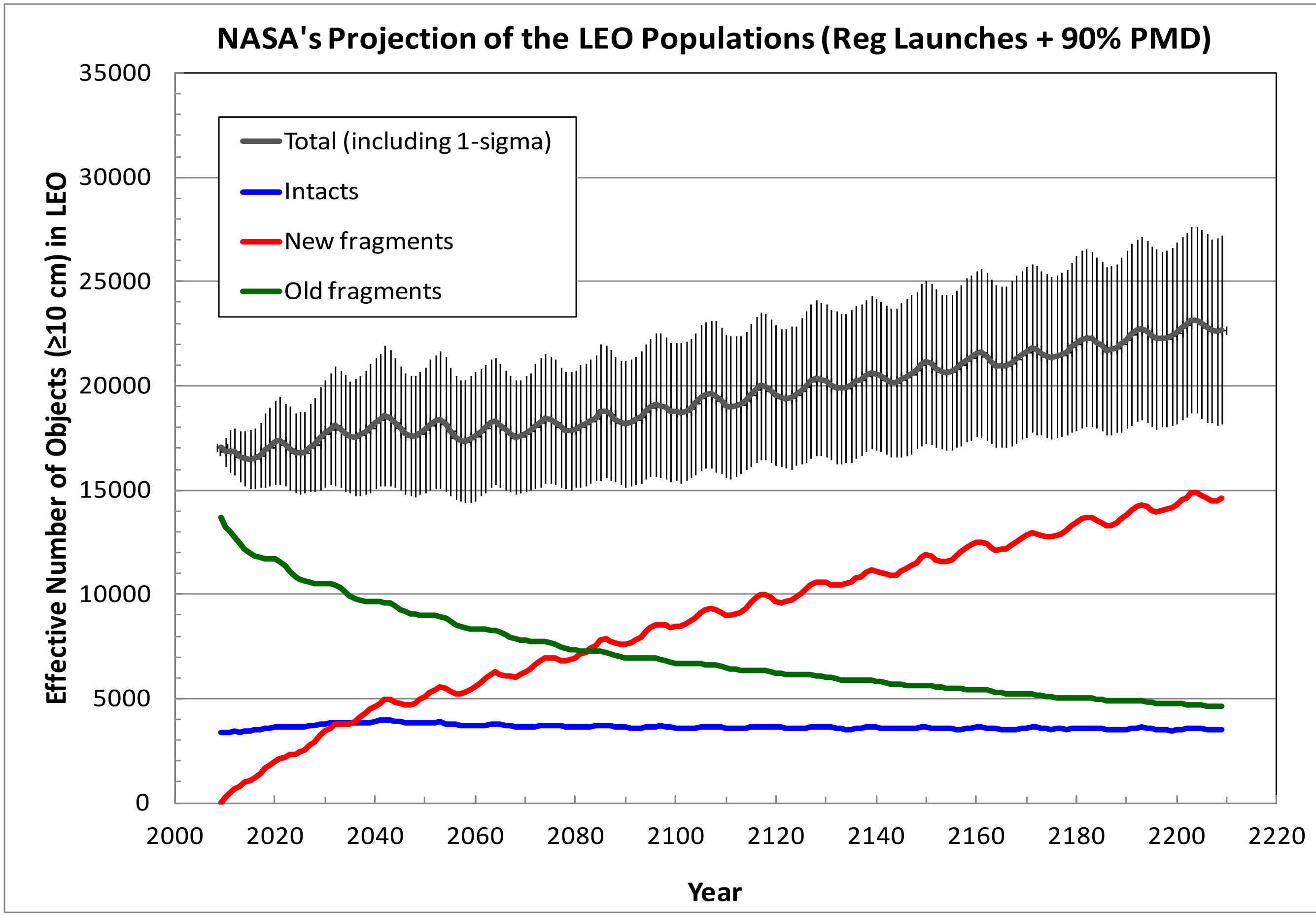
JAXA



Population Prediction Results

- All six models yielded comparable populations in 200-year forecasts.

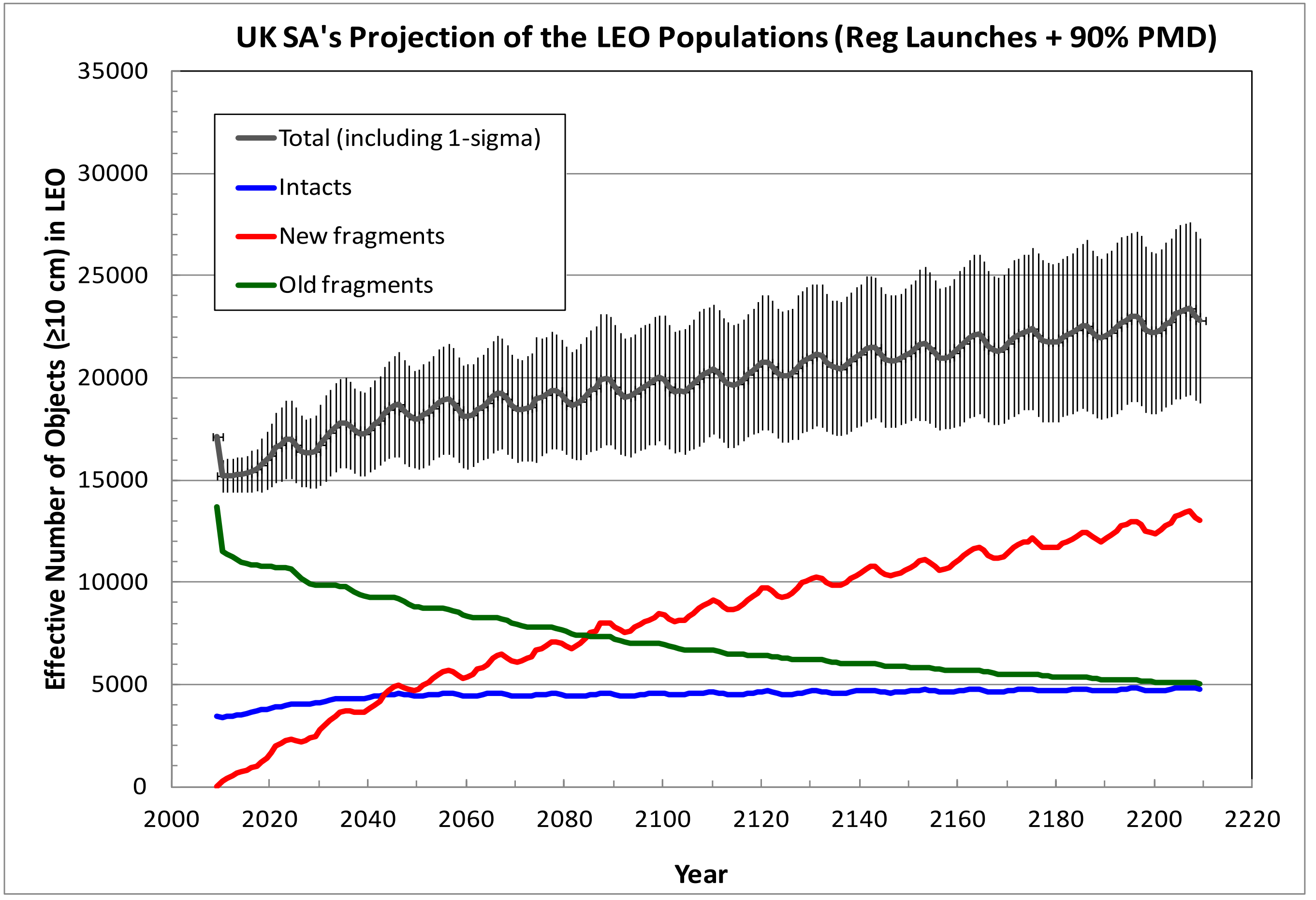
NASA



Population Prediction Results

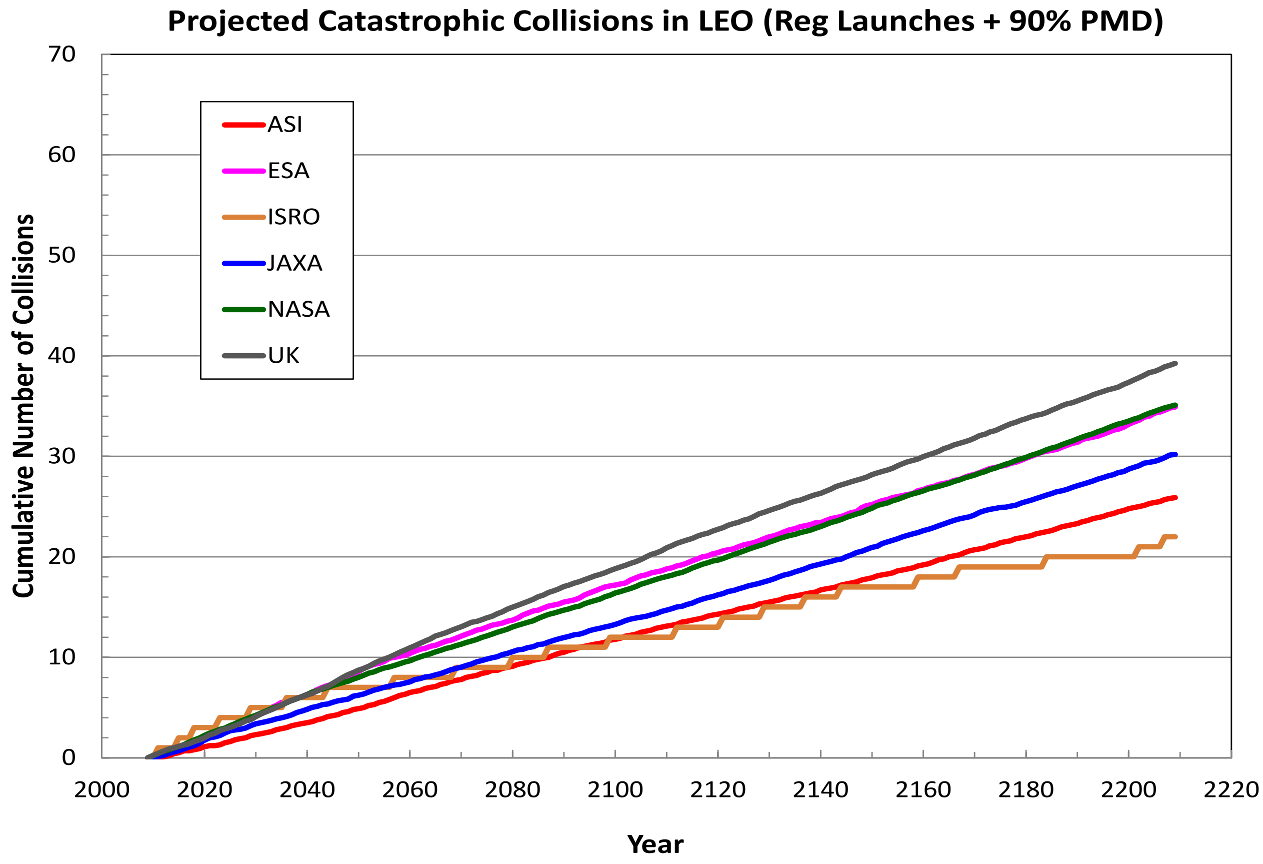
- All six models yielded comparable populations in 200-year forecasts.

UKSA



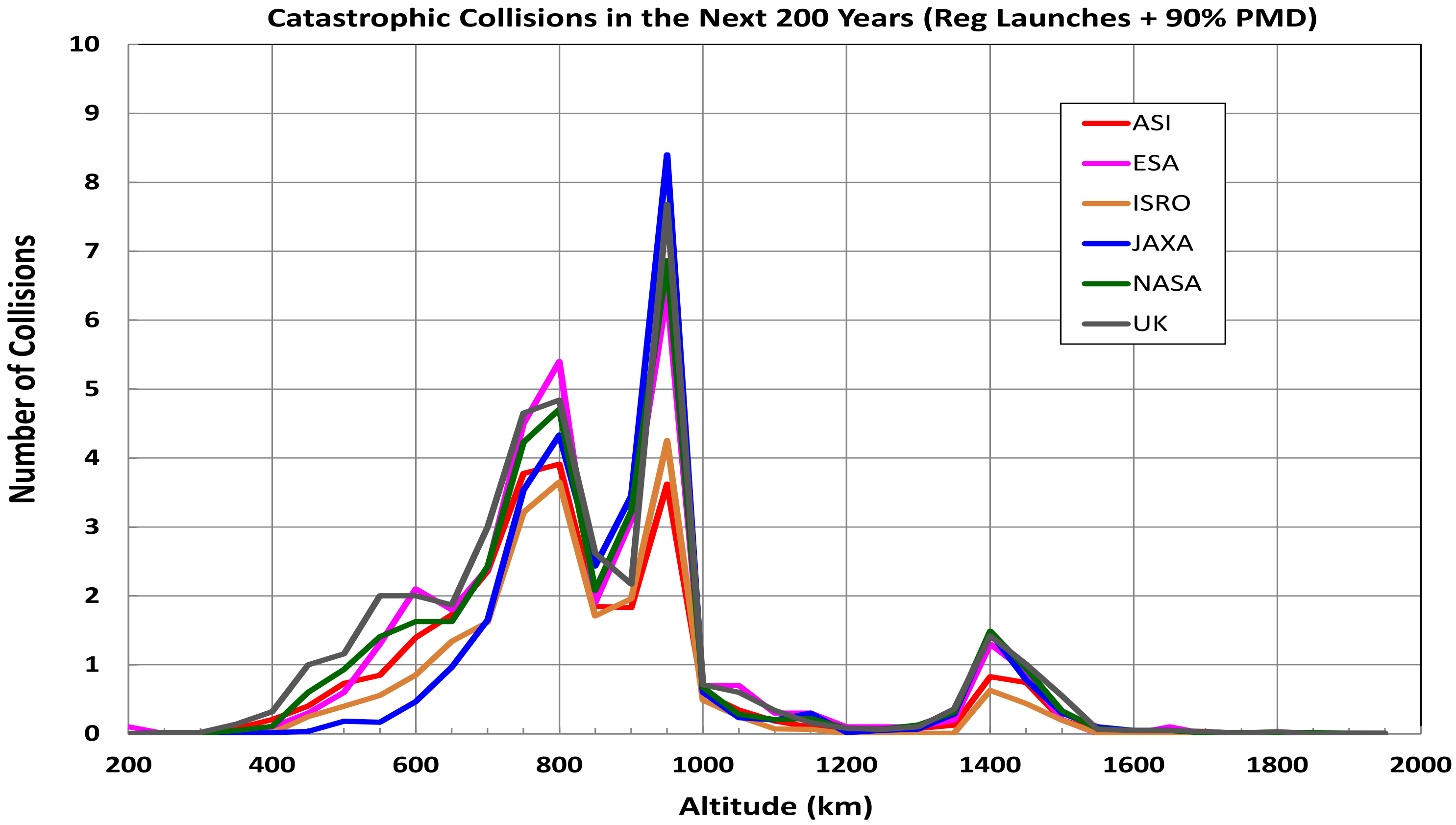
Rate of Catastrophic Collisions

- The rate of catastrophic collisions varied from 1 every 5 years to 1 every 9 years.



Regions of Catastrophic Collisions

- The majority of catastrophic collisions occurred near the 800 km and 1000 km altitudes due to high concentrations of space objects there.



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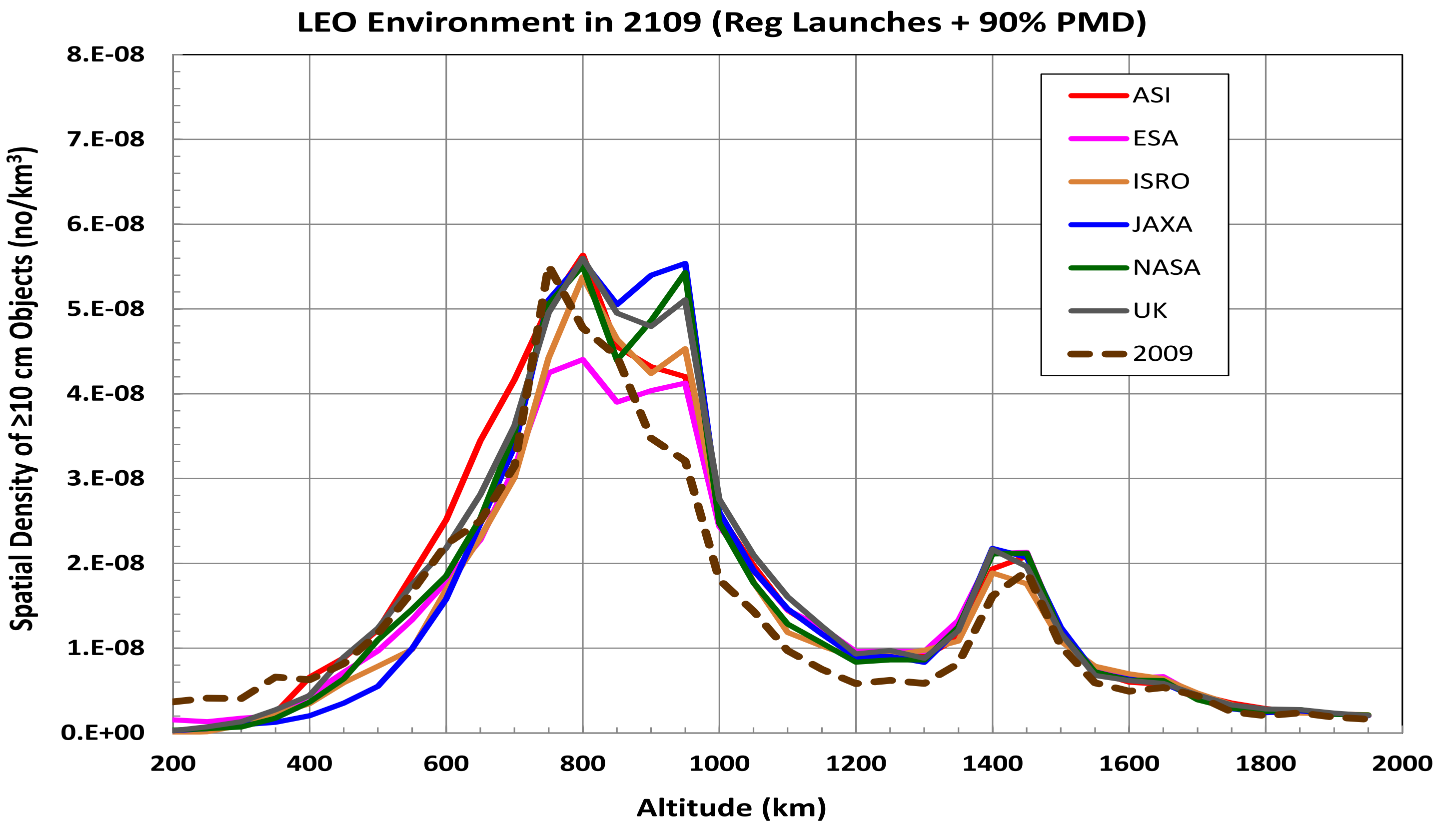
LEO Environment in 100 years

- The principal increase in the space object population will be at altitudes above 800 km, since atmospheric drag limits the accumulation of objects at lower altitudes.



Study Conclusions

- All six IADC member models yielded very similar qualitative results.
- The study confirmed the instability of the current LEO object population.
- Compliance with existing national and international space debris mitigation measures will not be sufficient to constrain the future LEO object population.
- To stabilize the LEO environment, more aggressive measures, especially the removal of the more massive non-functional spacecraft and launch vehicle stages, should be considered and implemented in a cost-effective manner.