

Collision Avoidance Modeling with DRAMA/ARES

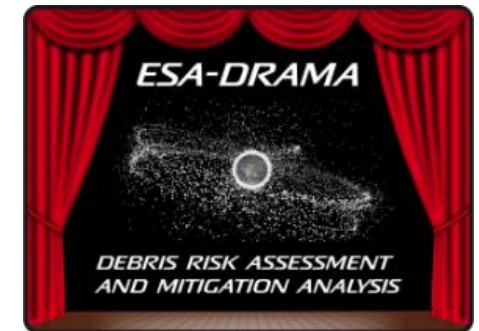
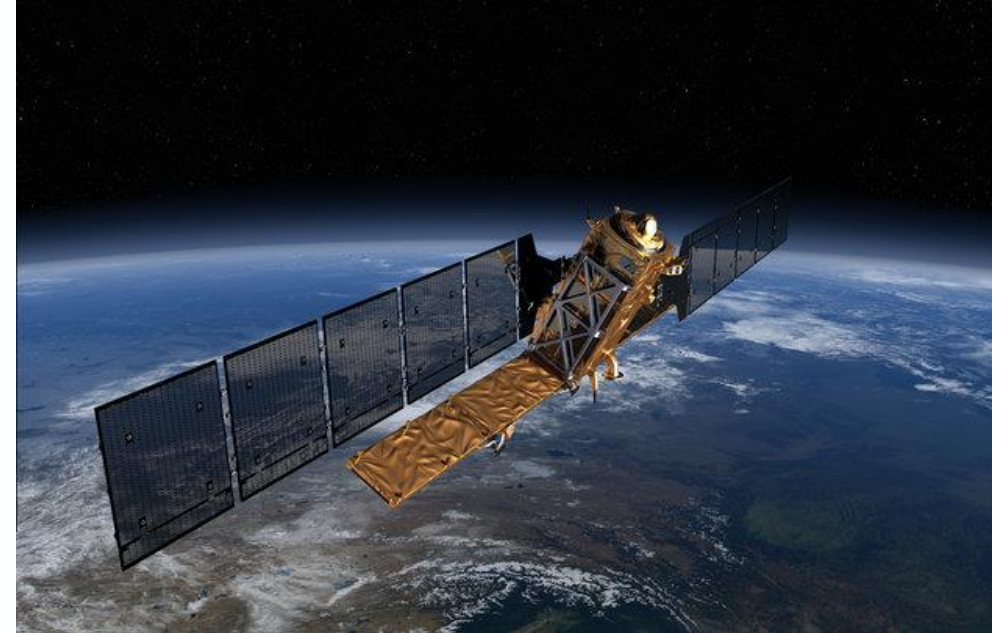
Vitali Braun

22/05/2024

What is ARES?

- ❑ Planning for collision avoidance requires...
 - Estimate on encounter rate
 - Knowledge on **associated event-wise state uncertainties**
 - Avoidance strategy

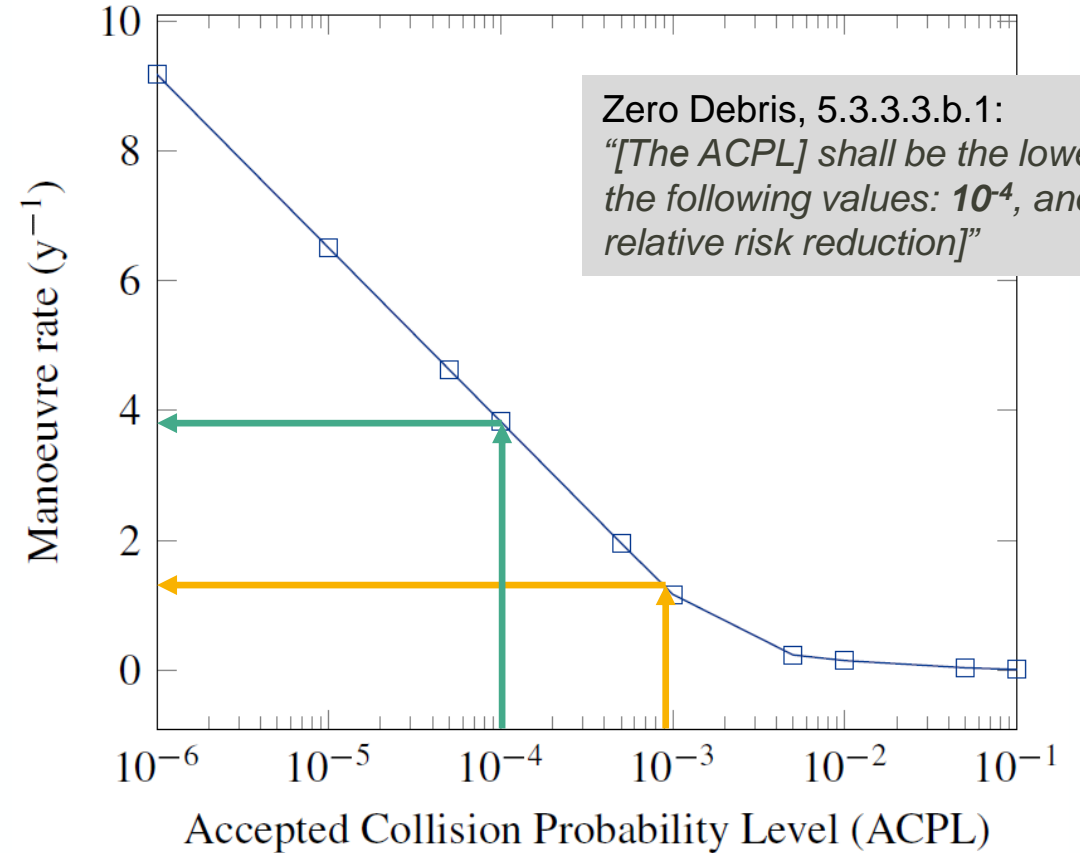
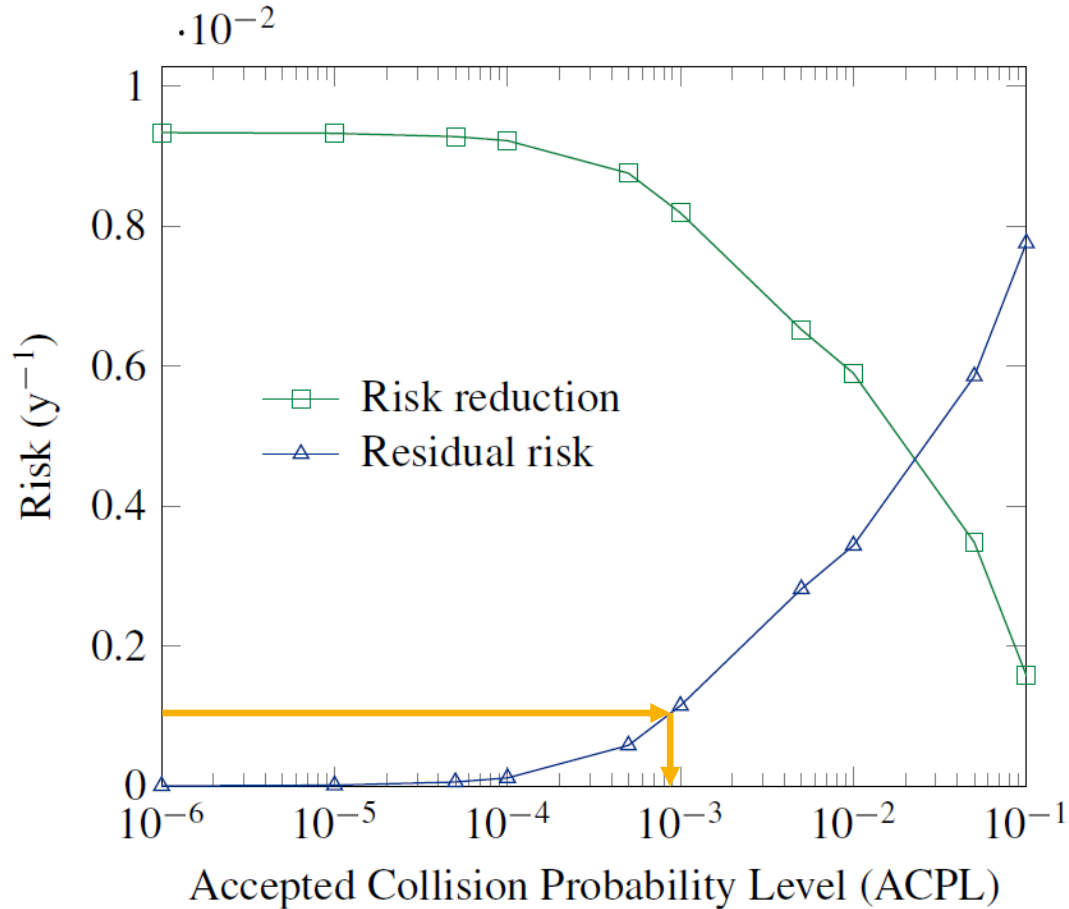
- ❑ Dedicated tool: ARES (Assessment of Risk Event Statistics)



Working with ARES

Zero Debris, 5.3.3.3.b.2:

“[...] The collision probability value such to **reduce the annual collision probability by at least 90%** with respect to not performing collision avoidance manoeuvres.”



Zero Debris, 5.3.3.3.b.1:
 “[The ACPL] shall be the lower of the following values: 10⁻⁴, and [0.9 relative risk reduction]”

Large Earth observation satellite (Sentinel-1, 700 km)

Lethal non-trackable objects (LNT)

Zero Debris:
"Cumulative collision probability with
space debris larger than 1 cm."

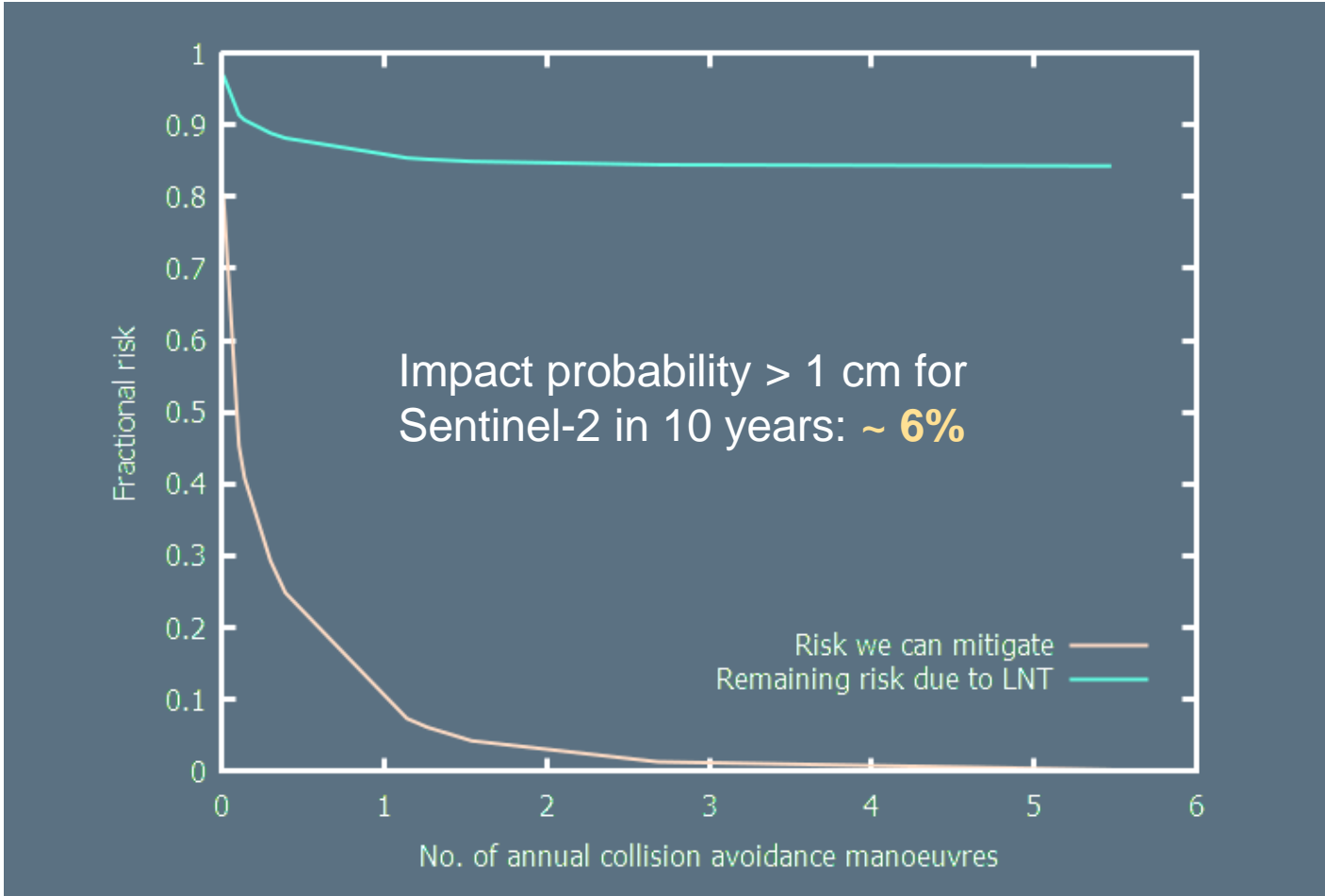
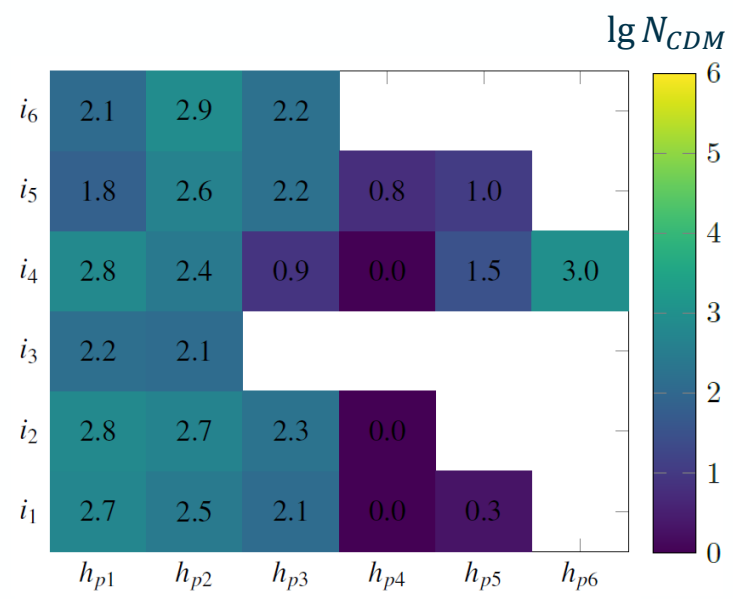
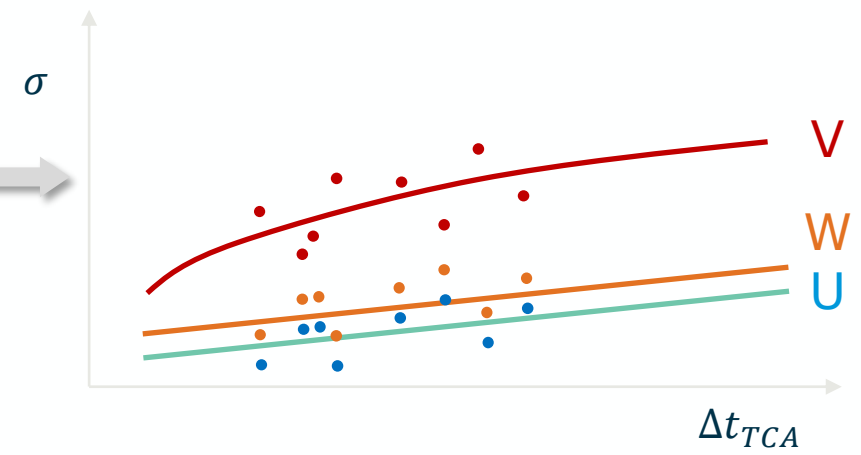


Image: ESA / P. Carril

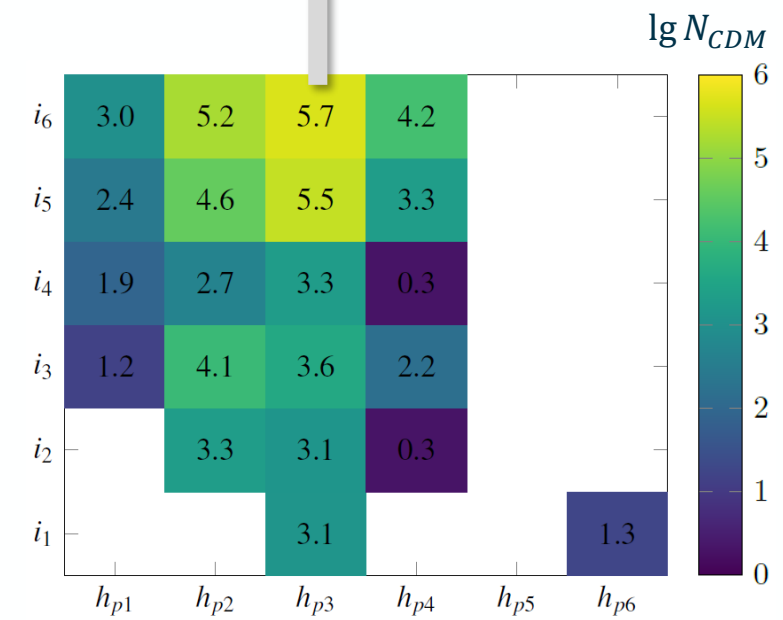
CDM analysis (2018)

$$\sigma_j = c_j \cdot 10^{a_j \cdot \Delta t_{TCA}}, \quad j \in (U, W)$$

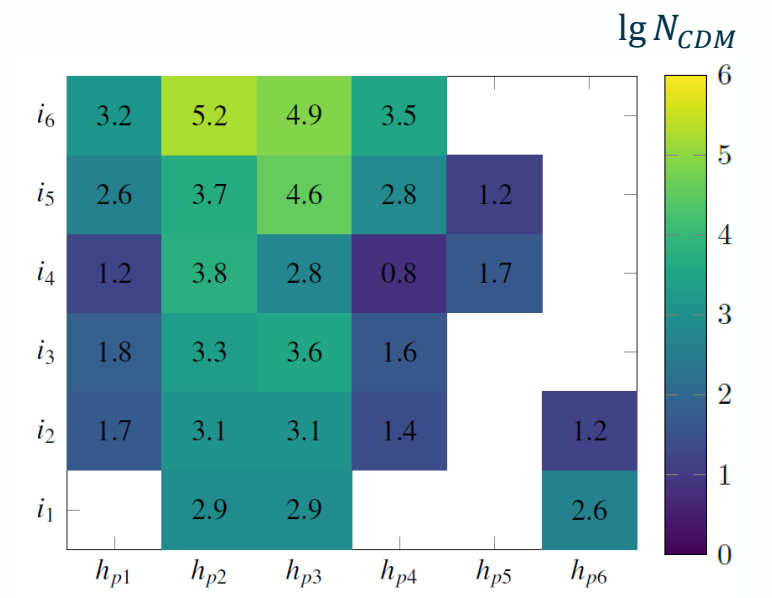
$$\sigma_V = c_V \cdot (b_V + \Delta t_{TCA})^{a_V}$$



Large, $e > 0.1$



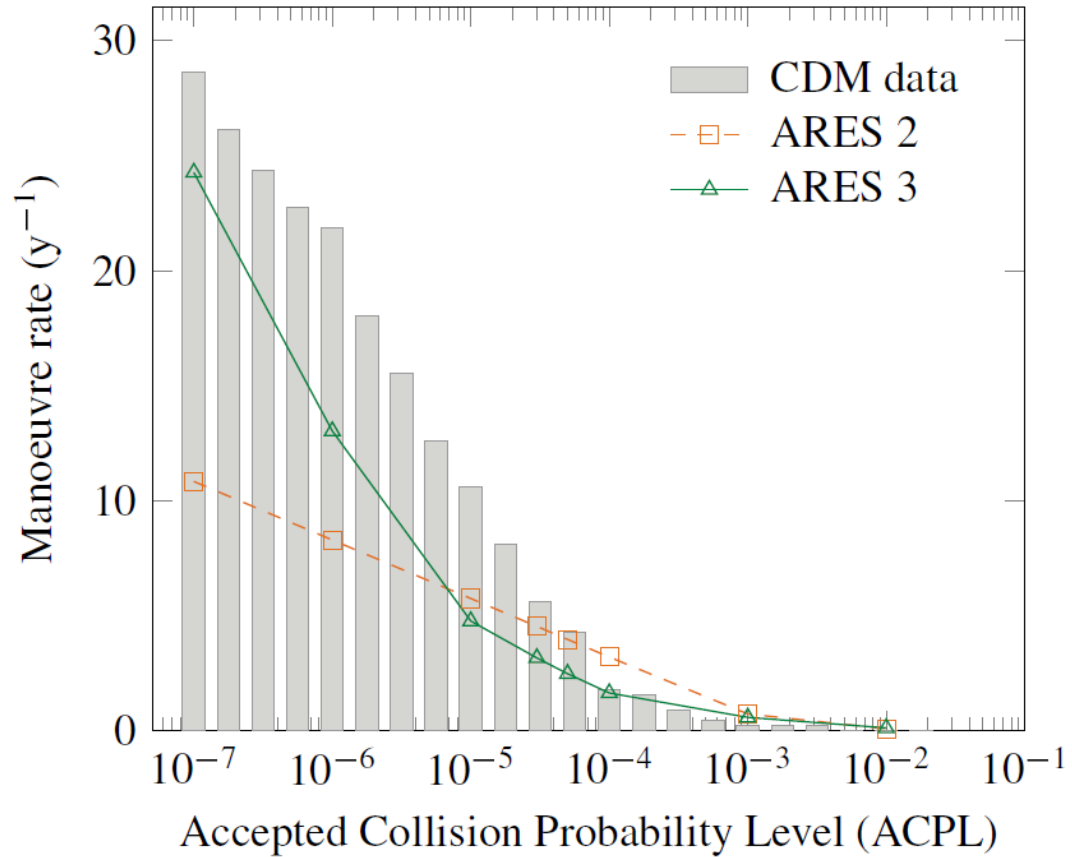
Small, $e < 0.1$



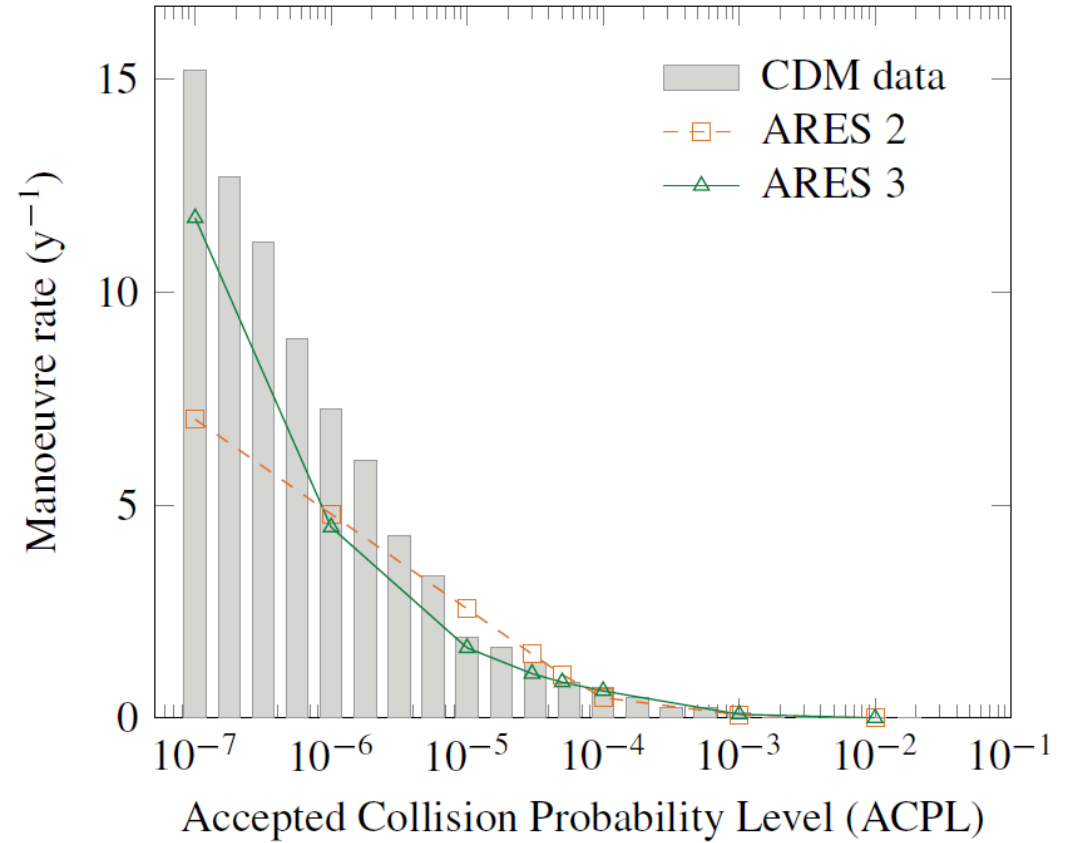
Large, $e < 0.1$

ARES validation (2018)

Sentinel 1A



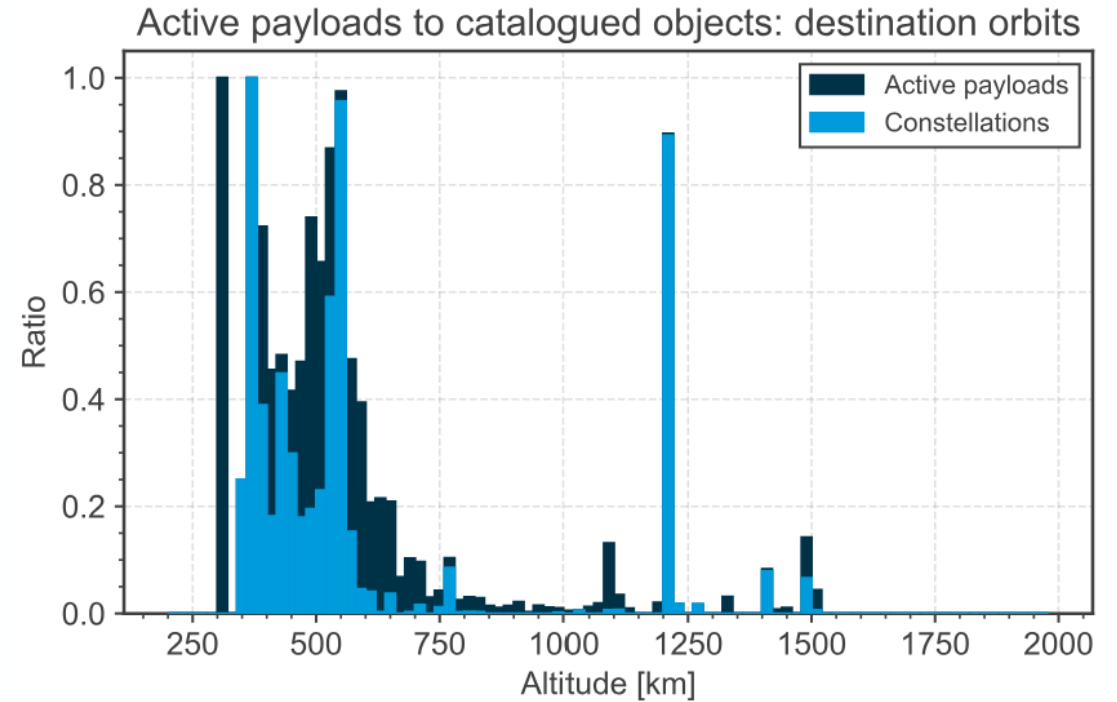
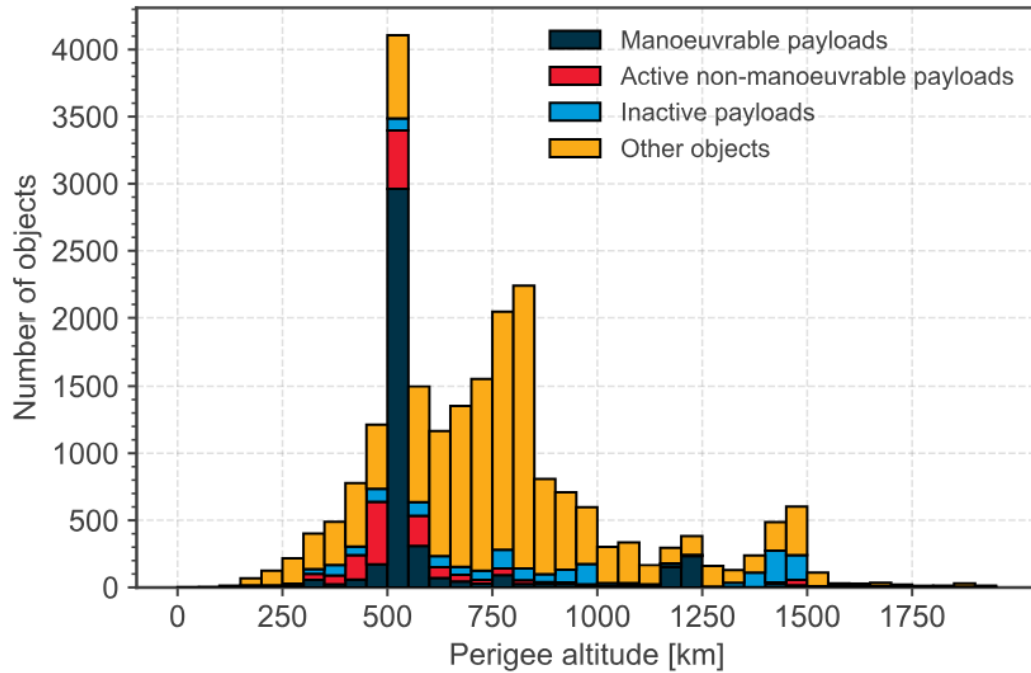
Cryosat 2



Coordination needs

Zero Debris, 5.3.3.2.e.2:

“[...] The estimated number of collision avoidance manoeuvres triggered thereby on other spacecraft.”



ESA's Annual Space Environment Report, 2023,
https://www.sdo.esoc.esa.int/environment_report/Space_Environment_Report_latest.pdf

Coming up in
DRAMA/ARES

