

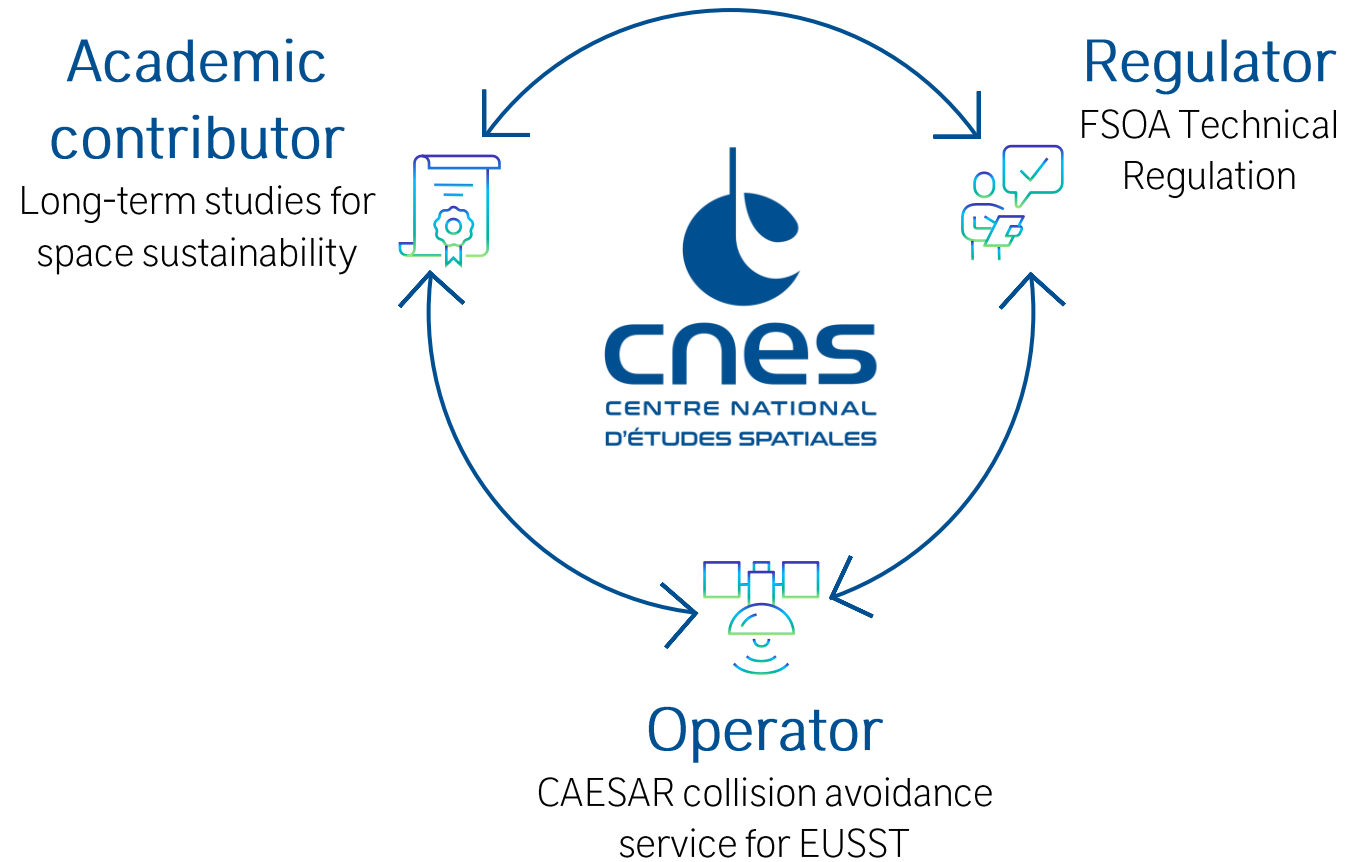
HOW CNES'S **REGULATOR & OPERATOR** ROLES SHAPE ITS **ENVIRONMENTAL INDEX** APPROACH ?

FRANÇOIS VINET, CNES

**2ND SPACE CAPACITY ALLOCATION FOR THE
SUSTAINABILITY OF SPACE ACTIVITIES WORKSHOP**

INTRODUCTION

HOW CNES'S REGULATOR &
OPERATOR ROLES SHAPE ITS
ENVIRONMENTAL INDEX
APPROACH?



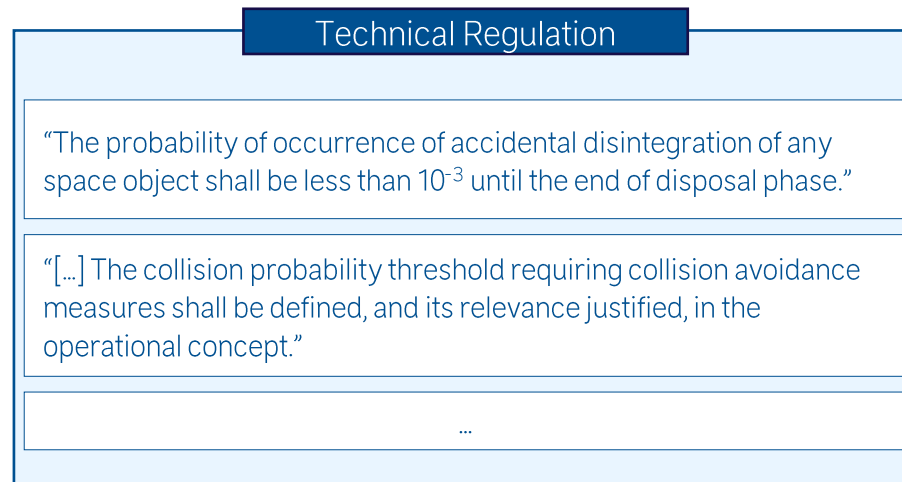
COMPLIANCE ASSESSMENT PROCESS

HOW CNES'S REGULATOR &
OPERATOR ROLES SHAPE ITS
ENVIRONMENTAL INDEX
APPROACH?

Assess compliance with the **Technical Regulation (TR)**

A complex evaluation process

- Quantitative and qualitative technical requirements



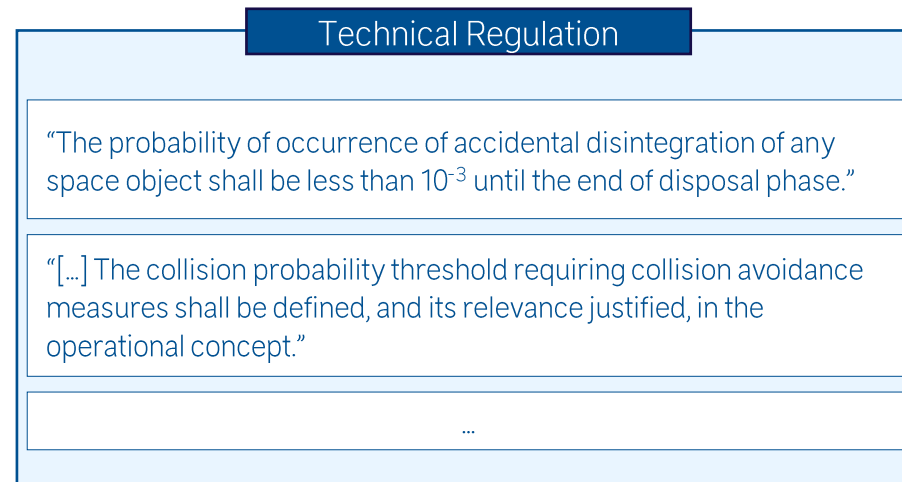
COMPLIANCE ASSESSMENT PROCESS

HOW CNES'S REGULATOR & OPERATOR ROLES SHAPE ITS ENVIRONMENTAL INDEX APPROACH?

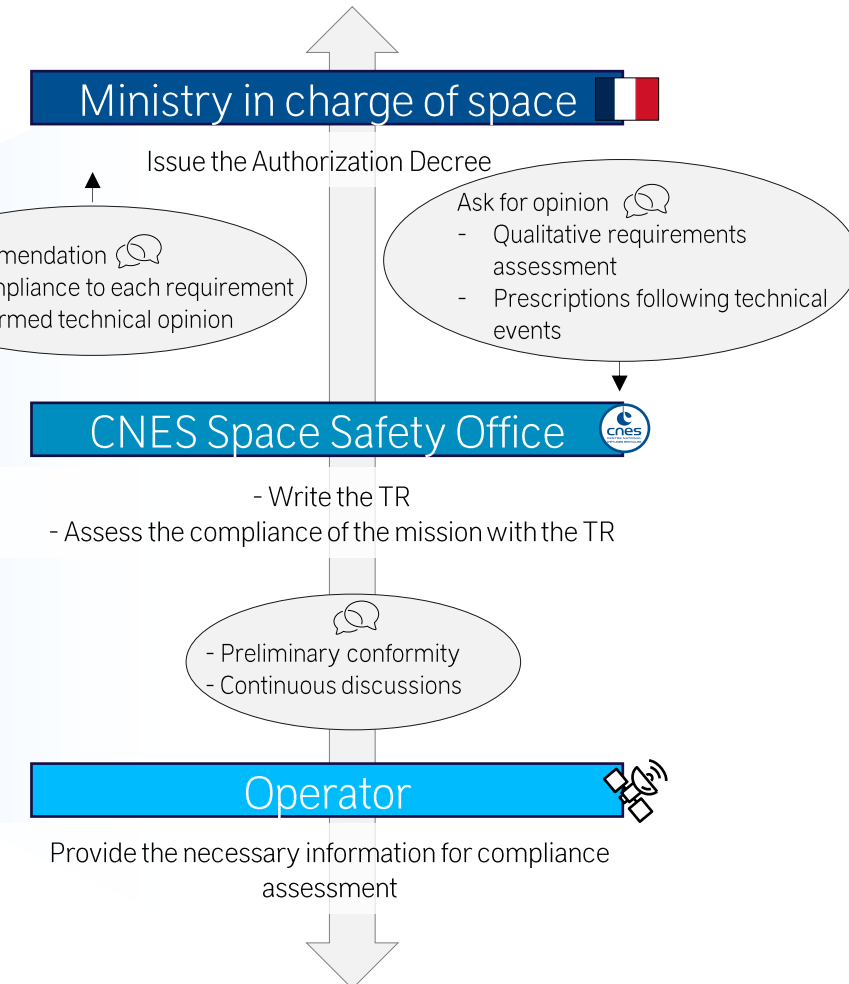
Assess compliance with the **Technical Regulation (TR)**

A complex evaluation process

- Quantitative and qualitative technical requirements



With
various
actors



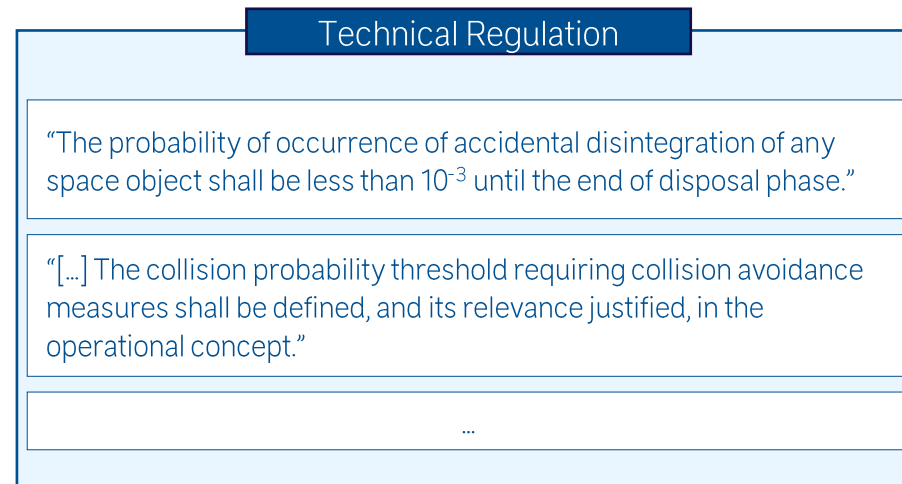
COMPLIANCE ASSESSMENT PROCESS

HOW CNES'S REGULATOR & OPERATOR ROLES SHAPE ITS ENVIRONMENTAL INDEX APPROACH?

Assess compliance with the **Technical Regulation (TR)**

A complex evaluation process

- Quantitative and qualitative technical requirements



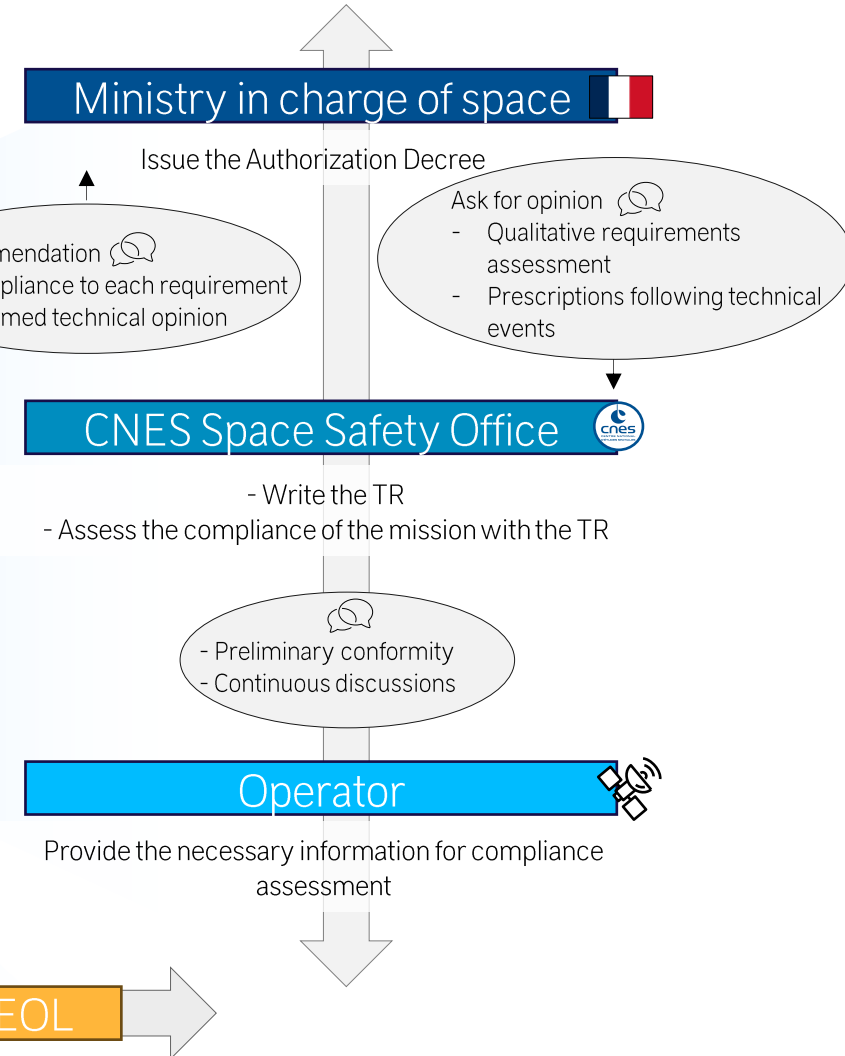
With various actors

Throughout the mission lifecycle

Discussions

Anomaly reported

Extension ask



POTENTIAL INDICES USE CASES

HOW CNES'S REGULATOR &
OPERATOR ROLES SHAPE ITS
ENVIRONMENTAL INDEX
APPROACH?

Increasingly complex discussions & analyses :

- Challenging space environment
- Increasing diversity and number of missions

Examples of complex discussions :

- Prescription following a technical event (anomaly, etc.)
 - *A maneuvering object is no longer able to perform passivation. Before end-of-life, it is therefore required to lower its orbit to limit the consequences in case of an explosion. From what end-of-life altitude is the risk considered acceptable?*
- Qualitative requirement assessment to inform the Ministry's decision
 - *Following a request for mission extension, the PMD reliability can no longer be assessed (outside the qualification domain): is the increased risk of failure to achieve PMD acceptable?*

POTENTIAL INDICES USE CASES

HOW CNES'S REGULATOR &
OPERATOR ROLES SHAPE ITS
ENVIRONMENTAL INDEX
APPROACH?

Increasingly complex discussions & analyses :

- Challenging space environment
- Increasing diversity and number of missions

Examples of complex discussions :

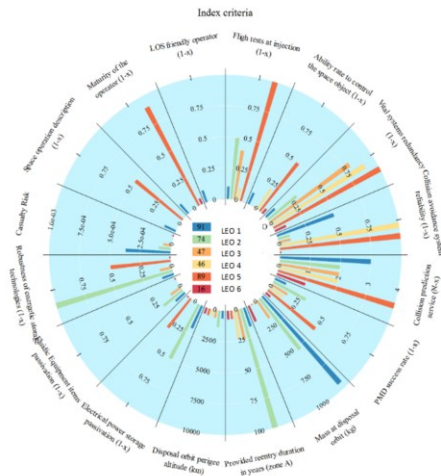
- Prescription following a technical event (anomaly, etc.)
 - *A maneuvering object is no longer able to perform passivation. Before end-of-life, it is therefore required to lower its orbit to limit the consequences in case of an explosion. From what end-of-life altitude is the risk considered acceptable?*
- Qualitative requirement assessment to inform the Ministry's decision
 - *Following a request for mission extension, the PMD reliability can no longer be assessed (outside the qualification domain): is the increased risk of failure to achieve PMD acceptable?*

➡ Need for an index !

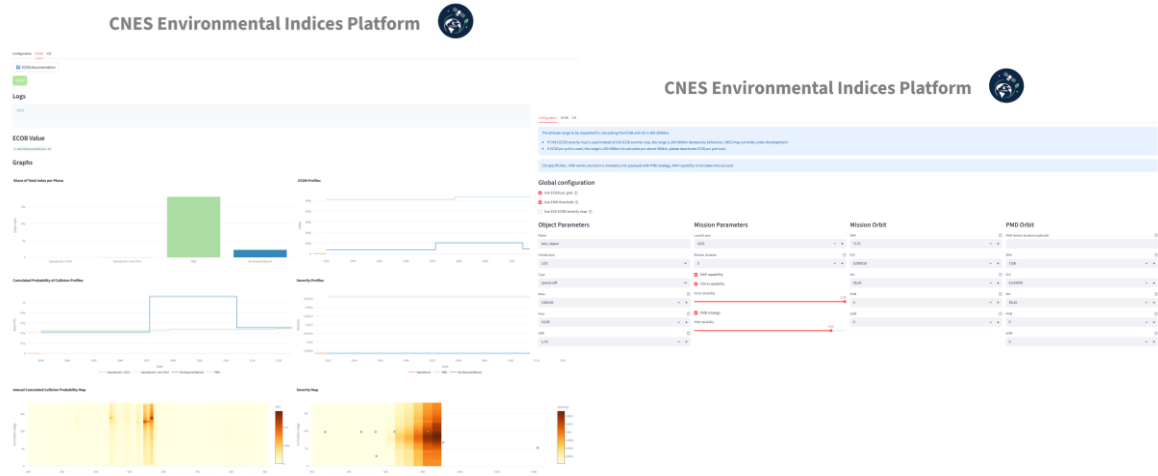
- ✓ Assess the impact of satellite and mission design
- ✓ Sensitive to the performance and efficiency of technologies rather than to the technologies themselves
- ✓ Interpretable / understandable by non-technical stakeholders
 - Linearity, additivity
- ✓ Index recognized by the entire assessed chain
- ✓ Time-stable index

CNES INDICES INITIATIVES

HOW CNES'S REGULATOR &
OPERATOR ROLES SHAPE ITS
ENVIRONMENTAL INDEX
APPROACH?



INDIGENE
(2019)



CNES Environmental Indices Platform
Decision-support platform
(2025)

- + Support to different initiatives :
 - Cosmos Sustainability Label (by Cosmos For Humanity)
 - ...

EXPERIENCED SEVERITY

HOW CNES'S REGULATOR &
OPERATOR ROLES SHAPE ITS
ENVIRONMENTAL INDEX
APPROACH ?

Risk : often defined considering the **sustainability** of **human activities** in space

Risk quantification :

- To assess the risk posed by the space environment to **human activities**, it is necessary to take **operational risk mitigation** into account to quantify the final impact of the environment on the **severity experienced**.

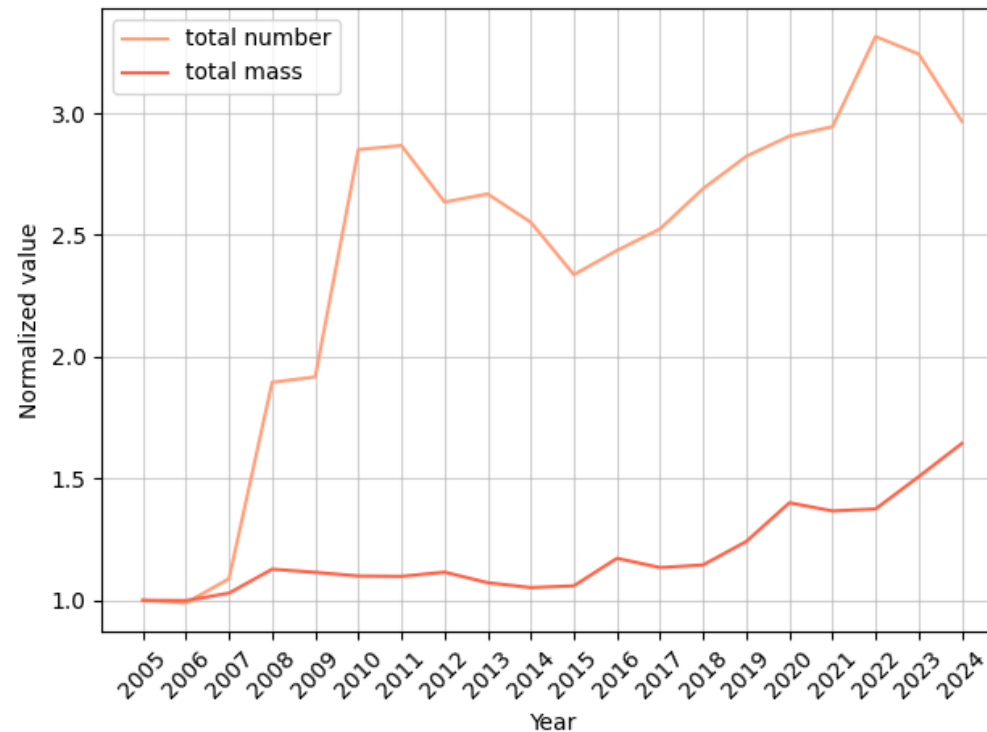
EXPERIENCED SEVERITY

HOW CNES'S REGULATOR &
OPERATOR ROLES SHAPE ITS
ENVIRONMENTAL INDEX
APPROACH?

Risk : often defined considering the **sustainability** of **human activities** in space

Risk quantification :

- To assess the risk posed by the space environment to **human activities**, it is necessary to take **operational risk mitigation** into account to quantify the final impact of the environment on the **severity experienced**.



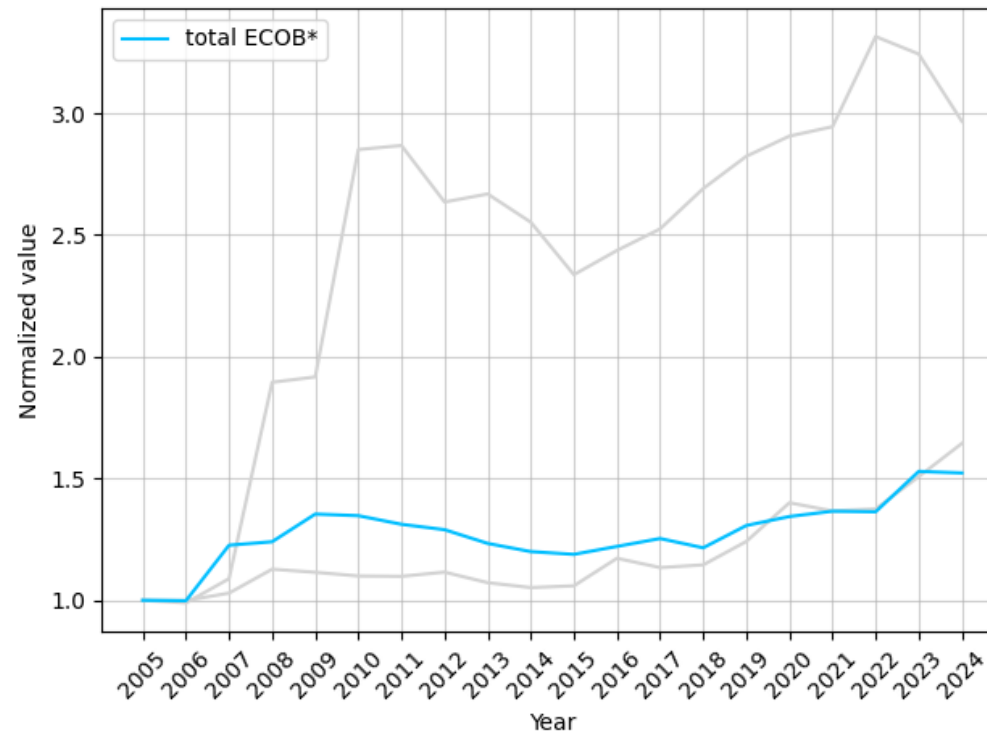
EXPERIENCED SEVERITY

HOW CNES'S REGULATOR &
OPERATOR ROLES SHAPE ITS
ENVIRONMENTAL INDEX
APPROACH?

Risk : often defined considering the **sustainability** of **human activities** in space

Risk quantification :

- To assess the risk posed by the space environment to **human activities**, it is necessary to take **operational risk mitigation** into account to quantify the final impact of the environment on the **severity experienced**.



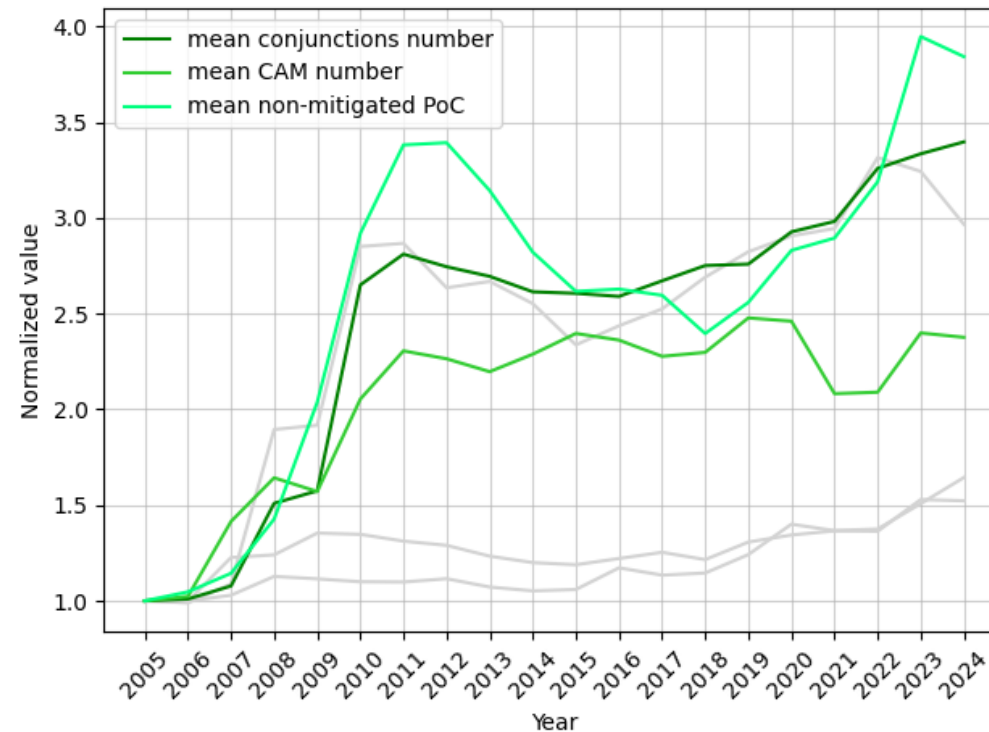
EXPERIENCED SEVERITY

HOW CNES'S REGULATOR &
OPERATOR ROLES SHAPE ITS
ENVIRONMENTAL INDEX
APPROACH?

Risk : often defined considering the **sustainability** of **human activities** in space

Risk quantification :

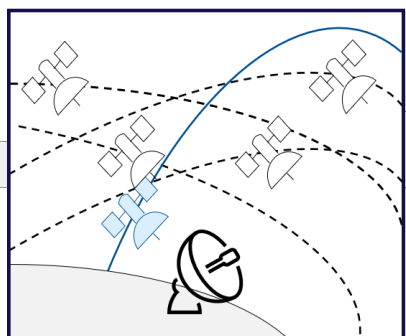
- To assess the risk posed by the space environment to **human activities**, it is necessary to take **operational risk mitigation** into account to quantify the final impact of the environment on the **severity experienced**.



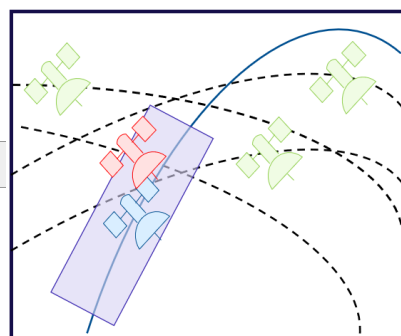
KEY OPERATIONAL PARAMETERS

HOW CNES'S REGULATOR &
OPERATOR ROLES SHAPE ITS
ENVIRONMENTAL INDEX
APPROACH?

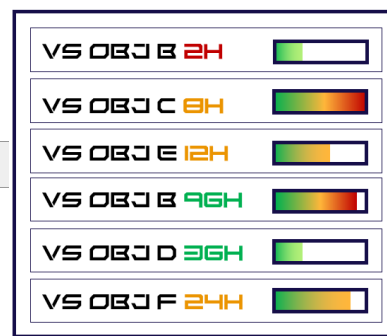
Risk mitigation operational pipeline :



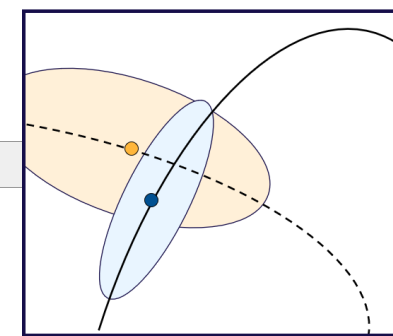
Initial catalog



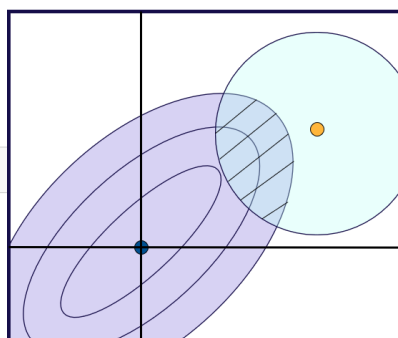
Population screening



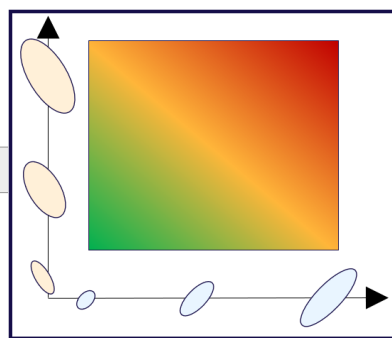
Conjunctions processing



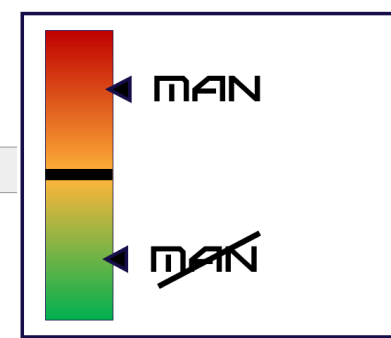
Incertitude modeling



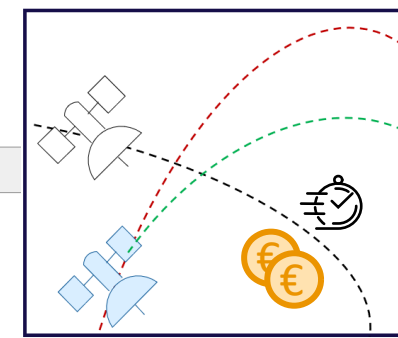
PoC calculation method



PoC post-processing



Maneuver decision



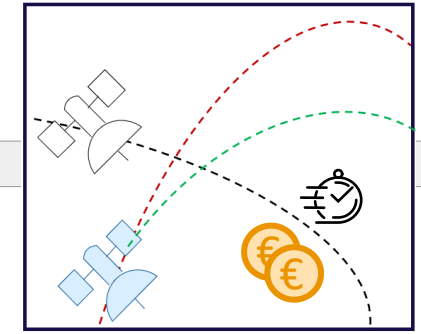
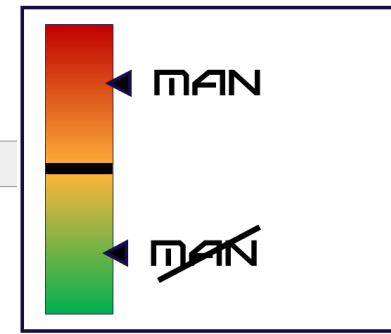
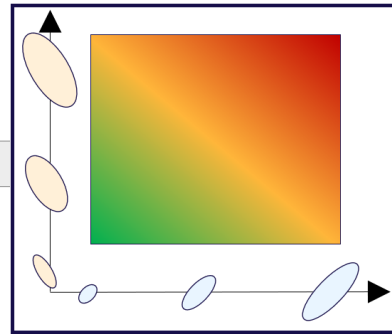
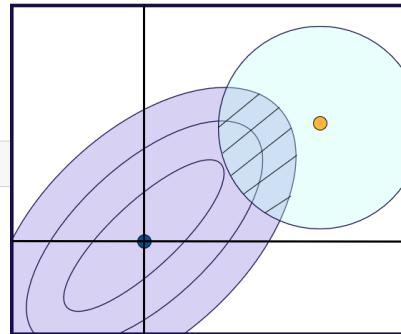
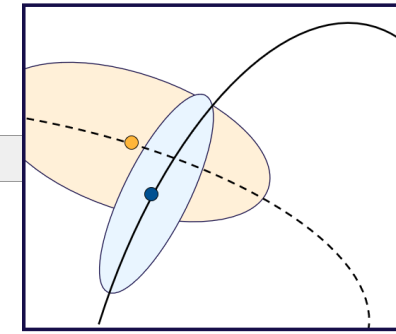
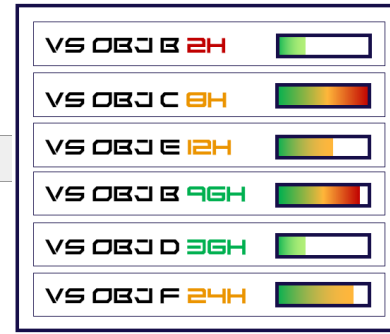
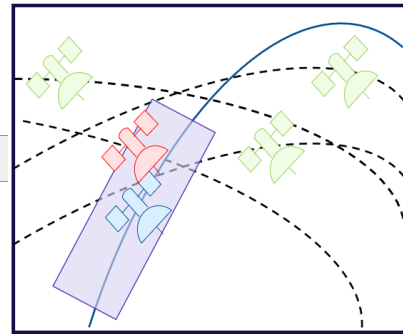
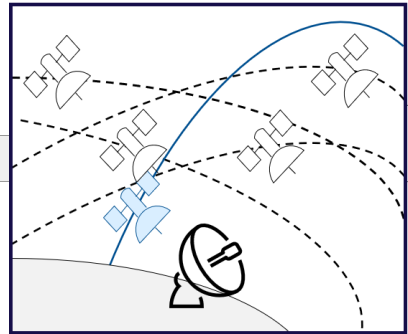
Maneuver implementation
(time and financial cost)

KEY OPERATIONAL PARAMETERS

HOW CNES'S REGULATOR & OPERATOR ROLES SHAPE ITS ENVIRONMENTAL INDEX APPROACH?

Risk mitigation operational pipeline :

operational parameters that affect the final experienced severity



Initial catalog
Catalog quality
Catalog freshness

Population screening
Screening boxes size

Conjunctions processing

Incertitude modeling
Covariances size

PoC calculation method

PoC post-processing

Maneuver decision

Maneuver implementation
(time and financial cost)

Max PoC method

Maneuver threshold

Targeted PoC reduction

Maneuver magnitude

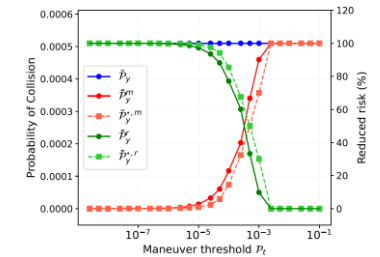
Maneuver duration

CNES INITIATIVES

HOW CNES'S REGULATOR &
OPERATOR ROLES SHAPE ITS
ENVIRONMENTAL INDEX
APPROACH ?

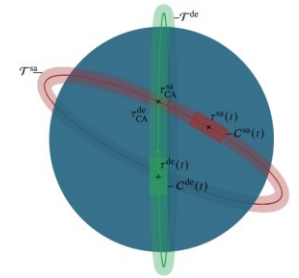
BRITOMARTIS

- Statistical evaluation of the risk from a secondary population on a target : **mitigation metrics** (PoC, CAM, etc.), **experienced severity**
- Processing each conjunction individually according to **CNES operational specifics** (MC runs)
- Ergodicity: replace an exposure time by a spatial exposure to efficiently compute conjunctions



ERGODIC RISK

- Alternative to the CUBE method for computing the probability of collision between two objects
- Decoupling of spatial screening threshold from position uncertainty magnitude of the objects



THANK YOU

**2ND SPACE CAPACITY ALLOCATION FOR THE
SUSTAINABILITY OF SPACE ACTIVITIES WORKSHOP**