Constellations de satellites : l’espace pollué et privatisé ?

Quelles conséquences spatiales et astronomiques?

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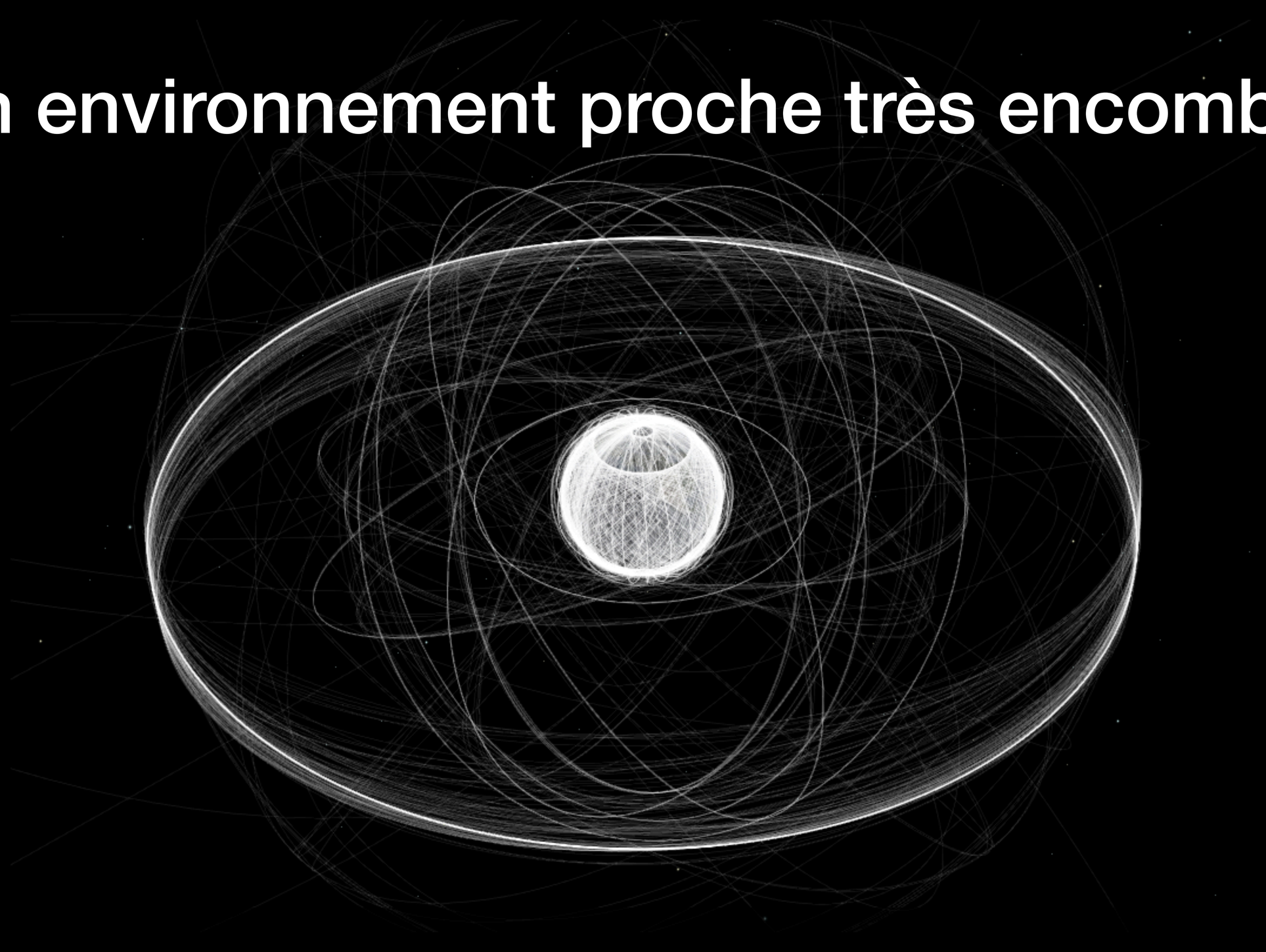
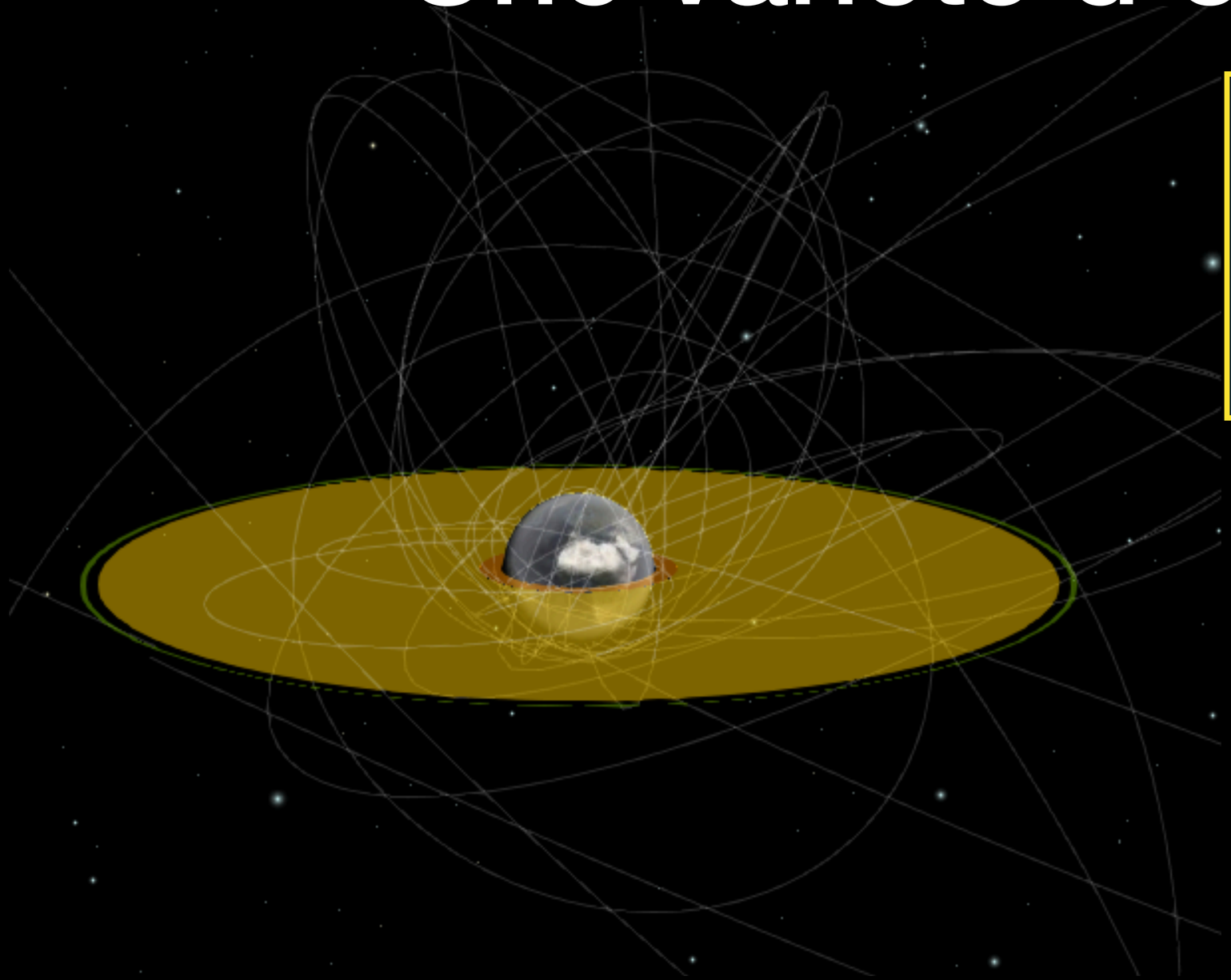
Un environnement proche très encombré



Une variété d’orbites



LEO (Low Earth Orbit)

4,176 satellites (85.91%)

MEO (Medium Earth Orbit)

132 satellites (2.72%)

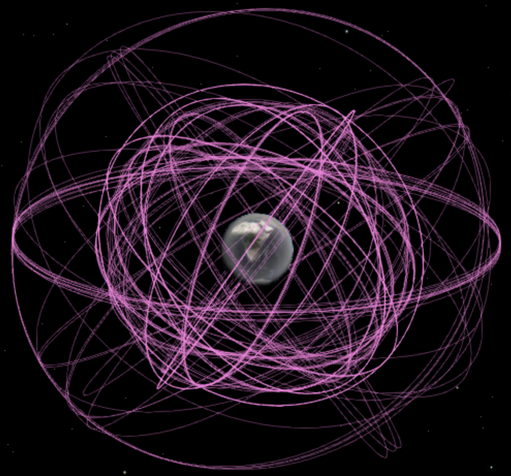
GEO (Geosynchronous Orbit)

519 satellites (10.68%)

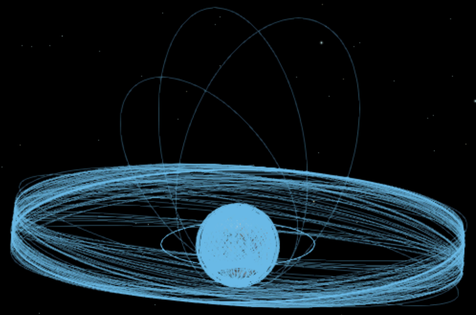
HEO (Highly Elliptical Orbit)

Pour quoi faire ?

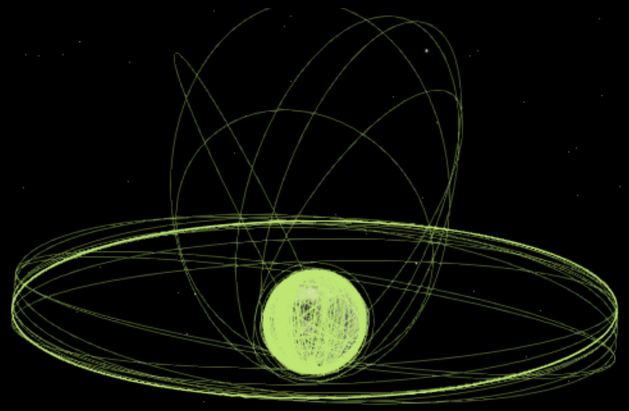
Localisation (146 - 3%)



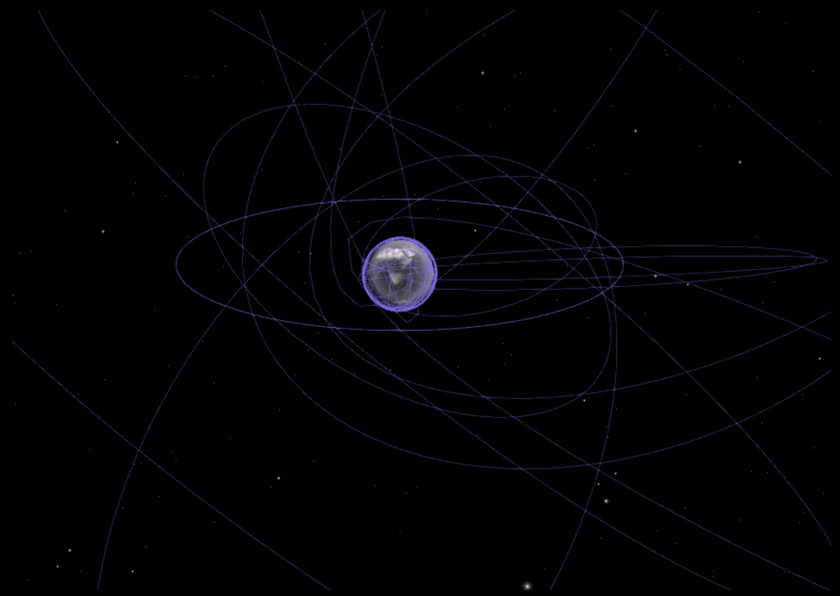
Communication (3478 - 70%)



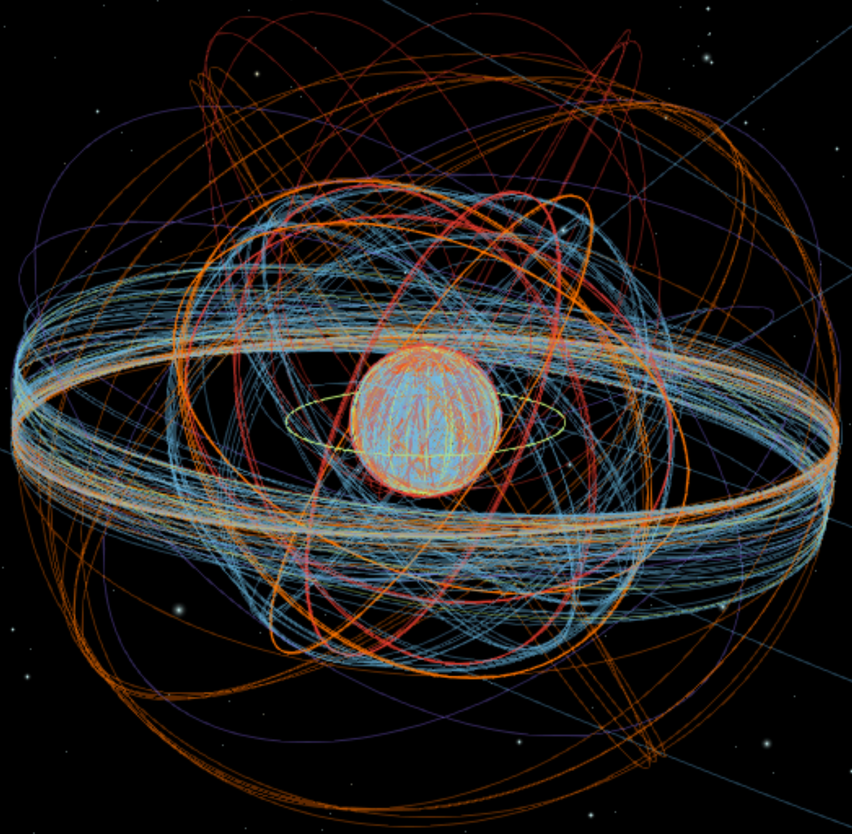
Observation de la Terre (899 - 18.5%)

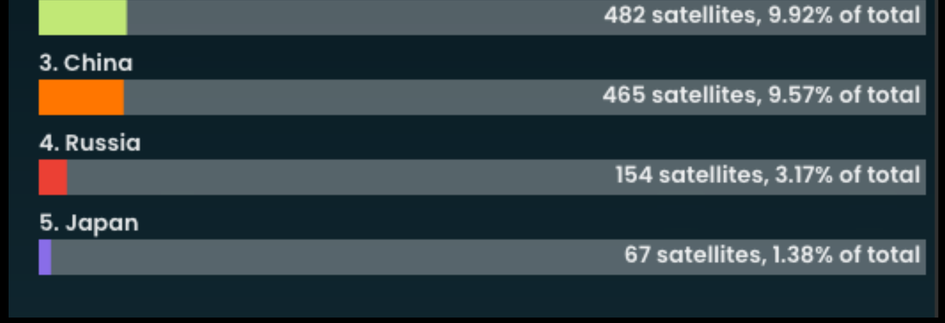


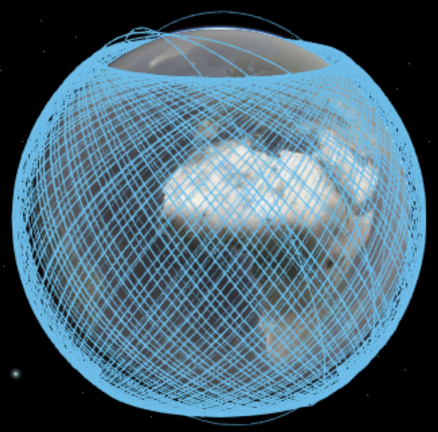
Observation de l’espace (83 - 2%)

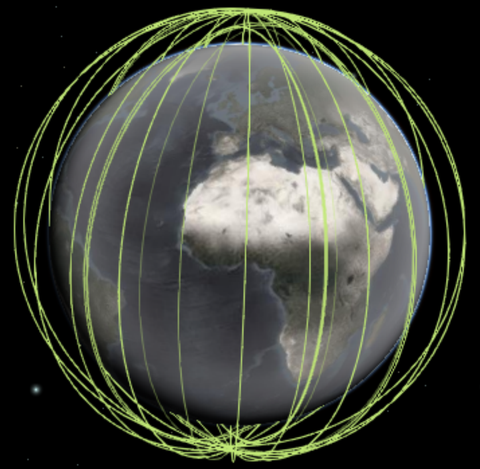


Des propriétaires divers









Space X - USA (2132 - 44%)

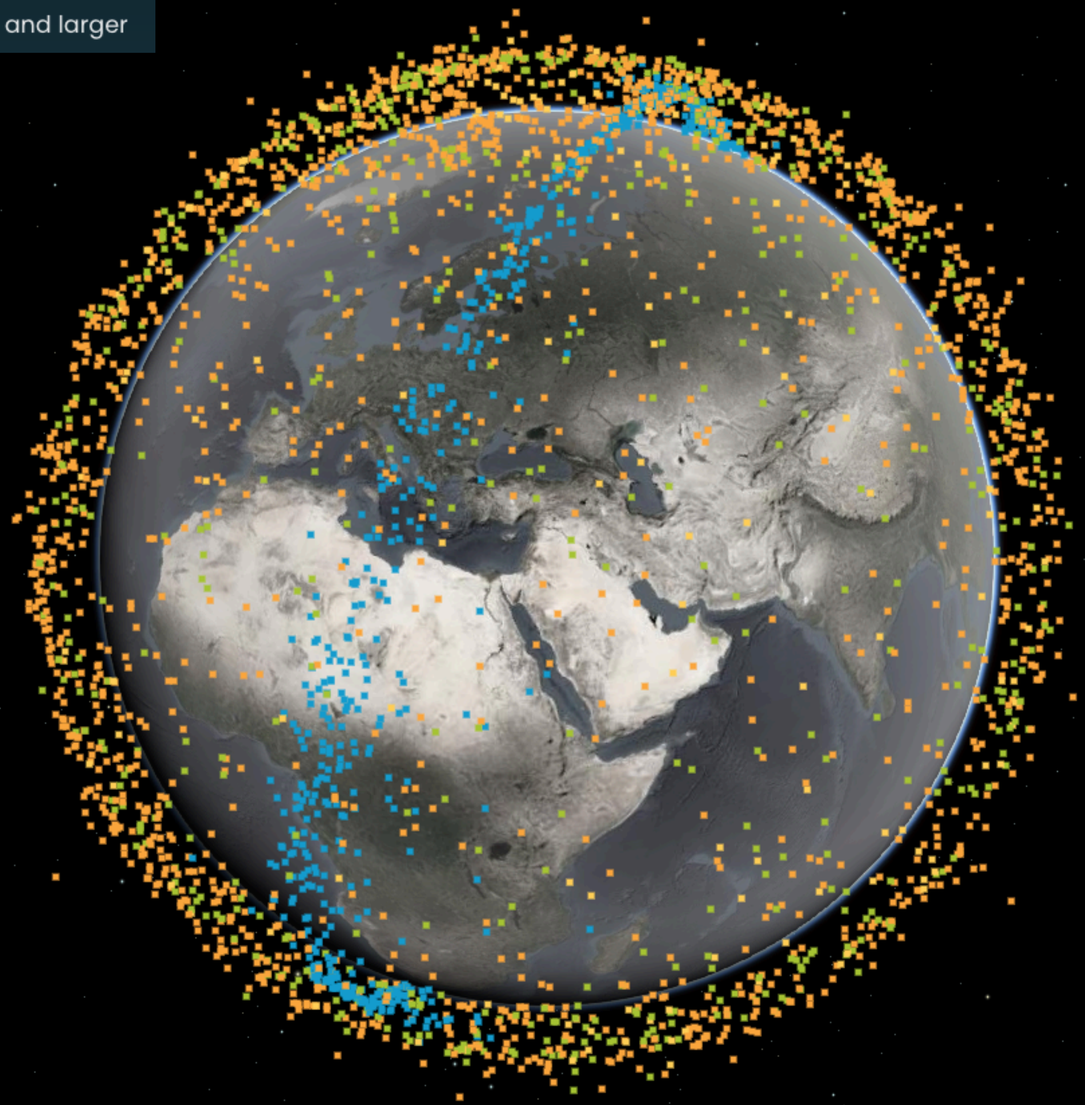
One Web - UK (425 - 9%)

Les débris

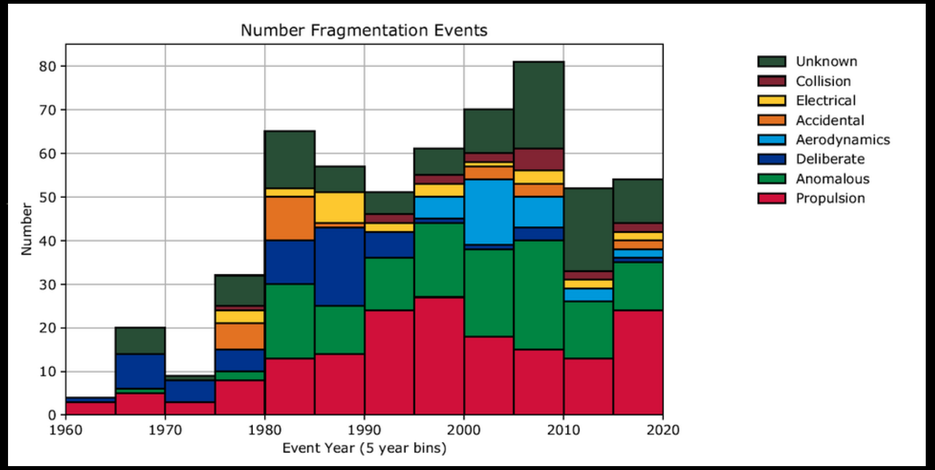
36,500 pieces of debris
larger than 10 cm/4 inches

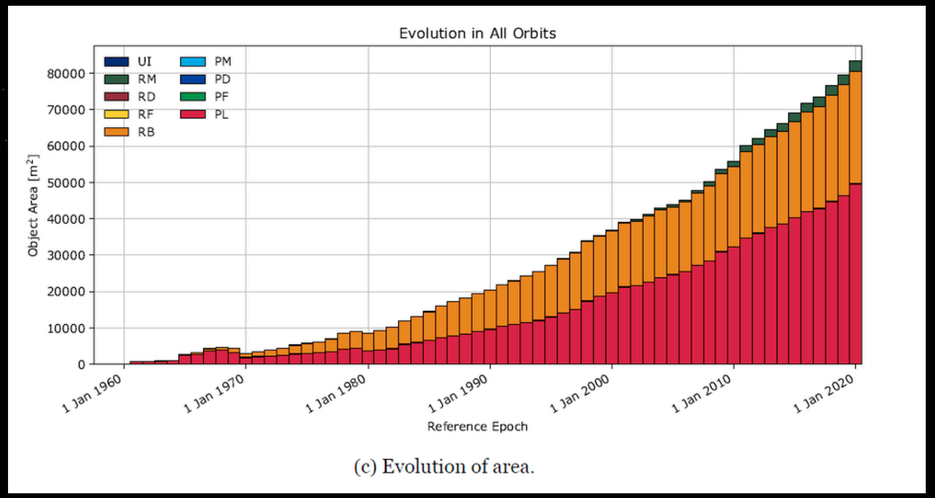
1,000,000 pieces of debris
larger than 1 cm/0.4 inches

130 million pieces of debris
about 1 mm/0.04 inches and larger



- **Cosmos 1408** Fragments de l'essai anti-satellite russe (2021)
- **Cosmos 2251** Fragments de la collision avec **Iridium 33** (2009)
- **Fengyun 1C** Fragments de l'essai anti-satellite chinois (2021)





(c) Evolution of area.

Et dans l'avenir ?

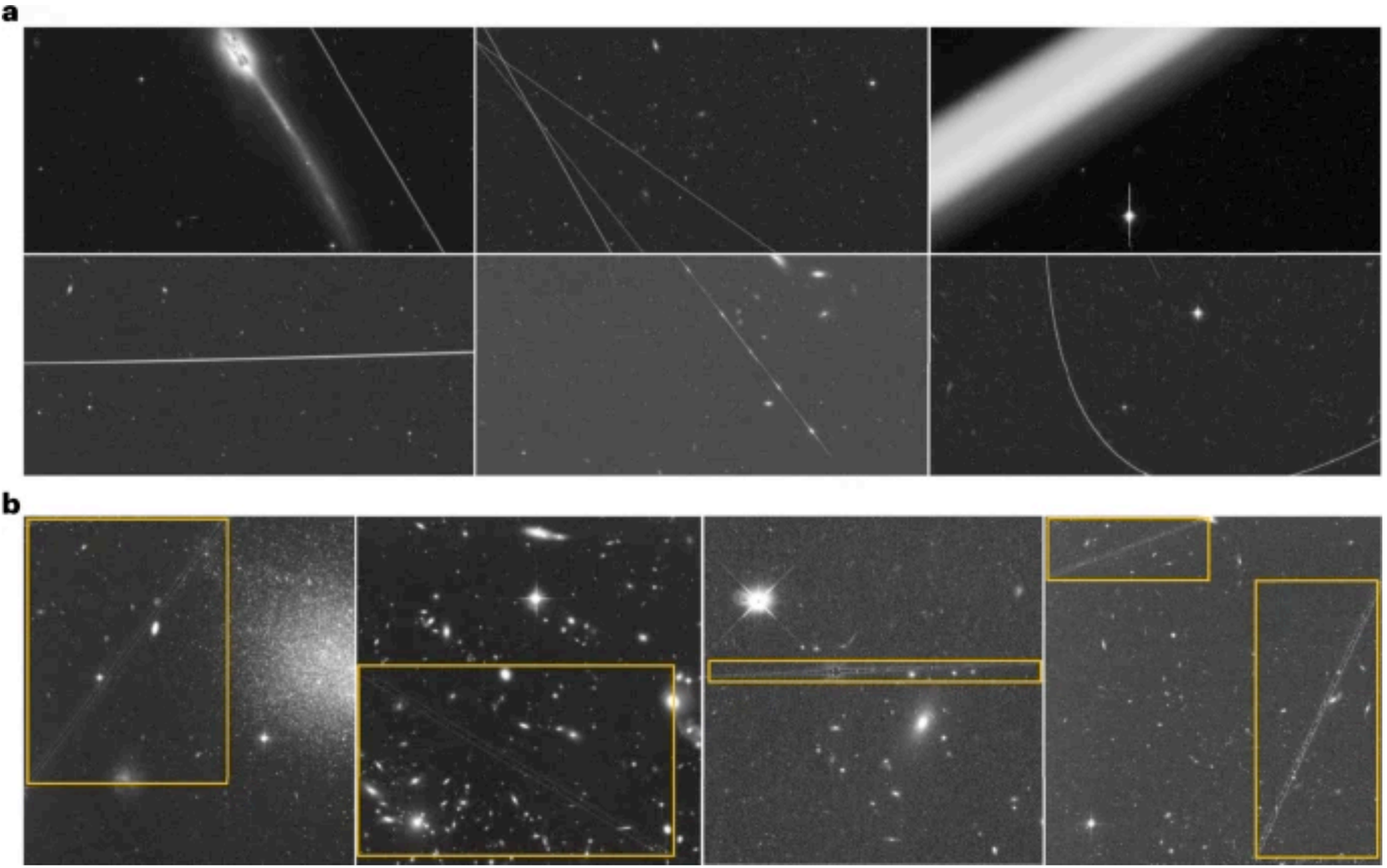
Constellation Name	Country	num. Satellites	Altitude [km]	Bands	Service Start
Starlink SpaceX	USA	42000	340 (~30k), 550 (~12k)	Ku, Ka, V	2020-2021
OneWeb	UK / IND	7000	1200	Ku	2022
BlueWalker3 AST SpaceMobile	USA	>100	500-600	V, L	2022-2024
Iridium	USA	75	780	L	2018
Telesat	CAN	512	~1000	Ka	2021-2025
Kuiper, Amazon	USA	3236	590, 610, 630	?	2022-2025
Samsung	KOR	4700	1400	?	2022-2030
Ubiquity – Lynk	USA	10+5000	500, 550	Ka, S	2022-2025
Kepler Comm.	USA	140	575	X, Ku	2021
Athena, Facebook	USA	>>10000	500, 550	?	2021-2030
LeoSAT	USA	108	1400	Ka	2022
Roscosmos	RU	640	870	L, X	2022-2026
StartRocket	RU	1400	450	optical	2022-2024
CASIC Hongyun	CHI	864	~1000	L, Ka	2022-2024
CASIC Xingyun	CHI				
CASC Hongyan	CHI	320	1100	L, Ka	?
Galaxy Space	CHI	144	~600	Ka, V	?
GW	CHI	12992	500/600 (~6k), 1145 (~6,9k)	V	?
Gelly	CHI	> 500 sat/year	<1000	L, Ku	2022-2024
Huawei	CHI	10000	<1000	<1THz (6G)	2022-2030
LuckyStar	CHI	156	1000	S	?
Commsat	CHI	800	600	optical	?
Xinwei	CHI	32	600	C, Ka, Ku	?
Sky & Space Global (3U Cube)	UK	200	From 500 to 800	L, S	2018
Astro Tech	IND	600	1400	C	?
Boeing	USA	3116	1200	V, C, Ka	withdrawn
Cube/NanoSATs	several	3100 + 1.5k/yr	from 200 to 2000 Most <600	various	>2005 Low orbit decayed
ALL	TOTAL	>100k Satellites	<1400	[1; 1000]GHz	within 2030

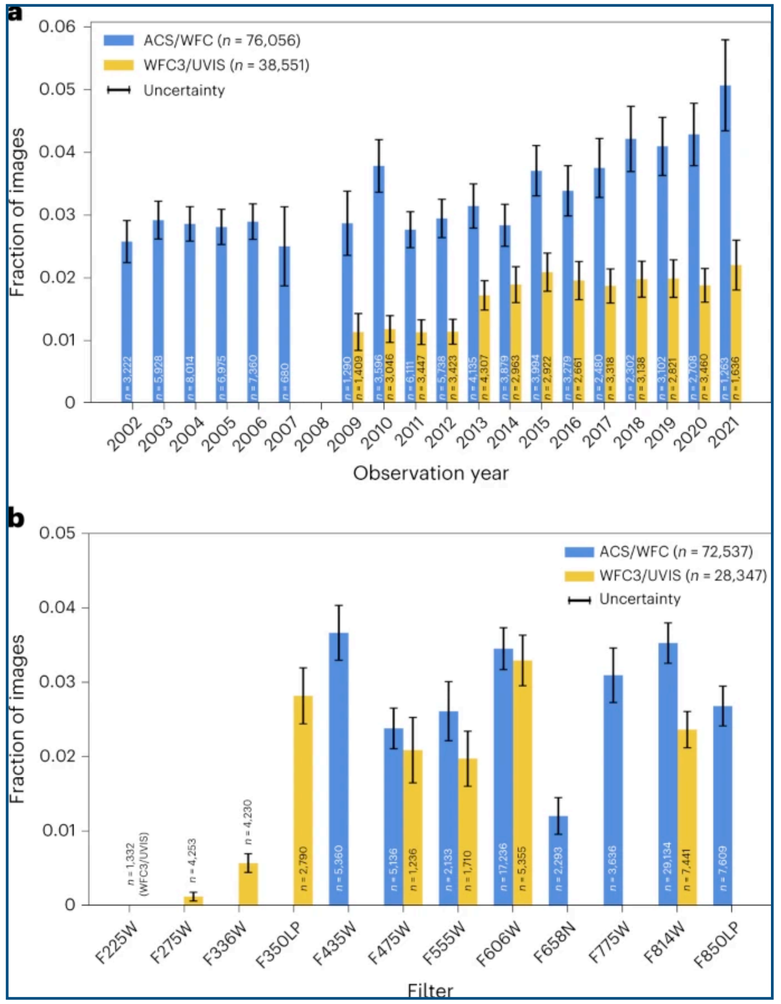
Authorization from NDRC Chinese National Development and Reform Commission	Authorization from Russian Roscosmos Space Agency	Authorization from FCC US Federal Communication Commission

Implications astronomiques

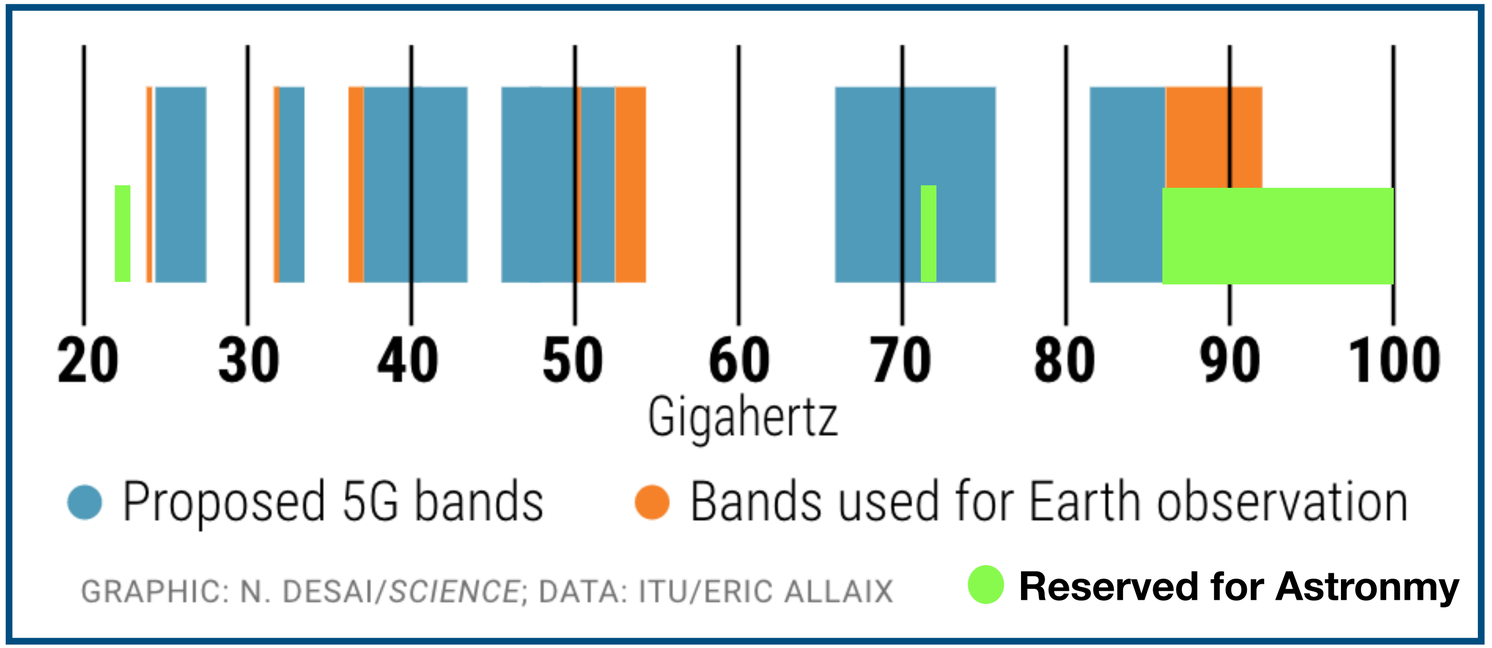
Satellites over Orion -Image Credit: Amir H. Abolfath

Même le Hubble Space Télescope





Et les ondes radars ?



Bandes d'observation en astronomie
Methanol (CH3OH) 12.178 GHz 12.17- 12.19 GHz
Formaldehyde (H2CO) 14.488 GHz 14.44- 14.50 GHz

Starlink : 10,70 - 12,75 GHz (sens espace vers Terre) et 14,0 - 14,50 GHz (sens Terre vers espace)

Grenoble et la pollution du ciel nocturne

XVIth General Assembly

Grenoble, France

1976

XVIe Assemblée Générale

Grenoble, France

1976

Resolution No. 9

Proposed by IAU Commission 50 (Identification and Protection of Existing and Potential Observatory Sites)

Proposée par la Commission 50 (Protection des Sites d'Observatoires Existants et Potentiels) de l'UAI

The International Astronomical Union notes with alarm the increasing levels of interference with astronomical observation resulting from artificial illumination of the night sky, radio emission, atmospheric pollution and the operation of aircraft above Observatory sites.

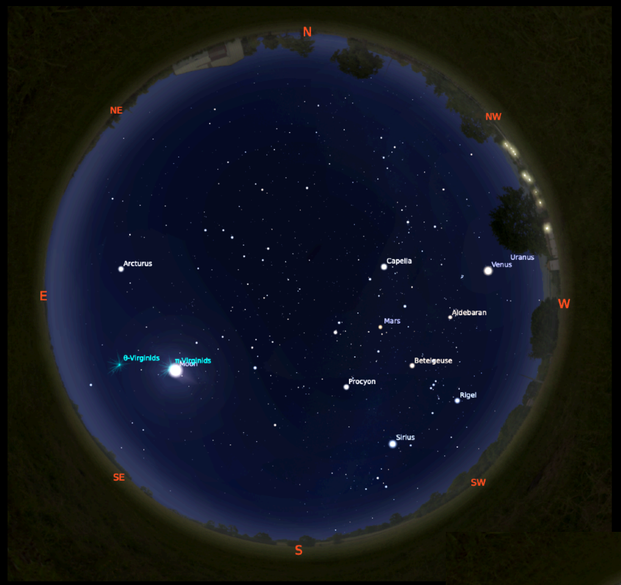
The IAU therefore urgently requests that the responsible civil authorities take action to preserve existing and planned observatories from such interference. To this end, the IAU undertakes to provide through Commission 50 information on acceptable levels of interference and possible means of control.

L'Union Astronomique Internationale s'inquiète vivement de l'augmentation des niveaux d'interférence avec les observations astronomiques, qui résulte de l'illumination artificielle du ciel nocturne, des émissions radio, de la pollution atmospérique et du survol par les avions des sites d'observatoires.

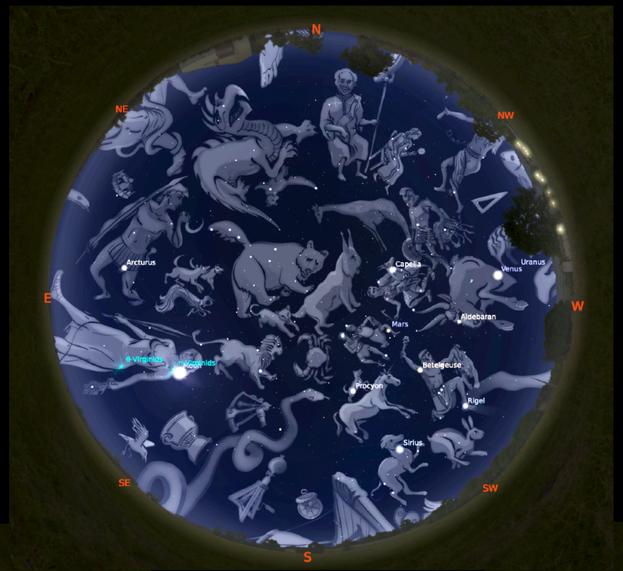
En conséquence, l'UAI demande instamment aux autorités civiles responsables d'entreprendre une action urgente afin de préserver de telles interférences les observatoires existants ou en projet. Dans ce but, l'UAI se charge de fournir, par l'intermédiaire de la Commission 50, tous renseignements concernant les limites acceptables d'interférence et les moyens possibles de contrôle.

Le ciel nocturne, un patrimoine commun

Hémisphère Nord



Ciel occidental



Ciel arabe

Ciel ojibwe

Ciel roumain