

Le Ciel étoilé en péril

1994-2024

Mais pas que... Et ce n'est pas fini...

« *Le ciel, nous ne le voyons presque plus alors que ce fut un spectacle familier, une interrogation quotidienne pour pratiquement tous les hommes jusqu'à une période très récente, Nous qui vivons dans des villes illuminées, on ne voit plus le ciel* ». Christian Grataloup, auteur avec Pierre Lena de l'Atlas historique du ciel

Présentation dédiée à David L. Crawford 1931 2024

**LES RENCONTRES
DU CIEL ET DE L'ESPACE**



LES 9, 10
ET 11 NOV. 2024
à la Cité des sciences et
de l'industrie

Mais la lumière est toujours là...



EP éteint...



Je lis toujours mon journal...
A 400 mètres de mon hôpital...



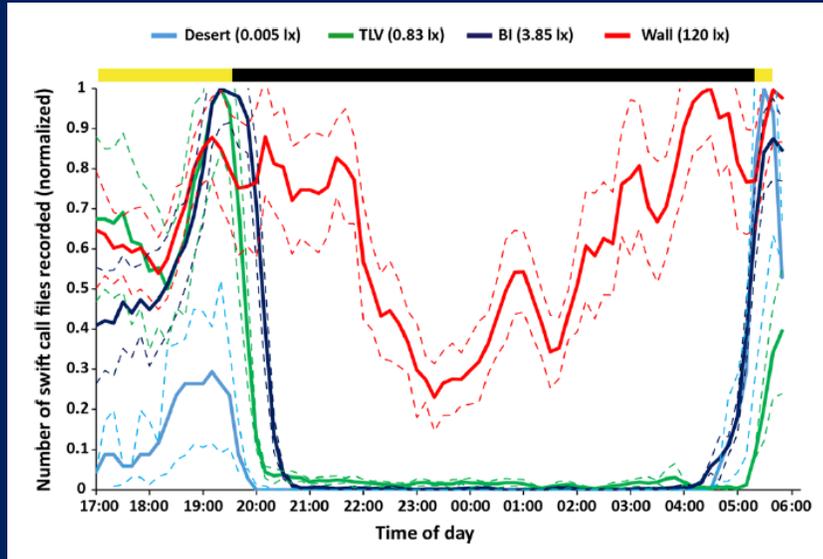
Les panneaux publicitaires à DEL...
Qui s'éteignent à une heure du matin
Et dans les magasins...



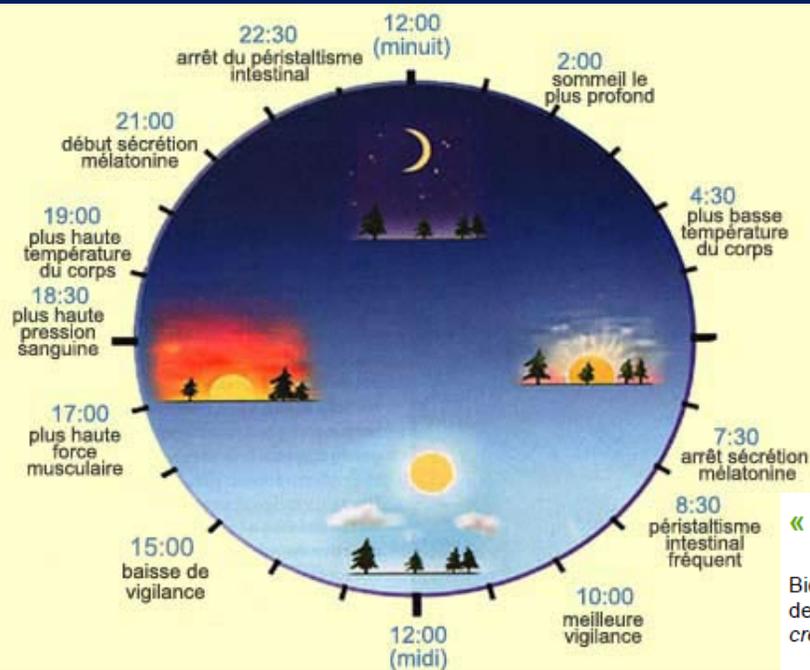
Et l'extinction ne résout pas tout...

“Si j'en avais le pouvoir, j'émettrais aujourd'hui un trou noir. Quelque chose comme un cône d'extinction forant au ventre l'épaisseur du jour. Pour rouvrir l'espace. Ce qui me terrifie, ce n'est pas ce chaos de clartés qui brouille la ville comme une avalanche de soleils. C'est qu'il n'y ait plus nulle part une seule ombre. Tout est féroce surexposé.”

— Alain Damasio, *So phare away*



Un exemple : Effets de la lumière nocturne sur l'activité diurne des martinets noirs. La barre en haut représente le cycle jour/nuit : Jaune = jour, noir = nuit.



« La lumière artificielle perturbe le comportement des espèces »

Bien que les communes et les entreprises ont compris l'intérêt d'éteindre en cœur de nuit pour faire des économies d'énergie, « l'enjeu désormais est de les sensibiliser sur l'éclairage à l'aube et au crépuscule pour protéger la biodiversité », estime Romain Sordello.

Cela passe par le développement de trames noires, des couloirs d'obscurité entre plusieurs zones naturelles pour permettre un réseau écologique propice à la vie nocturne. « Actuellement, une cinquantaine de collectivités ont terminé ou sont en train d'élaborer une trame noire, cela concerne des zones rurales mais aussi urbaines », indique-t-il.



Éclairage nocturne : pourquoi éteindre en pleine nuit ne suffit pas
14 octobre 2024
<https://reporterre.net/Eclairage-nocturne-pourquoi-eteindre-en-pleine-nuit-ne-suffit-pas>



Marseille la nuit. La 16e édition du Jour de la nuit a lieu samedi 12 octobre 2024. - Flickr / CC BY-NC 2.0 / ferhat.culfaz

Les communes françaises ont compris la nécessité d'éteindre la lumière en pleine nuit pour faire des économies d'énergie. Mais pour protéger la biodiversité, il faudrait aussi se passer d'éclairage à l'aube et au crépuscule.

La biodiversité c'est 24 heures sur 24 !

Notre mode de vie...

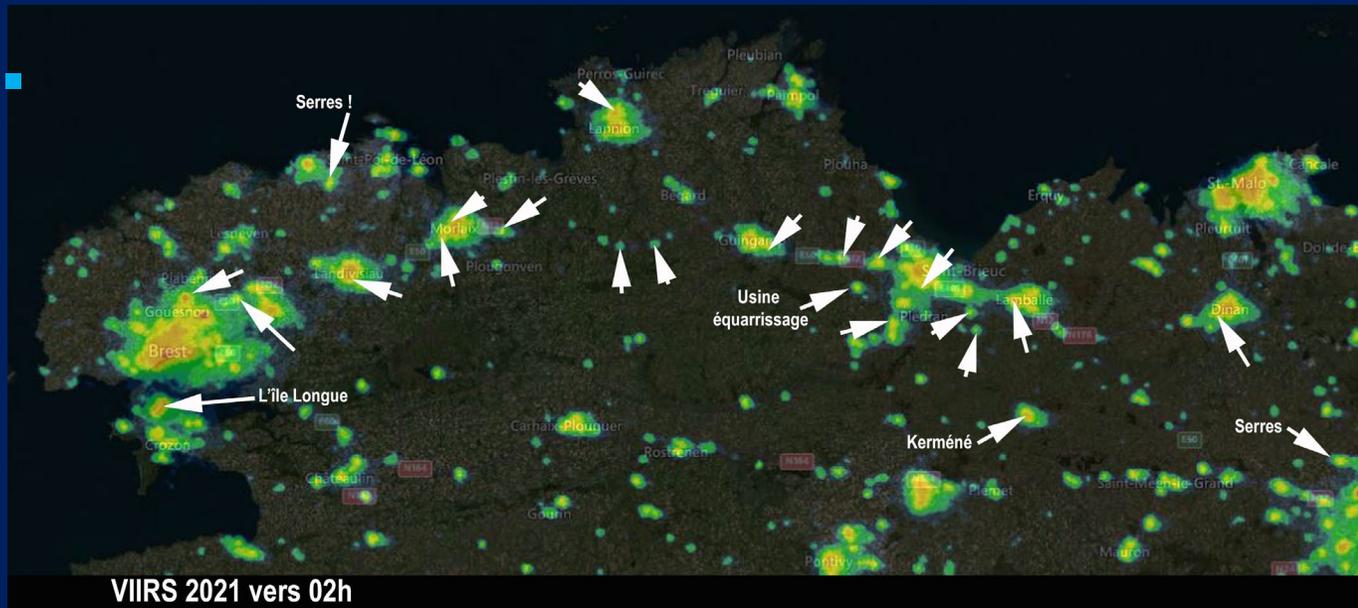
Négociable ?

Centres logistiques

Zones commerciales

Zones artisanales et industrielles

Eclairées toute la nuit...



Eoliennes



Luminaires... Et autres sources lumineuses...

Répartition angulaire



15°



75°

Distribution des flux lumineux

ULR < 1%

< 5%

> 95%

100% - ULR > 99%

Schéma à l'échelle



Réglementation non respectée...

Arrêté du 28 décembre 2018

Publicité lumineuses

Règlement Local de la Publicité

Difficiles à négocier et à faire respecter !

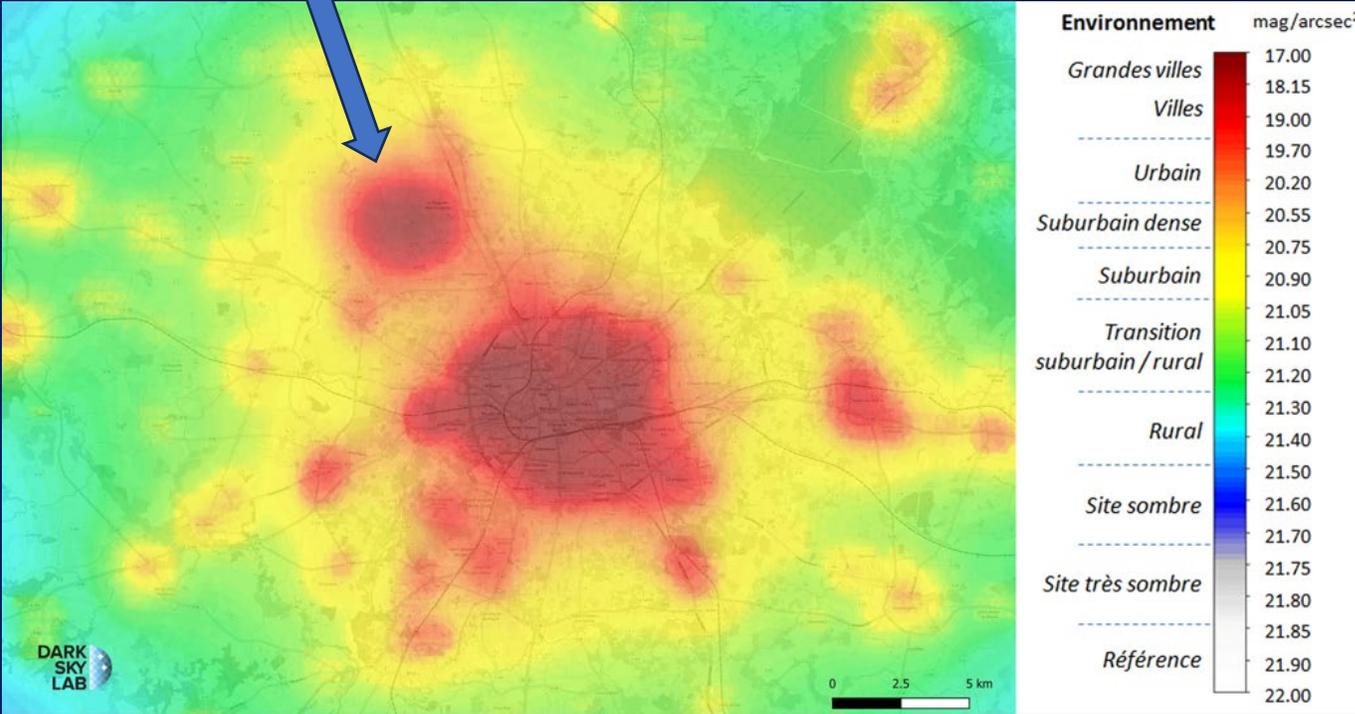
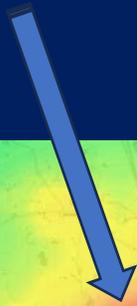
Luminaire...

Exemple Zone industrielle des châtelets



Réglementation non respectée... Arrêté du 28 12 2018 Publicité lumineuses

D'autres menaces pointent...



Les serres éclairées et chauffées...
Pour certains légumes toute l'année...

Méga constellation de satellites...



Pollution lumineuse traçantes...

Méga constellation de satellites...

Impacts...
Sur l'astronomie
professionnelle...



Sur la beauté du ciel...
Tout simplement...

Zones
interdites...

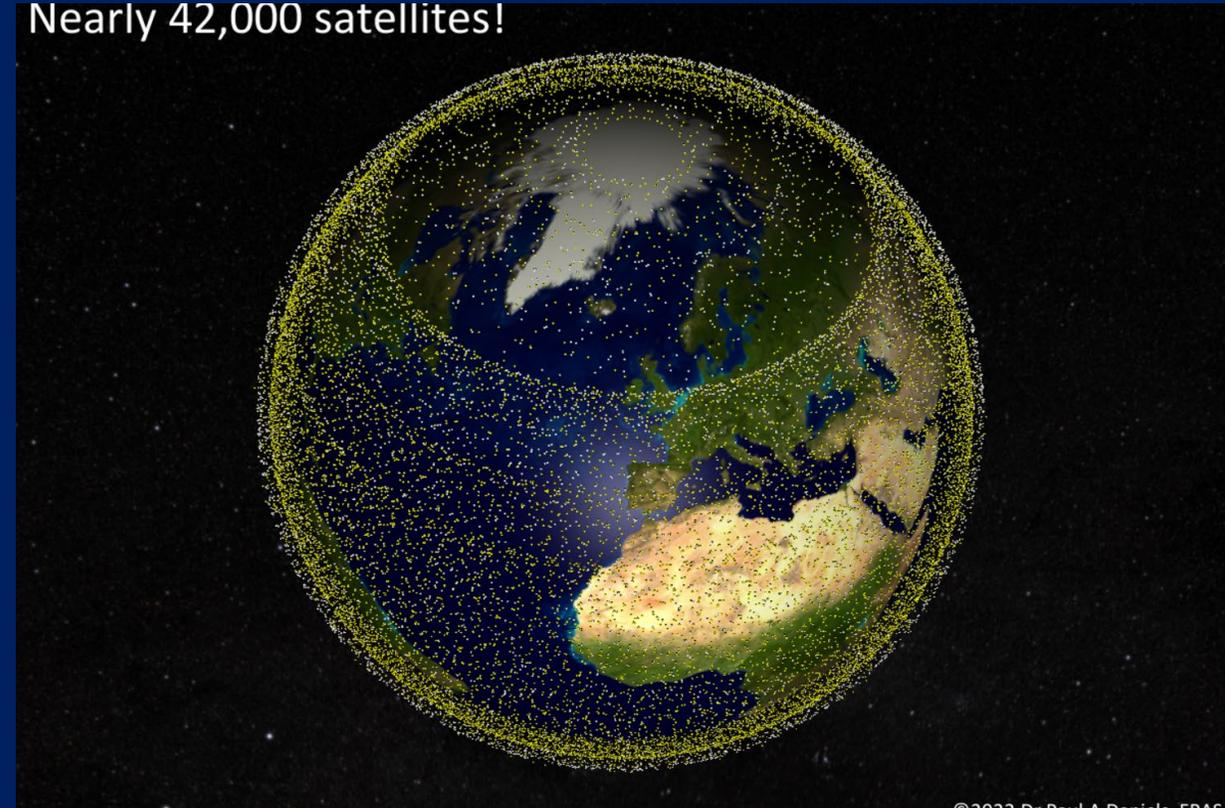
Méga constellation de satellites...



Kessler Effect....

Risque de collisions, débris...

Nearly 42,000 satellites!



Méga constellation de satellites...

Lancements de plus en plus nombreux...



Earth's Future

RESEARCH ARTICLE

10.1029/2021EF002612

Key Points:

- Air pollutant emission inventory for current space sector and future tourism input to a coupled chemistry and radiative transfer model
- Upper stratospheric Arctic ozone loss from launch chlorine and re-entry nitrogen oxide emissions undermines Montreal Protocol success
- Warming efficiency of space tourism (soot) emissions about 500-times greater than surface and aircraft sources of soot

Supporting Information:

Supporting Information may be found in the online version of this article.

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Citation:

Ryan, R. G., Marais, E. A., Balhatchet, C. J., & Eastham, S. D. (2022). Impact

Impact of Rocket Launch and Space Debris Air Pollutant Emissions on Stratospheric Ozone and Global Climate

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Abstract Detailed examination of the impact of modern space launches on the Earth's atmosphere is crucial, given booming investment in the space industry and an anticipated space tourism era. We develop air pollutant emissions inventories for rocket launches and re-entry of reusable components and debris in 2019 and for a speculative space tourism scenario based on the recent billionaire space race. This we include in the global GEOS-Chem model coupled to a radiative transfer model to determine the influence on stratospheric ozone (O_3) and climate. Due to recent surge in re-entering debris and reusable components, nitrogen oxides from re-entry heating and chlorine from solid fuels contribute equally to all stratospheric O_3 depletion by contemporary rockets. Decline in global stratospheric O_3 is small (0.01%), but reaches 0.15% in the upper stratosphere (~5 hPa, 40 km) in spring at 60–90°N after a decade of sustained 5.6% a^{-1} growth in 2019 launches and re-entries. This increases to 0.24% with a decade of emissions from space tourism rockets, undermining O_3 recovery achieved with the Montreal Protocol. Rocket emissions of black carbon (BC) produce substantial global mean radiative forcing of 8 $mW m^{-2}$ after just 3 years of routine space tourism launches. This is a much greater contribution to global radiative forcing (6%) than emissions (0.02%) of all other BC sources, as radiative forcing per unit mass emitted is ~500 times more than surface and aviation sources. The O_3 damage and climate effect we estimate should motivate regulation of an industry poised for rapid growth.



Pollution de la basse...
Et haute atmosphère....

Il y a longtemps...



Méga constellation de satellites...

Protecting Radio Windows for Astronomy

VERNON PANKONIN, *National Science Foundation*

Sky and Telescope Avril 1981 Déjà...

Astronomy & Astrophysics manuscript no. output
July 3, 2023

©ESO 2023

Unintended electromagnetic radiation from Starlink satellites detected with LOFAR between 110 and 188 MHz

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⁵ Department of Physics and Electronics, Rhodes University, PO Box 94, Makhanda, 6140, South Africa

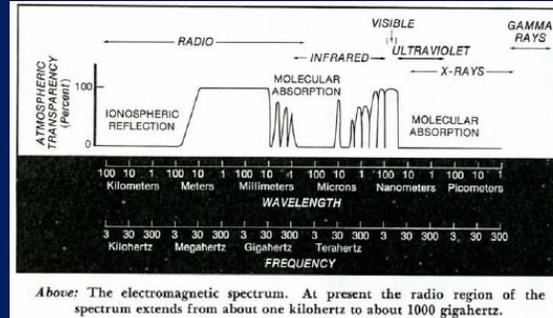
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Received March 10, 2023; accepted May 12, 2023

ABSTRACT

We report on observations of 68 satellites belonging to the SpaceX Starlink constellation with the LOFAR radio telescope. Radiation associated with Starlink satellites was detected at observing frequencies between 110 and 188 MHz, which is well below the 10.7 to 12.7 GHz radio frequencies used for the downlink communication signals. A combination of broad-band features, covering the entire observed bandwidth, as well as narrow-band (bandwidth < 12.2 kHz) emission at frequencies of 125, 135, 143.05, 150, and 175 MHz, was observed. The presence and properties of both the narrow- and broad-band features vary between satellites at different orbital altitudes, indicating possible differences between the operational state of, or the hardware used in, these satellites. While the narrow-band detections at 143.05 MHz can be attributed to reflections of radar signals from the French GRAVES Space Surveillance Radar, the signal properties of the broad- and narrow-band features at the other frequencies suggest that this radiation is intrinsic to the Starlink satellites and it is seen for 47 out of the 68 Starlink satellites that were observed. We observed spectral power flux densities vary from 0.1 to 10 Jy for broad-band radiation, to 10 to 500 Jy for some of the narrow-band radiation, equivalent to electric field strengths of up to 49 dB [$\mu\text{V m}^{-1}$] (as measured at a 10 m distance from the satellites, with a measurement bandwidth of 120 kHz). In addition, we present equivalent power flux density simulations of the full Starlink phase 1 constellation, as well as other satellite constellations, for one frequency band allocated to radio astronomy by the International Telecommunication Union (ITU). With these, we calculate the maximum radiation level that each satellite constellation would need to have to comply with regulatory limits for intended emissions in that band. However, these limits do not apply if the radiation is unintended, that is to say if it does not originate from intentionally radiated signals for radio communication or other purposes. We discuss the results in light of the (absence of) regulations covering these types of unintended electromagnetic radiation and the possible consequences for astronomical radio observations.

Key words. light pollution – space vehicles – telescopes – surveys



Above: The electromagnetic spectrum. At present the radio region of the spectrum extends from about one kilohertz to about 1000 gigahertz.



A&A, 689, L10 (2024)
<https://doi.org/10.1051/0004-6361/202451856>
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Astronomy
&
Astrophysics

LETTER TO THE EDITOR

Bright unintended electromagnetic radiation from second-generation Starlink satellites

C. G. Bassa^{1,*}, F. Di Vruno^{2,3,*}, B. Winkel^{4,3,*}, G. I. G. Józsa^{4,5,3,*}, M. A. Brentjens¹, and X. Zhang⁶

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Received 9 August 2024 / Accepted 29 August 2024

ABSTRACT

We report on the detection of unintended electromagnetic radiation (UEMR) from the second-generation of Starlink satellites. Observations with the LOFAR radio telescope between 10 to 88 MHz and 110 to 188 MHz show broadband emission covering the frequency ranges from 40 to 70 MHz and 110 to 188 MHz from the v2-Mini and v2-Mini Direct-to-Cell Starlink satellites. The spectral power flux density of this broadband UEMR varies from satellite to satellite, with values ranging from 15 to 1300 Jy, between 56 and 66 MHz, and from 2 to 100 Jy over two distinct 8 MHz frequency ranges centered at 120 and 161 MHz. We compared the detected power flux densities of this UEMR to that emitted by the first generation v1.0 and v1.5 Starlink satellites. When correcting for the observed satellite distances, we find that the second-generation satellites emit UEMR that is up to a factor of 32 stronger compared to the first generation. The calculated electric field strengths of the detected UEMR exceed typical electromagnetic compatibility standards used for commercial electronic devices as well as recommended emission thresholds from the Radiocommunication Sector of the International Telecommunications Union (ITU-R) aimed at protecting the 150.05–153 MHz frequency range allocated to radio astronomy. We characterize the properties of the detected UEMR with the aim of assisting the satellite operator with the identification of the cause of the UEMR.

Key words. light pollution – space vehicles – telescopes – surveys

Pollution radioélectriques et interférence

Des impacts trop méconnus...

Geophysical Research Letters*

RESEARCH LETTER

10.1029/2024GL109280

Key Points:

- We present the first atomic-scale molecular dynamics simulation of high-temperature aluminum ablation during reentry from low-Earth orbit
- The amount of aluminum oxide nanoparticles generated is quantified and the accumulation in the atmosphere is estimated
- The long-term accumulation of aluminum oxides from reentering satellites can cause significant ozone depletion

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Potential Ozone Depletion From Satellite Demise During Atmospheric Reentry in the Era of Mega-Constellations

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Abstract Large constellations of small satellites will significantly increase the number of objects orbiting the Earth. Satellites burn up at the end of service life during reentry, generating aluminum oxides as the main byproduct. These are known catalysts for chlorine activation that depletes ozone in the stratosphere. We present the first atomic-scale molecular dynamics simulation study to resolve the oxidation process of the satellite's aluminum structure during mesospheric reentry, and investigate the ozone depletion potential from aluminum oxides. We find that the demise of a typical 250-kg satellite can generate around 30 kg of aluminum oxide nanoparticles, which may endure for decades in the atmosphere. Aluminum oxide compounds generated by the entire population of satellites reentering the atmosphere in 2022 are estimated at around 17 metric tons. Reentry scenarios involving mega-constellations point to over 360 metric tons of aluminum oxide compounds per year, which can lead to significant ozone depletion.



AMERICAN ASTRONOMICAL SOCIETY

September 27, 2024

AAS Statement on the Atmospheric Impacts of Spacecraft Reentries and Launches

Les rentrées régulières des satellites des méga constellations...

Réglementer un Far West ?...



NSF statement on NSF and SpaceX Astronomy Coordination Agreement
January 10, 2023

<https://beta.nsf.gov/news/statement-nsf-astronomy-coordination-agreement>

Annonce

ESO and international partners petition UN for the protection of the Earth's dark and quiet skies

7 février 2022

<https://www.eso.org/public/france/annoncements/ann22001/?lang>



An international collaboration involving ESO has submitted a new paper to the United Nations Committee on Peaceful Uses of Outer Space (COPUOS) seeking better protections for the Earth's dark and quiet skies. The paper was accepted for discussion today at the ongoing session of the COPUOS Scientific and Technical Subcommittee, marking the first time the dark and quiet skies have ever been tabled as a formal agenda item by the United Nations. The paper, which has been endorsed by Chile, Spain and Slovakia, encourages the international community to protect global astronomical observing capabilities from disruptive and harmful artificial interference.

MANIFESTO / DICHIARAZIONE DI INTENTI DELLA

“FONDAZIONE PER LA SALVAGUARDIA DEL CIELO ASTRONOMICICO”

“Safeguarding the Astronomical Sky FOUNDATION”



Le osservazioni astronomiche da terra verranno gravemente danneggiate dal dispiegamento in corso di grandi flotte di satelliti per garantire il funzionamento delle future tecnologie di telecomunicazioni.

UNITED NATIONS
OFFICE FOR OUTER SPACE AFFAIRS

Space Debris Mitigation Guidelines of the Committee
on the Peaceful Uses of Outer Space



UNITED NATIONS

Pas facile devant les intérêts économiques et les consommateurs...

Réglementer ? Suite...

iau2401 — Press Release 15 February 2024



United Nations Agrees to Address Impact of Satellite Constellations on Astronomy

After several years' work by astronomers affiliated with the IAU CPS, a key UN body agreed last week to put on their agenda the issue of satellite constellations' impact on astronomy.

After intense discussions, the United Nations Committee on the Peaceful Uses of Outer Space (UN COPUOS) Scientific and Technical Subcommittee has agreed to include an item on its provisional agenda for the next five years with the title "Dark and Quiet Skies, astronomy and large constellations: addressing emerging issues and challenges". As the UN's top body for space-related matters, with delegates from more than 102 countries, COPUOS deals with all topics related to international cooperation and the exploration of space and planetary bodies, including the deployment of satellites, space debris mitigation, the long-term sustainability of space and the use of orbital slots.

iau2409 — Press Release

[Subscribe to the IAU e-Newsletter.](#)



8 August 2024

Satellite Mitigation Project Led by IAU CPS Wins Major Grant

The initiative is developing tools to accurately predict when satellites will cross the sky

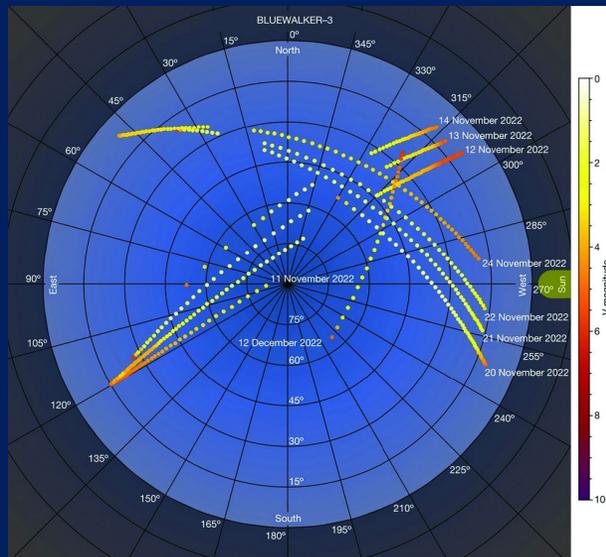
[Click to Enlarge](#)

The U.S. National Science Foundation has awarded \$750,000 to a project led by the IAU Centre for the Protection of the Dark and Quiet Sky from Satellite Constellation Interference to reduce the science impact caused by satellite constellations on astronomical observatories.

The IAU Centre for the Protection of the Dark and Quiet Sky from Satellite Constellation Interference (IAU CPS), which is co-hosted by NSF NOIRLab and the SKAO, has received a SWIFT-SAT grant [1] from the U.S. National Science Foundation (NSF).



Call to Protect the Dark and Quiet Sky from Harmful Interference by Satellite Constellations



Mobilisation... Quelle application ?

Réglementer ? A suivre...

Executive Committee WG “Dark and Quiet Sky Protection”
Resolution for consideration for the XXXII General Assembly

Protection of the Dark and Quiet Sky from harmful interference by satellite

constellations The International Astronomical Union XXXII General Assembly,

Recalling

1. Resolution 1 and Resolution 2 of the XI IAU General Assembly (1961) in response to the great dangers that activities in space such as “Project West Ford” posed to astronomical research,
2. Resolution B5 of the XXVII IAU General Assembly (2009) that affirmed that an unpolluted night sky should be considered a fundamental socio-cultural and environmental right, and that the protection of the astronomical quality of areas suitable for scientific observation should be taken into account when developing and evaluating national and international policies,
3. the creation in 2022 of the IAU Centre for the Protection of the Dark and Quiet Sky from Satellite Constellation Interference (CPS) to coordinate collaborative multidisciplinary international efforts with institutions and individuals and work across multiple geographic areas to help mitigate the negative impact of satellite constellations on ground-based optical and radio astronomy observations, as well as on humanity’s enjoyment of the night sky,
4. the inclusion of an item in the agenda of the World Radiocommunication Conference 2027 of the International Telecommunication Union (ITU) regarding the impact of non-geostationary satellites on radio astronomy stations in specific radio quiet zones and in radio frequency bands allocated to radio astronomy on a primary basis globally (Agenda Item WRC27 1.16),
5. the inclusion of the item “Dark and Quiet Skies, astronomy and large constellations: addressing emerging challenges and issues” in the [provisional]¹ agenda for five years of the Scientific and Technical Subcommittee of the United Nations Committee on the Peaceful Uses of Outer Space.

Recognising that

1. astronomy and astronomical observations are intrinsically a form of space exploration, and they enjoy freedoms and protections under international law whereby States are obligated to show due regard to the interests of other states in the peaceful exploration of Outer Space under the 1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies,
2. satellite constellations provide societal benefits, and that the support of space commerce and defence is a high priority of many governments,
3. the night sky is an object of intangible human heritage and profound importance for civilizations past and present, representing artistic, cultural, and religious value and significance to people worldwide,
4. the rapid proliferation of satellites in Low Earth Orbit (LEO) and beyond has negative effects on astronomical observations, scientific research, and the night sky, affecting ground-based optical observatories, space-based telescopes and the view of the night sky through reflected sunlight, and is increasing radio frequency interference at radio astronomy observatories through in-band and out-of-band transmissions and unintended electromagnetic radiation,

¹ Subject to the expected approval of the full COPUOS committee at their June, 2024 meeting, at which point we request that the term ‘provisional’ be struck.

5. access to a dark and radio-quiet sky is crucial for conducting fundamental research in astronomy, for important public services such as planetary defence and high-precision geolocation, and for continuing the numerous spin-off benefits of astronomical technology developments,

6. the utilisation of space for its many benefits should not come at the detriment of astronomical research and the access to the night sky for humanity, and given their global nature, there are no places on Earth that can fully escape the effects of satellite constellations,

7. the changing visual appearance of the sky impacts all of humanity, and there is a need for widespread inclusivity in decisions about the use of outer space.

Considering that

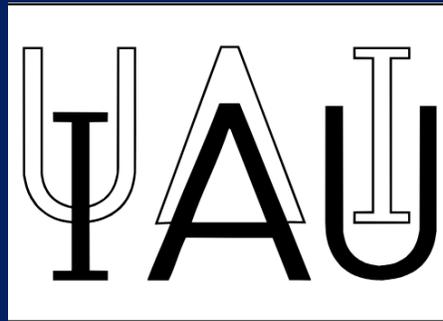
1. the IAU is uniquely positioned to provide recommendations to government administrations, the space industry, the public, and astronomers to mitigate the negative impacts of satellite constellations on astronomy,
2. the IAU supports the efforts and advocacy of scientific and professional societies in seeking protection of the Earth-Space environment,
3. while the professional astronomical community has the necessary expertise to produce technical studies, conduct observations of satellites in different wavelengths, and propose feasible mitigation measures, it lacks the funding to pursue these activities with the urgency needed,
4. broader issues of space sustainability also impact astronomy, such as the risk of an increase in space debris raising the diffuse night sky brightness level, or of a change in the chemistry of the stratosphere from launches and re-entries increasing atmospheric opacity,
5. the IAU, through the work of the CPS, has provided a legal and policy basis for advocacy that has been instrumental in progressing a national and international-level approach to mitigating the impact of satellite constellations,

Therefore resolves to

1. include the protection of the Dark and Quiet Sky as part of IAU’s mandate,
2. urge the Officers or their designees, on the basis of advice and co-ordination by the IAU CPS, to support and encourage appropriate nationally-based organisations to increase advocacy for national governments to:
 - A. Safeguard humanity’s access to the Dark and Quiet Sky,
 - B. Increase financial support for astronomy to offset and compensate for negative impacts on observatory operations, research and implementation of mitigation measures,
 - C. Encourage and support satellite operators and industry to collaborate with the IAU CPS and others in the astronomy community to develop, share and adopt best practices in interference mitigation, leading to widely adopted standards and guidelines,
 - D. Provide incentive measures for the space industry to develop and implement the required technology to minimise negative impacts of satellites on the Dark and Quiet Sky,
 - E. Establish informed regulations and conditions of authorization and supervision based on scientific assessments, practical experience, and impacts on the Earth-space environment, as well as obligations under international law, including environmental law. This includes codifying industry best practices that mitigate the negative impacts on astronomical observations,
 - F. Continue to support finding solutions to space sustainability issues, such as minimising the production of space debris that in aggregate may increase diffuse night sky brightness, or reducing any transformation of the atmosphere that decreases its transparency.
 - G. Work collaboratively within the United Nations to develop frameworks within which the issues of mitigation can be addressed on a worldwide and consistent basis.

And further resolves that

3. IAU members should positively engage with involved parties on matters related to the use of space – be it at local, regional, national, or international level – in efforts to address the urgent need for the protection of the Dark and Quiet Skies from satellite constellation interference.



Résolution de UAI 32^{ème} Assemblée générale...

Les astronomes ont été les premiers... Leur ciel est toujours menacé !

L'atmosphère...
Et la biosphère terrestre aussi...
La lutte n'est pas finie.
Après l'échec de la COP16...

A vous les générations futures !
J'ai confiance !
Franquin n'était pas sûr ?...



T'EN FAIS PAS,
MA PELOTE,
JE SUIS LÀ ...

... OUI,
ON RESPIRE UN PEU
MOINS FACILEMENT
QUE TOUT À L'HEURE,
MAIS... ILS VONT CERTAINEMENT
ORGANISER QUELQUE
CHOSE...

ÉCOUTE !
À CHAQUE JOUR
SUFFIT SA PEINE...
ET PUIS
IL COMMENCE À
FAIRE FRAIS ...

NOUS ALLONS
RENTRE...
LA NUIT PORTE
CONSEIL.

Quelques références...

Quelques études

Bright unintended electromagnetic radiation from second-generation Starlink satellites Bassa, C. G., et al.: A&A, 689, L10 (2024)

<https://www.aanda.org/articles/aa/pdf/2024/09/aa51856-24.pdf>

Extreme Flaring of Starlink Satellites Anthony Mallama and Richard E.Cole

<https://arxiv.org/pdf/2405.13091>

Potential ozone depletion from satellite demise during atmospheric reentry in the era of mega-constellations.

Ferreira, J. P., Huang, Z., Nomura, K.-i., & Wang, J. Geophysical Research Letters, 51 2024

<https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2024GL109280>

Impact of rocket launch and space debris air pollutant emissions on stratospheric ozone and global climate.

Ryan, R. G., Marais, E. A., Balhatchet, C. J., & Eastham, S. D. Earth's Future, 10, 2022

<https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2021EF002612>

En action...

Centre for the Protection of the Dark and Quiet Sky : <https://cps.iau.org/>

Call to Protect the Dark and Quiet Sky from Harmful Interference by Satellite Constellation

<https://cps.iau.org/documents/49/techdoc102.pdf>

United Nations Committee on the Peaceful Uses of Outer Space (COPUOS)

<https://cps.iau.org/news/united-nations-agrees-to-address-impact-of-satellite-constellations-on-astronomy/>

IAU2024 Resolution Protect DS & harmful interference satellite constellation 08 2024 Eng

https://iau.org/static/resolutions/IAU2024_Resol1_English.pdf