Event Summary Report:

UKSA-SWF Atmospheric Ablation Workshop

Event Date Tuesday, October 21, 2025

Report Date January 2026

Co-hosted by:

- Secure World Foundation
- The UK Space Agency

Directly before the 7th Summit for Space Sustainability, Secure World Foundation (SWF) and the UK Space Agency co-hosted a small workshop on the possible environmental impacts resulting from spacecraft disposal through atmospheric ablation. This event, which included subject matter experts from industry, government, and academia, focused on the presentation of key outcomes of atmospheric ablation studies recently funded by the UK Space Agency and then featured roundtable discussions to identify opportunities or challenges and consensus on further action.

Workshop Scope and Objectives

In recent years, several studies and articles have been published[1] providing preliminary scientific evidence indicating that space activities, including emissions resulting from both space launch and from space objects burning up during re-entry upon disposal (a process known as atmospheric ablation), may have impacts on Earth's atmosphere. However, this process and its impacts are currently poorly understood and there is need to enhance scientific understanding of, and community engagement on, this issue. The UK Space Agency commissioned a set of targeted studies to investigate the potential impacts of satellite re-entry (SWF was part of the research team for one of these studies). During this invitation-only workshop, which was held under Chatham House Rule, the key outcomes of atmospheric ablation studies funded by the UK Space Agency were presented and then discussed in roundtable discussions to identify opportunities or challenges and consensus on further action.

1 Understanding satellite re-entry: UK Space Agency leads global research on atmospheric ablation – UK Space Agency blog

Key objectives of the workshop included:

- To present outcomes of UK Space Agency-funded atmospheric ablation studies, and share information on knowns, unknowns, and the key challenges in deciding next steps.
- To encourage knowledge sharing on the issue and facilitate interactive discussion to identify gaps and opportunities/challenges and foster international collaboration.
- To identify consensus on next steps. What are the biggest unknowns? How do we turn them into knowns? How can the international community progress our understanding of the issue and continue to share knowledge? What needs to be considered in broader public/community/media engagement on this topic?
- To inform policy towards data-led decision making and encourage a better understanding of the topic and the environmental impacts on Earth before setting policy.

Key Findings: UK Space Agency Ablation Studies and Outcomes

The workshop opened with a short set of remarks from the UK Space Agency describing key outcomes of the atmospheric ablation studies funded by the Agency. The UK Space Agency has funded work looking at various aspects of the uncertainties surrounding atmospheric ablation and its impacts, including studies led by Durham University, the University of Leeds, the University of Southampton and by Belstead Limited. Results of these studies were published in October 2025.

These studies were motivated by a need to understand the impacts of design for demise and atmospheric ablation in its current form, on the health of Earth's atmosphere. The potential impacts from atmospheric ablation are currently an unquantifiable risk to space activities. We need to understand this issue far better otherwise it may become a global issue that repeats mistakes humanity made with other environmental issues such as the impact of chlorofluorocarbons (CFCs) on ozone levels. The need to investigate the issue is about better understanding to ensure that human activity in space is carried out in a sustainable way and can continue to provide the benefits that the space industry provides humanity. It is also important to understand how efforts to mitigate possible negative impacts on the atmosphere may be in tension with existing best practices for post-mission disposal and design for demise.

This set of remarks was followed by a detailed presentation from Dr. Minkwan Kim of the University of Southampton, describing the findings of the study he led. The presentation focused on outlining a comprehensive scientific and policy framework aimed at mitigating the possible environmental risks associated with atmospheric ablation of end-of-life spacecraft.

Broadly speaking, this study finds that, based on the number of spacecraft expected to be disposed of through atmospheric ablation by 2033, significant amounts of alumina, silica, and other metal oxides could be released, leading to measurable loss of ozone. The study

found that the increase in large constellations could result in 10,000 re-entries per year; the natural metal flux from meteoroid entry equates to an equivalent 3,650 re-entries per year. However, the study also outlines a number of uncertainties around this effect and its impact on the atmosphere, including:

- Understanding of the specific size and distribution of the metal oxide particles released during ablation (e.g. do they: stay local to where re-entry occurs; distribute in the atmosphere globally; concentrate at certain altitudes; concentrate in certain regions) and the duration of particle persistence in the atmosphere.
- Detailed knowledge of the specific species, alloys, or types of alumina and silica used in satellites, and at what amounts, and how they interact with other materials in the atmosphere.
- A lack of in-situ observations of re-entering objects to better inform and validate simulations.

The Southampton-led study concludes that addressing this emerging environmental challenge will need an internationally collaborative and multidisciplinary framework spanning engineering, atmospheric science, and regulatory policy to develop evidence-based strategies. This will require both technical and non-technical advances, which will need to be enabled by broader coordination across agencies, regulators, and industry.

Key Themes and Outcomes from Discussion At Workshop

Following the presentation of the study findings, workshop participants were divided into small groups and asked to discuss a set of questions related to the topic of the potential impacts of atmospheric ablation of spacecraft and the next steps towards addressing gaps, uncertainties and engagement needs.

In this discussion, it was generally recognized that while the possible impacts of spacecraft ablation on Earth's atmosphere are a growing issue of concern, it was also acknowledged that significant scientific uncertainty remains around the impacts and their possible magnitude. A common theme running through the discussion in this workshop was this blend of uncertainty and concern, which ultimately leaves responsible operators and policymakers alike in a position of being unable to act. In general, there is not sufficient evidence to act, either for the development of policy and regulation, or for spacecraft operators/manufacturers to adopt mitigation actions.

Discussions at the workshop centred around four key thematic areas, including suggestions of potential next steps and actions:

Theme 1: There is a clear need to continue focused research into this topic with goal of reducing uncertainties, closing knowledge gaps, increasing understanding across the community of this issue and its potential impacts.

There is a lack of understanding across the community into this issue and the potential scale of the problem. As one participant at the workshop described it: "the problem is that we don't understand what the problem is." Gaps in understanding include: details of materials used in satellite construction; the size and type of particles released during ablation; knowledge of the behaviour of those particles in the mesosphere; and understanding of the magnitude of impact from spacecraft ablation versus that from other sources. Some participants asked whether it is even understood which data and impacts should be measured. Efforts to reduce these uncertainties will require expertise from multiple scientific and technical disciplines, including materials science, atmospheric science, and spacecraft engineering.

Actions identified by participants at the workshop to address this theme included:

- ✓ Improvement in observation and measurement capacity is necessary to better understand the problem. There is a need for more in-situ re-entry data from actual spacecraft re-entries (in addition to simulation), as well as increased efforts and facilities for ground-based testing and measurement of materials behaviour during ablation.
- ✓ Participants also discussed the need to improve understanding of how controlled re-entry practices (e.g. angle and speed of re-entry) might affect ablation behaviour (particle size, altitude, amount).

Theme 2: There was consensus that there is a clear need to increase information-sharing around materials used in spacecraft design and manufacturing, as well as how those materials behave during ablation.

Participants commonly agreed that increasing information sharing around materials used in satellite design and construction, and how those materials behave during re-entry, is a key element needed to reduce the knowledge gaps and uncertainties; and to develop potential mitigation strategies. Participants acknowledged the lack of formal channels to share this information and concerns over potential proprietary data might limit the prospects for sharing materials data but were generally optimistic that such barriers could be overcome. In this discussion some participants expressed a view that the most urgent need from the scientific community is to establish a threshold for specific emissions or oxide releases at

which point there is concern for negative impact, which could then to serve to identify the materials of most concern and build information sharing mechanisms based on that.

Actions identified by participants at the workshop to address this theme included:

- ✓ The suggestion that, given current uncertainties, an incentive-based and voluntary approach to information sharing that proactively engages the satellite industry is needed.
- ✓ It was also noted that many of the space agencies which might fund further research into the issues of atmospheric ablation are also spacecraft designers and operators themselves and should be engaged as such in efforts to enhance data sharing around materials.
- ✓ Participants agreed that, at least in the near term, the need to share material information at the aggregate level (e.g. the percentage of specific alloys/materials in the total overall mass of a spacecraft) rather than specifics of design and how materials are used. This might help to overcome concerns around potential proprietary aspects.
- ✓ Some participants also noted that many key satellite breakup models (which might inform simulations of the types of particles released during ablation) are based on practices from the 1970s and 1980s which may not reflect modern satellites design and manufacturing approaches. There may be value in updating these model assumptions.

Theme 3: There was clear recognition of the global nature of this issue and its potential impacts, as well as the cognizant need for coordination on efforts.

While spacecraft, and their operations, are under individual national authorization and supervision, the potential impacts of atmospheric ablation occur in an area beyond national jurisdiction and have effects on a potentially global scale. Participants noted that some countries are currently more involved than others in research on this topic, and there likely would be benefit in increasing participation in that research. It was noted that it is important for those in the community working on this topic to understand what other key actors are doing about this issue and to try to find ways to link up.

Actions identified by participants at the workshop to address this theme included:

- ✓ Noting that is it important to have regional and international efforts to solve these problems (of reducing the uncertainties, of improving observations, and of enhancing materials information sharing); and that research efforts need to be well-provisioned by subject matter experts from the multiple disciplines involved in this challenge.
- ✓ Participants noted that improving international coordination of research on this topic comparison of common assumptions will be necessary.
- ✓ Some participants suggested that the Inter-Agency Space Debris Coordination Committee (IADC) might take up work on this topic and serve as a technical coordination forum. It was further suggested that outputs from IADC work on this topic might be reported to COPUOS for discussion in a governance and policy related forum.
- ✓ It was also noted the European Space Agency (ESA) has a working group in place on this topic which is open to additional participation.

Theme 4: There was also a recognition that that is too soon, and that information is too preliminary, to be able to regulate around this topic.

Given the noted uncertainties in understanding of this issue, most participants agreed that it is premature to develop regulation around impacts or mitigation. That said, participants also acknowledged that regulation often lags behind environmental challenges, and there is generally poor timeline alignment between the speed of industry innovation, the development of scientific certainty, and the pace of policy and regulation development. Some participants expressed concern that regulation might move too slow to be able to effectively respond to this issue.

Actions identified by participants at the workshop to address this theme included:

- ✓ There is a need to develop the argument to convince policymakers to fund the research necessary to develop the data needed to even answer the question of what potential impacts and mitigation approaches exist.
- ✓ Given the challenges of regulation development timelines and questions of efficacy and fit, participants suggested that standards on material disclosure or re-entry practices and industry guideline-based pathways might be pursued in the near to medium term to address elements such as enhancing materials data-sharing.

Conclusion: The Need to Build an Evidence Base

In this discussion, it was generally recognized that while the possible impacts of spaceflight activities on the environment are a growing area of concern, it was also acknowledged that scientists do not know the magnitude of effects from satellite re-entry emissions. Throughout the discussion at the workshop the need to build an evidence base – for operators, for policymakers, and for regulators – was a recurring theme. There was consensus that a more coordinated and consistent campaign to collect the evidence on the potential impacts is required to build the evidence basis necessary develop appropriate operational and policy responses. In doing so it will be beneficial to collect and frame the evidence base in a manner that enables policymakers and decisionmakers to consider this issue in the context of economic growth, industrial competitiveness and national security. Participants were generally of the view that developing this evidence base needs to be at the level of technical, scientific, and operational expertise, rather than at a political level; yet at the same time needs to include exchange and discussion between the technical and policy making elements.

Workshop Agenda

Time	Session
1330–1400	**Arrival**
1400–1405	**Welcome Remarks** Peter Martinez *Executive Director* *Secure World Foundation*
1405–1410	**Overview of UKSA Sustainability / Ablation Studies** Chris Young *Space Sustainability Lead* *UK Space Agency*
1410–1450	**UKSA Ablation Studies and Outcomes** Minkwan Kim *Professor* *University of Southampton (presentation)* Q&A moderated by Chris Young
1450–1455	**Introduction to Table Discussions** Ian Christensen *Senior Director, Private Sector Programs* *Secure World Foundation*
1455–1540	**Table Discussions** Workshop participants were be asked to discuss a set of questions related to the topic of the potential impacts of atmospheric ablation of spacecraft and the next steps towards addressing gaps, uncertainties and engagement needs.
1540–1550	**Break**
1550–1610	**Table Feedback**
1610–1615	**Closing Remarks by UKSA and SWF**
1615–1700	**Networking Reception**