

# Minutes from the Space Environment Impacts Expert Group meeting

Wednesday, 21 May 2025 1100-1615

Royal Astronomical Society, London / online

## Attendance

<b>Academia/Industry</b>	
<b>Name</b>	<b>Organisation/Role</b>
Prof Richard Horne	British Antarctic Survey, SEIEG Chair
Alex Tibble	British Antarctic Survey
Prof John Preston (online)	University of Essex
Prof Sean Elvidge (online)	University of Birmingham
Ellen Clarke (online)	British Geological Survey
Prof David Jackson (online)	Met Office
Dr Si Machin	Met Office Space Weather Operations Centre (MOSWOC)
Prof Gemma Attrill	Dstl
Prof Clive Dyer (online from lunch)	University of Surrey
CaptBryn Jones (online from lunch)	
Dr Mike Hapgood	Rutherford Appleton Laboratory
Mark Gibbs	MOSWOC
Dr Mario Bisi	Rutherford Appleton Laboratory
Prof Cathryn Mitchell	University of Bath
<b>HM Government representatives</b>	
Department for Energy Security and Net Zero (DESNZ)	
Department for Science, Innovation and Technology (DSIT)	
GO-Science	
UK Space Agency (UKSA)	
<b>In attendance</b>	
Martin Soltau	Space Solar, Co-CEO
Peter Stibrany	Space Solar, Chief Space Systems Architect
<b>Apologies</b>	
Prof Jonathan Eastwood, Imperial College London	
Prof Jim Wild, Lancaster University	
Department for Transport	
UK Space Agency	
DESNZ	

Agenda item	Discussion	Action
1. Welcome, Apologies, Review Agenda	The Chair welcomed everyone to the meeting and highlighted five apologies. There were no changes to the agenda.	N/A
2. Minutes and items arising, not on the Agenda	<p>The Chair stated that he has received one piece of feedback from Mike Hapgood on the last minutes, which had been incorporated.</p> <p>Comments on the minutes from Clive Dyer were taken at the meeting.</p> <p>The Chair also noted he had now received the Discussion document on Single Event Effects in Avionics from Clive.</p> <p>Minutes updated and agreed.</p> <p>Items arising: <b>Actions from last meeting</b></p>	

Action	Description	Progress
012024/03	The Chair to arrange for someone within the Space Based Solar Power team to present at a SEIEG meeting.	Complete
012025/01	SEIEG to review and update the current SEIEG Reasonable Worst Case Scenarios ahead of Met Office update of the NSRA technical assessment.	Ongoing
012025/02	Mike Hapgood to re-circulate email setting out views on what needs to be update in the NRSA technical assessment to account for new research.	Complete
012025/03	NSPOC should have follow up discussion with CAA and NATS on use of NSPOC re-entry events data.	Ongoing
012025/04	SEIEG chair to circulate text on SEIEG view on the S6 report that can be used by members as required.	Complete
012025/05	Bryn to draft a paper for CAA on how the aviation sector could gather the required feedback on space weather impacts.	Ongoing

Agenda item	Discussion	Action
3. Minutes and items arising, not on the Agenda /continued	<p><b>Celebrating success</b></p> <ul style="list-style-type: none"> <li>• Congratulations to Prof Jim Wild, who was elected to President of Royal Astronomical Society got 2-26-2028.</li> <li>• Congratulations to Prof Jonathan Eastwood, who was holding his inaugural lecture at Imperial College today.</li> <li>• The committee also congratulated Richard for receiving the Julius Bartels medal from the European Geosciences Union for his work on solar-terrestrial sciences.</li> <li>• Thank you to John Rees – recently retired and stepping down from SEIEG.</li> </ul> <p>The chair reminded everyone that they should consider nominating people for awards and medals to recognise their efforts – especially early career scientists.</p>	
4. Update from DESNZ and DSIT	<p>DESNZ and DSIT representatives stated that they were in the process of handing over responsibility for the risk of Severe Space Weather from DESNZ to DSIT, and with it the support to this meeting.</p>	
5. Space Based Solar Power – Presentation from Solar Space	<p>The Chair opened this item by stating that SEIEG looked last year at the Frazer-Nash report<sup>1</sup> on space based solar power to consider the potential impact of space weather. This led to an initial meeting of the Chair with Martin Soltau and Peter Stibrany from Space Solar in Cambridge, and an invitation to them to give a presentation on space based solar power to SEIEG for wider discussion.</p> <p>Martin Soltau and Peter Stibrany from Space Solar gave a presentation. It was agreed to put the presentation on the SEIEG web site after the meeting.</p>	
6. SBSP discussion	<p>Martin and Peter answered many questions from SEIEG members:</p>	

<sup>1</sup> <https://www.gov.uk/government/publications/space-based-solar-power-de-risking-the-pathway-to-net-zero>

	<p><b>Orbits.</b> Low Earth Orbit (LEO) for the development phase model (MERLIN). A full scale system would likely be for Geo-Synchronous Orbit (GSO).</p> <p><b>Structure size.</b> Of the order of 1500m in size (LEO 200-800m). Substrate layers of the PV around 40-50microns.</p> <p><b>Construction.</b> Peter showed the Group the construction of the structure. The construction would be conducted in-space at a higher orbit and then the SBSP would be lowered to its operational GSO. If constructed in/below GSO, it could interfere with other satellites.</p> <p><b>Debris/structural integrity.</b> The solution would not be designed for strength, rather stiffness. Space debris and incoming particles would generate plasma, possibly gas. Peter stated that they would consider using ‘bumpers’, that is, a sacrificial material 6-10cm away from the material to protect.</p> <p><b>Shadow/overflight.</b> Peter stated that satellites operate in a 2deg box. That is, 150km across from the ground. Peter’s view was that a 10m satellite has plenty of room, even if the final development models are ~1500m in length.</p> <p><b>Space weather/radiation.</b> Space Solar have considered space weather and radiation. Peter stated that all of their equipment would need to have the ability to bunker.</p> <p><b>Panel degradation due to radiation.</b> Solar Space have considered degradation and performance degradation is fairly well understood.</p> <p><b>Disposal.</b> Space Solar are exploring this with Louis Thirsk, Cambridge. As there are few moving or electronic parts, they would look to recondition those and reuse the structure.</p> <p><b>Radio Frequency spectrum.</b> Space Solar are working with Ofcom to secure the necessary bandwidth with ITU. Working towards 2031 for their agreement.</p> <p>Several other areas more directly related to space weather were also addressed, including:</p> <ul style="list-style-type: none"> <li>• Interference to radio astronomy caused by radio power spilling over into other frequency bands.</li> <li>• Interference to optical astronomy due to the reflection of sunlight by large satellites in orbit.</li> </ul>	
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- Solar array degradation due to solar energetic particle events (radiation storms) and galactic cosmic rays that would reduce power generation.
- Surface charging of the satellites caused by substorms that could cause anomalies and service outage.
- Internal charging of the satellites caused by radiation belts during geomagnetic storms and other space weather events that could cause anomalies and service outage.
- Effects of photon pressure, from the Sun and the downlink beam, on the orbit and attitude of the spacecraft
- Microwave beam power of  $240 \text{ W m}^{-2}$  exceeding human safety levels in the 2-6 GHz microwave part of the spectrum and thus requiring additional safety measures such as exclusion zones in the atmosphere and on the ground.
- Refraction and diffraction of the microwave beam caused by density irregularities in the ionosphere. Density irregularities are enhanced during space weather events and would lead to scintillations and may disperse the beam outside the receiver area on the ground.
- Self-focussing instabilities in the ionosphere caused by the high-power microwave beam that would distort the beam and cause hot spots outside the receiver area on the ground. This effect is likely to be enhanced during geomagnetic storms and may restrict the microwave beam power to lower levels.
- Increased satellite-drag during geomagnetic storms that would put additional stress on large satellite structures in Low Earth Orbit causing difficulty in maintaining spacecraft altitude and attitude, and directional control of the microwave beam.
- Collisions with space debris during geomagnetic storms leading to reduced performance and additional debris.
- Satellite drag, altitude control and de-orbiting large structures at the end of life.

Space Solar provided their assessment of all these issues. They noted that further research is required and openly welcomed any research collaborations.

In summary SEIEG recognised that space weather presents a special set of risks to the safe operation of space based solar power. The effects of the ionosphere

	<p>on the high-power microwave beam, and conversely the effects of the beam on the ionosphere, were considered the areas of highest uncertainty requiring more research.</p>	
<p>7. ESA early Coronal Mass Ejection warning mission proposal</p>	<p>SEIEG had been asked by DESNZ to consider the European Space Agency mission proposal for four satellites based on HENON as to whether it would help provide early warning to the energy sector of severe space weather.</p> <p>The mission plans to launch 4 satellites around the Sun in such a way that they effectively circulate around the Earth and increase the warning time to 2-3 hours compared to 30 minutes at L1. A possible launch date was in late 2026/early 2027.</p> <p>There was a broad discussion during which Clive suggested that any new satellite should contain a high energy proton telescope.</p> <p>Richard added that adding an electron detector would provide half an hour’s warning for SEP events as electrons arrive before the protons but are largely stopped by the magnetosphere.</p> <p>In summary, the Group thought that this mission would be a very important step forward for early warning as it would enable earlier measurements of the polarity of the interplanetary magnetic field (IMF). However, before it could be considered an operational mission more research would be required to establish how the solar wind measured by the spacecraft is correlated to that impinging on the magnetosphere.</p>	<p><b>25-1-2 Action:</b> The Chair would summarise SEIEG’s view of the mission proposal in a short report and send it to DESNZ.</p>
<p>8. Recent Space Weather events and impacts</p>	<p>Mark and Simon provided an update on recent space weather events.</p> <p>The Group discussed whether we were past the solar maximum. The southern hemisphere is in a declining phase. But there was uncertainty as to whether the northern hemisphere had peaked.</p> <p>It was noted that the Sun will remain very active for the next few years and that there will be more coronal holes and fast solar wind streams in the declining phase.</p>	

<p>9. Update on the SEIEG May 2024 Storm Report</p>	<p>The Chair reported one piece of feedback on the report from David Gibbs regarding the role of air traffic management in informing pilots about severe space weather. This was discussed and agreed to modify the text in the report.</p> <p>SEIEG discussed the roles of US dispatchers versus their UK equivalents.</p>	<p><b>25-1-3 Action:</b> The Chair would revise the relevant paragraph in the May 2024 storm report.</p>
<p>10. Other updates</p>	<p><b>Atmospheric scales.</b> These revisions are being led by the US. The Group discussed the benefits of working with the Europeans as it may be a quicker route to revise the scale. The Chair concluded that the Group would continue to support the US in their revision process.</p>	
<p>11. Any Other Business</p>	<p>Clive suggested that SEIEG would benefit from an aviation sub-group. This requires further discussion from the Group.</p> <p>SEIEG were reminded to update the Reasonable Worst Case Scenario document by the end of August 2025. Mike had already circulated the link, and the Chair would contact the lead for each area.</p>	
<p>12. Date of the next meeting</p>	<p>Friday 12 September in Sheffield (TBC)</p>	<p><b>25-1-4 Action:</b> Met Office members would help to book a suitable room for the SEIEG meeting in Sheffield</p>

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<p><b>012025/01</b></p>	<p>SEIEG to review and update the current SEIEG Reasonable Worst Case Scenarios ahead of Met Office update of the NSRA technical assessment.</p>	<p>Ongoing</p>
<p><b>012025/03</b></p>	<p>NSPOC should have follow up discussion with CAA and NATS on use of NSPOC re-entry events data.</p>	<p>Ongoing</p>

<b>012025/05</b>	Bryn draft paper for CAA on how the aviation sector could gather the required feedback on space weather impacts.	Ongoing
<b>25-1-2</b>	The Chair would summarise SEIEG's view of the mission proposal in a short report and send it to DESNZ.	New
<b>25-1-3</b>	The Chair would revise the relevant paragraph in the May 2024 storm report.	New
<b>25-1-4</b>	Met Office members would help to book a suitable room for the SEIEG meeting in Sheffield	New