

SPAN Data and Analysis Working Group

A White Paper on Space Data

Excellence in Growth: Space Data Infrastructure for a Competitive UK

Nicholas Walton (University of Cambridge)
Chair SPAN SDAWG

and

The SPAN Data and Analysis Working Group

V1 20260316

Version	Date	Author/ Contributor
v0.1	24 Nov 2025	Initial draft for discussion at SDAWG Nov 2025 meeting
V0.2	8 Jan 2026	Updated draft with various input discussed at the SPAN Board Strategy Day
V0.3	4 March 2026	Updated draft based on various inputs received in advance of March 2026 SDAWG meeting. Included input/ review from the SSEWG (Matt Middleton, University of Southampton), SETWG (Steve Hobbs, Cranfield University) and SEOWG (Anna Hogg, University of Leeds).
V0.9	13 March 2026	Incorporating comments received by Mark Sims (University of Leicester, SPAN co-Chair), David Clements (Imperial College London), Esther Conway (National Centre for Earth Observation, NERC), Steve Donegan (Centre for Environmental Data Analysis, RAL Space, STFC), Jan-Peter Muller (University College London), Alison Waterfall (Centre for Environmental Data Analysis, RAL Space, STFC), Mike Watson (University of Leicester), Anushka Sharma (University of Leicester, SPAN Liaison Manager)
V1.0	16 March 2026	Publication by SPAN

Contents

1	Summary and Key Recommendations	6
1.1	Key Space Data Roadmap Recommendations	7
2	Introduction and Scope of Paper	8
2.1	Background	8
2.2	Policy Context	8
2.3	Scope of the Review	8
3	Existing Capacity: Current State of the Art	9
3.1	Space and Solar System Science	9
3.1.1	Facilities	9
	Flagship Missions with Major UK Roles	9
	Current and Forthcoming ESA ‘Cosmic Vision’ Missions	9
	Planetary and Exploration Missions	10
	Bilateral Missions	10
	Ground based facilities	11
3.1.2	Data Scope	11
3.2	Earth Observation and Positioning, Navigation, and Timing (PNT)	11
3.2.1	Facilities	12
	ESA Earth Explorer Missions	12
	Copernicus and Sentinel Missions	12
	National and Commercial EO Assets	12
	Bilateral EO Missions	12
	Positioning, Navigation, and Timing	12
3.2.2	Data Scope	13
3.3	Space Situational Awareness and Space Weather	14
3.3.1	Facilities	14
	Space Surveillance and Tracking	14
	Space Weather Monitoring	14
	Research Facilities	15
3.3.2	Data Scope	15
4	Data and Digital Research Infrastructures	15
4.1	Science Data Centres	16
4.1.1	Mission-Specific Data Processing Centres	16
4.1.2	UK Solar Science Data Centres	16

4.1.3	National Centre for Earth Observation (NCEO) and CEDA/UKRI NERC Environmental Data Service.....	16
4.1.4	External Space Science Data Centres: ESA and ESO.....	16
4.2	Digital Research Infrastructure	17
4.2.1	IRIS	17
4.2.2	AIRR.....	17
4.2.3	DiRAC	17
4.2.4	JASMIN	18
4.2.5	National Data Libraries	18
4.3	Data Standards	18
4.3.1	The International Virtual Observatory Alliance.....	18
4.3.2	Planetary Data System.....	18
4.3.3	Wider International Standardisation	18
4.4	Data Resilience and International Dependencies	19
4.4.1	Data Ownership and Governance	19
5	Relevant Roadmaps and Capability Mapping Studies	19
5.1	Astronet.....	19
5.2	Space Partnership Capability Roadmaps.....	21
6	Challenges and Gaps.....	22
6.1	Creating Space Data Products	22
6.1.1	Pipeline Development and Sustainability	22
6.1.2	Calibration and Quality Assurance	22
6.1.3	Scale and Timeliness.....	23
6.1.4	Standardisation and Interoperability.....	23
6.1.5	Skills and Capacity.....	23
6.1.6	Data Exploitation Planning.....	24
6.1.7	Space Data used in Legal Cases	24
6.2	Access to Open Science and Open Data	24
6.3	Space Data AI and Cloud	25
6.3.1	The Promise of AI for Space Data.....	25
6.3.2	The Promise of Cloud Computing	25
6.3.3	Challenges and Risks	25
6.3.4	Addressing the Challenges.....	26
6.4	Space Data and People	26
6.4.1	Workforce Sustainability	26
6.4.2	Career Pathways	27
6.4.3	Training and Skills Development.....	27

6.4.4	Diversity and Inclusion	27
6.5	Space Data and the Environment.....	27
6.5.1	Energy Consumption of Space Data Infrastructure	27
6.5.2	Data Centre Environmental Impacts	28
6.5.3	Space-Based Data Processing and Orbital Data Centres	28
6.5.4	Current Gaps and Challenges and how to Address this.....	28
6.6	Document and Data Sharing.....	29
6.7	Key Data Gaps	29
6.7.1	Infrastructure Gaps	29
6.7.2	Processing Capabilities	29
6.7.3	Integration Challenges.....	29
6.7.4	International Dependencies	29
6.7.5	Skills and Capacity.....	29
6.7.6	Data Preservation	30
7	Building Competitive Advantage	30
7.1	Integrated Data Infrastructure	30
7.1.1	Key Astronet Recommendations for Data Infrastructure	30
7.1.2	Applying Astronet Principles to UK Space Data.....	31
7.2	Collaborative Frameworks: Benefits and Challenges.....	31
7.2.1	Benefits of Collaborative Approaches	31
7.2.2	Challenges and Limitations.....	31
7.2.3	Principles for Effective Collaboration.....	31
7.3	Regional Capability Clusters and National Coordination	31
7.3.1	Existing Regional Strengths	32
7.3.2	A Tiered National Infrastructure.....	32
7.4	Increasing the Academic—Industry Connection	32
7.4.1	Training and Career Paths.....	32
7.4.2	Recognition and Reward	33
7.5	Sustainability and Responsible Innovation	33
7.5.1	Environmental Considerations.....	33
7.5.2	Diversity and Inclusion	33
7.5.3	Open Science and Reproducibility	33
7.6	Supporting Coordination Mechanisms: The Role of SPAN.....	33
8	Action Plan.....	34
8.1	Science Data Products, Analysis Pipelines and Data Management.....	37
8.1.1	Short Term (1-2 years) Actions	37

8.1.2	Long Term (3-5 years) Actions	38
8.2	Preparing for Next-Generation Missions and Surveys	39
8.2.1	Short Term (1-2 years) Actions	39
8.2.2	Long Term (3-5 years) Actions	40
8.3	Training, Education and Skills.....	40
8.3.1	Short Term (1-2 years) Actions	40
8.3.2	Long Term (3-5 years) Actions	41
8.4	International Engagement and Data Resilience	41
8.4.1	Short Term (1-2 years) Actions	41
8.4.2	Long Term (3-5 years) Actions	42
8.5	Sustainability and Accessibility	42
8.5.1	Short Term (1-2 years) Actions	42
8.5.2	Long Term (3-5 years) Actions	43
8.6	Academic-Industry Collaboration and Knowledge Exchange	43
8.6.1	Short Term (1-2 years) Actions	43
8.6.2	Long Term (3-5 years) Actions	43
8.7	Governance and Coordination	44
8.7.1	Short Term (1-2 years) Actions	44
8.7.2	Long Term (3-5 years) Actions	44
8.8	Delivery and Accountability	44
8.8.1	Short Term (1-2 years) Actions	44
8.8.2	Long Term (3-5 years) Actions	45
9	Conclusions	46
10	References.....	47
11	Acknowledgements.....	48
Appendix A	List of Acronyms.....	48

1 Summary and Key Recommendations

The UK has a world-leading position in space science and Earth observation, with deep involvement in major international missions including, for example in the space science area the Gaia, Solar Orbiter, Euclid and forthcoming PLATO and ARIEL missions. This strength rests on decades of investment in instrumentation, data analysis expertise, and international partnerships. However, the UK's ability to maintain this position and maximise the return on its space investments is increasingly constrained by challenges in space data infrastructure, skills, and coordination.

This whitepaper, prepared by the SPAN Space Data and Analysis Working Group, examines the current state of UK space data capabilities across space science, Earth observation, space weather, and space situational awareness. It identifies critical gaps and challenges, and proposes an action plan aligned with international best practice.

The UK government funds activity across seven subsectors of the space economy: Satellite Communications; In-Orbit Servicing, Assembly and Manufacturing (ISAM); Launch and Space Transportation; Space Domain Awareness (SDA); Earth Observation and Data Architecture; Position, Navigation, and Timing (PNT); and Space Science and Exploration. Data is the cross-cutting enabler that underpins all seven. Data is an essential component to delivering the government's recently identified four priority areas of: Satellite Communications, Assured Access to Space, ISAM, and SDA. Each of these priority areas depends fundamentally on robust data infrastructure: SDA is a data-processing challenge at its core; satellite communications systems generate and route data; ISAM operations require real-time data architectures for autonomous in-orbit activity; and launch operations depend on precision data from tracking, telemetry, and space weather systems. This whitepaper, developed by the Space Academic Network (SPAN), provides an evidence base for the data infrastructure and skills investment needed to realise the UK's ambitions across these subsectors, and could provide input to the 'Plan for Space' that government will publish later in 2026.

The Opportunity: Space data underpins not only scientific discovery but also significant areas of future economic growth. Technologies developed using space data have wide relevance to, and impact for, the UK economy. Students and researchers who develop space data skills contribute across multiple sectors. The global space data market is expanding rapidly, and the UK is well-positioned to capture value, but only with strategic investment in data infrastructure, skills, and coordination. The UK Space Agency's merger into DSIT from April 2026 creates a unique opportunity to embed data infrastructure planning within the new unified civil space strategy, policy and delivery unit. The economic case is clear: every £1 of UK public investment in ESA programmes generates ~£7.50 in direct economic benefit (RAND Europe, 2025 [1]¹), UK Space Agency activity catalysed £2.2 billion in investment and revenue in 2024/25 (with a specific example of investment in the ESA Gaia mission demonstrating impact [37]), and satellite services now underpin 18% of UK GDP (£454 billion) [2]². Data infrastructure is the mechanism through which these returns are realised

The Actions: this whitepaper proposes 10 priority actions supported by an outline delivery plan organised across eight themes, to be delivered over the shorter term (1–2 years) and longer term (3–5 years). The actions align UK practice and national requirements with international frameworks.

The Impact: The UK has solid strengths in space data, world-class research groups, internationally recognised expertise, and leadership roles in major missions. The UK's competitive

¹ See <https://www.rand.org/randeurope/research/projects/2024/investment-space-agency.html>

² See UKSA factsheet for 2024/2025 at <https://www.gov.uk/government/publications/factsheet-the-uk-space-sector/factsheet-the-uk-space-sector>

position is at risk without strategic investment in data infrastructure, skills, and coordination. The challenges identified in this whitepaper are not insurmountable; indeed, they represent opportunities for the UK to strengthen its position if addressed proactively.

The action plan proposed here represents a UK Space Data roadmap for the coming five years. By integrating data planning into mission design, developing coherent policy, investing in people and infrastructure, and coordinating across sectors, the UK can ensure that its space data capabilities match its ambitions, delivering scientific discovery, economic benefit, and societal impact from its investments in space. Implementation of the roadmap will ensure maximal return from investment in Space hardware, transforming space data to information and insight.

1.1 Key Space Data Roadmap Recommendations

The following ten action topics represent the highest priorities. They are drawn from the more detailed action plan in Section 8 and address the most critical gaps in UK space data capabilities.

1. Action 1.2: Develop a UK Space Data Policy
2. Action 7.1: Establish Space Data Coordination Within DSIT
3. Action 4.1: Assess and Manage International Data Dependencies
4. Action 1.1: Integrate Data and Pipeline Planning into Mission Design
5. Actions 2.1, 2.2: Prepare for Next-Generation Space Missions
6. Actions 1.4, 3.3: Strengthen Pipeline Development Expertise
7. Action 1.3: Establish a UK Space Data Discovery Service
8. Action 4.3: Engage with European Open Science Cloud
9. Actions 5.1, 5.3: Address Environmental Sustainability
10. Action 7.2: Secure Sustainable Funding for Coordination

Indicative cost envelopes, to resource implementation of the full action plan, are summarised below:

Band	Actions (All)	Actions (Priority)	Cost (over 5yr)	Comments
LOW	21	8	£4–10M	Policy, reviews, coordination, standards. Achievable within existing budget flexibility.
MEDIUM	15	4	£30–60M	Service development, pilots, fellowships, platforms. Requires programme funding.
HIGH	5	1	£50–100M	Infrastructure, sustained RSE workforce, co-location labs, clusters, resilience. Requires spending review level prioritisation.
TOTAL	41	13*	£84–175M	<i>*13 individual actions across 10 priority topics. Priority Actions total: £20M to £40M</i>

2 Introduction and Scope of Paper

2.1 Background

This report aims to overview the main requirements and capabilities related to data across the various projects across the broad remit of UK Space research. This encompasses projects ranging from Earth Remote Sensing through to Space Science missions covering exoplanets through to Cosmology. The UK community is involved, either through leadership or as a significant partner, in a wide range of Space missions. Many have significant 'data' needs, with substantial ground segment processing and/or data archiving and distribution activities.

This paper identifies the projects and their data activities, and makes a range of key recommendations identifying areas where common approaches would be effective, and where less so.

It is of note that 'data' in the widest sense, underpins significant areas of future industrial development:

- Technologies developed using space science data will have an increasingly wide relevance to the UK's future economic growth.
- Students and staff in the academic sector who learn skills related to (science) data will contribute much more widely to the UK than only in scientific research.
- Issues such as data ownership and the rights to use the data for other purposes will need to be clear to avoid creating barriers and to protect the rights of those who have made the data available.

The report recommendations that follow, identify areas for investment in 'space data' now, to deliver enhanced outputs later.

2.2 Policy Context

This whitepaper is published at a key moment for UK space policy. From 1 April 2026, the UK Space Agency merges into the Department for Science, Innovation and Technology (DSIT), creating a single unit responsible for civil space strategy, policy and delivery. A full Plan for Space will follow 'later in 2026'. The government has identified seven subsectors of the space economy and is now prioritising four: Satellite Communications, Assured Access to Space, ISAM, and Space Domain Awareness; where it will 'go further and faster'.

The recommendations in this whitepaper are designed to support all seven subsectors. Space data infrastructure is not a subsector in its own right but is a foundational capability that determines the return on investment from each of them. This paper's recommendations are compatible with, and intended to inform, the Plan for Space, the (currently ongoing) UKRI Infrastructure Roadmap refresh (2025), DSIT's national data library initiative, and the UK's engagement with the European Open Science Cloud. The actions proposed here are also aligned with the government's Industrial Strategy and with the broader "One Government" approach to space announced in March 2026 [3] [4].

2.3 Scope of the Review

The review considers existing and planned facilities and issues in the following areas:

- Space-based assets and access
- Relevant ground-based infrastructure
- Data processing and analysis infrastructure
- Current data holdings

- Data access mechanisms
- QA and data standards
- Legal frameworks for accessing and processing the data

The review seeks to identify key gaps limiting the exploitation of space data.

We note that data are likely to become a key resource in the engineering of future space systems. Techniques such as Model-Based System Engineering are being used to design and validate space system designs, and can form the basis for verification and validation during manufacturing and Assembly, Integration and Test processes. These in turn inform Digital Twin technologies which are likely to be used for operating future space systems. Data is a key commodity at each of these phases which has significant value for developing future business: its ownership and rights for its use therefore become critical. For the purposes of this report we recognise this as an important aspect of space data, but one which is outside the scope of the report.

3 Existing Capacity: Current State of the Art

3.1 Space and Solar System Science

The UK has a world-leading position in space science research, with a substantial academic community and deep involvement in major international missions. The UK has world-class leadership in Solar Physics, X-ray Astronomy, Lunar and Planetary Geology, Exoplanets, and Astrobiology, with particular strengths in instrumentation including image sensors, infrared detectors, magnetometer instrumentation, sub-millimetre remote sensing, and X-ray optics.

3.1.1 Facilities

A non-exhaustive list of current and in-development missions with UK space and solar science involvement in the data processing include the following:

Flagship Missions with Major UK Roles

The NASA/ESA **James Webb Space Telescope** (JWST), launched in 2021, represents a landmark example of UK leadership in international space science. Scientists and engineers in the UK were crucial to the development of the ESA funded Mid-Infrared Instrument (MIRI). This was designed, built, and tested by an ESA consortium of 10 member countries led by the UK from the STFC's UK Astronomy Technology Centre (UKATC), with contributions from STFC RAL Space, University of Leicester, and Airbus UK. The UK's lead role involved taking responsibility for the overall design, science performance, mechanical, thermal and optical design, along with assembly, integration, testing and calibration software.

Gaia is the most scientifically productive space science mission ever flown by ESA, providing a unique map of the Milky Way with precise positions and astrophysical characterisation of over 2 billion stars. The UK coordinates significant data processing through Cambridge's Data Processing and Analysis Consortium (DPAC), handling astrometric solutions for billions of stars in what represents one of the largest data processing efforts in the history of astronomy. On average there have been around 2,400 publications per year based on Gaia data releases, with around 300 of those from UK-based authors.

Current and Forthcoming ESA 'Cosmic Vision' Missions

Solar Orbiter (ESA M1): The UK leads on several instruments including the Solar Wind Analyser (SWA) suite led by UCL/MSSL, the Magnetometer (MAG) led by Imperial College, and contributed to the Extreme Ultraviolet Imaging Spectrometer (SPICE) led by RAL Space. Engineers at AirbusDS in Stevenage designed and built the spacecraft.

Euclid (ESA M2): The UK has a major role in the VIS (visible imager) instrument, led from UCL's Mullard Space Science Laboratory, and in ground segment data processing. The charge-coupled device (CCD) detectors were provided by Teledyne e2v. The University of Edinburgh hosts one of nine Euclid Science Data Centres, with UK teams leading cosmic shear measurement pipelines.

PLATO (ESA M3): UK institutions are coordinating exoplanet data analysis pipelines and will contribute to catalogue production when the mission launches in 2026. PLATO will seek to identify and characterise 'Earth analogue' exoplanets, providing key targets for follow-up by Ariel and Webb.

Ariel (ESA M4): The UK leads the overall science of this exoplanet atmosphere characterisation mission and heads a consortium of 17 countries building the payload module. The UK Space Agency supports the development teams located at UCL, Cardiff University, University of Oxford, and STFC RAL Space. Teams at RAL Space will build and test the payload module, while scientists at UCL and Cardiff will lead performance analysis and develop algorithms to process returned data. Ariel is due for launch in 2031.

EnVISION (ESA M5): EnVISION is a mission to study the surface of Venus using SAR techniques. UKSA supports scientists at Royal Holloway, where the project is led, as well as Oxford and London Universities and Imperial College London. The project aims to map the surface of Venus to determine past and present levels of activity.

ESA M7 and beyond: The UK is strongly involved in several candidate missions for ESA M7 including THESEUS, which aims to study high redshift Gamma Ray Bursts, Matisse, which will study the surface of Mars, and Plasma Observatory, which will study the plasma environment around the Earth. The UK is also strongly involved in numerous proposals for ESA missions beyond M7 including M8, F3 and mini-F.

JUICE (ESA L1): The UK leads the J-MAG magnetometer with data processing responsibilities at Imperial College, contributing to the mission's exploration of Jupiter and its icy moons.

LISA (ESA L3): UK institutions contribute to gravitational wave data analysis techniques and pipelines for this future space-based gravitational wave observatory, building on heritage from LISA Pathfinder.

NewAthena³ (ESA L2): The UK is leading the international team responsible for the science data analysis, operation and calibration of the Wide Field Imager (WFI) instrument for this next-generation X-ray telescope as well as contribution the instrument hardware.

Planetary and Exploration Missions

BepiColombo: The UK holds PI-ship of the Mercury Imaging X-ray Spectrometer (MIXS), with data analysis leadership at the University of Leicester. The mission is currently en route to Mercury.

ExoMars/Rosalind Franklin Rover: The UK leads the PanCam instrument suite developed by scientists from UCL MSSL, University of Aberystwyth, Birkbeck College, and University of Leicester, and will manage rover operations and data generation. The Raman Laser Spectrometer includes a CCD camera developed by the University of Leicester, University of Bradford, and STFC RAL Space.

Bilateral Missions

As well as ESA space missions the UKSA has established a programme funding bilateral missions where ESA is not involved. These include:

³ Athena was initially selected for the L2 slot. Subsequently a rescope version of Athena ('NewAthena') is now scheduled for official adoption in early 2027. See <https://www.cosmos.esa.int/web/athena>

LiteBIRD: This is a CMB mission aiming to study the large scale B-mode polarisation which will provide insights into the physics behind inflation. The mission is led by JAXA in Japan, with considerable hardware and data analysis effort in the UK.

PRIMA: this is a candidate NASA probe mission which would become the next generation far-IR space mission after Herschel, studying a wide range of science from the Solar System to galaxy evolution and cosmology. There is a substantial data processing and analysis effort in the UK for PRIMA based at Sussex University, Imperial College and RAL Space, as well as significant hardware effort at Cardiff University.

Other bilateral missions are also being studied, all of which would involve significant data analysis work.

Ground based facilities

Many space science missions require access to ground based facilities in support of their mission science requirements. For instance, PLATO has a significant ground based programme making use of high resolution spectrographs on a number of telescopes (e.g. ESPRESSO on the ESO VLT) to obtain high precision radial velocities of stars hosting candidate exoplanets discovered by PLATO onboard cameras. Approaches to data developed for ground systems should be aligned with those developed for space science.

3.1.2 Data Scope

The UK has a demonstrated and comprehensive set of data leadership capabilities across the mission lifecycle, from initial instrument development through to long-term scientific exploitation. UK institutions frequently serve as lead investigators for key instruments or elements of the mission ground segment, taking end-to-end responsibility for data quality, processing, and scientific output. This leadership extends to operating dedicated science operations centres that manage the complex data flows from spacecraft telemetry through to public archives, ensuring data integrity and accessibility.

UK teams have developed sophisticated data processing pipelines and analysis software that have become community standards, particularly in areas such as spectrophotometry, astrometry, planetary imaging, and magnetospheric physics. The challenges of searching for tiny signals in large noise that characterise many space science missions are common to many other space and non-space fields, and the associated skills and advances in AI, Machine Learning and 'big data handling' developed by UK researchers are widely applicable both within the space sector (particularly in Earth Observation) and beyond, for example in the finance and healthcare sectors. Through STFC facilities and university-based centres, the UK provides long-term data curation and stewardship services that preserve these valuable datasets for future generations of researchers. Additionally, UK scientists have established international reputations for their leadership in data quality assurance and calibration procedures, ensuring that space science data meets the rigorous standards required for both operational applications and fundamental research.

3.2 Earth Observation and Positioning, Navigation, and Timing (PNT)

The UK has substantial capabilities in Earth observation and positioning, navigation, and timing, with academic groups contributing to mission development, instrument build, algorithm development, and scientific exploitation across a broad range of applications including climate science, environmental monitoring, and geospatial services. The SPAN UK Sats whitepaper [5]⁴ identifies Earth observation and science as a key area for sovereign UK satellite missions, noting

⁴ Download from <https://span.ac.uk/wp-content/uploads/2024/07/UK-UKSats-v4-220324.pdf>

the strategic importance of sensing and navigation technologies and the need for data exploitation plans to maximise return on investment from national EO assets.

3.2.1 Facilities

ESA Earth Explorer Missions

UK scientists have played leading roles in the ESA Earth Explorer programme, which delivers research-focused missions addressing key questions in Earth system science. UK involvement spans mission conception through to scientific exploitation, with notable contributions including CryoSat for ice sheet and sea ice monitoring, where UK, for instance, groups at UCL and the University of Leeds have led algorithm development for ice thickness retrieval and scientific analysis. The Aeolus mission, which provided the first space-based global wind profiles, benefited from UK contributions to data assimilation and scientific exploitation. The forthcoming Biomass mission, launched in 2025, is providing the first P-band synthetic aperture radar measurements from space to map forest biomass and carbon stocks, with significant UK scientific involvement. FORUM, scheduled for launch in 2027, will measure Earth's outgoing thermal radiation with unprecedented spectral resolution to improve understanding of the planet's energy balance.

Copernicus and Sentinel Missions

The Copernicus programme, jointly operated by ESA and the European Commission, provides operational Earth observation data through the Sentinel satellite constellation. UK researchers make extensive use of Sentinel data for applications ranging from atmospheric composition monitoring (Sentinel-5P) to land cover mapping (Sentinel-2) and ocean observation (Sentinel-3) in addition to land, sea and ice monitoring (Sentinel-1). The UK's re-association with Copernicus following the post-Brexit arrangements has restored full access to Sentinel data and participation in programme governance. UK institutions contribute to Sentinel ground segment operations and algorithm development, particularly for climate data records and long-term monitoring applications. Primary "member state" access to the Sentinel data products from the Copernicus program is maintained by STFC CEDA who operate a Data Hub Relay (DHR) that retrieves all data products in a short rolling archive for further dissemination to data clients. The Sentinel Mirror archive at CEDA is a selection of such products and is one such client.

National and Commercial EO Assets

The UK has developed national Earth observation capabilities including the NovaSAR-S synthetic aperture radar mission, a public-private partnership between SSTL and the UK government providing S-band SAR imagery. Data from NovaSAR supports applications in maritime surveillance, flood monitoring, and agricultural mapping, though exploitation frameworks to maximise the return from this sovereign capability are still being developed. The UK commercial EO sector includes companies such as SSTL, Earth-i, and Satellite Vu, with academic groups collaborating on algorithm development, calibration and validation, and scientific applications.

Bilateral EO Missions

The UK participates in bilateral Earth observation missions that complement ESA programmes. An example is the MicroCarb mission with the French Space Agency (CNES), for which the UK is the minor partner. MicroCarb aims to collect precise atmospheric column CO₂ data that can be translated into regional estimates of carbon emission and uptake, supporting international progress towards meeting the goals of the Paris Agreement. As highlighted in the SPAN whitepaper on Space Policy and Funding, UK scientists and engineers contribute across the mission lifecycle, from satellite assembly and testing to ground segment algorithms and scientific exploitation [6].

Positioning, Navigation, and Timing

UK expertise in PNT spans receiver technology, signal processing, and applications development. Academic groups contribute to the development of resilient PNT solutions that combine satellite

navigation with alternative sensors and signals to maintain positioning capability in challenging environments. The UK does not currently operate its own global navigation satellite system but participates in international programmes and has significant research activity in GNSS applications, space weather effects on navigation signals, and the development of quantum timing technologies that may underpin future PNT capabilities.

PNT data are also used for meteorology, including operational services based on GNSS occultation. The meteorological datasets generated are a valuable research resource.

3.2.2 Data Scope

UK Earth observation data holdings are distributed across multiple facilities. The Centre for Environmental Data Analysis (CEDA) at STFC RAL serves as the primary UKRI national archive for atmospheric and Earth observation data, hosting petabyte-scale holdings including satellite data records, climate reanalysis products, and model outputs. CEDA is the data archive component of the National Centre for Earth Observation (NCEO) as well as being the EO and Atmospheric data centre for the UKRI Environment Data Service (EDS).

CEDA and the Scientific Computing Department at STFC operate JASMIN, a data-intensive computing environment that enables researchers to analyse large datasets without requiring data transfer. Access to Copernicus Sentinel data is provided by the STFC CEDA Data Hub Relay (DHR) in collaboration with ESA, and is one member of a wider network of national relays dedicated to retrieval of Copernicus data for each member state. The CEDA DHR has recently been upgraded as part of a wider ESA program of improving capability and compatibility with other GS systems such as the DIAS and PRIP. One example is on-demand processing of products to allow distribution of processing load across the network. This new functionality also allows generation of more bespoke products and processing chains pertinent to national requirements. CEDA is pursuing this within the academic EO community and is eager to open this to the wider community.

The Earth Observation DataHub (EODH) is a UK Pathfinder project delivering access to Earth Observation data for effective decision making across government, business and academia, supported by key stakeholders UKRI NERC, DSIT and UKSA. Lead by the National Centre for Earth Observation (NCEO), specifically with members situated within the Centre for Environmental Data Analysis (CEDA) and the University of Leicester, the EODH project team provide oversight and management of a consortium of experts from across research and the commercial sector, including National Physical Laboratory, Met Office and Satellite Applications Catapult. Users of the Hub will be able to explore areas of interest in the UK and across the globe, harnessing space derived data to develop an improved understanding of our environment and create insights to support commercial and government decision-making.

As noted in the SPAN whitepaper on Space Policy and Funding⁵, the EO Data Hub initiative has been welcomed by the academic community as it enables users to investigate ideas at low cost, addressing the 'low TRL' side of software and data analysis development, though there is a need to continue adding data to the facility to maximise economic and scientific growth.

University groups hold mission-specific data products and derived datasets, particularly where UK teams lead algorithm development or scientific exploitation. For example, the University of Leeds Centre for Polar Observation and Modelling maintains ice sheet and glacier datasets derived from multiple satellite missions, while the University of Edinburgh hosts data products from carbon cycle research including outputs related to the MicroCarb mission.

Earth observation data volumes are substantial and growing rapidly, driven by increasing spatial and temporal resolution of sensors, expansion of satellite constellations, and the shift toward

⁵ Download from <https://span.ac.uk/wp-content/uploads/2024/10/SPAN-White-Paper-Academic-View-on-Future-of-Space-Policy-and-Funding-170924-V1.5-Final.pdf>

continuous monitoring rather than periodic surveys. The Copernicus programme alone generates multiple terabytes of data per day. Analysis-ready data (ARD) products that have been pre-processed to a consistent standard are increasingly important for enabling research and applications without requiring specialist remote sensing expertise.

3.3 Space Situational Awareness and Space Weather

Space Domain Awareness (SDA) is one of the government's four priority subsectors, and is at its core a data challenge: the ability to track, characterise, and predict the behaviour of objects in Earth's orbital environment depends entirely on the ingestion, fusion, and timely processing of data from ground-based sensors, space-based instruments, and international partners. The £85 million investment in the National Space Operations Centre announced in March 2026 will require the kind of robust data infrastructure, standards, and skilled workforce described throughout this whitepaper [30].

Space situational awareness and space weather represent increasingly important areas for the UK space sector, driven by growing dependence on space-based services, proliferation of satellites in low Earth orbit, and recognition of space weather as a risk to critical national infrastructure. The 2021 SPAN-commissioned report on UK Space Science identified Solar Physics, Space Weather and Plasma Physics [7]⁶ as one of the three main taxonomies of UK space science research.

3.3.1 Facilities

Space Surveillance and Tracking

The UK does not currently operate a sovereign space surveillance network comparable to the US Space Surveillance Network, but contributes to and benefits from international partnerships. The UK Space Agency participates in the EU Space Surveillance and Tracking (EU SST) partnership and maintains bilateral relationships with the US Space Force for conjunction warnings and collision avoidance data. Academic facilities contributing to UK SSA capability include optical telescopes operated by universities for satellite tracking and characterisation, and research programmes developing improved orbit determination algorithms and conjunction assessment methods.

SSA is a potential area of 'dual-use': the data can be used for collision avoidance to improve the safety of civil space operations (an aspect of developing concepts for space traffic management), but they are also valuable for military operators to understand threats to national and other space assets.

Space Weather Monitoring

UK space weather monitoring capability draws on both ground-based and space-based assets. The Met Office Space Weather Operations Centre (MOSWOC) provides operational space weather forecasts and warnings for government and industry users, drawing on data from international monitoring networks and space-based observatories. UK academic groups operate ground-based magnetometers, ionospheric sounders, and other instruments contributing to global monitoring networks.

The UK has world-class strengths in magnetometer instrumentation for magnetic field analysis, as highlighted in the UK Space Science report. Space-based contributions include UK involvement in ESA's Vigil mission (formerly Lagrange), which will provide side-on views of the Sun and solar wind from the L5 Lagrange point to improve space weather forecasting. UK-led instruments on Solar Orbiter, including the Magnetometer (MAG) led by Imperial College. These

⁶ Download from <https://span.ac.uk/wp-content/uploads/2024/07/SPAN-UK-space-science-nature-benefits-FINAL-REPORT-060421-compressed.pdf>

capabilities build on a strong heritage from earlier missions including SOHO, STEREO, Cluster, and Hinode.

Research Facilities

University groups maintain laboratory and computational facilities supporting SSA and space weather research. These include orbital dynamics simulation capabilities, space environment modelling tools, and facilities for studying the effects of radiation and plasma on spacecraft materials and components. The British Geological Survey operates the UK's magnetic observatories and maintains long-term geomagnetic records essential for understanding space weather impacts on ground-based infrastructure. STFC operates the Chilbolton observatory which is capable of tracking satellites and other space objects. This contributes to SSA studies.

3.3.2 Data Scope

Space situational awareness depends on timely access to observations of resident space objects, including active satellites, debris, and potentially hazardous objects. Two-line element (TLE) sets published by the US Space Force provide the primary publicly available source of orbital data, though accuracy limitations affect their utility for precision applications such as conjunction assessment and collision avoidance manoeuvre planning. Higher-accuracy data from commercial and government tracking networks is available under various sharing arrangements but is not uniformly accessible to academic researchers. The accuracy and provenance of orbital data is a significant concern, particularly as low Earth orbit becomes increasingly congested and the consequences of collision increase.

UK academic groups generate and use SSA-related data including optical observations of satellites and debris, radar tracking data where available, and derived products such as refined orbit determinations and conjunction probability assessments. Integration of data from multiple sources, including satellite operators who may hold proprietary tracking data, remains challenging. The UK Space Agency collects data on UK space activities for international reporting, including submissions to the UN on space debris, and there are opportunities to better coordinate academic contributions to national SSA data holdings.

Space weather data encompasses solar observations, in-situ measurements of the solar wind and magnetospheric plasma, ionospheric monitoring, and records of geomagnetic activity and its effects on technological systems. International data sharing is well established through organisations such as the International Space Environment Service (ISES), and many space weather datasets are openly available through archives maintained by space agencies and research institutions. UK contributions to international space weather data holdings include magnetometer data, ionospheric measurements, and scientific data products from missions such as Solar Orbiter and Cluster.

A particular challenge for space weather is the integration of research data with operational forecasting requirements. Research missions provide high-quality scientific data but may not deliver the real-time availability and continuity needed for operational services. The transition from research to operations, ensuring that advances in scientific understanding translate into improved forecasting capability, requires sustained attention to data standards, latency requirements, and the infrastructure connecting research data systems to operational forecasting centres.

4 Data and Digital Research Infrastructures

This section highlights a range of key data centres that aggregate Space data in the space science, solar science and earth observation domains. It also considers current digital research infrastructures that are enabling the generation of space data. This section does not consider

digital research infrastructures that ‘consume’ space data or are used to support the end user exploitation of space data.

4.1 Science Data Centres

The UK hosts a number of science data centres that play a critical role in processing, archiving, and distributing data from space missions. These facilities bridge the gap between raw spacecraft telemetry and the analysis-ready products used by researchers, and represent a core element of the national space data infrastructure.

4.1.1 Mission-Specific Data Processing Centres

The UK operates several mission-specific data centres embedded within university research groups. For instance, the University of Cambridge coordinates a substantial portion of Gaia data processing through its role in the Data Processing and Analysis Consortium (DPAC) [36], handling astrometric solutions for billions of stars in what represents one of the largest data processing efforts in the history of astronomy. The University of Edinburgh hosts one of nine Euclid Science Data Centres, with UK teams leading the development of cosmic shear measurement pipelines and contributing to the ground segment architecture.

The Mullard Space Science Laboratory at UCL leads data processing and calibration for the Solar Orbiter Solar Wind Analyser suite, managing the pipeline from telemetry to science-ready products. UK institutions are also developing exoplanet data analysis pipelines for PLATO and will contribute to catalogue production when the mission begins operations. Similar arrangements exist for other missions where the UK holds instrument PI-ships or significant ground segment responsibilities, including BepiColombo MIXS data processing at Leicester and J-MAG magnetometer data for JUICE at Imperial College.

4.1.2 UK Solar Science Data Centres

The UK Solar System Data Centre (UKSSDC) [8]⁷ serves as the national facility for solar science data curation and distribution. UKSSDC provides long-term archiving of data from UK-led and UK-participating solar science space missions, with particular strengths in solar-terrestrial and space plasma physics datasets. The centre supports data from missions including Cluster, Cassini-Huygens, and a range of solar observatories, and coordinates with international archives such as ESA's Planetary Science Archive and NASA's Planetary Data System to ensure UK-held data remains accessible to the global research community.

4.1.3 National Centre for Earth Observation (NCEO) and CEDA/UKRI NERC Environmental Data Service

The Centre for Environmental Data Analysis (CEDA) provides an archive of ~30PB of Earth Observation and Atmospheric Science data. CEDA is the data archive component for the NCEO, as well as the wider NERC EO and atmospheric science community and works closely with all members to ensure the provision of suitable EO data with the archives and support for using the JASMIN HPC facilities. Furthermore, as part of the NERC EDS, CEDA works closely with partner data centres to ensure that EO data and expertise is shared as well as combining experience on data dissemination and data services.

4.1.4 External Space Science Data Centres: ESA and ESO

UK researchers benefit significantly from access to the data archives operated by the European Space Agency (ESA) and the European Southern Observatory (ESO), which together represent some of the most comprehensive and well-curated astronomical data holdings in the world. The

⁷ See <https://www.ralspace.stfc.ac.uk/Pages/UK-Solar-System-Data-Centre.aspx>

ESA Science Data Centre (ESDC) at ESAC near Madrid provides access to data from the full range of ESA science missions, including flagship observatories such as XMM-Newton, Herschel, Euclid and Gaia, as well as planetary missions including Mars Express, Rosetta, and BepiColombo. ESDC implements standardised interfaces and provides value-added services including cross-mission searching, on-demand data processing, and science-ready data products that substantially reduce the effort required for researchers to exploit mission data.

ESO's Science Archive Facility provides access to data from the Very Large Telescope (VLT), ALMA, and other ground-based facilities in which the UK has a significant stake. The archive implements a consistent data model across instruments and provides both raw and processed data products, enabling research that combines space-based and ground-based observations. UK researchers make extensive use of these European archives, and UK institutions contribute to their development and operation. However, the relationship between UK national data holdings and these European archives is not always well coordinated, and there are opportunities to improve the discoverability of UK-held data through better integration with European archive services.

4.2 Digital Research Infrastructure

4.2.1 IRIS

IRIS (eInfrastructure for Research and Innovation in STFC) [9]⁸ provides coordinated computing, data storage, and networking services for UKRI-STFC-funded science communities. IRIS supports mission-dedicated processing for a number of space science projects, though questions remain about commitments to shared hardware infrastructure for UKSA supported missions. Establishing clearer policies on the use of IRIS resources for core UKSA mission processing would help ensure that space data activities can benefit from national-scale infrastructure investment rather than relying solely on project-specific allocations.

4.2.2 AIRR

The AI Research Resource (AIRR) [10]⁹ represents a significant government investment in AI infrastructure, with facilities established at Bristol and Cambridge. These resources offer potential opportunities for space data applications, particularly in areas such as automated classification, anomaly detection, and large-scale image analysis. However, engagement between the space data community and AIRR remains limited, and there is scope to develop use cases that would demonstrate the value of AI infrastructure for space science and Earth observation applications.

4.2.3 DiRAC

DiRAC (Distributed Research utilising Advanced Computing) [11]¹⁰ provides distributed computing capabilities used by several particle physics and astronomy projects across Leicester, Durham, Edinburgh and Cambridge Universities. The system enables workload management across heterogeneous computing resources and has been deployed for large-scale data processing tasks. Its applicability to emerging space data challenges, particularly those involving distributed processing across multiple sites, merits further exploration. DiRAC co-designs the hardware of the supercomputing facilities enabling innovation and benchmarking for science.

⁸ <https://www.iris.ac.uk>

⁹ <https://www.gov.uk/government/publications/ai-research-resource/airr-advanced-supercomputers-for-the-uk>

¹⁰ <https://dirac.ac.uk/>

4.2.4 JASMIN

JASMIN is the UK's data analysis facility for environmental science, and is designed, integrated and operated by the Science & Technology Facilities Council (STFC) on behalf of the Natural Environment Research Council (NERC). JASMIN provides a bespoke high-throughput computing environment for academic environmental science community, including Earth Observation, that is centred around storage and data analysis, providing flexibility for a range of data-intensive analysis workflows. It has direct access to the CEDA archive, allowing direct access to many Earth Observation datasets, as well as providing workspaces for community collaboration.

4.2.5 National Data Libraries

Preliminary planning is in progress regarding the development of national UK data libraries [12]¹¹, which could potentially provide coordinated access to key UK research data assets. Space data (including that from PNT and metrology) currently has no clearly defined place within this emerging framework, representing both a gap and an opportunity. Strategic engagement with the national data library initiative could help position space data within broader government data infrastructure planning, ensuring that the UK's substantial investments in space missions translate into accessible, well-curated data holdings that support research, policy, and commercial applications.

4.3 Data Standards

4.3.1 The International Virtual Observatory Alliance

Interoperability across astronomical data archives depends critically on the adoption of common standards, with the International Virtual Observatory Alliance (IVOA)¹² playing a central role in defining protocols and data models for astronomy. IVOA standards include the Table Access Protocol (TAP) for database queries, the Simple Image Access Protocol (SIAP) for image retrieval, and the VOTable format for tabular data exchange. UK institutions have been active contributors to IVOA standards development, and major UK data centres implement IVOA-compliant interfaces that enable seamless cross-archive queries through tools such as TOPCAT and Aladin.

4.3.2 Planetary Data System

In planetary science, the Planetary Data System (PDS) standards developed by NASA provide the primary framework for data archiving and exchange. The PDS4 standard defines a comprehensive information model covering observational data, derived products, and documentation, with an emphasis on long-term preservation and self-describing data formats. ESA's Planetary Science Archive (PSA)¹³ implements PDS4-compliant interfaces and works closely with NASA to ensure interoperability between European and US planetary data holdings. UK planetary scientists contribute data to both PSA and PDS archives, and adherence to these standards is essential for ensuring that data from UK-led instruments on missions such as BepiColombo and the ExoMars rover remain accessible and usable over multi-decade timescales.

4.3.3 Wider International Standardisation

The UK contributes to international standards relevant to space systems. These standardisation activities include the International Organisation for Standardisation (ISO) (with the sub-committee TC20 / SC13 responsible for developing space data standards, largely by cooperating with the Consultative Committee on Space Data Systems (CCSDS)). CCSDS standards are widely used

¹¹ See <https://www.gov.uk/government/publications/national-data-library/national-data-library>

¹² See IVOA pages at <https://www.ivoa.net/>

¹³ See PDS standards implemented by ESA at <https://www.cosmos.esa.int/web/psa/pds4-standards>

for satellite telecommand and telemetry, and enable ground segment interoperability. The British Standards Institute provides secretariat support for the UK in this area.

4.4 Data Resilience and International Dependencies

The government has recognised space as Critical National Infrastructure, and the 2025 Strategic Defence Review identified investment in the resilience of military space systems as an urgent requirement. Data resilience is central to this: the UK's ability to operate in and through space depends on assured access to tracking, telemetry, calibration, and situational awareness data. The National Space Operations Centre, to receive £85 million in development funding [13][14]¹⁴, will depend on robust data architectures connecting ground-based sensors, space weather monitoring, and orbital tracking systems. The data infrastructure recommendations in this whitepaper directly support the government's priority investment in Space Domain Awareness and national space resilience.

Recent international developments have highlighted vulnerabilities in the UK's access to space data held on international platforms. Earth observation data hosted on commercial cloud services such as Amazon Web Services and Google Cloud may not be maintained if commercial priorities shift, and key infrastructure such as the Sentinel Hub is owned by non-UK entities. Potential reductions in US science budgets [15]¹⁵ threaten access to NASA datasets, including the Planetary Data System and the Astrophysics Data System, which are vital for UK and European planetary science and astrophysics research.

Examples of abrupt data access changes demonstrate the risks associated with dependence on external data sources. Resilience of data access including the possibility of UK or European archives to maintain access to critical datasets, needs to be investigated. There is a growing recognition of the need for a clear strategy to ensure continued access to essential data, balancing the benefits of international collaboration and commercial cloud services against the risks of dependence on infrastructure outside UK control.

4.4.1 Data Ownership and Governance

Issues may emerge over data ownership in the context of commercial cloud platforms, particularly regarding the use of data for training large language models. Many cloud platforms may use data stored on their services for proprietary AI training purposes, raising questions about intellectual property, confidentiality, and compliance with licensing arrangements such as Creative Commons. The space data community requires clearer guidance on data governance in cloud environments, including the responsibilities of data providers and the implications of different hosting arrangements for data ownership and reuse rights.

5 Relevant Roadmaps and Capability Mapping Studies

This section notes challenges identified in space science data identified in recent UK and European level studies.

5.1 Astronet

¹⁴ See UK Gov announcement 4 Mar 2026 at <https://www.gov.uk/government/news/space-firms-to-scale-up-and-thrive-in-britain-with-government-backing-for-bolder-strategy>

¹⁵ See e.g. <https://aas.org/press/aas-statement-nasa-cuts> and <https://www.space.com/space-exploration/european-space-mission-threatened-by-nasa-budget-cuts>

The Astronet¹⁶ (a consortium of European funding agencies, research organisations and associated bodies) Roadmap 2022-2035 [16] contains reference to a number of key space data challenges relevant to UK space science data infrastructure, in the following key areas:

Data Volume & Complexity Challenges:

- Exponential growth in data volumes: next-generation facilities (e.g. SKA, ELT, GaiaNIR, LISA) will produce petabyte-scale datasets requiring new approaches
- Multi-messenger astronomy: the need to integrate gravitational wave, neutrino, electromagnetic, and cosmic ray data in real-time
- Time-domain astronomy: managing high-cadence observations and rapid alert systems for transient phenomena
- Multi-wavelength integration: combining data from ground and space-based observatories across the electromagnetic spectrum

Infrastructure & Processing Challenges:

- Distributed computing requirements: the need for federated computing infrastructure beyond single national capabilities
- Real-time processing: automated pipelines for immediate data reduction and alert generation
- Long-term data preservation: ensuring decades-long accessibility of scientific data products
- Energy consumption: Environmental impact of large-scale data centres and computing facilities

Access & Interoperability:

- FAIR data principles: making data Findable, Accessible, Interoperable, and Reusable across international boundaries
- Virtual Observatory evolution: the need for enhanced tools and services for seamless data discovery and access
- Cross-facility coordination: harmonizing data formats and metadata standards across ESA, ESO, and national facilities
- Open science requirements: balancing immediate open access with proprietary periods for PIs

Skills & Methodology Gaps:

- Data science expertise shortage: the need for astronomers trained in machine learning, AI, Research Software Engineers (RSEs) and advanced statistics
- Software sustainability: maintaining and evolving community data analysis tools
- Reproducibility crisis: ensuring scientific results can be verified through transparent data and code sharing

Emerging Technology Challenges:

- Machine learning integration: developing trustworthy AI for automated classification and anomaly detection
- Cloud computing adoption: transitioning from traditional HPC to commercial cloud services
- The move towards Exascale compute noting the governments investment as part of government's AI Research Resource (AIRR) into ISAMBARD at Bristol University and DAWN at Cambridge as pre-Exascale systems
- Edge computing: processing data closer to telescopes to reduce transfer requirements
- Quantum computing preparation: preparing algorithms for future next generation quantum computing opportunities

¹⁶ <https://www.astronet-eu.org/>

There are a number of UK specific implications resulting from the Astronet roadmap. The UK must effectively coordinate its contributions to major European data infrastructures including ESO, ESA, and the SKA Observatory, ensuring that national investments align with and complement international programmes while maximizing scientific return. This presents a significant opportunity to leverage the UK's recognized strengths in artificial intelligence and machine learning for astronomical data analysis, potentially positioning the UK as a leader in next-generation data processing techniques. However, this ambition requires sustained funding for data infrastructure that matches investments in instrumentation development, recognizing that modern astronomy's scientific output depends equally on both capabilities. STFC facilities and university computing centres play a critical role in the European data landscape, serving as key nodes in distributed processing networks and repositories for long-term data curation. Throughout these developments, the UK must carefully balance building secure sovereign capabilities that ensure national research independence with meaningful participation in international collaborations that provide access to global data resources and shared infrastructure costs, ultimately maximizing both scientific impact and value for money.

Many of these challenges align closely with issues identified in the UK Space Partnership Roadmaps, as discussed in the next section, particularly the need for scalable infrastructure, data fusion capabilities, and skills development in advanced data analytics.

5.2 Space Partnership Capability Roadmaps

The Space Partnership¹⁷ Capability Roadmaps are a comprehensive strategic planning document with 22 detailed roadmaps that chart the UK's space ambitions from 2024 to 2035 across six major capability areas: Space Domain Awareness, Space Transportation, Earth Applications, In-Orbit Applications, Space Science, and Space Exploration & Human Spaceflight. This strategic roadmap aims to guide government investment, industry development, and academic research to ensure the UK captures its share of the growing global space economy while addressing national priorities including NetZero, resilience, and scientific leadership [17].

Of the 22 'Roadmap' documents, several have a significant 'data' angle. These include, with key data issues highlighted:

Roadmaps 14-18 (Space Science):

- End-to-end support from data analysis to curation
- Data processing pipelines and analysis software
- Long-term data preservation and exploitation

Roadmaps 19-21 (Exploration):

- Mars data generation and processing
- Access to exploration mission data
- LEO experiment data management

Roadmap 4: UK is a country of choice for space data assurance

- Central focus on data quality, validation, calibration, and assurance services
- Development of metadata and provenance assurance
- Digital identifiers and international registries

Roadmap 5: UK is an important contributor to global environmental early warning systems

- Emphasis on space data and derived insights across Government
- Scalable infrastructure for integrating satellite & non-satellite data
- Data fusion and merging techniques

¹⁷ See <https://www.spacepartnership.org.uk/about/>

Roadmap 6: UK strengthens climate change & NetZero knowledge base

- Climate-quality historical records and prediction systems
- Data services for carbon and greenhouse gas observations

There is strong alignment in the challenges identified in these capability roadmaps, and as set out in the Astronet roadmap, this reflecting shared recognition of fundamental data infrastructure needs across the European space science community. For instance, both documents identify an acute skills gap in advanced data analytics, with the UK roadmaps calling for building competency in AI/ML applications across multiple roadmaps, while Astronet identifies the shortage of astronomers trained in machine learning and data science as a critical bottleneck. The challenge of data integration appears prominently in both documents. The UK roadmaps emphasize fusion of space-enabled PNT systems, integration of space weather data, and harmonization between civil and defence systems, while Astronet focuses on multi-messenger and multi-wavelength astronomy requiring real-time integration across diverse data streams.

6 Challenges and Gaps

6.1 Creating Space Data Products

Space missions generate significant data streams. To take the case in space science, these data are initially uncalibrated. To be of value these 'raw' data need to be transformed into calibrated data products, often organised in 'levels', from instrument signature removed L1 science ready data, to L2 products of astrophysical parameters, and then L3 products, which are generated from the particular mission and a range of other science data to derive further characterisation of the sources observed. Likewise, for earth observation data, raw data is calibrated and then higher level geophysical parameters are generated.

The analysis pipelines that are required to transform the raw to L1 and higher level data products must be developed, implemented, operated and maintained. Increasingly complicated space science missions set increasing requirements and challenges in the realm of data generation, in a range of areas including the following.

6.1.1 Pipeline Development and Sustainability

Data processing pipelines require substantial upfront investment in software development. Funding models though typically prioritise hardware and instrumentation over longer term software engineering support. Pipeline code often relies on institutional knowledge held by small teams or individual developers, creating vulnerability when key personnel move on or retire. As noted in the SPAN Policy whitepaper, many technical staff are employed on "soft money" with short-term contracts, and universities are increasingly unable to bridge funding gaps due to broader financial pressures facing higher education.

The need to maintain and update pipelines across mission lifetimes of 10–20+ years conflicts with typical project funding cycles of 3–5 years. Academia and industry have suggested 10-year flexible funding cycles with a 15-year outlook to better match the long-term nature of space missions. Legacy codebases developed for earlier missions may be difficult to adapt for modern computing environments, yet complete rewrites are rarely resourced, leaving teams to maintain ageing software stacks while simultaneously delivering science-ready products.

6.1.2 Calibration and Quality Assurance

Developing and maintaining instrument calibration procedures to the precision required for scientific exploitation demands ongoing effort throughout the entire mission operation and post operations phases. Cross-calibration between instruments, missions, and ground-based

observations remains technically challenging and resource-intensive, often requiring specialist expertise that is difficult to retain over multi-decade mission timescales.

Documentation of calibration procedures and data provenance is often incomplete, hindering reproducibility and long-term data utility. Quality assurance processes are frequently under-resourced, leading to delays in data product releases or inconsistent product quality. These shortcomings can propagate through downstream analyses, affecting the reliability of scientific conclusions drawn from space data.

6.1.3 Scale and Timeliness

The exponential growth in data volumes from recent space missions is outpacing the development of processing infrastructure and techniques. Missions such as ESA's Gaia, Euclid, and the forthcoming PLATO and LISA, generate data at scales that require fundamentally different approaches to storage, processing, and distribution than earlier generations of space observatories. As noted in the Astronet Roadmap, next-generation facilities will produce petabyte-scale datasets requiring new approaches to data management.

Increasing demand for near-real-time data products, for example in space weather monitoring or rapid transient follow-up, requires processing architectures that differ fundamentally from traditional batch processing approaches. Multi-messenger astronomy, integrating gravitational wave, neutrino, electromagnetic, and cosmic ray data in real-time, presents particular challenges. Balancing the computational cost of reprocessing entire mission archives when calibration improves against delivering timely products to the community presents ongoing operational challenges. While the UK has invested in large-scale exabyte computing and high-performance computing facilities, a "silo" problem persists, with many facilities not joining the dots across different areas of application.

6.1.4 Standardisation and Interoperability

Inconsistent data formats and metadata standards across missions and institutions impede data discovery, integration, and reuse. As discussed earlier, international standards exist especially for astronomy and planetary data. However, even here, adoption is uneven and implementation varies, reducing practical interoperability between datasets from different sources.

The lack of standardised approaches to uncertainty quantification and error propagation limits the scientific utility of derived products. Users combining data from multiple missions must often develop bespoke solutions to reconcile differing conventions, adding friction to multi-mission and multi-wavelength science that would otherwise benefit from the UK's broad portfolio of space data assets.

The adoption of data standards in other space data domains is less mature. Earth observation data increasingly follows standards, for example the SpatioTemporal Asset Catalog (STAC) specification and Cloud-Optimised GeoTIFF (COG) formats, but standardisation across space weather, space situational awareness, and emerging commercial data sources remains fragmented. Encouraging broader adoption of established standards and supporting their evolution to meet new requirements represents an important area for community coordination.

In addition, various cloud-optimised formats have been adopted by parts of the community including Zarr/Virtual Zarr. Encouraging broader sharing of knowledge around nascent data standards represents an important area for community coordination.

6.1.5 Skills and Capacity

There is a shortage of personnel with the combined expertise in both domain science and modern software engineering practices needed to develop robust data pipelines. The 2023 UK Space Agency Space Sector Skills Survey found that over 50% of space organisations reported struggling to recruit skilled people, a constraint that applies acutely to data-intensive roles

requiring expertise in AI, ML, RSE, and advanced analytics. The Astronet Roadmap identifies this shortage of astronomers trained in machine learning and data science as a critical bottleneck for the field [18][32].

Training in data product creation is often informal and ad hoc, with limited structured career pathways for those specialising in this critical area. The recognition and reward structures within academia do not adequately value contributions to data infrastructure, making it difficult to attract and retain talent. Scientists trained on data-intensive projects such as Gaia or EO data analytics often move to commercial data industries, representing both a benefit to the broader economy and a loss of specialist capacity for the space sector.

6.1.6 Data Exploitation Planning

Data exploitation plans are not always built into mission design from the outset, limiting the return on investment from space data assets. Without early consideration of how data will be processed, archived, and made accessible, missions risk delivering raw holdings that remain underutilised by the wider research community.

Initiatives such as the EO Data Hub [19]¹⁸ demonstrate the value of accessible data platforms for enabling low-cost investigation of ideas and "low TRL" software and data analysis development, but sustained investment is needed to expand data holdings and user access. Maximising the scientific and economic return from UK missions requires mechanisms to ensure that data exploitation is considered as a core deliverable alongside hardware and operations.

6.1.7 Space Data used in Legal Cases

Space Data, in particular Earth Observation data, may be used in evidence in legal cases, e.g. for war crimes prosecutions or smuggling operations. For this use, the two aspects of (a) data archiving, and (b) data processing may be subject to rigorous scrutiny. Processes need to be in place to ensure that the data being examined are the data it is claimed they are, and that the results obtained from any analysis of the data can be trusted.

6.2 Access to Open Science and Open Data

There are a number of limitations in the current access to space data. Access is fragmented across multiple repositories and platforms, with no single portal providing unified discovery of UK-held space data across missions and disciplines. This makes it difficult for researchers to identify and exploit the full range of available assets. There are data portals such as the ESA sky [20]¹⁹ which do provide significant coverage of space science data, but is currently limited to public data. Integration between space and non-space datasets remains limited, hampering research that would benefit from combining satellite observations with ground-based, airborne, or in-situ measurements. Varying levels of data maturity, from raw observations to analysis-ready products, create barriers for users who lack the specialist skills to process lower-level data. Mixed open and restricted access policies depending on data source and application add further complexity, with researchers often uncertain about what data they can access and under what terms.

The Astronet Roadmap emphasises the importance of FAIR data principles (Findable, Accessible, Interoperable, Reusable) and the need for continued evolution of Virtual Observatory tools and services. Balancing immediate open access with proprietary periods remains a point of ongoing discussion within the community. The challenge of ensuring decades-long accessibility of scientific data products, as required for climate records and long-term monitoring, requires sustained commitment to data preservation infrastructure that project-based funding models

¹⁸ See <https://www.nceo.ac.uk/our-research/national-programmes/eodh/> and the EO Data Hub access point at <https://eodatahub.org.uk>

¹⁹ See <https://sky.esa.int>

struggle to provide. The development of suitable Jupyter Notebook repositories in line with CEOS best practice is an example of how interoperability of data across platforms can be supported²⁰. Recognising that data may have commercial or other operational value in some cases, it is important that the legal basis for data use and ownership, etc. is properly understood and defined.

6.3 Space Data AI and Cloud

Artificial intelligence and cloud computing are transforming how space data is processed, analysed, and exploited. These technologies offer substantial benefits, enabling analysis at scales previously impossible, accelerating scientific discovery, and democratising access to data, but they also introduce new challenges and risks that the UK space data community must carefully navigate.

6.3.1 The Promise of AI for Space Data

The Astronet Roadmap identifies AI/ML as an emerging priority, and the May 2025 EU Council conclusions on satellite data recognised that AI can play a significant role in identifying patterns and anomalies while emphasising the need for appropriate governance [21].

AI and machine learning techniques are increasingly essential for space data applications, for example:

- **Classification and detection:** ML models can classify millions of astronomical sources, identify transient events in real-time, detect anomalies in spacecraft telemetry, and categorise land use in Earth observation imagery at speeds impossible for human analysis.
- **Data fusion:** AI techniques can integrate heterogeneous data sources, combining space-based observations with ground-based data, historical records, and auxiliary datasets to generate insights beyond what any single source provides.
- **Automated processing:** ML-enhanced pipelines can adapt to changing instrument characteristics, perform intelligent quality assessment, and make real-time decisions about data prioritisation and follow-up observations.
- **Scientific discovery:** AI is increasingly used not just for routine processing but for hypothesis generation and discovery, identifying unexpected phenomena in large datasets that would escape traditional analysis.

6.3.2 The Promise of Cloud Computing

Cloud platforms offer significant advantages for space data in terms of:

- **Scalability:** Cloud resources can scale dynamically to meet processing demands, accommodating burst requirements during data releases or time-critical analysis without maintaining idle capacity.
- **Data colocation:** Bringing computation to where data is stored, rather than transferring petabytes to users, is increasingly the only practical approach for large datasets.
- **Accessibility:** Cloud-based science platforms can provide uniform access to data and tools regardless of a researcher's institutional resources, potentially democratising participation in space science.
- **Collaboration:** Shared cloud environments facilitate collaboration across institutions and borders, enabling distributed teams to work on common datasets and pipelines.

6.3.3 Challenges and Risks

Despite these benefits, AI and cloud adoption for space data presents significant challenges, for instance in that:

²⁰ See CEOS best practices guides at <https://ceos.org/publications-key-documents/>

- Many cloud platforms scrape the data and information stored on their platforms to train their proprietary Large Language Models (LLMs). This can lead to loss of proprietary and confidential data and information, and loss of intellectual property.
- **Data security** in the cloud is highly dependent on the security infrastructure of the commercial platform owner. There have been and continue to be numerous reports of failures in cloud security from various providers. It is unclear what insurance and liability issues might apply in the event of data loss or data leakage of space related information from such a cloud provider. At some level you only have control of data in a data centre that you own and control. For instance, data stored on commercial cloud platforms may be physically located outside UK or European jurisdiction, with implications for legal frameworks, access rights, and national security for sensitive applications.
- A variety of **licensing arrangements** apply to space data and documentation. Some of these, such as Creative Commons, can place responsibilities on other data users. Within academia this is usually not an issue, but where commercial users, especially in the context of LLM training, are involved, these licensing terms are often ignored. Such data may thus be misused and misattributed.
- **Trustworthiness and Validation** in a scientific context. For instance, traditional validation approaches may be inadequate for AI systems that can exhibit unexpected behaviours on edge cases or out-of-distribution inputs. Comprehensive testing is difficult when the space of possible inputs is vast. AI systems may produce different results depending on hardware, software versions, random seeds, and training data ordering, challenging scientific reproducibility requirements.
- **Governance and Regulation** is an area that is rapidly evolving. The EU's AI Act, entering application in phases from 2024, classifies AI systems by risk level and imposes requirements on high-risk applications. Earth observation systems used for critical infrastructure monitoring or emergency response may fall within regulated categories. International standards for AI in space applications are nascent, creating uncertainty for developers and operators [22].

6.3.4 Addressing the Challenges

The UK should develop clear guidance on:

- Which cloud platforms and services are appropriate for different categories of space data
- Requirements for AI systems used in space data applications, including validation, uncertainty quantification, and interpretability
- Licensing frameworks that protect UK interests while enabling beneficial AI development
- Skills development pathways combining space domain expertise with AI/ML capability

A balanced approach is needed, one that captures the substantial benefits of AI and cloud technologies while managing the real risks they present.

6.4 Space Data and People

The space data workforce faces significant challenges that threaten the UK's ability to maintain its position as a leader in space science and data analysis.

6.4.1 Workforce Sustainability

University staff employed on 'soft money' with short-term contracts face uncertainty, with internal procedures requiring notification of possible redundancy 6 months before the end of funding. Much detailed technical and project expertise is held by such staff and is critical to the success of projects. The current state of university finances and changes to UKRI funding which are negatively impacting in some areas of science (e.g. the recent issues around UKRI-STFC funding

[24]²¹) means that providing matched funding to support committees, workshops and initiatives is increasingly difficult, as institutions work to avoid sliding further into economic difficulty [25]²².

6.4.2 Career Pathways

There are limited structured career pathways for those specialising in space data infrastructure and software development. The recognition and reward structures within academia prioritise publications over contributions to data systems, pipelines, and archives. This makes it difficult to attract and retain talent in these critical roles. Dual-sector fellowships and secondments, enabling academic researchers to spend time embedded in industry and government, and vice versa, to build skills and understanding across sectors, maybe beneficial in this area.

6.4.3 Training and Skills Development

Training in space data skills is often informal and ad hoc. While undergraduate and postgraduate programmes provide foundation knowledge, the specific skills needed for space data processing, including specialist software engineering, pipeline development, and data management, are typically learned on the job.

6.4.4 Diversity and Inclusion

Efforts to widen participation and reach underserved and underrepresented communities are ongoing across the sector. Academic and industry professionals contribute to outreach through organisations such as the National Space Academy and the national STEM centre, emphasising the importance of diversity and inclusion in addressing the space sector's skills challenges.

6.5 Space Data and the Environment

The environmental impact of space data infrastructure is an emerging concern that the UK space data community must address proactively. The Astronet Roadmap explicitly recommends that 'astronomy projects should include environmental footprint assessments' and develop 'reduction plans regarding... computing, to follow (at the least) the European timeline towards carbon-neutrality.' As data volumes from space missions grow exponentially, the energy and resource requirements for processing, storing, and distributing this data present both challenges and opportunities for sustainable practice.

6.5.1 Energy Consumption of Space Data Infrastructure

Data centres supporting space data activities consume significant amounts of electricity for computing and cooling. The UK's national research computing facilities, including IRIS, JASMIN, and DiRAC, collectively represent a substantial energy footprint. Individual missions can require considerable processing resources: the ESA Gaia data processing consortium, for example, has used hundreds of millions of CPU hours across multiple data releases, with comparable requirements anticipated for ESA Euclid and future missions.

The trend toward more complex processing pipelines, machine learning applications, and reprocessing of archival data will increase energy demands. Training large AI/ML models for astronomical classification or Earth observation analysis can be particularly energy-intensive. DiRAC sites capture energy information: Whole system, Per-node energy, Storage energy,

²¹ See e.g. the UK Parliament's Science, Innovation and Technology Committee session exploring the impact of scientific research cost pressures, and its 4 March 2026 session investigating STFC specifically at <https://committees.parliament.uk/event/26683/formal-meeting-oral-evidence-session/>

²² See SPAN Whitepaper: Bridging the Gap Between Industry and Academia in the UK Space Sector: download from https://span.ac.uk/wp-content/uploads/2025/10/SPAN-Whitepaper-Bridging_the_Gap-Strengthening_IndustryAcademia_Collaboration_in_the_UK_Space_Sector_v1.9.pdf

Cooling and UPS energy and some capture network fabric energy. Without deliberate intervention, the carbon footprint of UK space data activities will grow substantially over the coming decade.

6.5.2 Data Centre Environmental Impacts

Beyond electricity consumption, data centres have broader environmental impacts including:

- **Water usage:** Many data centres use water for cooling, with large facilities consuming millions of litres annually. In regions facing water stress, this presents sustainability challenges.
- **Land use:** Purpose-built data centre facilities require significant land, often on greenfield sites with associated habitat and agricultural impacts.
- **Embodied carbon:** The hardware lifecycle: manufacturing, shipping, installation, and disposal of servers, storage, and networking equipment, contributes substantially to total environmental impact, often exceeding operational emissions over a facility's lifetime.
- **Electronic waste:** The rapid refresh cycles for computing hardware generate significant e-waste, much of which is not recycled effectively.

Initial efforts from the UKRI Net Zero Digital Research Infrastructure (DRI) Scoping Project [23]²³ provides a framework that space data activities could further develop.

6.5.3 Space-Based Data Processing and Orbital Data Centres

An emerging concept with potential environmental implications is the deployment of data processing capabilities in orbit. Space-based data centres could potentially:

- Reduce the volume of data that must be downlinked by performing initial processing on-orbit
- Take advantage of solar power in space, though with significant embodied carbon in launch and spacecraft manufacture
- Reduce cooling requirements in the thermal environment of space

While currently speculative for most applications, on-board processing is already used in Space Science and Earth observation missions to reduce downloaded data volumes, and more sophisticated edge computing in space is an active area of technology development. The environmental case for space-based processing requires careful lifecycle assessment comparing launch and spacecraft emissions against terrestrial alternatives. In addition the potential rapid increase in number of satellites in near earth orbit will have wider implications in terms of near earth orbit congestion, impact on science [38], and in the longer term, fundamental impacts on humankind's ability to experience the wonder of a 'dark' sky [39].

6.5.4 Current Gaps and Challenges and how to Address this.

The UK space data community currently lacks: baseline measurements, reporting frameworks, reduction targets, procurement criteria and skills and awareness of environmental sustainability as it relates to space data.

International partners are increasingly addressing these challenges. ESA has committed to net-zero operations and is assessing the environmental footprint of its activities. NASA has sustainability initiatives across its centres. The European Open Science Cloud (EOSC) is considering environmental sustainability as part of its federation principles. The Astronet Roadmap's explicit recommendations on environmental assessment and carbon neutrality timelines reflect growing consensus within the European astronomy community [28].

²³ See <https://net-zero-dri.ceda.ac.uk/> - the pilot project released its Final Report in August 2023 (<https://zenodo.org/records/8199984>).

The UK should ensure its space data activities align with these international expectations, both as a matter of responsible practice and to maintain credibility in collaborative programmes where sustainability is increasingly scrutinised.

Section 8.5 of this action plan proposes specific actions to address environmental sustainability, including conducting footprint assessments (Action 5.1) and developing reduction plans aligned with carbon neutrality timelines (Action 5.3). These actions should be prioritised as part of the broader modernisation of UK space data infrastructure.

6.6 Document and Data Sharing

Sharing of documents and data between institutions currently involves the use of a wide range of different, and often incompatible, approaches and platforms. This can slow collaborations, lead to timewasting obstacles, and, in the worst case, may lead to loss of data. A uniform approach that is compatible with all platforms would help ease these difficulties and streamline data and document sharing. Ensuring resilience in data access arrangements and maintaining copies of critical data within UK or European infrastructure are important considerations for the community.

6.7 Key Data Gaps

Key areas for improvement in maximising effective utilisation of space data include:

6.7.1 Infrastructure Gaps

The lack of unified national space data infrastructure means that UK-held space data is fragmented across multiple repositories with no single discovery portal. The UK Space Agency currently lacks a clear data policy comparable to the more joined-up approaches adopted by organisations such as NERC (e.g. EO Data Hub, EDS). Space data has no defined place within the emerging national data library framework, representing both a gap and an opportunity for strategic engagement.

6.7.2 Processing Capabilities

Limited real-time processing capabilities constrain emerging applications in areas such as space weather monitoring, transient astronomy follow-up, and time-critical Earth observation. The transition to cloud-native and analysis-ready data formats is incomplete, and many datasets remain difficult to access without specialist processing skills.

6.7.3 Integration Challenges

Insufficient integration between civil and defence data systems limits opportunities for dual-use applications and efficient use of national resources. The need for improved data fusion techniques combining space and terrestrial sources has been identified in multiple roadmaps, but progress is hampered by inconsistent standards and limited interoperability.

6.7.4 International Dependencies

As discussed in Section 4, vulnerabilities in access to space data held on international platforms represent a significant gap. Earth observation data hosted on commercial cloud services may not be maintained if priorities shift, and actual substantial reductions in US science budgets threaten access to NASA and NOAA datasets vital for UK research.

6.7.5 Skills and Capacity

Skills gaps in advanced data analytics and AI/ML applications remain a critical constraint. The shortage of personnel with combined domain science and software engineering expertise affects the UK's ability to develop and maintain data pipelines, exploit new analysis techniques, and maximise scientific return from space data investments.

6.7.6 Data Preservation

Key datasets risk being switched off or becoming inaccessible as missions end and funding lapses. The lack of sustained funding for long-term data archiving and preservation and the absence of clear responsibilities for data stewardship beyond mission lifetimes represent significant gaps in the current landscape. Additionally, the issue of long-term preservation for cloud-optimised or cloud-native data, which are increasingly common as data offerings from EO missions and projects, has not been resolved.

7 Building Competitive Advantage

The UK has a strong foundation in space data capabilities, with world-leading research groups, internationally recognised expertise in instrumentation and data analysis, and a track record of delivering major contributions to ESA and bilateral missions. Building on this excellence requires strategic investment in data infrastructure, collaboration frameworks, regional capabilities, and the connections between academia, industry, and government that translate research strength into economic and societal benefit.

Astronomy has entered the era of ‘Big Science, Big Data, AI Data’ and which in turn requires a balanced and integrated supporting e-infrastructure where large flagship observatories are complemented by computation and data centres, as well as technology development infrastructures²⁴.

7.1 Integrated Data Infrastructure

Various recent studies have identified critical gaps in the funding and development of e-infrastructures to process, manage, and make available vast amounts of data from telescopes, theoretical models, numerical simulations, and laboratory experiments.

These gaps are now brought into increased focus by the needs of facilities such as Euclid, the Square Kilometre Array (SKA), and the Vera Rubin Observatory, making it ever more urgent to include computing and data requirements at the core of strategic planning.

7.1.1 Key Astronet Recommendations for Data Infrastructure

The Astronet Roadmap makes three core recommendations that are relevant for UK space data strategy:

1. **Mission and facility planning should integrate plans for the production of science-ready data products and analysis tools**, and these initiatives should be funded for the long-term preservation and exploitation of the scientific data. This aligns with SPAN's emphasis on building data exploitation plans into mission design from the outset, and addresses the challenge that software and data infrastructure are often treated as afterthoughts to hardware development.
2. **‘Tiered’ approach for data infrastructure should be adopted** and developed for all types of astrophysical data, including models, simulations, and mock catalogues, connecting where beneficial with similar frameworks developed for other scientific disciplines. For the UK, this implies strengthening connections between mission-specific data centres, national facilities such as IRIS and JASMIN, and international archives including ESA's science data centres.
3. **Develop a collaborative, open, and synergistic view of the astronomy-computing ecosystem**, encompassing data, software, analysis, simulations, and modelling. Data and

²⁴ AstroNet Roadmap 2022-2035: https://www.astronet-eu.org/?page_id=521

software storage and sharing facilities, archives, and cloud computing platforms are all facets of this integrated framework requiring sustained funding.

7.1.2 Applying Astronet Principles to UK Space Data

These three key principles extend beyond astronomy to all domains of UK space data. Earth observation, space weather, and space situational awareness would all benefit from integrated planning that treats data infrastructure as a core deliverable alongside mission hardware. The current fragmentation of UK space data across multiple repositories, the lack of a unified discovery portal, and the absence of a clear UKSA data policy all represent gaps that Astronet-style integrated planning could address.

7.2 Collaborative Frameworks: Benefits and Challenges

7.2.1 Benefits of Collaborative Approaches

International and cross-sector collaboration is fundamental to the UK's success in space data. The UK's membership of ESA provides access to missions and infrastructure beyond national budgets, with a significant positive economic return on investment. Collaborative data processing efforts such as the Gaia DPAC, which involves UK researchers across 6 institutions as part of a 400-person European consortium, demonstrate how distributed teams can deliver capabilities that no single institution could achieve alone.

Cutting-edge research relies on the interplay of instruments both large and small, across multiple wavelengths and messengers, as well as theoretical, numerical, and laboratory investigations. The ecosystem of European infrastructures needs to be balanced and synergised to deliver the best science. For the UK, this means ensuring that national data capabilities connect effectively with European and international infrastructures.

Academic-industry partnerships enable the translation of research advances into operational capabilities. Where good partnerships exist, they become deep relationships where each side recognises they can achieve more through collaboration, resulting in accelerated commercialisation of world-class research. Bilateral missions allow the UK to adopt first-mover positions, build the knowledge economy, and exercise soft power through international partnerships.

7.2.2 Challenges and Limitations

However, collaborations also present challenges. Distributed data processing across multiple institutions can lead to inconsistent approaches and coordination overhead. Dependencies on international partners create vulnerabilities, as highlighted by concerns over potential budget cuts in external partner funding, that can have a knock-on impact on UK access to externally provided data.

Industry and academia can sometimes operate in parallel, responding to different incentives and timelines, perhaps competing for the same oversubscribed funding. Intellectual property arrangements, NDA negotiations, for example can become points of friction. Rebuilding trust through transparency, mutual respect, and shared outcomes is essential.

7.2.3 Principles for Effective Collaboration

Effective data collaborations should be built on early engagement from 'day zero'; mutual benefit with appropriate recognition and funding for all partners; sustained commitment across funding cycles; clear governance establishing data sharing agreements upfront; and aligned incentives that reward collaborative outcomes.

7.3 Regional Capability Clusters and National Coordination

The UK's space capabilities are geographically distributed across regional clusters combining academic research, industrial capacity, and supporting infrastructure. One model to shape the UK Space e-infrastructure envisages a balanced infrastructure connecting large facilities with distributed capabilities.

7.3.1 Existing Regional Strengths

Major concentrations of current space data capability include Harwell (e.g. STFC RAL Space, UKSA, ESA ECSAT, Satellite Applications Catapult, UK Space Science Data Centre); Cambridge (e.g. Gaia DPAC and PLATO, machine learning applications); Edinburgh (Euclid Science Data Centre, climate research, MicroCarb); London/Surrey (UCL MSSL instrument and data processing leadership); and Leicester (X-ray astronomy, planetary science). Significant capabilities also exist at Southampton, Glasgow, Manchester, Oxford, Imperial College, Cardiff, and many other institutions.

7.3.2 A Tiered National Infrastructure

Applying a tiered infrastructure concept to the UK context suggests a framework connecting:

- Mission-specific data centres embedded in universities and research organisations, providing specialist processing and scientific expertise
- National facilities including IRIS, JASMIN, and DiRAC, providing scalable computing and storage infrastructure
- International archives including ESA science data centres, ESO archives, and Virtual Observatory services
- Commercial cloud platforms where appropriate, with careful attention to data governance and long-term sustainability

Regional hubs have been proposed to provide focal points where universities and companies jointly shape R&D priorities and access shared facilities. Increased (or in fact just) funding for these clusters would enable them to support innovation directly rather than acting solely as coordinators.

However, these clusters must be connected (or coordinated) nationally to avoid fragmentation. The current "silo" problem, where HPC facilities do not join the dots across different areas, must be addressed through coordination mechanisms that enable data and expertise to flow across institutional and regional boundaries.

7.4 Increasing the Academic—Industry Connection

Workforce development is critical to achieving scientific goals, with specific suggestions of relevance in the space data domain:

7.4.1 Training and Career Paths

Adequate training and career paths for researchers specialising in advanced instrumentation, computing, and data science is essential. For the UK, this means addressing the shortage of personnel with combined domain science and software engineering expertise identified in UKSA skills surveys.

Modern Astronomy research with emphasis on 'Big Science and Big Data', artificial intelligence, and technology R&D should be promoted as part of national education curricula. Joint R&D and training programmes in close cooperation with industry, including training for entrepreneurship and social innovation, would strengthen the pipeline of skilled graduates.

7.4.2 Recognition and Reward

There is a need to expand recognition and reward structures to value contributions to data infrastructure, education, and public engagement alongside traditional publication metrics. The current academic incentive structure makes it difficult to attract and retain talent in data-intensive roles. Dual-sector fellowships and secondments would help build skills and understanding across sectors.

7.5 Sustainability and Responsible Innovation

Questions of sustainability and development must be an integrated part of planning, including issues around the impact of research on the planet and the recruitment of a broad and inclusive workforce.

7.5.1 Environmental Considerations

Various reviews, e.g. the Astronet Roadmap, have recommended that projects include environmental footprint assessments and reduction plans regarding construction and management of facilities, travel, and computing, following European timelines towards carbon neutrality. For UK space data, this means considering the energy consumption of data centres and computing facilities, which will increase as data volumes grow unless steps are taken to improve efficiency and adopt renewable energy sources.

Edge computing approaches that process data closer to instruments and reduce transfer requirements may offer both performance and environmental benefits. The choice between on-premise HPC, commercial cloud services, and hybrid approaches should consider carbon footprint alongside cost and capability.

7.5.2 Diversity and Inclusion

Diversity and inclusion should be central to funding strategies and plans, with standardised data collection and suitable metrics to enable meaningful comparisons and action. The UK space sector has made commitments in this area, but progress requires sustained attention and resources.

7.5.3 Open Science and Reproducibility

Reproducibility and open science have become vital with the increasing volume and complexity of data. The UK should work towards fully open and FAIR-compliant data holdings, while balancing immediate open access with appropriate proprietary periods where necessary (e.g. mission consortia members having early access to science data).

7.6 Supporting Coordination Mechanisms: The Role of SPAN

Effective implementation of the strategic directions outlined above requires coordination mechanisms that connect the UK academic community with government, industry, and international partners.

The Space Academic Network provides coordination and representation for the UK academic space community. The SPAN Data and Analysis Working Group brings together experts from across UK institutions to identify common challenges, develop collective positions on data policy, and engage with government and industry.

Current SPAN initiatives relevant to data include the Space Environment Special Interest Group coordinating academic activity in SSA and space weather; input to UK Space Frontiers 2035; engagement with UKSpace and the Space Partnership; and coordination with the Space Universities Network on education and training.

SPAN's SDAWG has identified the consolidation of space data infrastructure as a priority and stands ready to support the UKSA within DSIT in developing the data infrastructure component of the Plan for Space. The academic community represented by SPAN brings deep technical expertise across the full range of UK space data activities, and can provide independent analysis, community consultation, and technical review to support government decision-making. SPAN's role is to complement and inform government structures, not to duplicate them; its value lies in providing the collective academic voice and cross-mission perspective that no single institution or project can offer

8 Action Plan

This action plan translates the challenges identified in Section 6 and the strategic directions outlined in Section 7 into concrete actions for the UK space data community. The plan takes into account wider SPAN assessments of Space Science, input from the SPAN SDAWG, with consideration of the recommendations in the STFC led Astronet Science Vision and Infrastructure Roadmap 2022-2035. Also of note are recent developments in Space Data policy from the USA (e.g. NASA's Scientific Information Policy: SPD-41a [26]²⁵) and Europe (e.g. ESA's EarthCODE [27]²⁶ initiative and developments in the European Open Science Cloud (EOSC)²⁷ and in particular the EOSC EU Node [29]²⁸). The UK should ensure its space data policies and infrastructure are compatible with and contribute to these international frameworks, while addressing specific national requirements and opportunities.

The plan is structured around the key themes presented earlier in sections 6 and 7. Suggested actions are given for the shorter term (1-2 years) and longer term (3-5 years).

The actions proposed below serve all seven government subsectors.

The following table maps each action theme to the subsectors it most directly supports, with the UK government's four priority subsectors²⁹ (marked in bold):

Action Theme	Links to Space Subsector
8.1 Data Products and Pipelines	SatComms, SDA, ISAM, Launch , EO, PNT, Science
8.2 Next-Generation Missions	Science, EO, SDA
8.3 Training and Skills	All 7 (cross-cutting)
8.4 International and Resilience	SDA , EO, PNT, Science
8.5 Sustainability and Access	All 7 (cross-cutting)
8.6 Academic-Industry Collaboration	SatComms, ISAM , EO, Science
8.7 Governance and Coordination	All 7 (cross-cutting)
8.8 Delivery and Accountability	All 7 (cross-cutting)

The following table summarises the linkages between the challenges identified in Section 6, strategic responses in Section 7 and the Actions in this Section 8.

²⁵ See <https://science.nasa.gov/researchers/science-information-policy/>

²⁶ See <https://earthcode.esa.int/>

²⁷ See https://research-and-innovation.ec.europa.eu/strategy/strategy-research-and-innovation/our-digital-future/open-science/european-open-science-cloud-eosc_en

²⁸ See <https://open-science-cloud.ec.europa.eu/>

²⁹ See speech from 4 March 2026, listing the current UK Government priority sectors, at <https://www.gov.uk/government/speeches/minister-lloyd-speech-at-space-comm-expo-2026>

Section 6 Challenge	Section 7 Response	Section 8 Actions
6.1 Creating Space Data Products		
6.1.1 Pipeline Development and Sustainability	7.1 Integrated Data Infrastructure	1.1 Pipeline planning; 1.4 Pipeline expertise; 1.5 Tiered infrastructure; 1.8 Open software ecosystem
6.1.2 Calibration and Quality Assurance	7.1 Integrated Data Infrastructure	1.1 Pipeline planning (incl. calibration/QA); 1.6 Science-ready data services
6.1.3 Scale and Timeliness	7.1 Integrated Data Infrastructure	1.5 Tiered processing; 1.7 ML/AI pipelines; 2.5 Real-time data pathways
6.1.4 Standardisation and Interoperability	7.1 Integrated Data Infrastructure	1.3 Discovery service (VO standards); 1.8 Open ecosystem (Jupyter/CEOS); 4.6 International standards
6.1.5 Skills and Capacity	7.4 Academic–Industry Connection	3.1 Skills assessment; 3.2 Dual-sector fellowships; 3.3 Career pathways; 3.5 Apprenticeships
6.1.6 Data Exploitation Planning	7.1 Integrated Data Infrastructure	1.1 Pipeline planning from Phase A; 1.6 Science-ready data services
6.1.7 Space Data in Legal Cases	—	1.2 Data Policy (incl. data provenance)
6.2 Access to Open Science and Open Data		
Fragmented access; no single portal; FAIR compliance gaps; mixed access policies	7.1 Integrated Data Infrastructure; 7.5.3 Open Science	1.2 Data Policy (FAIR mandate); 1.3 Discovery Service; 4.3 EOSC engagement; 5.4 Equitable access
6.3 Space Data AI and Cloud		
AI/ML for classification, data fusion, automated processing, scientific discovery	7.1 Integrated Data Infrastructure	1.7 ML/AI pipeline capabilities
Cloud scalability, data colocation, accessibility	7.1 Integrated Data Infrastructure	1.5 Tiered infrastructure (Tier 3 cloud); 1.6 Science-ready data services
Cloud data security, LLM scraping, IP/licensing risks, data sovereignty	7.1 Integrated Data Infrastructure	1.2 Data Policy (cloud governance, security, licensing); 4.7 AI governance
AI trustworthiness, validation, reproducibility, EU AI Act	—	4.7 International AI governance for space data

6.4 Space Data and People		
Workforce sustainability; soft money; short-term contracts	7.4 Academic–Industry Connection	3.3 Career pathways; 7.1 Coordination within DSIT
Career pathways for data specialists	7.4 Training and Career Paths	3.2 Dual-sector fellowships; 3.3 Career pathways; 3.5 Apprenticeships
Training informal and ad hoc	7.4 Training and Career Paths	3.1 Skills assessment; 3.5 Apprenticeships
Diversity and inclusion	7.5 Diversity and Inclusion	5.2 Embed D&I in data programmes
6.5 Space Data and the Environment		
Energy consumption, water usage, e-waste, carbon footprint of data infrastructure	7.5 Environmental Considerations	5.1 Footprint assessment; 5.3 Environmental impact reduction plans
6.6 Document and Data Sharing		
Incompatible platforms; fragmented sharing across institutions; risk of data loss	7.2 Principles for Effective Collaboration	1.3 Discovery Service (incl. common sharing approaches); 6.2 Collaboration frameworks (incl. inter-institutional sharing)
6.7 Key Data Gaps		
Infrastructure: no unified portal; no UKSA data policy; space data absent from national data library	7.1 Integrated Data Infrastructure	1.2 Data Policy; 1.3 Discovery Service; 4.4 National Data Library engagement
Processing: limited real-time capability; incomplete cloud-native transition	7.1 Integrated Data Infrastructure	1.5 Tiered infrastructure; 1.6 Science-ready data; 2.5 Real-time pathways
Integration: civil–defence silos; data fusion gaps across missions and wavelengths	7.2 Collaborative Frameworks	2.4 Multi-messenger integration; 2.6 Space/solar system and EO–environmental data integration; 2.7 Cross-matching and fusion
International dependencies: NASA/NOAA data access; commercial cloud hosting risks	7.2 Collaborative Frameworks	4.1 Assess dependencies; 4.2 ESA data centre engagement; 4.5 UK/European data resilience
Skills: AI/ML gaps; shortage of combined domain science and	7.4 Academic–Industry Connection	3.1–3.5 (all training, career and skills actions)

software engineering expertise		
Data preservation: datasets at risk when missions end and funding lapses	7.1 Integrated Data Infrastructure	1.1 Preservation in mission plans; 1.2 Data Policy; 1.5 Tiered infrastructure (long-term storage)

Note: Some actions address multiple challenges; the table shows primary linkages. Actions are numbered as in Section 8.

The list of actions given below have been categorised into indicative cost bands to give an indication of scale of investment required. A phased approach, beginning with LOW-cost policy foundations in years one and two, progressing to MEDIUM-cost service development, and building to HIGH-cost infrastructure investment, would significantly strengthen UK's position in Space moving into the 2030's.

Band	Cost (over 3 to 5 year timeframe)	Nature of Investment
LOW	< £1M	Policy, reviews, assessments, coordination. Achievable through reprioritisation of existing budgets or modest additional funding.
MEDIUM	£1M – £10M	Service development, pilot programmes, fellowship schemes, standards engagement. Requires dedicated programme funding but within scale of existing UKSA/STFC call mechanisms (e.g. NSIP, STFC grants).
HIGH	> £10M	Infrastructure build, sustained multi-year programmes, large-scale computing/storage. These will require a spending review case or co-investment with national infrastructures e.g. IRIS, JASMIN, AIRR, SCIF.

The indicative costs represent rough order of magnitude resourcing for that action, in some cases building on or extending investment made elsewhere in the UK programme.

8.1 Science Data Products, Analysis Pipelines and Data Management

Mission and facility planning should integrate plans for the production of science-ready data products and analysis tools. The generation of high-quality, well-calibrated, documented data products is fundamental to maximising scientific return from UK investment in space missions.

8.1.1 Short Term (1-2 years) Actions

Action 1.1: [LOW] ** Integrate Data and Pipeline Planning into Mission Design **

Establish requirements that UKSA-funded missions and UK contributions to ESA/bilateral missions include detailed science data pipeline and data management plans from Phase A onwards. These plans should cover production of science-ready data products, data calibration and quality assurance, analysis tools, long-term preservation, exploitation pathways, and software sharing arrangements. Pipeline development and data product generation and validation should be adequately resourced relative to hardware and treated as core deliverables.

Who: UKSA, STFC, mission team leads

Action 1.2: [LOW] ** Develop UK Space Data Policy **

UKSA should develop a comprehensive space data policy establishing principles for data management, preservation, access, and exploitation across all UKSA-funded activities. The policy should mandate FAIR compliance for publicly-funded space data and explicitly address how UK requirements interface with ESA, NASA, and other international data sharing arrangements. The scope would cover cloud platform selection criteria, data security requirements, data provenance, licensing compliance, and protections against commercial data scraping.

Who: UKSA, DSIT, STFC

Action 1.3: [MED] ** Establish UK Space Data Discovery Service **

Develop a unified discovery interface for UK space data implementing Virtual Observatory standards (IVOA protocols). The service should provide federated access to metadata across distributed UK holdings, connect to ESA archives (building on services such as ESA sky) and international VO infrastructure, include common approaches to document and data sharing across institutions and be designed for future integration with the European Open Science Cloud federation.

Who: STFC, UKSA, universities

Action 1.4: [HIGH] ** Strengthen UK Pipeline Development Expertise **

Invest in developing and retaining expertise in science data pipeline development across UK institutions. This includes supporting longer term Research Software Engineer (RSE) positions with space data specialisation, funding pipeline development as a recognised long running mission activity (at all stages: the conceptual design, development, operation and post-operation phases) and creating career pathways for pipeline developers.

Who: STFC, UKSA, universities

8.1.2 Long Term (3-5 years) Actions

Action 1.5: [HIGH] Implement Tiered Processing Infrastructure

Develop a tiered UK processing infrastructure framework connecting:

- Tier 1: Mission-specific processing centres with specialist expertise and near-instrument knowledge
- Tier 2: National facilities (IRIS, JASMIN, DiRAC) providing scalable batch processing and storage
- Tier 3: Wider science cloud-based processing for burst capacity and user-driven reprocessing
- Tier 4: Desktop/institutional access to science platforms for custom analysis

Who: STFC, UKSA, university processing centres

Action 1.6: [MED] Develop Science-Ready Data Services

Invest in capabilities to produce and serve science-ready data products, reducing barriers for users without specialist processing skills. Priorities include cloud-native formats, on-demand processing, and integration with VO infrastructure. 'Science platforms' providing storage and computing near the data could inform the design. Encourage inter-connects with similar frameworks in other disciplines as recommended by Astronet.

Who: STFC, UKSA, UK processing centres

Action 1.7: [MED] Build Machine Learning/AI Pipeline Capabilities

Develop UK capabilities for incorporating machine learning/AI into science data pipelines, including: automated classification and anomaly detection; learned calibration corrections; intelligent quality assessment; and efficient search and retrieval. AI approaches can improve pipeline performance and enable processing at scales infeasible with traditional methods, but

require careful validation and uncertainty quantification. Investment should focus on trustworthy, interpretable ML/AI suitable for scientific applications.

Who: STFC, Alan Turing Institute, universities

Action 1.8: [MED] Develop Open Pipeline and Software Ecosystem

Build infrastructure supporting an open, collaborative approach to pipeline development, including: software repositories with version control and citation mechanisms; shared development environments; documentation platforms; and community contribution frameworks. UK mission software should be released under open permissive licenses where appropriate, with Digital Object Identifiers for citation. This supports reproducibility and FAIR principles.

Who: STFC, universities, international partners

8.2 Preparing for Next-Generation Missions and Surveys

The Astronet Roadmap emphasises that cutting-edge research relies on the interplay of instruments both large and small, and identifies specific facility priorities including massive spectroscopic surveys, exoplanet characterisation, and next-generation astrometry. ESA's Voyage 2050 programme has selected science themes for three Large missions extending to 2050 and beyond. UK data infrastructure must be prepared to exploit these opportunities, which will generate data at unprecedented scales and require new approaches to processing, storage, and analysis [31].

8.2.1 Short Term (1-2 years) Actions

Action 2.1: [LOW] ** Assess Data Infrastructure Requirements for Upcoming Sky Surveys **

Conduct a comprehensive assessment of UK data infrastructure requirements for major upcoming space sky surveys where the UK has significant involvement. This should identify data volumes, processing requirements, archive needs, and cross-matching challenges. The assessment should inform investment priorities and identify gaps in current capability.

Who: STFC, university survey teams, UK data centres

Action 2.2: [MED] ** Support Voyage 2050 Large Mission Data Systems **

As ESA Voyage 2050 Large missions progress through development, ensure UK early stage participation in data system design and implementation. The Enceladus mission (L4)³⁰ will require integration of orbiter and potential lander data with Earth-based observations. Subsequent Large missions, whether addressing exoplanet characterisation, Milky Way archaeology, or early Universe probes, will each present distinct data challenges at scales exceeding current missions. For GaiaNIR [35] (a concept proposed for the ESA L5 launch slot) this would include maintaining and developing expertise from current UK Gaia [36] participation, preparing for petabyte-scale catalogue management, and developing scientific exploitation tools for combined optical/NIR astrometric catalogues. UK should contribute to mission definition studies with data exploitation expertise, building on experience from current missions.

Who: UKSA, STFC, university groups engaged in Voyage 2050

Action 2.3: [LOW] Assess Multi-Facility Data Integration Requirements

Review requirements for integrating UK space data with data from major ground-based facilities (ESO VLT/ELT, SKA, CTA, gravitational wave detectors) where the UK has significant involvement. Identify interface requirements, timing constraints, and infrastructure needs.

Who: STFC, university groups, facility operators (e.g. SKAO)

³⁰ https://www.esa.int/Science_Exploration/Space_Science/Saturn_s_moon_Enceladus_top_target_for_ESA

8.2.2 Long Term (3-5 years) Actions

Action 2.4: [MED] Implement Multi-Messenger Data Integration

Develop capabilities for integrating data across electromagnetic, gravitational wave, neutrino, and cosmic ray observations. UK involvement in LIGO, Virgo, and future Einstein Telescope will generate data requiring sophisticated integration with space-based observations from missions including LISA. ESA's Voyage 2050 identified "new physical probes of the early Universe" including gravitational waves as a priority theme for Large missions.

Who: STFC, universities, international collaborations

Action 2.5: [MED] Develop Real-Time Data Pathways

Establish infrastructure for rapid data exchange supporting time-domain astronomy, including transient alerts, rapid follow-up coordination, and multi-messenger event response. Connect UK capabilities to international networks including VOEvent infrastructure.

Who: STFC, universities

Action 2.6: [MED] Connect Space and Solar System Data

Ensure effective data integration between remote sensing observations and in-situ measurements for solar system science, connecting data from missions such as Solar Orbiter, JUICE, and future lunar and planetary missions with ground-based solar and planetary observation networks. ESA's Voyage 2050 identified 'Moons of the Giant Planets' as the first Large mission theme, with Enceladus as the top target, a UK data infrastructure should be prepared to support such missions. Additionally it is important to support the integration of Earth Observation data with broader environmental data from UKRI-NERC and European data centres. This can be facilitated through the provision of infrastructure that captures and executes standardized workflows.

Who: STFC, UKSA, university groups

Action 2.7: [MED] Develop Catalogue Cross-Matching and Data Fusion Infrastructure

Invest in infrastructure for cross-matching and fusing data across major catalogues and surveys. Next-generation surveys will each contain billions of sources; scientific exploitation increasingly requires combining data across wavelengths, epochs, and measurement types (photometry, spectroscopy, astrometry). Virtual Observatory protocols provide a foundation, but scalable cross-matching services and multi-survey analysis environments are needed.

Who: STFC, UK data centres, VO community

8.3 Training, Education and Skills

A range of earlier roadmaps have recommended ensuring adequate training and career paths for researchers specialising in computing and data science, and promoting Big Data and AI as part of education curricula. The UK faces specific challenges in this area that require targeted action. Here a range of actions are identified as relevant.

8.3.1 Short Term (1-2 years) Actions

Action 3.1: [LOW] Assess Space Data Skills Requirements

Carry out a detailed survey mapping space data skills requirements across academic and industry employers, identifying specific gaps in pipeline development, AI/ML applications, data engineering, and archive management. Use this to inform curriculum development and training investment.

Who: UKSA, Space Skills Advisory Panel, SPAN, UKspace, SUN

Action 3.2: [MED] Pilot Dual-Sector Fellowship Scheme

Establish a pilot scheme for dual-sector placements enabling academic researchers to work in industry/government and vice versa, specifically targeting space data roles. Build on existing models (e.g. Royal Society Industry Fellowships).

Who: UKSA, STFC, EPSRC, Royal Society, RAEng, industry, SUN

8.3.2 Long Term (3-5 years) Actions

Action 3.3: [LOW] ** Establish Recognised Career Pathways for Data Specialists **

Work with research funders and institutions to establish recognised career pathways for space data specialists, including Research Software Engineers, data scientists, and archive managers. Develop recognition frameworks that value data contributions alongside publications.

Who: UKRI, universities, learned societies (e.g. RS)

Action 3.4: [LOW] Enhance Recognition for Education and Engagement

Develop mechanisms to recognise and reward researchers' contributions to education and public engagement in their career progression, as recommended by Astronet. Include outreach and training delivery in assessment criteria for grants and promotions.

Who: UKRI, universities, learned societies (e.g. RS)

Action 3.5: [MED] Develop Apprenticeship Pathways

Create apprenticeship pathways and conversion courses enabling career changers to enter space data roles, expanding the talent pipeline beyond traditional academic routes.

Who: UKRI, universities, industry, DSIT

8.4 International Engagement and Data Resilience

The UK's space data capabilities are deeply integrated with international frameworks. Recent policy developments, e.g. the EU Data Act, ESA's EarthCODE, the EOSC federation, NASA's open science requirements, are creating opportunities and obligations. The May 2025 EU Council conclusions on satellite data emphasised the need for integration of new and existing systems, interoperability of infrastructures, use of common standards and support initiatives for harmonisation of procedures. The UK should engage proactively with these frameworks and manage dependencies and build resilience [33].

8.4.1 Short Term (1-2 years) Actions

Action 4.1: [LOW] ** Assess International Data Dependencies and Risks **

Conduct risk assessment of UK dependencies on international data sources, particularly NASA datasets (PDS, ADS, Astrophysics archives) and commercial cloud-hosted data. The Planetary Science Decadal Survey noted that over half of new NASA-funded science is sourced from archives, similar dependencies likely exist in UK research. Identify critical datasets and develop contingency approaches, learning from EU discussions on 'European sovereignty in research data'.

Who: UKSA/ DSIT, STFC, NERC

Action 4.2: [LOW] Strengthen ESA Data Centre Engagement

Enhance UK engagement with ESA science data centres (ESAC, ESDC) and Copernicus data services, ensuring UK requirements are represented in service development and that UK data holdings are appropriately connected to European infrastructure. This provides an opportunity to leverage ESA centres, and reduce the need for duplication of services in the UK.

Who: UKSA, STFC, NERC, UK data centres

Action 4.3: [MED] ** Engage with EOSC Federation **

Ensure UK space data infrastructure is designed for compatibility with the European Open Science Cloud federation. The EOSC EU Node launched in October 2024 as the first node of the

federation, providing data, tools, and services to researchers across Europe. UK participation in or connection to this federation would enhance access for UK researchers and visibility of UK data assets.

Who: UKRI, UKSA, STFC, DSIT

Action 4.4: [LOW] Engage with National Data Library Initiative

Ensure space data is represented in DSIT's national data library framework. Develop position articulating distinctive requirements of space data and opportunities for integration with national infrastructure. Connect this engagement with broader European data infrastructure developments.

Who: UKRI, UKSA, STFC, DSIT, SPAN

8.4.2 Long Term (3-5 years) Actions

Action 4.5: [HIGH] Develop UK/European Data Resilience Capability

In coordination with ESA and European partners, develop capabilities to maintain access to critical international datasets in adverse scenarios. The EU Space Act (proposed June 2025) addresses security and resilience of space infrastructure, the UK should engage with implementation and consider complementary national measures. Options include mirror archives, bilateral agreements, or investment in alternative sources [34].

Who: UKSA, STFC, ESA, SPAN

Action 4.6: [LOW] Maintain Active Role in International Standards

Sustain UK participation in international standards development (e.g. IVOA, IPDA, etc) to ensure emerging standards reflect UK requirements and UK expertise contributes to global best practice. The EU Council's emphasis on 'common standards' and 'harmonisation of procedures' for satellite data underlines the importance of standards engagement. Coordinate national positions through SPAN working groups.

Who: STFC, UKSA, UK data experts, SPAN

Action 4.7: [LOW] Contribute to International AI Governance for Space Data

Engage with emerging frameworks for AI application to space data, including the EU AI Act's implications for Earth observation and crisis management applications. The May 2025 EU Council conclusions recognised that AI can play a crucial role in identifying patterns and issues in satellite data while emphasising the need for appropriate governance. UK should contribute expertise to ensure frameworks are practical and science-enabling.

Who: UKSA, DSIT, Alan Turing Institute, STFC

8.5 Sustainability and Accessibility

Sustainability, ethics, equality, and diversity should be considered as part of decision-making processes. This is a growing priority for the European astronomy community, as identified for instance in the Astronet Roadmap that UK space data activities should prioritise.

8.5.1 Short Term (1-2 years) Actions

Action 5.1: [LOW] ** Assess Environmental Footprint of UK Space Data Infrastructure **

Conduct an environmental footprint assessment of UK space data infrastructure, including data centres, computing facilities, and associated activities. Establish baseline metrics for energy consumption, carbon emissions, and water usage. This could build on earlier initiatives, such as the UKRI Net Zero Digital Research Infrastructure Scoping Project [23]³¹.

Who: STFC, UKSA, data centre operators

Action 5.2: [LOW] Embed Diversity and Inclusion in Data Programmes

³¹ See <https://net-zero-dri.ceda.ac.uk/>

Ensure diversity and inclusion are central to funding strategies for space data programmes, with standardised data collection and suitable metrics to enable meaningful comparison and action. Review existing programmes for accessibility and barriers to participation.

Who: UKSA, UKRI, DSIT

8.5.2 Long Term (3-5 years) Actions

Action 5.3: [MED] ** Develop Environmental Impact Reduction Plans **

Based on the assessment, develop impact reduction plans for UK space data infrastructure aligned with UK and European carbon neutrality timelines. Incorporate environmental considerations into infrastructure investment decisions. Adopt sustainable computing practices across UK space data activities (e.g. use of renewable energy for data centres where possible, edge computing to reduce data transfer requirements).

Who: STFC, UKSA, data centre operators

Action 5.4: [MED] Ensure Equitable Data Access

Develop policies and infrastructure ensuring equitable access to UK space data for researchers regardless of institutional resources or geographic location. This includes supporting access for researchers in developing countries and smaller institutions.

Who: UKSA, STFC, international partners (e.g. EU Research Frameworks).

8.6 Academic-Industry Collaboration and Knowledge Exchange

8.6.1 Short Term (1-2 years) Actions

Action 6.1: [HIGH] Support Regional Cluster Data Capabilities

Provide funding for regional space clusters to develop shared data infrastructure, enabling them to support innovation directly. Priorities include shared computing facilities, data access platforms, and specialist support staff that can serve multiple cluster members.

Who: UKSA, Innovate UK, universities, industry, regional space clusters

Action 6.2: [LOW] Develop Model Collaboration Frameworks

Create and promote model collaboration agreements for academic-industry partnerships in space data, building on Lambert Agreements³² and Brunswick templates³³. Provide templates, guidance, and best practice examples to reduce friction in establishing partnerships. The frameworks should include common approaches to inter-institutional document and data sharing.

Who: UKRI, SPAN, UKspace, university research offices

8.6.2 Long Term (3-5 years) Actions

Action 6.3: [MED] Create Innovation Pathways for Data Technologies

Establish clear pathways for translating academic space data research into commercial applications and operational capabilities, including proof-of-concept funding, incubation support, and routes to market for data products and services.

Who: UKSA, Innovate UK, Satellite Applications Catapult

Action 6.4: [HIGH] Establish or Expand Space Data Colocation Labs

Develop "Space Data Collaboration Labs" (coLabs) as place-based hubs where universities and companies jointly shape R&D priorities, workforce needs, and testbed capabilities for space data applications. CoLabs should enable seamless flow of expertise and shared access to facilities and would build upon newly established Space Enterprise Lab network.

³² <https://www.gov.uk/guidance/university-and-business-collaboration-agreements-lambert-toolkit>

³³ <https://arma.ac.uk/brunswick-templates/>

Who: UKSA, Innovate UK, universities, industry, regional space clusters

8.7 Governance and Coordination

8.7.1 Short Term (1-2 years) Actions

Action 7.1: [LOW] ** Establish Space Data Coordination Within DSIT **

As the new UKSA within DSIT establishes its structures, space data infrastructure is given explicit strategic oversight within the unit's governance. This could take the form of a data infrastructure function or advisory panel within the new unit, drawing on expertise from STFC, NERC, Met Office, industry (UKspace), and academia (SPAN). The aim is not to create a new external body but to ensure that data infrastructure investment is coordinated alongside hardware and mission commitments through the One Government approach. SPAN's SDAWG could provide academic community input and technical review to support this function.

Who: UKSA/DSIT (lead), STFC, NERC, Met Office, SPAN (SDAWG), UKSpace

8.7.2 Long Term (3-5 years) Actions

Action 7.2: [LOW] ** Secure Sustainable Funding and Develop UK Space Data Roadmap Process **

Establish a regular community-driven process for developing and updating UK space data strategy, modelled on the Astronet Roadmap approach with broad consultation, panel input, and transparent prioritisation. Align with UK Space Frontiers 2035 and successor initiatives. Ensure data coordination is resourced within DSIT structures.

Who: UKSA, STFC, SPAN (SDAWG), wide space community

8.8 Delivery and Accountability

The recommendations above form a coherent action plan to maximise the potential of space data for space research, discovery, and wider economic and societal impact. In order to achieve this a concrete and resourced implementation process is required.

8.8.1 Short Term (1-2 years) Actions

Action 8.1: [LOW] Establish Implementation Governance

This implementation should be overseen by the proposed Space Data Coordination Group (see **Action 7.1**), reporting to UKSA and DSIT. SPAN's SDAWG should provide academic community input and independent progress monitoring. The governance structure should include mechanisms for tracking alignment with international frameworks (NASA, ESA, EU) and adapting to policy changes.

Who: UKSA/DSIT, STFC, SPAN (SDAWG)

Action 8.2: [LOW] Prioritise and Resource Initial Actions

Identify highest-priority actions for immediate attention and secure appropriate resourcing. Priority should be given to:

- Action 1.1 (Data and pipeline planning in mission design): required for all subsequent improvement
- Action 1.2 (UK Space Data Policy): establishes the space data framework
- Action 7.1 (Space Data Coordination Group): enables implementation oversight
- Action 4.3 (EOSC engagement): positions UK within the European data infrastructure

Actions should be categorised by resource requirements: policy and coordination actions achievable through existing mechanisms with modest additional resource; infrastructure investments requiring dedicated funding through spending reviews; skills and training requiring

coordination across funders; and international engagement requiring diplomatic and strategic investment alongside technical work.

Who: UKSA, DSIT, STFC

Action 8.3: [LOW] Establish International Benchmarking Framework

Develop a framework for benchmarking UK progress against international comparators, with specific targets, that could include for instance:

Framework	Key Requirement	UK Target
EU Data Act	Cross-sector data sharing frameworks	Align UK approach by 2028
EOSC	Federated research data infrastructure	UK connection/node by 2029
ESA EarthCODE	FAIR compliance for space data	Assessment by 2027, full compliance by 2030
NASA SPD-41a	Mandatory data management plans from proposal stage	UK Space Data Policy by 2027

Who: UKSA, STFC, SPAN (SDAWG)

8.8.2 Long Term (3-5 years) Actions

Action 8.4: [LOW] Implement Progress Monitoring and Reporting

Establish regular progress monitoring with:

- Annual progress review by Space Data Coordination Group against action plan milestones
- Major refresh aligned with Astronet Roadmap cycles and international developments
- Transparent reporting to space data community through SPAN channels
- Monitoring of international policy developments (NASA, ESA, EU) with adaptation as required

Success metrics could be tracked across key areas, including, as examples:

Area	Metric	International Benchmark
Data Management	% of UK missions with funded data/pipeline plans from Phase A mission definition	NASA: 100% (mandatory)
FAIR Compliance	% of UK space data assessed as FAIR-compliant	ESA EarthCODE target
Infrastructure	Data discoverable through unified service; tiered architecture implemented	Copernicus Data Space Ecosystem
Skills	Space data skills gap reduction; number of joint training programmes	Astronet recommendations
Sustainability	Carbon footprint of UK space data infrastructure; reduction trajectory	Astronet/Net Zero DRI goals
International	UK representation in standards bodies; EOSC connection status	EU interoperability goals

Who: Space Data Coordination Group, SPAN (SDAWG), UKSA

9 Conclusions

The UK has world-leading strengths in space data: internationally recognised research groups, leadership roles in major ESA and bilateral missions, deep expertise in data processing and pipeline development, and a growing commercial space sector. These capabilities have been built over decades of sustained investment and deliver substantial returns. Data infrastructure is the mechanism through which these returns are realised.

However, the UK's competitive position is at risk. This whitepaper identifies six critical challenges: the importance of adequate resourcing of software at all stages of development in mission funding; a shortage of personnel with combined domain science and software engineering expertise; growing dependencies on international data platforms whose continuity cannot be assured; the unprecedented scale and complexity of next-generation missions; emerging risks from commercial cloud platforms and AI; and the absence of cross-sector coordination of space data investment. None of these challenges is insurmountable, but all require deliberate action.

The merger of UKSA into DSIT from April 2026 and the forthcoming Plan for Space create a unique window of opportunity to embed data infrastructure within national space strategy. The actions proposed in this whitepaper, organised across eight themes and supported by indicative cost estimates, provide a practical roadmap for doing so. Critically, seven of the ten highest-priority actions fall within the 'Low' cost band (£4–10M collectively) and can be initiated within existing budget flexibility, these are primarily policy, coordination, and assessment actions that establish the framework on which larger investments can build.

Three actions lay the foundations for a coherent UK Space Data Framework. First, the UK needs a Space Data Policy, establishing expectations for data management, open access, and FAIR compliance across all publicly funded missions. Second, the new UKSA unit within should include a data infrastructure coordination function, ensuring that data investment is considered alongside hardware and mission commitments. Third, the pipeline workforce, the Research Software Engineers, data scientists, and calibration specialists who transform raw telemetry into science-ready data products, must be recognised as the key element in the UK's ability to extract value from its space investments, and supported through structured career pathways, longer-term funding, and dual-sector fellowships.

The international context reinforces the urgency. ESA's Voyage 2050 programme, the European Open Science Cloud, the EU AI Act, and evolving open science requirements from NASA and ESA are all reshaping the landscape in which UK space data operates. The UK must engage proactively with these frameworks to ensure compatibility, influence standards, and manage dependencies, particularly given the vulnerabilities exposed by potential reductions in US science budgets and the concentration of critical data services on commercial cloud platforms.

The experience of the ESA Gaia mission demonstrates what strategic data investment can achieve: a programme that has produced more peer-reviewed papers annually than any other ESA mission, with widespread spillover benefits as advanced statistical methods and algorithms developed for astronomical data processing are applied in other sectors. The lesson from Gaia is clear, long-term funding stability, early pipeline planning, and investment in skilled people deliver disproportionate scientific and economic returns.

The UK academic space community, represented through SPAN and its working groups, can support government in developing and implementing these recommendations. The actions proposed here are designed to complement and inform wider strategic initiatives currently underway in the UK including the DSIT/UKSA Plan for Space, the UKRI Infrastructure Roadmap, and the national data library initiative. They represent a call to ensure that the UK's substantial and growing investments in space hardware are matched by the data infrastructure, skills, and coordination needed to realise their full potential.

10 References

- [1] Bryan, B. et al., Evaluating the Benefits of the UK's Investments in the European Space Agency, RAND Europe, RR-A3101-1, 2025. https://www.rand.org/pubs/research_reports/RRA3101-1.html
- [2] UKSA, Factsheet: The UK Space Sector, August 2025. <https://www.gov.uk/government/publications/factsheet-the-uk-space-sector>
- [3] UKRI, Infrastructure Roadmap Programme (refresh 2025). <https://www.ukri.org/what-we-do/creating-world-class-research-and-innovation-infrastructure/infrastructure-roadmap-programme/>
- [4] UKSA, Corporate Plan 2025–26. <https://www.gov.uk/government/publications/uk-space-agency-corporate-plan-2025-26>
- [5] SPAN, UK Sats Whitepaper, March 2024. <https://span.ac.uk/wp-content/uploads/2024/07/UK-UKSats-v4-220324.pdf>
- [6] SPAN, White Paper: Academic View on Future of Space Policy and Funding, September 2024. <https://span.ac.uk/wp-content/uploads/2024/10/SPAN-White-Paper-Academic-View-on-Future-of-Space-Policy-and-Funding-170924-V1.5-Final.pdf>
- [7] SPAN, UK Space Science: A Summary of the Research Community and its Benefits, April 2021. <https://span.ac.uk/wp-content/uploads/2024/07/SPAN-UK-space-science-nature-benefits-FINAL-REPORT-060421-compressed.pdf>
- [8] STFC RAL Space, UK Solar System Data Centre (UKSSDC). <https://www.ralspace.stfc.ac.uk/Pages/UK-Solar-System-Data-Centre.aspx>
- [9] STFC, IRIS: Infrastructure for Research and Innovation in STFC. <https://www.iris.ac.uk>
- [10] HM Government, AI Research Resource (AIRR). <https://www.gov.uk/government/publications/ai-research-resource>
- [11] STFC, DiRAC: Distributed Infrastructure with Remote Agent Control. <https://dirac.ac.uk/>
- [12] DSIT, National Data Library. <https://www.gov.uk/government/publications/national-data-library>
- [13] DSIT, 'Space firms to scale-up and thrive in Britain with government backing for bolder strategy', 9 March 2026. <https://www.gov.uk/government/news/space-firms-to-scale-up-and-thrive-in-britain-with-government-backing-for-bolder-strategy>
- [14] HM Government, Strategic Defence Review 2025. <https://www.gov.uk/government/publications/the-strategic-defence-review-2025-making-britain-safer-secure-at-home-strong-abroad/the-strategic-defence-review-2025-making-britain-safer-secure-at-home-strong-abroad>
- [15] American Astronomical Society, AAS Statement on NASA Cuts, 2025. <https://aas.org/press/aas-statement-nasa-cuts>
- [16] Astronet, Science Vision and Infrastructure Roadmap 2022–2035, 2022. https://www.astronet-eu.org/?page_id=521
- [17] Space Partnership, UK Space Capability Roadmaps 2025. <https://www.spacepartnership.org.uk/capability-roadmaps/>
- [18] UKSA, Space Sector Skills Survey 2023 Report. <https://www.gov.uk/government/publications/space-sector-skills-survey-2023>
- [19] NCEO, Earth Observation Data Hub (EODH). <https://www.nceo.ac.uk/our-research/national-programmes/eodh/>
- [20] ESA, ESA Sky. <https://sky.esa.int>
- [21] Council of the EU, Council Conclusions on Satellite Data, May 2025. <https://data.consilium.europa.eu/doc/document/ST-9288-2025-INIT/en/pdf>
- [22] European Parliament and Council, Regulation (EU) 2024/1689 (EU AI Act), June 2024. <https://eur-lex.europa.eu/eli/reg/2024/1689>
- [23] Sheridan, S. et al., UKRI Net Zero Digital Research Infrastructure Scoping Project: Final Report, August 2023. DOI: 10.5281/zenodo.8199984. <https://zenodo.org/records/8199984>
- [24] UK Parliament, Science, Innovation and Technology Committee: oral evidence session on STFC funding, 4 March 2026. <https://committees.parliament.uk/event/26683/formal-meeting-oral-evidence-session/>

[25] SPAN, Bridging the Gap Between Industry and Academia in the UK Space Sector, October 2025. <https://span.ac.uk/wp-content/uploads/2025/10/SPAN-Whitepaper-Bridging-the-Gap-Strengthening-IndustryAcademia-Collaboration-in-the-UK-Space-Sector-v1.9.pdf>

[26] NASA, Scientific Information Policy: SPD-41a. <https://science.nasa.gov/researchers/science-information-policy/>

[27] ESA, EarthCODE: Earth Science Collaborative Open Development Environment. <https://earthcode.esa.int/>

[28] European Commission, European Open Science Cloud (EOSC). <https://digital-strategy.ec.europa.eu/en/policies/open-science-cloud>

[29] European Commission, EOSC EU Node. <https://open-science-cloud.ec.europa.eu/>

[30] Baroness Lloyd of Effra, 'Minister Lloyd Speech at Space-Comm Expo 2026', DSIT, 4 March 2026. <https://www.gov.uk/government/speeches/minister-lloyd-speech-at-space-comm-expo-2026>

[31] ESA, Voyage 2050: Final Recommendations from the Senior Committee, 2021. <https://www.cosmos.esa.int/web/voyage-2050>

[32] London Economics for UKSA, Size and Health of the UK Space Industry 2024, July 2025. <https://www.gov.uk/government/publications/size-and-health-of-the-uk-space-industry-2024>

[33] European Parliament and Council, Regulation (EU) 2023/2854 (EU Data Act), December 2023.

[34] European Commission, Proposal for a Regulation on the EU Space Programme (EU Space Act), proposed June 2025.

[35] GaiaNIR consortium pages at <https://www.gaianir.org>

[36] Gaia participation by country at <https://www.cosmos.esa.int/web/gaia/dpac>

[37] Report highlights impact of UK contribution to the Gaia mission, UK Space Agency, Oct 2023: <https://www.gov.uk/government/news/report-highlights-impact-of-uk-contribution-to-the-gaia-mission>

[38] Satellite megaconstellations will threaten space-based astronomy, Borlaff et al, 2025, Nature 648, 51-57

[39] IAU Centre For The Protection Of The Dark And Quiet Sky, <https://cps.iau.org/>

[All web links checked 16 March 2026]

In addition, key references are linked in the text of the document.

11 Acknowledgements

During the preparation of this work, the authors used Clause Opus 4.5 and 4.6 (Anthropic PBC) in order to rephrase and précis some sections, generate list of acronyms and check action numbering. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Appendix A List of Acronyms

Acronym	Definition	Acronym	Definition
ADS	Astrophysics Data System (NASA)	MSSL	Mullard Space Science Laboratory (UCL)
AI	Artificial Intelligence	NASA	National Aeronautics and Space Administration
AIRR	AI Research Resource	NCEO	National Centre for Earth Observation
ALMA	Atacama Large Millimetre Array	NDA	Non-Disclosure Agreement

ARD	Analysis-Ready Data	NERC	Natural Environment Research Council
CCD	Charge-Coupled Device	NOAA	National Oceanic and Atmospheric Administration
CCSDS	Consultative Committee on Space Data Systems	NSIP	National Space Innovation Programme
CEDA	Centre for Environmental Data Analysis	PDS	Planetary Data System
CEOS	Committee on Earth Observation Satellites	PI	Principal Investigator
CMB	Cosmic Microwave Background	PNT	Position, Navigation and Timing
CNES	Centre National d'Études Spatiales	PRIP	Production Interface Delivery Point
COG	Cloud-Optimised GeoTIFF	PSA	Planetary Science Archive (ESA)
CTA	Cherenkov Telescope Array	QA	Quality Assurance
DHR	Data Hub Relay	RAL	Rutherford Appleton Laboratory
DIAS	Data and Information Access Services	RS	Royal Society
DiRAC	Distributed Research utilising Advanced Computing	RSE	Research Software Engineer
DPAC	Data Processing and Analysis Consortium (Gaia)	SAR	Synthetic Aperture Radar
DRI	Digital Research Infrastructure	SCIF	Space Clusters Infrastructure Fund
DSIT	Department for Science, Innovation and Technology	SDA	Space Domain Awareness
ECSAT	European Centre for Space Applications and Telecommunications	SDAWG	SPAN's Space Data and Analysis Working Group
EDS	Environmental Data Service (UKRI NERC)	SEOWG	SPAN Earth Observation Working Group
ELT	Extremely Large Telescope (ESO)	SETWG	SPAN Engineering and Technology Working Group
EO	Earth Observation	SIAP	Simple Image Access Protocol
EODH	Earth Observation Data Hub	SKA	Square Kilometre Array
EOSC	European Open Science Cloud	SKAO	Square Kilometre Array Observatory
EPSRC	Engineering and Physical Sciences Research Council	SOHO	Solar and Heliospheric Observatory
ESA	European Space Agency	SPAN	Space Academic Network
ESAC	European Space Astronomy Centre	SPD	Science Policy Document (NASA)
ESDC	ESA Science Data Centre	SPICE	Spectral Imaging of the Coronal Environment
ESO	European Southern Observatory	SSA	Space Situational Awareness

FAIR	Findable, Accessible, Interoperable, Reusable	SSEWG	SPAN Space Science and Exploration Working Group
GDP	Gross Domestic Product	SST	Space Surveillance and Tracking
GNSS	Global Navigation Satellite System	SSTL	Surrey Satellite Technology Limited
HPC	High Performance Computing	STAC	SpatioTemporal Asset Catalog
IAU	International Astronomical Union	STEM	Science, Technology, Engineering and Mathematics
IPDA	International Planetary Data Alliance	STEREO	Solar Terrestrial Relations Observatory
IRIS	Infrastructure for Research and Innovation in STFC	STFC	Science and Technology Facilities Council
ISAM	In-orbit Servicing, Assembly and Manufacturing	SUN	Space Universities Network
ISES	International Space Environment Service	SWA	Solar Wind Analyser (Solar Orbiter)
ISO	International Organisation for Standardisation	TAP	Table Access Protocol
IVOA	International Virtual Observatory Alliance	TLE	Two-Line Element (set)
JASMIN	Joint Analysis System Meeting Infrastructure Needs	TRL	Technology Readiness Level
JAXA	Japan Aerospace Exploration Agency	UCL	University College London
JWST	James Webb Space Telescope	UKATC	UK Astronomy Technology Centre
LEO	Low Earth Orbit	UKRI	UK Research and Innovation
LIGO	Laser Interferometer Gravitational-Wave Observatory	UKSA	UK Space Agency
LISA	Laser Interferometer Space Antenna	UKSSDC	UK Solar System Data Centre
LLM	Large Language Model	VIS	Visible Imager (Euclid instrument)
MAG	Magnetometer (Solar Orbiter instrument)	VLT	Very Large Telescope (ESO)
MIRI	Mid-Infrared Instrument (JWST)	VO	Virtual Observatory
MIXS	Mercury Imaging X-ray Spectrometer	WFI	Wide Field Imager (NewAthena instrument)
ML	Machine Learning	XMM	X-ray Multi-Mirror Mission (ESA)
MOSWOC	Met Office Space Weather Operations Centre		