WORKSHOP REPORT

Artificial Intelligence and Earth Observation: from Innovation to Services

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LOCATION Brussels, Belgium

Artificial intelligence (AI) and machine learning (ML) are rapidly transforming the way Earth observation (EO) data can be processed, analysed and turned into operational services. At the same time, Copernicus, Europe's flagship Earth Observation initiative is generating unprecedented volumes of environmental data and Destination Earth (DestinE) is developing new capabilities such as digital twins of the Earth system.

Against this backdrop, the workshop "*Artificial Intelligence and Earth Observation: from Innovation to Services*" held 9-10 March 2026 in Brussels, Belgium, brought together policy makers, researchers, industry representatives and service providers to explore how these technological developments can be harnessed to strengthen Europe's EO ecosystem. Co-organized by the Directorate-General for Defence Industry and Space (DG DEFIS), and the Directorate-General for Communications Networks, Content and Technology (DG CNECT), and with support from the European Centre for Medium-range Weather Forecast (ECMWF), the European Health and Digital Executive Agency (HaDEA), the Joint Research Centre (JRC), and the European Union Agency for the Space Programme (EUSPA), this workshop gave an expert, state-of-the-art account on the latest developments in AI to take full advantage of European EO, digital tools and their combination to support EU competitiveness and resilience.

1. STRATEGIC AND PROGRAMMATIC CONTEXT

1.1 POLICY DRIVERS AND SOCIETAL CHALLENGES

Speakers[1] from DG DEFIS and DG CNECT jointly framed the EU's need to harness the power of digital technologies to sustain and enhance Copernicus' role as the world's leading environmental monitoring programme. Their remarks underscored how evolving policy priorities (e.g. climate resilience, disaster management, security, biodiversity, supply-chain stability) intersect with rapid advances in AI/ML and High-Performance Computing (HPC), and how synergies between Copernicus and DestinE can accelerate the development of trusted, high-impact services for a broad, diverse stakeholder community.

1 Michel Rixen, Programme Officer, Earth Observation, DG DEFIS, EC
Christoph Kautz, Director Space Policy, Satellite Navigation and Earth Observation, DG DEFIS, EC
Thomas Skordas, Deputy Director-General, DG CNECT, EC

1.2 COPERNICUS AS A FOUNDATIONAL ASSET FOR EU POLICY

The opening session emphasised policy drivers and societal challenges. Copernicus was reaffirmed by C. Kautz as a foundational asset for evidence-based decision making in EU policy, from agriculture and marine management to emergency response and defence. Speakers highlighted that 2025 had ranked among the warmest years on record, reinforcing the urgency of real-time environmental intelligence. They argued that EO-based AI-enhanced analytics and predictive modelling significantly improve our ability to detect, anticipate, and mitigate systemic risks (climate extremes, pandemics, geopolitical disruptions…) and to ensure Europe's competitiveness and resilience in a rapidly changing world.

1.3 EUROPEAN AI AND HPC INFRASTRUCTURE STRATEGY

The speakers laid out the EU's strategy to build and interconnect cutting-edge digital infrastructures. Copernicus' open data are the elementary foundations for an effective use of AI. Yet, to unleash its full potential requires abundant, interoperable computing resources. To this end, the European AI Strategy aims to establish "AI factories" (networks of HPC clusters) and plans for industry-led AI "gigafactories" to deliver scalable, on-demand AI training and inference.

1.4 DESTINATION EARTH AND EARTH'S DIGITAL TWINS

DestinE leverages HPC infrastructure to develop a digital twin engine and the first operational digital twins of the Earth, integrating physics-based models with emerging AI methods to produce local forecasts, hazard predictions, and climate adaptation scenarios. In the coming years, DestinE aims to integrate additional twin components (ocean and sea ice, land evolution, waves and hydrology) with the long-term goal of creating a comprehensive digital representation of the Earth system trained on multi-petabyte[2] EO archives.

1.5 BUILDING AN INCLUSIVE EO–AI INNOVATION ECOSYSTEM

The importance of an inclusive innovation ecosystem was stressed. Beyond public sector research and institutional modelling centres, the vision encompasses startups, Small & Medium Enterprises (SMEs), academia, and end users (policy makers, service providers, industry, civil society). Open, trusted AI services hosted on Copernicus and DestinE platforms will foster new applications in sectors such as energy, transport, insurance, health, and urban planning. The next EU Multiannual Financial Framework (2028–2034) will embed dedicated funding lines for space-based EO, AI integration, and digital twins, ensuring sustained support for research, operationalisation, uptake, and capacity building.

1.6 FUTURE DIRECTIONS

Taken together, the opening session charted a cohesive roadmap: (1) align Copernicus and DestinE policies to boost AI-enabled analytics for operational policy support; (2) deploy and connect HPC and AI infrastructure to process ever-growing EO datasets; and (3) nurture a pan-European innovation ecosystem through open data, interoperable platforms, and targeted funding. The final keynote set the stage for the technical and application-focused discussions to follow, underscoring that the success of Copernicus and DestinE will depend on collaborative development of trustworthy, high-value services by the entire EO and AI community. It closed on the following thought from T. Skordas: "The difference will come from the EO and AI community, from your ideas, from your perspectives, from your ambitions, from your, I would say, visionary ways of developing these things in Europe."

2 1 Petabyte (PB) = 1000 TeraByte (TB) = 1000000 GigaByte (GB)

2. THE AI/ML REVOLUTION

2.1 EUROPE'S INTEGRATED AI POLICY AND INFRASTRUCTURE LANDSCAPE

Session 2[3] opened with an overview of the EU's comprehensive AI strategy, which combines "AI factories" (19 HPC clusters integrated into a network and dedicated to training and inference) with forthcoming industry-led "gigafactories" (up to 100 000 GPUs each) and expanded cloud capacity under the Cloud and AI Development Act. This digital infrastructure ecosystem is complemented by data-sharing "data labs", European Digital Innovation Hubs for upskilling and deployment support, and a proposed EU AI Academy for harmonized curricula. Regulatory clarity is provided by the AI Act and a Digital Omnibus, while the new "Apply AI" strategy and its sectoral alliance mobilise stakeholders to co-design frontier models which can support a wide variety of versatile applications (among them space, security, energy, …). Together, these policy, infrastructure, and skills elements aim to position Europe as a leader in AI.

2.2 AI WEATHER FORECASTING AT OPERATIONAL SCALE

Building on this ecosystem and longstanding investments by its Member States, the European Centre for Medium-Range Weather Forecasts (ECMWF) has operationalised two AI Forecasting Systems (AIFS) – one deterministic (AIFS Single), and one probabilistic (AIFS Ensemble). Both are trained on the Copernicus ERA5 reanalysis dataset which comes with eight decades of hourly data, outperforming its physics-based counterparts at equivalent lead times, with a computational footprint reduced from hours on supercomputers to minutes even on a single Graphics Processing Unit (GPU). AIFS demonstrates up to 12-hour lead gains in tropical cyclone track accuracy and improved extreme-temperature forecasts, demonstrating a large value added for preparedness against extreme events. ECMWF's open-source artificial neural networks framework enables end-to-end workflows, from HPC-scale data curation to lightweight "Forecast-in-a-Box" deployments on cloud, desktop, or mobile. They are paving the way for portable, rapid-update forecasting at minimal energy cost, benefiting also the needs in - for example - Africa, as initiated through DG INTPA's ArcX Climate Change Resilience activities.

2.3 DEMOCRATISING EO ANALYTICS THROUGH NO-CODE AND CONVERSATIONAL AI

Luca Girardo from the European Space Agency showcased a no-code AI toolkit for EO practitioners. Users train custom segmentation or detection models via intuitive annotation of representative image regions, then apply them at scale to derive change maps (e.g., deforestation, infrastructure development) with confidence filtering and analytics export. A complementary conversational AI interface integrates natural-language prompts, accesses heterogeneous EO layers and socio-economic indicators, and synthesizes interactive data stories, thereby bridging the gap between raw Copernicus data and actionable insights. This domain-specific AI stack, aligned with European Data Spaces and the AI Act, offers users a level of trust and reputability through clear data provenance, transparent governance and compliance, and repeatable validation.

3 Mauro Facchini, Head of Unit, Earth Observation, DG DEFIS, EC
Gaspard Demur, Deputy Head of Unit, AI Innovation and Policy Coordination - EU AI Office, DG CNECT, EC
Matthew Chantry, Strategic Lead for Machine Learning, ECMWF
Luca Girardo, Copernicus and Destination Earth Advanced Infrastructure Services Manager, ESA
Quentin Gaudel, ML systems architect, Mercator Ocean International
Isabelle Benezeth, Ministry of Research and Innovation, France
Andrea Taramelli, Associate Professor, IUSS University, Italy

2.4 AI-BASED OCEAN FORECASTING AND BENCHMARKING

In oceanography, machine-learning architectures such as Mercator Ocean's GLONET model, forecast parameters over ten days, including temperature, salinity, surface currents, or sea surface height. Trained on a high-resolution reanalysis, GLONET delivers forecasts in seconds to minutes on CPUs/GPUs, enabling near-real-time operational use. Its development underlines the need for specialised metrics to verify physical consistency variables. The launch of the open "OceanBench" system invites the community to evaluate new ML models against standardised datasets and physics-informed criteria, fostering reproducible, trustworthy ocean-forecasting innovations.

2.5 NATIONAL AI–EO INITIATIVES SUPPORTING EUROPEAN OBJECTIVES

Copernicus delegates Isabelle Benezeth from France and Andrea Taramelli from Italy highlighted national AI-EO initiatives aligned with EU frameworks. For example, France's "One Forest Vision" integrates in situ and LiDAR data to improve monitoring of tropical forests, generating climate-relevant indicators for international commitments. In Italy, the national space economy plan was established to support many sectors, such as civil protection, or the oil and gas industry, where HPC and AI were identified as key assets. Both cases emphasized close public-private collaboration and shared national-EU infrastructures to overcome fragmentation and improve operational services.

2.6 FUTURE DIRECTIONS

Across these contributions, recurring themes emerged: the imperative to federate computing and data resources, to co-design domain-tuned, explainable models, to democratize AI-driven EO through no-code and conversational tools and to institutionalise rigorous validation, for instance via ECMWF's scorecards. As Europe moves from pilots to industrial-scale services, sustained collaboration among policy makers, research centres, industry, and end users will be essential to exploit the full potential of the AI/ML revolution in Earth observation.

3. BIG DATA AND HIGH-PERFORMANCE COMPUTING

3.1 SCALING DATA INGESTION AND STORAGE

Speakers[4] converged on the unprecedented data volumes that underpin next-generation AI for Earth system applications. An ECMWF representative quantified current operational flows as orders of magnitude beyond traditional "big data," with ~6 TB of daily observational inputs, 400 TB of model output per run, and an active archive growing by nearly 1 PB per day. The session emphasised that these massive repositories must remain easily accessible: ECMWF sustains over 500 TB of daily reads, and the Copernicus Climate Data Store serves 115 PB across 6500 daily users. Such rates demand systems with tightly coupled storage–compute capabilities and optimised data delivery layers to ensure data quality and accessibility at scale.

4 Babis Tsitlakidis, Head of Sector, Destination Earth, High Performance Computing and Applications, DG CNECT, EC
Tiago Quintino, Head of Development Section, ECMWF
Jedrzej Bojanowski, Director of EO Data Science and Products, CloudFerro
Juan Pelegrin, Head of Sector, AI Factories, HPC and Applications, DG CNECT, EC
Miruna Stoicescu, AI for Digital Solutions Lead, EUMETSAT
Luca Girardo, Destination Earth & Copernicus Advanced Infrastructure Services Manager, ESA

3.2 TRANSFORMATIVE TRAINING AND INFERENCE PARADIGMS

There has been a paradigm shift in AI model life cycles, whereby training and inference become first-order HPC tasks. The replication of weather forecasts can now be done on 51 GPUs in 1 min 40 s, compared with 1 h 20 min on 2500 Central Processing Unit (CPU) cores which is an acceleration of more than 50 times and lays the foundation for real-time, high-resolution models. This shift obliges "AI-ready" data placement at the proximity of GPU memory: training datasets (~10 TB per ensemble run) must reside on the same HPC fabric to avoid network bottlenecks. Future architectures should collocate AI training pipelines and data orchestration services within Europe's emerging AI factory and HPC centres.

3.3 MODULAR AI STACKS AND ECOSYSTEM INTEGRATION

A couple of modular frameworks that bridge large-scale Earth-system archives and user workflows were introduced. The award-winning, open-source ANEMOI platform defines standard abstractions for dataset construction, model specification, and distributed inference, while Earthkit components handle on-the-fly data transformations and interpolation. Anchored in these tools, the "Forecast-in-a-Box" concept packages end-to-end operational chains—physical and AI models, post-processing, and visualisation—into deployable software visualisations. CloudFerro's representative extended this modular approach to EO data layers via vector embeddings, advocating the transformation of multispectral, multiresolution, and temporal stacks into compact numerical representations. Embeddings facilitate cross-modal search (text-to-image, image-to-image), anomaly detection, and downstream model training, reducing per-task preprocessing from petabyte challenges to manageable vector queries.

3.4 ACCESS MODELS AND SERVICE INFRASTRUCTURES

The session highlighted evolving access methods whereby on-demand HPC resources and data services converge in hybrid public–private ecosystems. DG CNECT outlined the Commission's AI factory initiative — 19 AI factories and 13 supporting "antennas" across Europe — deploying 2.6 billion € and ~24 000 GPUs in 18 months, with forthcoming gigafactories scaling to >100'000 GPUs and integrated private–public business models. Panellists emphasized streamlined access modes: from rapid-prototyping within 48 hours for small and medium-sized enterprises to competitive allocations for large HPC centres. Speakers urged users, from Copernicus R&D communities to downstream service providers, to leverage these centres for computing, algorithmic support, training, and data stewardship.

3.5 FUTURE DIRECTIONS

Across all presentations and discussion, four thematic challenges emerged: (1) sustaining the storage of exabyte-scale, high-quality archives; (2) re-architecting workflows to colocate data with GPU-based AI training; (3) encapsulating complex EO and value added service processing into modular, open stacks that foster community contributions; and (4) democratising access via an integrated AI factory network underpinned by European sovereignty and ethical safeguards. Panellists agreed that these combined efforts will shape Copernicus and Destination Earth into trustworthy, user-driven platforms, advancing climate resilience and service innovation in the forthcoming Multiannual Financial Framework.

4. USER NEEDS AND TRUSTWORTHY AI

4.1 DATA-DRIVEN REQUIREMENT ELICITATION

Session 4 opened with a demonstration of how machine learning accelerates the translation of EU policy needs into actionable EO specifications. At the Knowledge Centre on Earth Observation (joint project from JRC and DG DEFIS), natural-language processing and text-mining algorithms process thousands of policy documents and stakeholder surveys to extract target indicators, application domains and product requirements. The process includes automating metadata harmonisation – standardising variable names, spatial and temporal resolutions, and data formats. This enables the imputation of missing attributes (i.e., not encoded "by hand") while assigning confidence scores to the generated metadata. The organisation of products in taxonomical trees further promotes adaptive cataloguing so that thematic branches (e.g., "atmospheric outbreak early warning") reorganise dynamically around user-specified criteria. This helps identifying last-mile gaps in products and services as well as delivery gaps when products exist but cannot be discovered or packaged in a way that makes it accessible to the user. Finally, clustering techniques distil hundreds of user-reported "last-mile gaps" into priority themes (e.g., land-cover change, emissions monitoring, water-quality surveillance) thereby providing evidence-based guidance for Copernicus research calls and service evolution.

4.2 OPERATIONALISING AI FOR SERVICE GAPS

Speakers[5] from national EO services underscored the potential of AI to bridge persistent product-service divides. For instance, Germany introduced the "AI4FloodDamage" project which ingests post-inundation imagery to flag damaged areas in hours rather than days. Early tests demonstrate promising accuracy, and current work focuses on integrating the core ML module into existing disaster-management platforms. France's INERIS has embedded neural-network modules into its CAMS-based air-quality pipeline, all without replacing the physics-based core.

4.3 BUILDING TRUST AND GOVERNANCE

A panel discussion[6] focused on the criteria that render AI-powered EO services dependable and accountable. The panellists agreed that transparency of training data and model architectures is paramount. Hybrid modelling approaches that combine physics-based and AI models help building trustworthiness and protect against implausible predictions in data-sparse contexts. Robust interpretability frameworks offer post-hoc insights. It was underscored that institutional data providers (Copernicus, EU Commission services, national agencies) must remain "in the room" as AI layers proliferate, to maintain close relationships with end users. Finally, federated orchestration across Europe's emerging AI- and HPC-factory network will reinforce data sovereignty and policy compliance, enabling a continuum of fit-for-purpose AI services that respond promptly to evolving user needs.

5 Mark Dowell, KCEO Team Lead, KCEO-JRC, EC
Miguel Vallejo Orti, Project Officer, KCEO-JRC, EC
Ruben Piroska, Coordinator of CEMS, German Federal Office of Civil Protection and Disaster Assistance
Antoine Guion, Research Engineer in Air Quality Modeling and Forecasting, French National Institute for Industrial Environment and Risks
Matteo Mattiuzzi, Expert Copernicus Land Monitoring Service, European Environment Agency

6 Stefanie Lumnitz, Policy Officer, Climate & Planetary Boundaries, DG RTD, EC
Hannah Kofler, Product Manager Image Processing and Data Science, Constellr
Alistair Francis, Co-founder and Partner, Asterisk labs

5. DIGITAL TWINS AND AI

5.1 ACCELERATING EARTH-SYSTEM MODELLING WITH AI EMULATORS

Starting the second day of the workshop, speakers[7] illustrated how analogous machine-learning emulators are under development to address atmospheric, oceanic, terrestrial and cryospheric components of the Earth system. AI Earth-system emulators include for example a data-driven soil-moisture emulator that reproduces seasonal drought anomalies, a sea-ice concentration emulator matching monthly ice-edge retreat, a wave-height simulator that captures storm propagation across the Pacific, and a river discharge emulator matching observed seasonal cycles and timing of high flows.

5.2 MODULAR "LEGO" CONSTRUCTION OF CRYOSPHERIC TWINS

Stef Lhermitte, Professor at Katholieke Universiteit Leuven introduced an EO-driven digital twin of ice sheets, built "functional modules" which include, for instance, a super-resolution model for melt detection of the ice sheet and a model for predicting sea-level rises. Users assemble modules like building blocks to generate ensemble projections under specified scenarios. Emulators run orders of magnitude faster than traditional ice-dynamics solvers, making interactive exploration feasible on web dashboards or Jupyter clients without exclusive access to top-tier HPC.

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6. AI IN ACTION

6.1 ENTREPRENEURSHIP AND ECOSYSTEM PATHWAYS

Session 6[8] examined how Earth-observation SMEs and start-ups navigate commercialisation, ecosystem support and funding frameworks to bring AI-driven services to market. Presentations emphasised that AI is not an end but an enabler of new, better services. Examples include AgroApps' decade-long effort to fuse remote-sensing and agronomic models for crop-specific forecasts, GEOSYSTEMS HELLAS's fusion of big data and machine learning to monitor urban infrastructures and maritime domains, or EarthPulse's platform-driven scaling of geospatial analytics for critical-asset resilience. Participants credited initiatives like the EUSPA-AI Week with lowering the barrier to co-design with public authorities but cautioned that many SMEs still struggle to hire enough staff with AI expertise and to secure long-term projects. Across cases, success hinged on iterative, stakeholder-centric pilots that translated AI outputs into domain-specific decision support, transforming "proofs of concept" into services that end users value and can afford.

6.2 DATA BOTTLENECKS AND MODELING STRATEGIES

A recurring theme was the critical shortage of high-quality, domain-specific training and validation data. Sentinel-derived indices proved sufficient for broad-scale applications (e.g., crop-type mapping), but niche use cases – vegetable phenology, rail-track buckling risk, illegal

7 Bertrand Le Saux, Policy Officer for Destination Earth and AI Applications, High Performance Computing and Applications, DG CNECT, EC
Sara Hahner, Scientist for Machine Learning, ECMWF
Alain Arnaud, Director Digital Ocean Department, Mercator International
Stef Lhermitte, Professor, KU Leuven

8 Vasileios Kalogirou, Space Downstream R&I Officer, EUSPA
Betty Charalampopoulou, EARSC Board of Directors, President and CEO GEOSYSTEMS HELLAS S.A.
Conrad Bielski, Chief Technology Officer, Riscognition
Fran Martin, Geospatial Product & Project Lead, EarthPulse
Danijela Ristic-Durrant, Senior R&D Project Manager, OHB-DS
Machi Simeonidou, Managing Director, AgroApps

maritime movements – demanded inputs with a finer resolution or in situ ground truth that are often proprietary, restricted by GDPR or simply unavailable. It was illustrated how satellite land-surface temperatures, once downscaled and fused with track-side sensors, can yield 24-hour forecasts of rail-welding stress. Other case studies showed how security-sensitive projects overcame data gaps by integrating national microsatellite video and radio feeds in a multi-source fusion architecture.

6.3 EMBEDDING TRUSTWORTHY AI IN OPERATIONAL CHAINS

Operational uptake depends on seamless Machine Learning Operations integration, transparent model governance and human-in-the-loop validation. EarthPulse's "Julia" project exemplifies modular interfaces that slot AI elements into existing workflows, delivering additional alerts and recommendations rather than raw model outputs. Trust is fostered through interpretable features, knowledge-graph linkage of AI detections to asset registries, and Large Language Model -powered natural-language querying that democratises access to complex geospatial datasets. Equally important is continuous customer feedback: SMEs report that end users will not accept "black-box" forecasts without clear accuracy metrics, error attributions and prescribed response protocols. Finally, panellists urged the continued expansion of Copernicus Data Space services and EU-funded HPC infrastructures to democratise computing and storage capacities ensuring that the AI-EO nexus remains inclusive, accountable and responsive to evolving user needs.

7. RESEARCH AND INNOVATION

7.1 FOUNDATIONS FOR VISION-LANGUAGE AND TIME-SERIES TASKS

In Session 7, keynote speaker Professor Begüm Demir outlined the urgent need for large, high-fidelity EO–text corpora to drive next-generation Earth-observation assistants. General-purpose AI assistants like GPT-5 produce only generic captions on Sentinel-2 imagery and miss the land-cover class, spatial relation, and area-specific details critical for Earth observation. The newly released "EGONetText" dataset pairs Sentinel-2 image patches across ten European countries with templated captions (presence, area, spatial relations). Models fine-tuned on EGONetText showed substantial performance improvements, of over 30%.

7.2 CURATED EO FOUNDATION MODELS AND AGENT-BASED SELECTION

The proliferation of over 160 open-source EO foundation models has outpaced the users' ability to choose and integrate them. To address this, Prof. Demir's team introduced REMSEN, a "model selection agent" that maps user constraints (task, hardware, data modality) to rank candidate models according to user needs. Looking ahead, the community is exploring multi-agent frameworks to coordinate cross-modal workflows, integrate geospatial and time-series foundation models and to embed domain knowledge into automated reasoning loops. Such agent architectures promise to democratise access to complex EO analytics. However, this works only when they are underpinned by curated metadata.

7.3 OPEN SCIENCE

Panellists[9] from OpenGeo Hub, +Atlantic, eOdyn Intelligence, Agenium Space and the National Technical University of Athens underscored that breakthroughs in AI research will only result in societal impact through open, community-driven toolchains and collaboration. Open-source infrastructure (data repositories, code libraries, model hubs) fosters transparency, reproducibility and rapid iteration, which is echoing successes in Wikipedia-style community models.

7.4 EDGE AI

Deploying AI algorithms at the edge, directly on board a satellite, can optimise data processing and transmission. François De Vieilleville of Agenium Space highlighted the benefits of this approach: reduced use of on-board mass memory, the ability to process more data, lower bandwidth requirements, and faster downlink transmission. However, it also brings challenges, notably the currently still limited on-board computing power. Any neural network deployed on board must be carefully tuned and optimised to operate within strict constraints. Addressing these challenges can also improve ground-based data processing by increasing the power efficiency of AI processing chains.

8. DIGITAL TRANSFORMATION OF EARTH OBSERVATION SERVICES

8.1 DIGITAL TWINS FOR CLIMATE-READY DECISION SUPPORT

Jenni Kontkanen, a representative from CSC-IT Centre for Science, presented the DestinE Climate Digital Twin, including its monitoring –and evaluation tools and sector-specific applications (urban heat extremes, wind energy), connected by a common data governance. By running impact models "on-the-fly" as simulations progress for rapid scenario testing, these workflows supply locally relevant indicators (extreme event storylines, adaptation metrics) at spatial and temporal scales that traditional global models cannot match.

8.2 AI FACTORIES, DATA SPACES AND HYBRID MODELING PILLARS

Europe's emerging AI-factory networks and Copernicus data-space services may supply the computing capacity, curated EO datasets, and expert facilitation needed to scale AI-powered EO applications from prototypes to regular operations. Horizon-funded projects are already embedding machine-learning surrogates into sea-ice, aerosol and land-surface models while "big-learning" urban-extreme frameworks fuse station, in situ and EO archives to generate future climate risk maps. These hybrid physics-ML workflows, co-designed with domain experts, demonstrate how AI can both accelerate model runtimes and enrich impact-level insights.

9 Massimo Ciscato, Head of Sector, Space Research, HaDEA, EC
Marko Curavic, Head of Unit, Space Research Unit, HaDEA, EC
Begüm Demir, Full Professor, TU Berlin
Yann Guichoux, Founder & President, eOdyn
Francois De Vielleville, Chief Technology Officer, AGENIUM SPACE
Tom Hengl, Director & Co-founder, OpenGeoHub Foundation
Ioannis Papoutsis, Assistant Professor, National Technical University of Athens
Ana Oliveira, Chief Technology Officer, +Atlanti

8.3 FROM PILOTS TO PRODUCTION: TRUST, INTEROPERABILITY AND AUTONOMY

Speakers[10] cautioned that closing the gap between cutting-edge research and 24/7 operational services requires sustained attention to trustworthiness, data interoperability and time-to-market. Key obstacles include fragmented data governance, reliance on non-European computing platforms, and the need for clear value propositions that justify long-term investment. Panellists called for strengthening European autonomy in hardware, software and high-performance computing to safeguard data sovereignty and lower entry barriers for SMEs.

9. CONCLUSION

9.1 PROGRESS AND CHALLENGES

The "Artificial Intelligence and Earth Observation: from Innovation to Services" workshop showcased remarkable strides in integrating AI and Earth observation across policy, infrastructure and application domains. Europe has designed and begun deploying a federated HPC and "AI-factory" network, linking Copernicus data flows, the DestinE digital-twin platform and national computing centres with hundreds of thousands of GPUs now accessible to researchers, SMEs and public services. Operational AI forecasting at ECMWF and open benchmarks in weather or ocean forecasting demonstrate that neural-network emulators can outpace traditional solvers while slashing energy and time budgets. Modular software stacks (ANEMOI, Earthkit, Forecast-in-a-Box), vision-language corpora like EGONetText, and advancements on AI Earth system modelling of atmosphere, cryosphere and land now underpin interactive decision-support tools for urban heat, flood damage, sea-ice and carbon-flux scenarios. SMEs have leveraged Horizon Europe co-design calls to deliver end-user pilots in agriculture, infrastructure monitoring and maritime security.

Yet several hurdles persist. Exabyte-scale archives still strain data-ingestion and storage layers, while fragmented governance and inconsistent metadata impede interoperability. High-quality, domain-specific training datasets remain scarce and are rather for niche use cases. GDPR or proprietary constraints further throttle in situ validation. Trust and explainability are not yet integrated into most production chains, and 24/7 operational readiness demands rigorous and reliable ML operations, human-in-the-loop checks and standardised error metrics. Europe's reliance on non-European cloud and hardware poses a strategic vulnerability, and many SMEs struggle to hire staff with advanced AI expertise or secure sustainable funding beyond pilot phases.

9.2 FUTURE DIRECTIONS

To close these gaps, the community must extend and deepen current collaboration and synergies. First, DestinE's rollout should bring ocean, land-evolution and hydrology twins online, with unified APIs. Second, data-space services must mature into interoperable repositories where AI training pipelines can collocate seamlessly with computing capacities and deliver real-time analytics. Third, an European AI Academy and cross-sector Digital Innovation Hubs should train the next generation of AI-EO practitioners, embedding ethics, hybrid phys-

10 Vincent-Henri Peuch, Director for Engagement with the EU, ECMWF
Jenni Kontkanen, Development Manager in Digital Twin Technologies, CSC - IT Center for Science
Babis Tsitlakidis, Head of Sector, Destination Earth, HPC and Applications, DG CNECT, EC
Elisabeth Hamdouch, Deputy Head of Unit, Earth Observation, DG DEFIS, EC
Aurélien de Truchis, Vice-President, Data Sciences, Kayrros
Peter Salamon, Head, Copernicus Emergency Management Service, DG JRC, EC
Franz Immler, Head of Sector, Environmental Observations, DG RTD, EC

ics-ML design and best practices in ML operations into core curricula. Fourth, open certification frameworks for emulator fidelity, uncertainty propagation and governance must be accelerated, so that end users in emergency management, insurance or urban planning can trust AI-derived insights. Finally, Europe must invest in home-grown platforms and leverage its AI-factory network to bolster hardware-software sovereignty. By knitting together Earth observation, digital twins, modular AI toolchains and community-driven co-design, the EU can transform proofs-of-concept into resilient, user-centric services, delivering in the decade ahead on both climate adaptation and strategic competitiveness.