Copernicus Data Stores (CDS and ADS): Modernising Europe's Open Climate and Atmosphere Data Platforms

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Briefing title
Copernicus Data Stores (CDS and ADS): Modernising Europe's Open Climate and Atmosphere Data Platforms

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INTRODUCTION

The Copernicus Data Stores are the two online platforms through which the climate and atmospheric data produced under Copernicus, part of the EU Space Programme, are made openly available. The Climate Data Store (CDS) serves the Copernicus Climate Change Service (C3S) and the Atmosphere Data Store (ADS) serves the Copernicus Atmosphere Monitoring Service (CAMS). Both are run by the European Centre for Medium-Range Weather Forecasts (ECMWF), an intergovernmental organisation that implements these services on behalf of the European Commission. Their users include EU institutions and agencies, national and regional authorities, researchers and businesses, many of whom rely on the data for routine decision support or have built automated workflows on top of it. Between 2022 and 2025 ECMWF rebuilt every layer of the service, from the web interface to the processing engine and the cloud infrastructure. This large-scale restructuring was driven by outdated legacy systems with insufficient capacities to manage the rising demand for data and the increasing Copernicus reporting requirements. The new platforms replaced the old system on 26 September 2024 and in 2025 delivered between 95 and 130 terabytes (TB) of data per day.

The project is instructive well beyond the climate field because it shows how a heavily used public data service can be renewed without interrupting service delivery. Moreover, the extensive atmospheric and climate data are increasingly relevant for supporting public authorities in policy making and implementation, and for private actors and various sectors of strategic economic importance.



Key facts

- **Project:** Copernicus Data Stores (CDS and ADS): Modernising Europe's Open Climate and Atmosphere Data Platforms.
- **Applicant:** European Centre for Medium-Range Weather Forecasts (ECMWF), acting as Copernicus Entrusted Entity for C3S and CAMS on behalf of the European Commission. ECMWF was established in 1975 as an independent intergovernmental organisation, is supported by 35 states and employs over 500 staff from 30 countries at sites in Reading, Bonn and Bologna.
- **Country and level of government:** European and international level (intergovernmental organisation serving EU institutions, Member States and users worldwide).
- **Duration and key dates:** Phase 1 (modernisation and transition) from 28 February 2022 to 31 December 2025; new CDS and ADS operational from 26 September 2024.
- **Funding:** EU funds under the Copernicus Programme (EU Space Programme), through C3S/CAMS Joint Services contracts; the responsible Commission department is the Directorate-General for Defence Industry and Space (DG DEFIS).
- **Main components:** renewed web interface and application programming interface (API); new back-end processing engine; cloud infrastructure; KPI-compliant user management; service monitoring and incident management; in-platform analysis tools (public JupyterHub, analysis-ready data services); user support and training.
- **Headline results:** 389,266 registered CDS users by end-2024; 95 to 130 TB delivered a day in 2025; around 475,000 requests a day from some 4,700 daily active users; more than 96% of requests completed successfully; metadata quality score of 88% against the FAIR principles.

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1. Relevance

European climate and air-quality policies are increasingly relevant for informing policy makers in their responses to natural hazards and disasters, such as heat, drought, wildfire smoke and floods. Decisions in these areas are expected to be well-substantiated, resting on transparent and verifiable evidence. The datasets that supply this evidence are very large, heterogeneous and technically demanding. Hence, institutions using large data sets independently often reach inconsistent results or duplicate each other's effort. The CDS, which according to the applicant's presentation has been in operation for roughly ten years, was created to reduce this problem by offering a single portal to hundreds of quality-assured datasets, among them observations, seasonal predictions and ERA5, a reconstruction of the past global climate. The ADS performs the same function for the atmospheric composition and air-quality data produced by CAMS.
When the modernisation began in 2022, rising demand and changing governance requirements had outgrown the original systems. The legacy access routes had not been designed for the volumes now being requested, and the Copernicus programme required more detailed reporting on who uses the service and how well it performs, which could only be produced by a new user-management system able to generate key performance indicators (KPIs). Because the Data Stores underpin cross-border services that EU institutions, Member States and intermediary organisations use every day, a breakdown or a poorly managed changeover would have had immediate operational and reputational consequences. The applicant therefore gave the work priority over other pending issues, treating it as a matter of protecting core public-service capacity rather than as a routine renewal of IT equipment.

The political salience of the service is reflected in its institutional and legal structure. Within the European Commission, DG DEFIS is responsible for Copernicus, while the data also serve the Directorates-General for Climate Action (CLIMA), Environment (ENV), Energy (ENER) and Communications Networks, Content and Technology (CONNECT). The applicant reported that C3S data are explicitly referred to in a growing number of EU legislative acts, such as the Ambient Air Quality Directive, which mentions forecasting and modelling based on Copernicus data or the Taxonomy Regulation, which is a key framework for informing decisions on sustainable investment. Moreover, the team has regular contacts with other policy makers and briefs Members of the European Parliament directly.

As such, the project closely aligned with Category II (“Investing in Infrastructure, Mobility and Energy”) because it develops and maintains open digital infrastructure that functions as a critical public utility. The delivery of the related services is based on an established mandate to provide objective and reliable data for policy makers. The applicant's case for the added value of the modernised service rests on a comparison with the legacy Data Stores and with fragmented or one-off portals, including national solutions. A single entry point with harmonised web and API access replaces several separate routes to the data; continuous monitoring against KPIs makes performance transparent and auditable, which most alternative portals cannot do consistently; and because data can be processed and visualised on the platform itself, individual institutions no longer need to build their own infrastructure to handle datasets of this size.

2. Project design and implementation

ECMWF ran the modernisation in its capacity as Copernicus Entrusted Entity, the body to which the European Commission has delegated the implementation of C3S and CAMS, through a joint workstream called the Data Store Service (DSS) that covered both the CDS and the ADS. ECMWF kept overall programme governance in house, including technical management, setting priorities and deciding when new components were accepted into operation, while most development and evolutive maintenance (the continuing addition of new functions alongside the correction of faults) was delivered by an external supplier. Additional specialist contracts, for example for serverless data access and visualisation services, fed into user-facing applications. The validation

team observed a clear division of tasks between programmatic oversight by DG DEFIS, service delivery and strategic implementation within ECMWF, and private companies that supplied data-driven applications through contracts and tenders. Progress was followed through formal reviews, Service Level Board meetings, risk monitoring and KPI reporting.

Resources were divided so that ECMWF retained the functions on which reliability and accountability depend. It managed the Common Cloud Infrastructure, the shared cloud environment on which the Data Stores run, at both infrastructure and platform level, looked after the data catalogue and monitored the service, while contractors handled software development, platform enhancement and operational maintenance. Consumption of cloud resources was tracked operationally, and performance was measured through indicators such as the share of requests completed successfully, the volume of data delivered and the number of active users.

Development followed an agile model built around a single shared backlog, a running list of requirements, faults and enhancements, which was split between new features and operational support and prioritised jointly by ECMWF and the contractor at regular meetings. Changes reached users through controlled 'system sessions', consisting of monthly releases supplemented by hot fixes and urgent deployments where necessary, and every release passed automated and manual tests before being promoted to production. Working in small, tested steps was a necessity rather than a methodological preference, since the service could not be switched off while it was being rebuilt and each change had to be introduced alongside normal operation with procedures designed to limit any effect on users.

The implementation proceeded in five stages:

- **2022, initiation and mobilisation:** kick-off of the modernisation contract, with governance arrangements, the delivery rhythm and a roadmap of requirements, risks and deliverables agreed.
- **2022 to 2024, build and iterative enhancement:** development of the new front end, back-end engine and cloud infrastructure through the shared backlog and regular releases.
- **2024, controlled migration and cutover:** decommissioning of the legacy CDS and ADS and entry into operation of the new platforms on 26 September 2024, with users migrating their accounts, API credentials and endpoints.
- **2025, consolidation and scaling:** stabilisation and performance work on the Common Cloud Infrastructure under growing demand, with monitoring of resource use and service KPIs.
- **Q4 2025 to 2026, transition:** planned close of Phase 1 and handover to a follow-on platform enhancement contract.

The cutover was the most delicate stage, because many users reach the Data Stores through scripts and automated workflows rather than through the website. Registration on the legacy systems was closed during the transition, and users were moved across progressively, re-registering under the new user-management model and updating their API credentials and endpoints with the help of migration guidance. Quarterly uptake figures temporarily appeared lower than expected, since activity left the old systems before the new ones were fully populated, and the statistics themselves had to be redefined: from Q4 2024 onwards total user numbers were reported as the sum of legacy and new registrations, while 'active users' were counted on the new systems only. The applicant explains that re-registration would remain below historic totals for some time and that the new onboarding collects more detailed, KPI-compliant information about users, so a combined method was needed to keep reporting comparable during and after the transition without changing the project's objectives.

Once the new platforms were live, rapidly increasing traffic, testing system capacities. The team responded with ongoing configuration tuning, improved observability (the ability to see what is happening inside the system in real time), bug fixing and performance work on core back-end components such as the broker, scheduler and database, together with measures to increase availability, all of which the applicant treats as

continuous work rather than a milestone that can be closed.

Support operated under service level agreements (SLAs), and questions and problems raised through the ticketing system and community forums were turned into backlog items, which kept platform changes tied to difficulties that users had actually encountered. During the validation visit the team demonstrated the support arrangements, which combine virtual-assistant self-help guides, community announcement forums and ticketing for technical issues, as well as the training offer of free data-analysis tutorials, shareable Jupyter Notebooks (interactive documents that combine code, data and explanation) and an open online course that has served over 3,000 users. To reach local government, ECMWF works through intermediaries: under a National Collaboration Programme it acts, as the applicant put it, as a 'wholesaler' of data that national climate centres 'translate' for municipalities, and institutional applications such as the European Climate Data Explorer of the European Environment Agency (EEA) present policy-relevant regional climate indicators built on the Data Stores.

3. Outcome

The central objective, replacing the legacy systems without breaking continuity for users and their automated workflows, was achieved on 26 September 2024, when the new CDS and ADS became the operational services and the old platforms were decommissioned. By the end of 2024 the CDS had almost 400,000 registered users, and in the three months after go-live more than 67,000 users had registered on the new CDS and around 3,000 on the new ADS, with CDS data delivery peaking above 140 TB in a single day.

In 2025 the platform operated at full scale, delivering 95 to 130 TB of data a day, processing around 475,000 requests a day from ~4,700 daily active users and completing more than 96% of requests successfully. On the atmospheric side, access to CAMS data through the ADS remained stable, with high uptime and only short incidents that were resolved. The usability objectives also produced concrete results: a public JupyterHub now allows users to analyse data on the platform instead of downloading it, analysis-ready, cloud-optimised (ARCO) data services and time-series access make large datasets easier to handle, metadata quality reached a score of 88% against the FAIR principles (data that are findable, accessible, interoperable and reusable), and reuse is governed by the CC-BY licence, which permits any use provided the source is credited.

Among the uses documented during the validation visit, the European Investment Bank (EIB) relies on a climate-based screening tool powered by C3S data to assess hazards affecting infrastructure investments, which according to the presentation also helps it comply with climate risk legislation. The EEA integrates the data into climate profiles in its applications and into its Spatially Explicit Environmental Data (SEED) application to run species distribution models, and the European Food Safety Authority (EFSA) increasingly uses climate-related data in its risk assessments. C3S data also feed global assessments such as those of the Intergovernmental Panel on Climate Change (IPCC), are used to train artificial intelligence (AI) weather models and to plan renewable energy sites, and allow media outlets such as the Reuters Climate Monitor to produce climate-tracking visualisations through which journalists and citizens can hold public bodies to account. At the other end of the scale, the applicant described users in Timor-Leste who, after following the online course, produced their own agricultural drought risk assessments with CDS tools.

The modernised Data Stores also serve as a data bridge to other platforms, notably WEkEO and the Copernicus Data Space Ecosystem, which pass Copernicus products on to their own user communities, and the same architecture hosts additional Copernicus services and datasets. In its presentation the applicant cited a socioeconomic study estimating that every euro spent on the service returns ten euros in benefits to European society; this figure relates to the service as a whole rather than to the modernisation project specifically. The jury noted that businesses from small and medium-sized enterprises (SMEs) to large international companies use the data for investment, risk assessment and new products, in sectors ranging from renewable energy and insurance to health.

The modernised platform has moved into business-as-usual operation under the Data Store Service, with regular releases, monitoring and continuous improvement embedded in standard service management. Phase 1 was planned to end in Q4 2025 with a managed handover to a follow-on contract, CJS2_211_bis (Data Store Service: Platform Enhancement), foreseen from Q1 2026 to provide technical support and maintenance and to continue developing the platform's functions. Longer-term funding appears secure: the consensus meeting recorded that a sufficient and stable budget is explicitly in place, and the applicant stated that the service is secured until at least 2035. Rather than adding data outside its own expertise, ECMWF intends to widen use by standardising metadata so that CDS data can be combined with sources such as Eurostat statistics, and the jury, citing interest from Eurostat, the EIB and environmental bodies, considered the model transferable to other public-data domains.

Success factors

- A mature and well-defined governance model coordinated by ECMWF, with structured roles for scientific partners, IT contractors, cloud providers and operational teams.
- A clear migration plan, supported by testing and performance monitoring, which kept the service available to existing users throughout the changeover.
- A strongly user-oriented approach to providing high-quality data, which the evaluators identified as the main source of lessons for other organisations.
- An open approach with no restrictions on data use, allowing a wide and diverse range of stakeholders to benefit.
- Sustained effort to translate complex platform data into concrete policy outcomes, backed by comprehensive training for stakeholders.
- Efficient use of resources through the reuse of existing Copernicus components, shared storage and centralised computational workflows.
- Architectural principles, including open standards, API-based access and federated data pipelines, that other European data initiatives can adopt.
- Results that can be verified through KPIs such as user numbers, system availability and the growth of the data catalogue.
- A secure institutional and financial basis as a permanent part of the Copernicus programme, funded through the EU Space Programme under long-term mandates.

Lessons learned and recommendations

1. **Run a data platform as an operational service with measurable performance.** Defining a small set of indicators, such as the share of requests completed, the volume delivered and the number of active users, and reporting them regularly made reliability visible to the funding body and gave the team early warning when demand began to strain the system.

2. **Modernise in small, tested releases while the service stays live.** A single prioritised backlog holding both new features and fault reports, a fixed monthly release rhythm and testing before each release allowed ECMWF to rebuild every layer of the Data Stores without a prolonged shutdown.

3. **Treat migration as a change for users, not only for systems.** Users with automated workflows need new credentials, endpoints and guidance well before the cutover, and administrations should decide in advance how usage will be reported during a migration so that a temporary dip is not mistaken for a loss of users.

4. **Keep control of governance when delivery is outsourced.** ECMWF procured development competitively but retained prioritisation, acceptance into operation, cloud management and monitoring, so that a change of supplier would not cost the organisation its knowledge of, or authority over, the service.

5. **Bring the analysis to the data.** Hosting notebooks and analysis-ready data on the platform spares each user organisation the cost of building its own infrastructure for large datasets, which matters most for smaller administrations with limited technical capacity.

6. **Reach local government through intermediaries.** Rather than serving every municipality directly, the service supplies national climate centres that adapt the data to local needs, a division of labour between a central supplier and organisations closer to end users that suits other centrally produced data as well.

7. **Arrange the next contract before the current one ends.** Planning the follow-on platform enhancement contract and the handover between suppliers during Phase 1 reduced the risk of a gap in maintenance once the modernisation phase closed.

8. **Make data easy to combine with other sources.** Open licensing under CC-BY and attention to metadata quality allow users to link climate data with statistical and other datasets, which widens the range of policy questions the same data can help to answer.

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