SESAR 3 ER 1 Green-GEAR – D2.2 – Updated data management plan

Deliverable ID:	**D2.2**
Project acronym:	**Green-GEAR**
Grant :	**101114789**
Call :	**HORIZON-SESAR-2022-DES-ER-01**
Topic :	**WA 2.7 ATM application-oriented Research for Aviation Green Deal**
Consortium coordinator :	**DLR e.V.**
Edition date:	**30 August 2024**
Edition:	**02.00**
Status :	**Official**
Classification:	**PU**

Abstract

Green-GEAR aims at enabling and incentivising optimum green trajectories and airspace use through new ATM procedures; it develops three new SESAR Solutions to this end.

The Data management plan (DMP) in its present updated version compiles a list of necessary data to feed the activities in WP3, 4, and 5, and the means of results collection and dissemination. The input data/databases are described here, as is the eventual access to the data. Furthermore, the strategy for the management of the research outputs is described.

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Document history

Edition	Date	Status	Company author	Justification
00.01	10/11/2023	Draft	UoW / Tatjana Bolic	Initial DMP, draft for input request
00.02	20/11/2023	Draft	UoW / Tatjana Bolic	draft for internal review
00.03	28/11/2023	Release Candidate	UoW / Tatjana Bolic	inclusion of comments received, for approval
00.04	30/11/2023	Final	DLR / Bauer	acronyms added, formalities
01.00	30/11/2023	Release	DLR / Bauer	first submission
01.01	16/08/2024	Draft	UoW / Tatjana Bolic	updated DMP, draft for input request
01.02	26/08/2024	Draft	UoW / Tatjana Bolic	draft for internal review
01.03	29/08/2024	Release Candidate	UoW / Tatjana Bolic	Inclusion of comments received, refrerences, acronyms
01.04	30/08/2024	Final	DLR / Bauer	formalities checked
02.00	30/08/2024	Release	DLR / Bauer	first submission of updated version

The participants/consortium confirm(s) the correct application of the Grant Agreement, which includes data protection provisions, and compliance with GDPR or the applicable legal framework with an equivalent level of protection, in the frame of the Action. In particular, the participants/consortium confirm(s) to be up to date with their consent management system.

Green-GEAR

GREEN OPERATIONS WITH GEOMETRIC ALTITUDE, ADVANCED SEPARATION & ROUTE CHARGING SOLUTIONS

Green-GEAR

This document is part of a project that has received funding from the SESAR 3 Joint Undertaking under grant agreement No 101114789 under European Union's Horizon Europe research and innovation programme. UK participants in Green-GEAR have received funding from UK Research and Innovation (UKRI) under the UK government's Horizon Europe funding guarantee [grant numbers 10087714 (NATS) and 10091252 (University of Westminster)].

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List of acronyms

Acronym	Description
AO	Airline Operator
arXiv	“archive" (open-access repository of electronic preprints and postprints)
ATC	Air Traffic Control
ATFM	Air Traffic Flow Management
ASCII	American Standard Code for Information Interchange
ATM	Air Traffic Management
BADA	Base of Aircraft Data
CERN	Conseil Européen pour la Recherche Nucléaire (European Organization for Nuclear Research)
CORDIS	Community Research and Development Information Service
D*<no.>*	Deliverable *<no.>*
DDR 2	Demand data repository 2
DES	Digital European Sky
DLR	Deutsches Zentrum für Luft- und Raumfahrt e.V. (German Aerospace Center)
DMP	Data management plan
DWD	Deutscher Wetterdienst (German Meteorological Service)
EC	European Commission
ECAC	European Civil Aviation Conference
ECMWF	European Centre for Medium-Range Weather Forecasts
EDB	[aircraft engine] emissions databank
ER	Exploratory Research

Acronym	Description
ERA5	ECMWF re-analysis (product)
FAIR	Findable, accessible, interoperable, reusable
FDR	Flight Data Recorder
GDS	Global Distribution System
GDPR	General Data Protection Regulation
Green-GEAR	Green operations with Geometric altitude, Advanced separation & Route charging Solutions
GRIB	GRIdded Binary *or* General Regularly-distributed Information in Binary form
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ICRAT	International Conference for Research in Air Transportation
JU	Joint Undertaking
M<*no.*>	project month <*no.*>
OpenAIRE	(network of Open Access repositories, archives and journals)
R&D	Research & Development
RVSM	Reduced Vertical Separation Minima
SESAR	Single European Sky ATM Research
STATFOR	[EUROCONTROL] Statistics and Forecasts Service
TMA	Terminal Manoeuvring Area
TRL	Technology Readiness Level
UK	United Kingdom [of Great Britain and Northern Ireland]
UKRI	UK Research and Innovation
WA	Working Area
WP <*no.*>	Work package <*no.*>

Table 1: List of acronyms

1 Data summary

The consortium fully supports the intentions of the Horizon Europe program to make publicly available, as soon as possible, all research data and take measures to enable third parties to access, mine, exploit, reproduce and disseminate these data, free of charge for any user. The document will be updated at M22. In this section we describe the initial input data for the project, per Solution. It is likely that the data requirements will change as the project advances. All changes will be reported in the planned update of the document.

Certain input data identified for the project activities are not owned by the consortium and will be available to all project participants under confidentiality constraints, or are owned by the consortium partners and the usage restrictions still apply. There is a need for certain datasets to remain closed according to the principle “as open as possible, as closed as necessary”, and we describe the datasets and constraints when applied. The project will use mostly existing data, from the established data providers/databases in our research area. Sections 1.1, 1.2 and 1.3 contain descriptions of identified datasets, expected size of the data and data providers.

The results, that is to say output data and the deliverables (describing assumptions, methodology, and assessments), will be made available, and details on intended strategy can be found in section 2.2. The consortium will use the identified data for modelling purposes, to test proposed research objectives and collect the data needed for the Solutions’ assessment, as a tool for progressing to the higher technology readiness level (TRL). It is likely that models used in Green-GEAR will create large amounts of data, most of which would not be of interest to a wider audience as related to the minutiae of running network under certain hypotheses. The consortium will hold three stakeholder workshops (this falls under WP6), to obtain feedback on the assumptions and results. We intend to use these opportunities to identify the resulting data that will be of interest to the wider audience.

1.1 WP3 Vertical Guidance using Geometric Altimetry

Table 2 lists the data sets to be used in the Geometric Altimetry Solution, and how to find this data.

Table 2. Input data sets for WP3.

Dataset	Information (and size)	Origin	Purpose
Traffic data	Historic traffic data of tracks of flights containing coordinates (or waypoints), timestamps, aircraft types, etc.	NATS surveillance data	Traffic data is used as the basis for fast-time simulation assessment. Using historic data ensures the fidelity of traffic loading by axis and ATC sector.
Airspace design	Existing TMA structures, procedures, routes and flying restrictions. Future TMA structures, procedures, routes and flying restrictions based on geometric altimetry.	NATS airspace design tools	Airspace design data is used as the basis for benefit assessment and fast-time simulation.

Dataset	Information (and size)	Origin	Purpose
Meteorological data	Many meteorological parameters (e.g. wind direction and speed, temperature and pressure eddy dissipation rate) are required for the geometric altimetry analysis. In particular, pressure data variation is key to analysing the current inefficiencies in barometric altimetry due to the Transition Layer.	Historic UK weather data in Gridded Binary GRIB2	Meteorological data is used in benefit assessment and fast-time simulation.
	Meteorological parameters such as wind direction and speed, air density, temperature, pressure for given areas and altitudes and/or along given flight tracks, e.g. ERA5 from ECMWF, size is several GB.	ECMWF, DWD or else	Required as input for flight simulations with geometric and barometric altimetry
Flight Data	Flight Data Recorder (FDR) data from example flights with A320 ATRA	DLR**	Validation of flight simulations
6-degree-of-freedom aircraft simulation model	Aircraft simulation model of A320 ATRA	DLR**	Detailed flight simulation for verification whether the change from barometric to geometric altimetry has an influence on flight dynamics of the aircraft
Base of aircraft data (BADA)	Aircraft properties such as wing span, wing area, drag polars, thrust, fuel flow for various example aircraft. The size of the data depends on the number of aircraft types used, but in any case it is only a moderately sized table.	EUROCONTROL*	BADA data forms the basis of the aircraft performance model used by the fast-time simulator.

* Access to the database subject to the approval for the license.

** For proprietary reasons data cannot be made available outside DLR.

1.2 WP4 Separation Minima

Table 3 below describes the datasets identified by the WP4 Separation Minima.

Table 3. Input data sets for WP4.

Dataset	Information (and size)	Origin	Purpose
Traffic flow data	For the collision risk analysis aggregated data (i..e passing frequencies) originating from tracks of flights containing coordinates (or waypoints), timestamps, aircraft types, etc. The available software for the wake vortex risk analysis uses a data format with a size of approximately 200MB for the aircraft trajectory data of 24 hours for the ECAC area, but the software could be adapted for other data formats as well if required.	EUROCONTROL, own adaptation for reduced separation	Passing frequencies and the traffic mix are necessary for the risk estimation. Aircraft trajectories are necessary for the wake vortex risk estimation.
Height keeping performance data	Height monitoring units are used to assess the height keeping performance of aircraft in the operational environment. The performance is specified in ASCII files. This type of data is required for the case where geometric altimetry is used.	EUROCONTROL,	Height keeping performance of different aircraft are important input parameters for the risk estimation.
Meteorological data	Many meteorological parameters (e.g. wind direction and speed, temperature, eddy dissipation rate) are required for the wake vortex risk analysis. These data need to be available for large areas and not just along the aircraft trajectories because the wake vortices typically drift away from the aircraft trajectories by several miles. The available software for the wake vortex risk analysis uses GRIB data, but the software could be adapted for other data formats as well if required. The size of a GRIB dataset for 24 hours for the ECAC area is approximately 5GB.	ECMWF	Meteorological data are necessary for the wake vortex risk estimation.
Base of aircraft data (BADA)	Aircraft masses and wingspans are required for the wake vortex	EUROCONTROL*	Aircraft masses and wingspans are necessary

Dataset	Information (and size)	Origin	Purpose
	risk analysis because the initial circulation of a wake vortex and also the descend rate of a wake vortex depend on these parameters. The size of the data depends on the number of aircraft types used, but in any case it is only a small table containing a few numbers.		for the wake vortex risk estimation.
Incident data related to non-nominal height deviations	Typically consists of incidents like level busts, wrongly (assigned) flight levels, etc. This data is typically gathered in the context of EUR RVSM collision risk assessment in order to perform the RVSM introduction evaluations.	EUROCONTROL	Is required for computing the total vertical error, which is part of the collision risk.

* Access to the database subject to the approval for the license.

1.3 WP5 Green route charging Solution

Table 4 lists the input datasets identified for the WP5.

Table 4. Input datasets for WP5.

Dataset	Information (and size)	Origin	Purpose
Airspace structure/designs	Airspace structures, procedures, routes and flying restrictions for en-route, ECAC wide (~20MB)	EUROCONTROL*	Capacity usage assessment
Demand data repository 2 (DDR2)	Flight intentions, flight plans, actual trajectories, flight attributes, ATFCM measures, etc. (~5GB)	EUROCONTROL*	Europe-wide modelling of the route charging mechanism impact
Aviation Data for Research	Flight intentions, flight plans, actual trajectories, flight attributes, etc. (~5GB)	EUROCONTROL*	Europe-wide modelling of the route charging mechanism impact, in case the DDR2 data is not available
Base of aircraft data (BADA)	Aircraft performance data (size depends on the number of aircraft types used)	EUROCONTROL**	Aircraft trajectory performance modelling, assessment of emissions
Unit rates	Unit rates applied by different states in the ECAC area. Unit rates applied by different states in the ECAC area (~1MB)	EUROCONTROL	Baseline modelling of current route-charging and further economic and environmental assessments
Cost of delay	Cost of delay functions, including various cost components, for strategic and tactical applications (~1MB)	UoW	Economic evaluation of route-charging mechanisms

Dataset	Information (and size)	Origin	Purpose
ERA5	Weather forecast for the state of Atmosphere (several GB)	Climate Data Store[3]	Assessment of emissions at network level
Stated Preference Survey	Data on attributes of route charging alternatives	Green-GEAR collection	Estimation of airline utility functions
Aircraft database	Aircraft registrations, engines, age	OneSky Network	More accurate emissions estimation
ICAO Aircraft Engine Emissions Databank (EDB)	ICAO Emissions Databank for use with pycontrails library	ICAO	Emissions estimation

* Data available under the license terms and conditions.

** Access to the database obtained, under license.

The data available to UoW, under license restrictions.

1.4 WP2 Common methods and data integration

The planned Green-GEAR Solutions address different, but related topics. Demonstrating the synergies of Green-GEAR, the Solutions are supported by the Common Assessment Methods Task 2.3. The planning and the requirements of specific experiments needed, having the same approach to definition of research hypotheses, definition of experimental/validation scenarios, reliability, sensitivity and validity of exercises, generalisation of the exercise results and their transfer to the operational environment, is secured through this approach. As a part of this, we are trying to streamline the baselines across the Solutions. Here we report on the ongoing choices for the baseline scenario dates.

Figure 1 depicts the network traffic evolution across months, for years 2019-2023. As can be seen, 2023 traffic (purple line) is still lower than the traffic in 2019 (blue line). The traffic in years 2020-2022 was impacted by the Covid-19 and related travel restrictions. In year 2023 we see the recovery, but the traffic levels are not yet at the 2019, even though the delays are already higher than in 2019, which was the year with the highest demand so far. Average number of flights in September 2019 was 30917, with the 1,79 min of ATFM delay per flight. Even though the average number of flights in September 2023 is lower (28047), the delays are significantly higher, at 2.08 min/flight[4].

The 2023 traffic numbers are still catching up with the 2019 ones, but creating much higher ATFM delay, which is one of the indicators that the ATM situation is still in the recovery mode. As the years 2020-2022 were still under direct pandemic impact, we believe that the best choice for the baseline traffic data for modelling of the ECAC area, is year 2019.

[3] https://cds.climate.copernicus.eu/

[4] Source: https://www.eurocontrol.int/Economics/BalancedScorecard.html

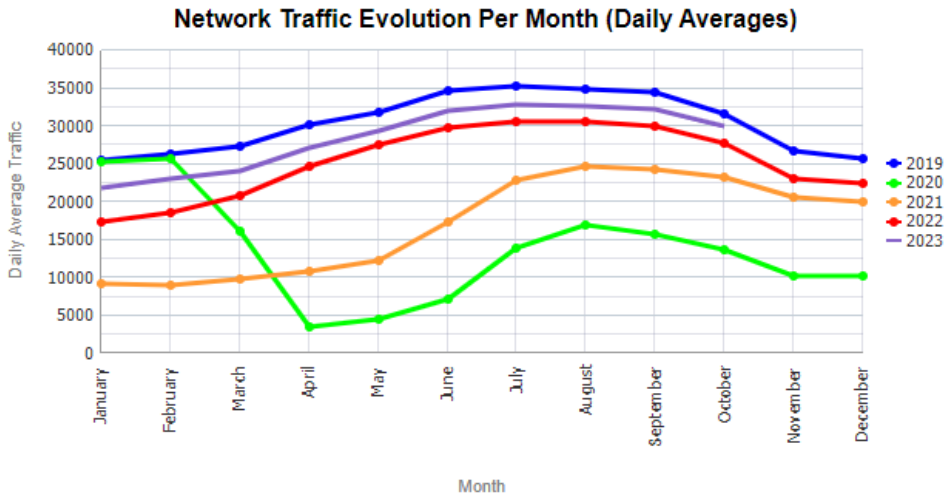

Figure 1. Network traffic 2019-2023 (source: EUROCONTROL's Network Dashboard).

Environmental impact of the Green-GEAR Solutions is an important part, and the aircraft emissions depend on the aircraft age and the age of engines.

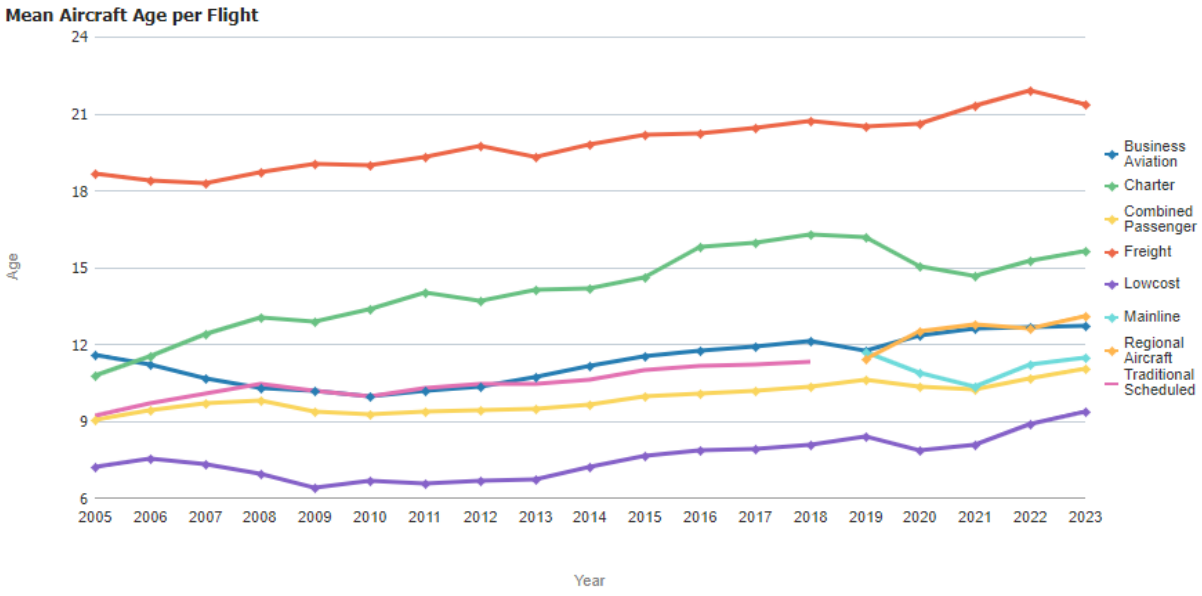

Figure 2. Mean aircraft age per flight, 2005-2023 (source: EUROCONTROL's STATFOR).

Thus, the traffic and weather data (and other datasets, if needed) will be sourced for 2019. The consortium is still discussing the exact time frame needed, i.e. a day, a week, a month, or a few months. Thus, for the ECAC area modelling, the traffic from September 2019 will be chosen, as it contains busy traffic, delays are not excessive, and the autumn weather conditions can facilitate the creation of contrails (which is one of the negative environmental impacts of aviation).

However, the TMA simulations will need to take 2023 as a baseline year due to the significant change in traffic mix using the London TMA pre- and post-pandemic. Examples include: heavy quad-engined

jets have largely been retired, the loss of Flybe Dash 8s, and many airlines have taken the opportunity to bring in new fleets. Furthermore, there has also been a major airspace change affecting the north LTMA since 2019 (“SAIP AD6”).

As the GeoAlt Solution depends on the aircraft characteristics and their equipage, it has been decided to use 2023 London TMA traffic in the exercises (for baseline, and building the future scenarios).

2 FAIR data

2.1 Making data findable, including provisions for metadata

The data that can be shared will be shared, the provisions (how, identifiers to be used, etc.) are described in the following sections. For the input datasets that cannot be shared, Table 5 gives details on where to find them and what are the access requirements. The databases listed here all have their own metadata.

Table 5. Information to find data used in Green-GEAR.

Dataset	Information
Demand data repository 2 (DDR2)	EUROCONTROL's database: https://www.eurocontrol.int/ddr, with the following access conditions: "Access to the DDR portal is restricted to air navigation service providers (ANSPs) and airline operators (AOs) within Europe, on the basis of approval of a licence agreement and formal acceptance by EUROCONTROL. Airlines are allowed to download (historical or forecast) traffic data for their own fleets only."
Airspace structure/ designs	This is one of the files available through the DDR2 database, falls under the same access conditions as DDR2.
Aviation Data for Research	EUROCONTROL's database: https://www.eurocontrol.int/dashboard/rnd-data-archive, with the following access conditions: "In order to access the Aviation Data for Research Repository, users need to first register to OneSky Online (the EUROCONTROL Extranet), then request access to the Aviation Data set itself. The repository is open for all R&D use. Please consult the Terms of Use that have to be signed-off by each individual user."
Base of aircraft data (BADA)	EUROCONTROL's aircraft performance database https://www.eurocontrol.int/model/bada , with the following access conditions: "The use of BADA is regulated through a license agreement which stipulates the terms and conditions of use based on the contractual constraints EUROCONTROL is committed to with its data providers. The provision of access is subject to EUROCONTROL's approval. In order to request a BADA licence, you must: Register to EUROCONTROL's OneSky Online – your secure path to many of EUROCONTROL's online tools and dashboards, including BADA. Log in and access the BADA User Interface."
Unit rates	EUROCONTROL's Aviation Intelligence dashboard: https://www.eurocontrol.int/ServiceUnits/Dashboard/EnRouteUnitRates.htmlhttps://www.eurocontrol.int/ServiceUnits/Dashboard/EnRouteUnitRates.html. The site provides the graphs and metadata.
Cost of delay	The data is available at these references [1] [2].
ERA5	This data is provided by ECMWF and Copernicus and is licensed, but freely available. Details on datasets and access can be found here: https://confluence.ecmwf.int/pages/viewpage.action?pageId=88257857 and here: https://cds.climate.copernicus.eu/#!/home https://cds.climate.copernicus.eu/
Aircraft database	Available on OpenSky Network portal, freely available for research purposes: https://opensky-network.org/aircraft-database, Terms of Use and License agreement can be found here: https://opensky-network.org/about/terms-of-use

Dataset	Information
ICAO Aircraft Engine Emissions Databank (EDB)	The dataset is hosted by EASA on behalf of ICAO: https://www.easa.europa.eu/en/domains/environment/icao-aircraft-engine-emissions-databank. Terms of Use and License agreement: TBD

To enable researchers to find and use the input data, the exact data used from each database will be described in the DMP updates, as those depend on the methodology and modelling choices that are currently being made by the consortium.

2.2 Making data accessible

2.2.1 Repository

As mentioned in the section 1, the input data will be available under "as open as possible, as closed as necessary" conditions. The results of interest to the ATM (and wider) research community will be provided. Depending on the format of results, their size and eventual confidentiality or licensing, we foresee the use of the following options:

- Trusted repositories,
- As appendices in public deliverables,
- On request,
- Making the code available, through the trusted repository.

The consortium partners have explored and used Zenodo[5] in the past (for example see [3]). Zenodo is an open platform, born from OpenAIRE project and managed by CERN. This would be our first choice for the repository.

Some results could be rather small, in case of which, we plan to include those as appendices in the public deliverables. The deliverables will be available at the project website, and at the CORDIS website, under the project results. The Green-GEAR project permanent identifier is the following: doi: 10.3030/101114789.

In case a portion of results end-up deemed as restricted, we foresee that the interested parties might request the data from results owners. In this case, the description of the procedure will be included in one of the planned DMP updates.

[5] https://zenodo.org/

2.2.2 Data

As already mentioned, many of the input datasets are subject to licensing and related restrictions. Table 6 describes the restrictions on the closed datasets.

Table 6. Description of the restrictions for the closed datasets.

Dataset	Restrictions description
Demand data repository 2 (DDR2)	Access to the portal is restricted to air navigation service providers (ANSPs) and airline operators (AOs) within Europe, on the basis of approval of a licence agreement and formal acceptance by EUROCONTROL. Downloads and generation operations are subject to counters, which limits the number of weekly operations per user. Access to the tool and downloaded data cannot be shared. Access is restricted
Airspace structure/designs	Access to the portal is restricted to air navigation service providers (ANSPs) and airline operators (AOs) within Europe, on the basis of approval of a licence agreement and formal acceptance by EUROCONTROL. Downloads and generation operations are subject to counters, which limits the number of weekly operations per user. Access to the tool and downloaded data cannot be shared.
Aviation Data for Research	The 'Aviation Data for Research' ATM Datasets must be used exclusively for R&D purposes and in accordance to terms of use specified in a licence agreement.
Base of aircraft data (BADA)	BADA is subject to the license agreement. Each user needs to request access, for a specified purpose, which is subject to approval. The License lists additional restrictions on the use, as "YOU are strictly prohibited from using BADA for any comparisons of any kind between aircraft types (from the same or different aircraft manufacturers) where the intent of such a comparison is to identify a direct relationship between aircraft performances between different aircraft types. Therefore, YOU shall not mention any name of aircraft type in the publication. However, general (system-wide) comparisons of aircraft performance of different aircraft types for research purposes to assess ATM system performances may be allowed."
Flight data	Access restricted due to proprietary reasons.
6-degree-of-freedom aircraft simulation model	Access restricted due to proprietary reasons.

The results that are of interest to the research community will be identified during the project, at the stakeholder workshops, and will then be made available based on the strategy described in section 2.2.1.

2.2.3 Metadata

The datasets used as the input data all have their own metadata which is available from the data provider.

For the research results and other outputs, we will strive to use trusted repositories and permanent identifiers. To the best of our knowledge, this is the longest and as permanent as available today. The metadata and any needed additional information will be provided together with the data.

2.3 Making data interoperable

The consortium will strive to make results interoperable, following the standards in the ATM.

2.4 Increase data re-use

For the input data, we will provide the assumptions, and where available filtering code, to enable other researchers to use the same data, under same assumptions. These will be available within the project deliverables, and if necessary linked to the results' data repositories.

For the results chosen for publication (see sections 1 and 2.2.2), the consortium will provide necessary documentation, description, and code if needed.

3 Other research outputs

The pre-prints display the transparency of the peer-review process, and allow for collecting feedback from scientific community. Green GEAR will submit the project publications to arXiv (https://arxiv.org/, a well-known pre-print server for science) as soon as the publications are submitted to journals for peer review.

The consortium commits to following the guidelines of the Horizon Europe Open Access policy, especially to providing the open access to peer-reviewed scientific publications (Gold or Green Open Access models will be used), as each Horizon Europe beneficiary must ensure open access (free of charge) to all peer reviewed scientific publications of its results (in accordance with Article 17 of the Model Grant Agreement and the guidelines on complying with them provided in the Annotated Grant Agreement (Article 17)). The authors will retain sufficient intellectual property rights to comply with the open access requirements, see Table 7

Table 7. Type of research output and access strategy.

Type	Availability	Location
Deliverables	Public	Project website, CORDIS (doi: 10.3030/101114789)
White papers	Public	Project website, CORDIS (doi: 10.3030/101114789)
Conference papers	Public	E.g. SESAR Innovation Days[6], ATM R&D Seminar[7], ICRAT[8]
Journal papers	Public through open access or academic sharing archives like arXiv	Chosen journals, with the green or gold open access policy for publications

[6] https://www.sesarju.eu/sesarinnovationdays

[7] https://www.atmseminar.org/

[8] https://www.icrat.org/

4 Allocation of resources

We do not foresee any costs for making data and other research outputs FAIR. For the input data that needs to be "as open as possible, as closed as necessary", the consortium will provide the description of the data and the ways of obtaining access and appropriate licenses.

The results and other research output will be made FAIR, according to the strategy described in section 2.2.1, which is free, and as permanently available as possible today. Which results will be published will be decided later on in the project, in consultation with stakeholders (on the usefulness of data) and consortium partners (on the details of how, where and for how long). These details will be provided in the scheduled DMP updates.

The UoW, as WP2 leader is responsible for the overall data management in the project. However, there are some aspects that each partner will be providing. Table 8 lists the Data Protection Officers of partners and person responsible for data management within the project.

Table 8. Data protection officers of Green-GEAR partners.

Partner	DPO	E-mail	Comment
DLR	Uwe Gorschütz	datenschutz@dlr.de	Data Protection Officer
EUROCONTROL	Jurgen TOCK	jurgen.tock@eurocontrol.int	Data Governance Officer
	Hans Holderbach	data-protection-officer@ eurocontrol.int	Data Security Officer
NATS	John Godsell	John.godsell@nats.co.uk	Responsible for data management within project.
NLR	Patrick Jonk	patrick.jonk@nlr.nl	Responsible for data management within project.
	Odette van Randwijck	Odette.van.Randwijck@nlr.nl	Privacy Protection (contact via Patrick Jonk)
UNITS	Valentina Carollo	dpo@units.it	Data Protection Officer
	Lorenzo Castelli	castelli@units.it	Responsible for data management within project.
UoW	Elaine McMillan	dpa@westminster.ac.uk	Data Protection Officer
	Tatjana Bolic		Responsible for data management within project.
Airbus	Pascal Andrei		Chief Security Officer
Airbus Operations SAS	Pascal Andrei		Chief Security Officer

5 Data security

As explained in the section 2.1, most of the input data will be sourced through the data providers, which have their own provisions on the data security, recovery and transfer of data.

Regarding the results, based on the type of results (see section 2.2.2 for the publication strategy), different repository options will be possible. The consortium intends to store data in trusted repositories, those that currently have the long-term preservation available, accompanied with all the necessary documentation.

The details will be added in the planned update of this DMP.

6 Ethics

We do not foresee ethics or legal issues impacting results sharing (the input data are subject to licensing agreements, as described in section 2).

The only resulting data set that touches upon ethics issues is the data that will be **derived** from the Stated Preference Survey. The Survey will be anonymised and the appropriate informed consent forms will be included into it, as described in deliverable D1.2 Ethics Plan.

7 Other issues

Not applicable.

8 References

[1] A. Cook and G. Tanner, " European airline delay cost reference values, updated and extended values. Technical report,," University of Westminster, 2015.

[2] BEACON consortium , "D3.2 Industry briefing on updates to the European cost of delay," 2021.

[3] G. Gurtner, *Air Traffic Management hotspots in Europe with airline cost functions,* Zenodo, 2023.

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