Guide on Copernicus DEM GLO-30 for Flight Procedure Design

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Executive summary

An Instrument Flight Procedure (IFP) is a fundamental component of the aviation industry. The use of accurate and proper terrain and obstacle data is critical to ensuring the safety and quality of the procedure.

The approval and implementation of flight procedures are the responsibility of a certified Flight Procedure Design Organization, in accordance with EU regulation 2017/373 [RD 6].

All flight procedures must be designed in accordance with the criteria specified in ICAO Doc 8168 (Vol II) *Procedures for Air Navigation Services – Aircraft Operations, commonly known as PANS OPS* [RD 1]. Requirements regarding obstacles and terrain are defined in ICAO Annex 15 Aeronautical Information Services [RD 3]. The terrain-related provisions of ICAO Annex 15 are transposed into EU legislation through EU Regulation 2017/373, specifically in **Annex VI- Part-AIS**.

The Copernicus DEM (Digital Elevation Model) (henceforth, CopDEM) is a Digital Surface Model (DSM) which represents the surface of the Earth including buildings, infrastructure, and vegetation. The CopDEM is provided in three different instances, named EEA-10, GLO-30, and GLO-90, which vary in access permissions, geographical extent, spatial resolution and format. These guidelines focus on the acquisition of **Copernicus GLO-30,** as its technical characteristics make it suitable for Flight Procedure Design (FPD) without additional cost to the user.

The **Copernicus Data Space Ecosystem (CDSE)** serves as the official gateway to satellite imagery from the Copernicus Programme.

According to the terrain data value requirements defined in ICAO Annex 15 [RD 3] for the four designated coverage areas, the technical specifications of Copernicus GLO-30 meet the criteria for Area 1 (the entire territory of a State) and Area 2 (the vicinity of an aerodrome).

For the adoption of CopDEM in EU falling under EASA regulation, the terrain data source shall either be officially recognized by National Aviation Authorities from sources that have been validated according to the specifications set out in EU Regulation 2017/373 [RD 6], or undergo a data validation process performed by the FPD provider as specified in GM1 to AMC1 FPD.OR.100 “Flight procedure design (FPD) services NON-AUTHORITATIVE SOURCE”.

Requirements for the adoption of CopDEM outside the umbrella of EASA regulations have not been assessed since these guidelines fall beyond its scope.

In general, users intending to utilize CopDEM for FPD activities should ensure that its technical features align with their applicable regulatory framework before use.

The development of an IFP design follows a series of steps from data acquisition to final publication. This document outlines how Flight Procedure Design organizations can acquire and download CopDEM datasets for use in the IFP design process.

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ACKNOWLEDGEMENTS

This section acknowledges the individuals and organizations whose insights and expertise have contributed to the validation and review of the content presented in this document. Each acknowledgment represents a valuable contribution towards ensuring the accuracy and reliability of the information herein presented.

Special thanks to the European Union Copernicus Programme for providing publicly available data for free and under an open license.

1 Purpose of the document

This document aims to introduce Flight Procedure Design Organizations to the benefits of using Copernicus Digital Elevation Model (DEM) as a potential terrain/surface data source for the design of Instrument Flight Procedures. The document includes:

- Guidance on accessing and downloading the data.
- Copernicus DEM technical characteristics
- Considerations and applicability
- Value proposition of Copernicus DEM, including reasons to switch from other alternatives.

2 Guidance on how to access and download Copernicus data.

The Copernicus DEM is provided in three different instances, named EEA-10, GLO-30, and GLO-90, which vary in access permission, geographical extent, spatial resolution, and format, as explained in Section 3. These guidelines focus on the acquisition of **Copernicus GLO-30,** since it offers technical characteristics suitable for FPD without additional cost to the user.

Copernicus DEM GLO-30 is a public, free-to-use DEM that offers global coverage at a spatial resolution of 30 meters. The data is available at the Copernicus Data Space Ecosystem (CDSE). The CDSE serves as the official gateway to satellite imagery from the Copernicus Programme, providing access to data and resources for users.

The information provided in this section describes (as of June 2025) how to access and download Copernicus DEM data. Readers must be aware that CDSE may change over time in how to access and download this data. In the event of any doubt or future misalignment with the process described below, users are encouraged to visit the documentation portal, refer to the CDSE Forum, or submit a request via their user support helpdesk.

CDSE offers a wide range of infrastructure, services, and tools designed to unlock the full potential of Earth observation data. However, since these guidelines focus on the downloading process to obtain data for particular use in the FPD designing process, the most suitable steps for this purpose are described below.

While there may be other ways to download Copernicus data, the Copernicus Browser from the CDSE serves as the official gateway to satellite imagery from the Copernicus Programme, and hence the only method covered by this guide.

To access and download CopDEM through the CDSE, the following steps should be followed:

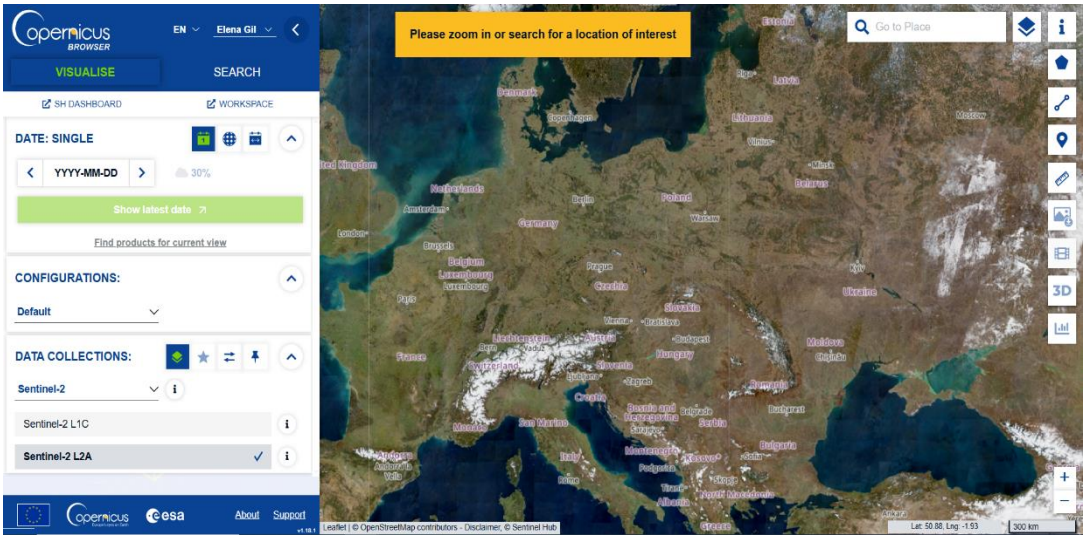
- Create a free **CDSE account** at https://dataspace.copernicus.eu/. Go to the register or login page to create the new account, or use this link, and then complete all mandatory fields.

  Important: Use the checkbox to include the access to CCM (Copernicus Contributing Missions) data in the request. By clicking this box, a second section will need to be filled in; choose *"Public"* as user category and *"Not Applicable"* for Copernicus Service Project name.

Note that once access has been requested to the CCM data, it may take some time to gain access to the system. A verification email confirming access to Copernicus Contributing Missions will be sent to the registered email.

CopDEM data can be visualized and downloaded from the **Copernicus Browser,** an easy-to-use interface to viewing and analysing satellite imagery. The CDSE offers the option to use Application Programming Interfaces (API) to perform automated downloads; however, it is assumed this is not a common practice in the field, and therefore its use is not covered in this guide.

- Once the account is created, access to the Copernicus Browser will be allowed. Click on Copernicus Browse or 'Explore data', and the following page will appear:



The Copernicus Browser offers two ways to obtain and download available data, through the tabs 'VISUALIZE' and 'SEARCH'. These allow geographically selecting data by custom area of interest (AOI) or by predefined grids, respectively:

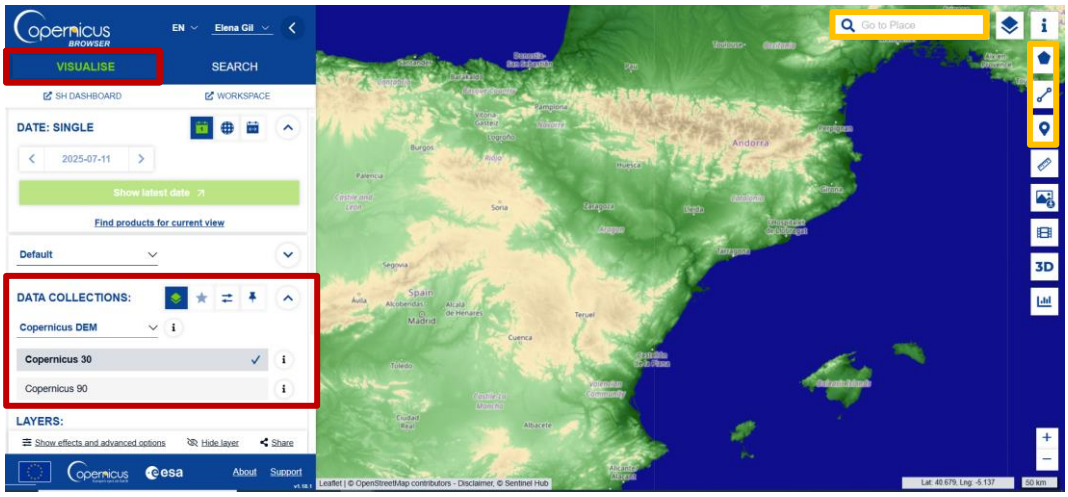
  - Predefined grids
    - Grids cover 1 x 1-degree areas.
    - Each grid comes in a separate file.
    - Grids can be selected by defining an AOI. If AOI covers multiple areas and a single DEM file is needed, stitching must be done by the user.
    - Files contain metadata
  - Custom AOI
    - CDSE provides a single file, even if AOI spans multiple grids.
    - Aspects such as image format, resolution or coordinate system can be user-defined.

- Download **by custom AOI:**

  1. Click on **'VISUALIZE'**
  2. Under the **Configurations pane**, select **"Default"** from the dropdown menu.

     Under **Data Collections**, select **Copernicus DEM.** Two **freely** available product resolutions are provided, CopDEM GLO-30 (30 m) and GLO-90 (90 m). Copernicus DEM EEA 10 is offered as a data source as well; however, **EEA-10 is a COP DEM data set available for eligible users only.**

     Check '**Copernicus 30' for Copernicus GLO-30** (it might be needed to zoom in to visualize Copernicus DEM in the browser as in the image below)



3. To define an area of interest, the Copernicus Browser provides three different alternatives in the options on the right:

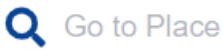
   - To '**Create an area of interest**' , which allows drawing a rectangle or a polygonal area over the region wanted to retrieve data from, by using the available options.

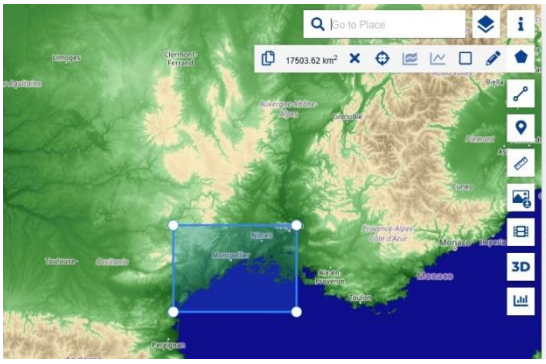
   - To **'Draw a line'** , which allows drawing a line over the region wanted to retrieve data from.

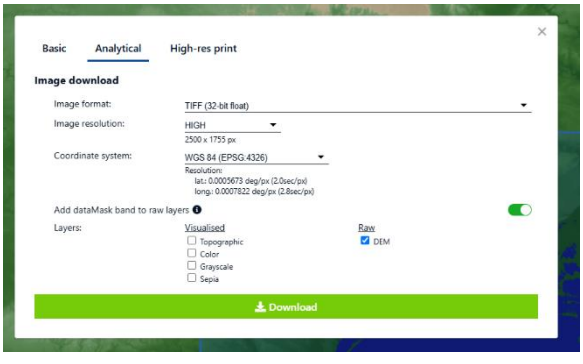
   - To **'Mark point of interest'** , which allows placing a mark at a point of interest.

   In order to find the region of interest, Copernicus Browser includes a search pane.

4. Once the area is selected, click on **Download image** , and a new window will appear:





5. Navigate to the **Analytical tab** and select the desired options to download the data file (i.e., raw -> DEM). A compressed file will be automatically downloaded.

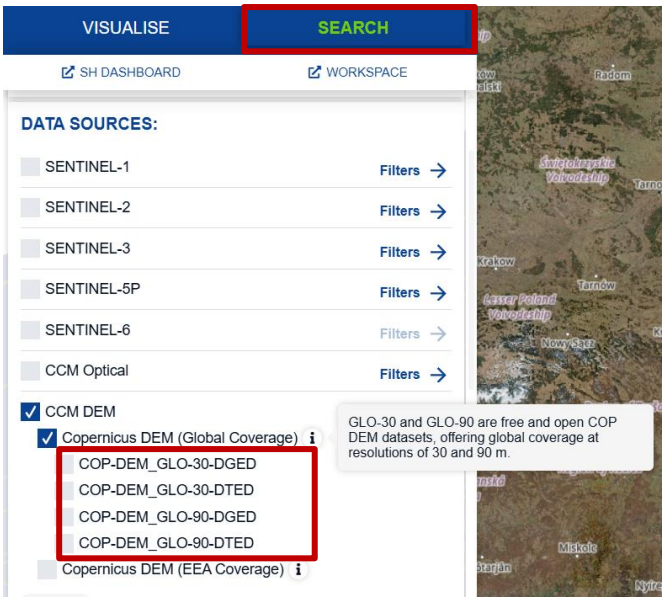
Note that by using a custom AOI, information downloaded will not include the corresponding XML file with either the metadata or quality layers.

- Download by **predefined grids**:

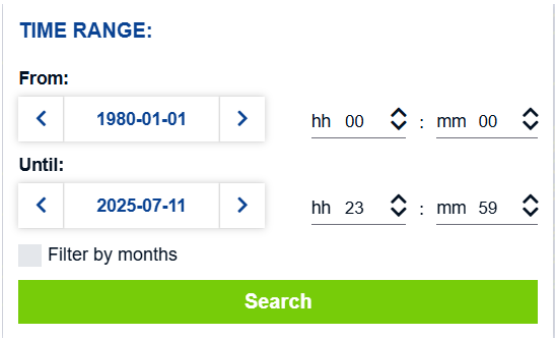
1. Click on **SEARCH** and select the relevant DATA SOURCES.

   Both Copernicus GLO-30 and GLO-90 provide two product formats, DGED (Defence Gridded Elevation Data) and DTED (Digital Terrain Elevation Data).

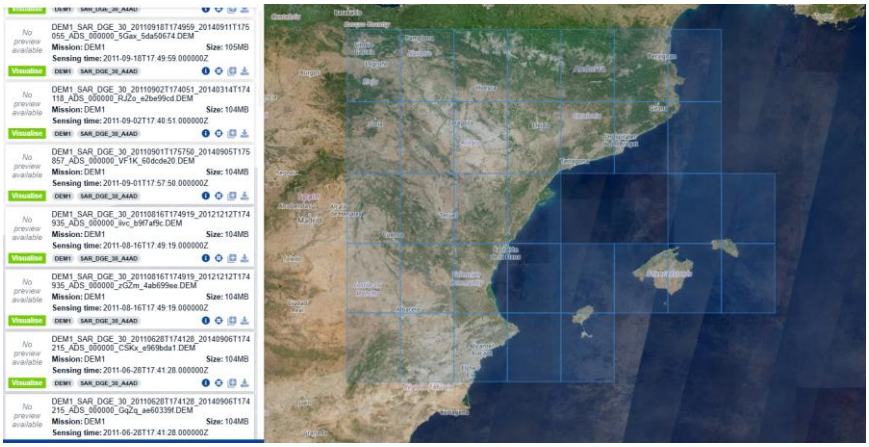
   Further information on the difference between products can be found in section 3, Copernicus DEM Technical characteristics.



2. In **TIME RANGE**, a month-time window is shown by default, setting the current date as 'To' date (e.g., From 2025-06-11 and To 2025-07-11). An earlier date as '**From'** date shall be selected to reflect previous or existing products (e.g., From 1980-01-01 and To 2025-07-11).



3. Optional. An area of interest can be drawn by using the tools explained before to limit the region to search for available products from.
4. Click on **Search** at the bottom of the page, and all available products will show up in a list on the left, and the grids' outlines will show on the map, as in this image:



5. Click on **a grid** to open a new window.
6. Then, click on the ⓘ **(info) icon** to view and download all available data for the selected area.

3 Copernicus DEM Technical characteristics

The Copernicus DEM is a Digital Surface Model (DSM) which represents the surface of the Earth, **including buildings, infrastructure, and vegetation**. Copernicus DEM is derived from an edited DSM named WorldDEM™, in which editing offshore and coastlines, special features such as airports and implausible terrain structures have been applied. For full product specification please refer to Copernicus DEM Product Handbook [RD 2]

The WorldDEM product is based on the radar satellite data acquired during the TanDEM-X Mission, which was funded by a Public Private Partnership between the German State, represented by the German Aerospace Centre (DLR) and Airbus Defence and Space.

The Copernicus DEM is provided in 3 different instances named **EEA-10, GLO-30 and GLO-90**. The Copernicus DEM instances have:

- Varying access permissions
  - Free and open CopDEM data sets: GLO-30 and GLO90
  - CopDEM data set available for eligible users only, **to be accessed by authorized organizations only**: EEA-10
- Varying geographical coverage
  - global coverage: GLO-30 and GLO90
  - area of the EEA member states and the 6 cooperating countries (EEA39): EEA-10
- Varying spatial resolution (0.3 to 3.0 arc seconds)
- Varying format
  - DGED (Defence Gridded Elevation Data): Data provided as 32-bit floating point data in GeoTIFF file format, including the corresponding XML metadata and quality layers.
  - DTED (Digital Terrain Elevation Data): Data provided as 16-bit signed integer in GeoTIFF format. Corresponding XML files are provided with this version, but no quality layers.
  - INSPIRE: This format is only available for the EEA10 instance.

Considering the technical features of the Copernicus DEM data set, this document covers only the Copernicus DEM GLO-30, as it offers technical specifications suitable for FPD without additional cost to the user. In contrast with GLO-30, EEA-10 is not publicly available, and GLO-90 is of lower resolution. Hence, they have been excluded from this document.

The main technical specifications for the Copernicus DEM instance GLO-30 are summarized in the table below:

Specification Parameter		Value
File Format		GeoTiff | DTED
File Data Type		32 Bit, floating point (DGED) or 16 Bit, signed integer (DTED format)
Coordinate Reference System	Horizontal	WGS84-G1150 (EPSG 4326)
	Vertical	EGM2008 (EPSG 3855)
Grid Spacing		1.0”
Absolute Vertical accuracy		< 3m in the 95% of all geocells in the EEA39 ($LE90_{ABS}$ DLR) (as per Copernicus DEM Validation Report) < 4m (90% linear error) as per Copernicus DEM Product Handbook)
Relative Vertical Accuracy		< 2m (slope ≤ 20%) < 4m (slope > 20%)
Vertical resolution		6 significant figures
Horizontal accuracy		< 6m (90% circular error)
Confidence level		Quality values shown at LE90
Date stamp		Oldest data from 2011 Latest revision from 2024

Table 1 Copernicus DEM specification parameters (DGED and DTED format)

For more detailed information on the Copernicus GLO-30 (and other Copernicus DEM instances) main specifications and validation results, both the Copernicus DEM Product Handbook [RD 2] and the Copernicus DEM Validation Report [RD 8] can be consulted.

4 Considerations and applicability

Copernicus DEM GLO-30, as seen in [Section 3] offers technical characteristics that align with the terrain data requirements specified in ICAO Annex 15. As such, it is suitable for use in flight procedure design strictly as terrain data. Flight Procedure Design Organizations considering the use of the Copernicus DEM GLO-30 should be aware of several considerations, including the contexts in which it is appropriate for use.

The following considerations have been identified under the umbrella of ICAO and EASA regulatory framework. In general, users willing to make use of CopDEM for FPD activities should ensure that its technical features align with the user's applicable regulatory framework before its use.

CONSIDERATIONS:

- **DSM vs DTM:**

  Copernicus DEM GLO-30 data is obtained using radar interferometry techniques. This involves using radar signals to measure the height of the surface of the Earth, creating a Digital Surface Model (DSM) that **includes features like buildings and vegetation.**

  It is important to understand that **terrain and obstacles are two different data sets**. Terrain data shall contain digital representations of the terrain surface in the form of continuous elevation values at all intersections of a defined grid referenced to a common datum (like in Copernicus DEM), whereas obstacle data shall contain the digital representation of the vertical and horizontal extent of obstacles that in terms of aviation constitute a potential hazard to aircraft operations due to its vertical significance compared to the surrounding terrain or features [RD-7]

  As stated in **ICAO Annex 15 Para 5.3.3.4.1:**

  > *"Obstacles data shall not be included in terrain data sets".*

  So, for the purpose of acquiring both values, different data sets should be used. Obstacles **can't be directly extracted** from Copernicus DEM GLO-30. In this context, since the Copernicus DEM can be considered as a DSM, for it to be contemplated as a terrain data set, procedure designers may need to:

  - Remove above-ground features manually or through algorithmic filtering, or
  - Conduct a suitability assessment to determine whether the existing DSM data, in its current form, meets the required accuracy and operational thresholds for the intended application. In this case, the responsible organization must document and justify that the data's characteristics are sufficient for safe and compliant use as terrain data.

- **Data authoritativeness:**

  As per **AMC1 FPD.OR.100:**

  "The FPD provider should use data coming from authoritative sources. If the data used is not formally made available by an authoritative source or does not meet the applicable data quality requirements (DQRs), but is required by end users, the FPD provider may use data from other (non-authoritative) sources, provided such data has been verified and validated by the FPD provider itself and/or other ATM/ANS providers to conform with the relevant standards and DQRs"

  Prior to using Copernicus DEM GLO-30 data, FPD organizations should confirm with their National Civil Aviation Authorities whether it qualifies as an authoritative source. If it does not, as described in GM1 to AMC1 FPD.OR.100 Flight procedure design (FPD) services NON-AUTHORITATIVE SOURCE for the use of non-authoritative sources, the FPD organization may need to perform appropriate validation of the data:

  "When validating data from a non-authoritative source, the FPD provider should proceed by using either additional information sources to validate this data (like satellite imagery, data or manuals from other providers, users, military, etc.), or data which has been tested and confirmed through operations."

- **Vertical Reference System**

  The vertical reference system used by Copernicus DEM is the EGM2008 geoid. In contrast, aviation regulations—including ICAO Annex 15—commonly require data to be expressed relative to the EGM96 geoid.

  EGM2008 is an improved model offering higher resolution and accuracy, but for compatibility reasons, a vertical transformation to EGM96 may be necessary to ensure integration with other aeronautical data sets and tools.

APPLICABILITY:

According to **ICAO Annex 15** [RD 3], there are four different coverage areas where different numerical value requirements apply for terrain data:

- Area 1: The entire territory of a State.
- Area 2: The vicinity of an aerodrome.
- Area 3: An area bordering the movement area on an aerodrome.
- Area 4: The radio altimeter area operating in front of a precision approach runway, Category II or III.

Concerning the required accuracy, the specific numerical values for terrain are detailed below:

	Area 1	Area 2	Area 3	Area 4
Post Spacing	3 seconds in arc (approx. 90 m)	1 second in arc (approx. 30 m)	0.6 seconds in arc (approx. 20 m)	0.3 seconds in arc (approx. 9 m)
Vertical accuracy	30 m	3 m	0.5 m	1 m
Vertical resolution	1 m	0.1 m	0.01 m	0.1 m
Horizontal accuracy	50 m	5m	0.5 m	2.5 m
Confidence level	90%	90%	90%	90%
Data classification integrity level	ordinary	essential	essential	essential
Maintenance period as necessary	as necessary	as necessary	as necessary	as necessary

Table 2 ICAO terrain data requirements.

Considering the previous table, it can be assumed that **Copernicus GLO-30 is in line with the terrain data requirements for Area 1 and Area 2**.

Finally, yet importantly, the **Copernicus DEM GLO-30** data set is expected to continue receiving **maintenance** updates, corrections, and improvements **until at least 2026**. After this maintenance period, the data set will remain freely accessible for download through the Copernicus CDSE. Users are encouraged to periodically check for updated releases to ensure they are working with the most accurate and current version of the data.

We can conclude that **Copernicus DEM GLO-30** is a valuable resource for flight procedure design, especially for initial terrain modelling and analysis in **Area 1 and Area 2** regions.

5 Value proposition

When considering free-to-use elevation models, Copernicus Digital Elevation Model stands out as a widely recognized and valuable resource. However, it's essential to acknowledge that Copernicus is not the sole option in this domain. NASA's SRTM, ALOS AW3D30 and national DEMs, among others, are offered as other free-to-use alternatives.

Despite the availability of these alternatives, Copernicus DEM maintains a unique value proposition, especially when compared to other free-to-use Global Digital Elevation Models (GDEM) such as SRTM and AW3D30.

Taking all this into consideration, here are some advantages of using Copernicus data when compared to different Digital Elevation Models:

Improved accuracy against other GDEMs

Overall, Copernicus DEM GLO-30 stands as the most accurate free-to-use GDEM.

Numerous studies, including "Novel approach for ranking DEMs: Copernicus DEM improves one arc second open global topography" [RD 5] or "Vertical accuracy assessment of freely available global DEMs (FABDEM, Copernicus DEM, NASADEM, AW3D30 and SRTM) in flood-prone environments" [RD 4] have shown that the Copernicus DEM outperforms other 1" GDEMs that are free of cost in terms of both vertical and horizontal accuracy values.

Below can be found a table extracted from [RD 4] with the error metrics for each freely available GDEMs:

Metric (m)	SRTM	AW3D30	GLO-30 (DGED)	GLO-30 (DTED)
ME (m)	2.42	3.04	2.00	2.00
MAE (m)	3.72	3.66	2.53	2.56
STD (m)	4.81	4.88	4.46	4.47
RMSE (m)	5.38	5.75	4.89	4.89
Median (m)	1.65	1.85	0.21	0.28
NMAD (m)	3.65	2.82	1.27	1.38
LE90 (m)	8.47	8.89	7.71	7.72
LE95 (m)	11.19	13.15	12.00	11.98

Table 3 Overall error metrics for each DEM [RD 4]

To assess the vertical accuracy of each DEM listed in the table above, a total of 65 collated DTMs derived from airborne LiDAR surveys (each with a reported RMSE value within 0.3 m) were used. For more references on how these values were obtained, see document [RD 4].

Considering all the measured variables, Copernicus DEM GLO-30 stands out as the most accurate solution overall. Utilizing the best available GDEM improves and enhances safety throughout the entire flight procedure design process.

Potential Cost Savings where a national DEM is not available:

There is potential for cost savings in the design process, particularly regarding the terrain product. By utilizing the Copernicus DEM, expenses on buying a Digital Elevation Model for the target area or hiring third-party services for site surveys can be minimized or avoided altogether.

In general, national DEMs, using high-precision Light Detection and Ranging (LiDAR) surveys deliver high-resolution DTMs at higher accuracies than GDEMs, including Copernicus DEM. IGN's DTM5, for instance has a free-to-use DTM5 with a spatial resolution of 5m with vertical accuracies of down to 0.2m.

These surveys are usually only available in limited areas (national territory), and only in high-income countries, so **Copernicus DEM can be of great use, especially in areas lacking a national free data set of sufficient quality.**

Homogenized Data across borders:

The Copernicus DEM offers a solution for ensuring homogenized data, particularly beneficial in border areas of study involving different countries and their national data sets.

In summary, the utilization of the Copernicus DEM GLO-30 for Flight Procedure design within the EU and globally, presents a compelling value proposition by providing easy access to high-quality data, enhancing confidence and transferability of results, potentially reducing costs, improving design quality and coverage, and facilitating consistency in data sources across borders. This comprehensive approach can significantly benefit procedural design efforts across various geographical and administrative contexts within the European Union and worldwide.

For further consultation or to share any feedback on this guidelines, please do not hesitate to contact us at egnos-adoption@essp-sas.eu, service.development@essp-sas.eu or our Helpdesk (helpdesk@egnos.gsc-europa.eu)

Readers are encouraged to contact any of the email addresses provided in this document to share feedback, ask questions, or suggest improvements for future revisions of these guidelines

Annex A: Reference documents.

RD	Title
RD 1.	ICAO Doc 8168 (Vol II) Procedures for Air Navigation Services – Aircraft Operations
RD 2.	Copernicus DEM Product Handbook
RD 3.	ICAO-Annex-15-Aeronautical-Information-Services
RD 4.	Vertical accuracy assessment of freely available global DEMs (FABDEM, Copernicus DEM, NASADEM, AW3D30 and SRTM) in flood-prone environments
RD 5.	Novel approach for ranking DEMs: Copernicus DEM improves one arc second open global topography
RD 6.	EU 2017/373
RD 7.	EUROCONTROL Terrain and Obstacle Data Manual
RD 8.	Copernicus DEM Validation Report

Table 4 Reference documents

Annex B: Acronyms and abbreviations.

Acronym	Definition
ANS	Air Navigation Service
AOI	Area of Interest
ATM	Air Traffic Management
CCM	Copernicus Contributing Missions
CDSE	Copernicus Data Space Ecosystem
DEM	Digital Elevation Model
DGED	Defence Gridded Elevation Data
DSM	Digital Surface Model
DTED	Digital Terrain Elevation Data
DTM	Digital Terrain Model
EASA	European Union Aviation Safety Agency
EEA	European Environmental Agency
ESA	European Space Agency
EU	European Union
EUSPA	European Union Agency for the Space Programme
FPD	Flight Procedure Design
GDEM	Global Data Elevation Model
GIS	Geographical Information System
ICAO	International Civil Aviation Organization
IFP	Instrument Flight Procedure
LiDAR	Light Detection and Ranging
SAR	Synthetic Aperture Radar

Table 5 Acronyms and abbreviations