Carbon Atmospheric Tracer Research to Improve Numerics and Evaluation

CATRINE
Carbon Atmospheric Tracer
Research to Improve
Numerics and Evaluation

D9.5 Midterm Dissemination and exploitation report

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CATRINE: Carbon Atmospheric Tracer Research to Improve Numerics and Evaluation

Horizon Europe RIA (Research and Innovation Action)

Copernicus for Atmosphere and Climate Change, including CO2
TOPIC ID: HORIZON-CL4-2023-SPACE-01-31

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1 Executive Summary

The project's dissemination and exploitation activities present a crucial element in the success of the CATRINE project, as they ensure that results are taken up by the wider community and are sustainable beyond the initial funding period, thus providing value for money.

D9.2 was the first version of this Dissemination and Exploitation (D&E) Plan and provided the initial plans for the D&E work.

This mid-term Dissemination and Exploitation Report D9.5 provides an update of the dissemination and exploitation activities half way through the project, whilst a final Dissemination and Exploitation Report with detailed descriptions of dissemination activities, exploitable results and related activities will be produced towards the end of the project.

The dissemination plan identifies instruments and targets. These include activities organised by CATRINE (including workshops, website, news items, etc.) as well as important events attended by CATRINE members (i.e. workshops, conferences, seminars, etc.).

The present deliverable provides the potential exploitation avenues in terms of outputs as well as respective exploitation activities during and after the end of the project, thus fulfilling the requirements of the Description of Action (DoA).

This document is a living document which will be developed during the lifetime of the project to follow and share the developments of the CATRINE project.

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2 Introduction

To enable the European Union (EU) to move towards a low-carbon economy and implement its commitments under the Paris Agreement, a binding target was set to cut emissions in the EU by at least 40% below 1990 levels by 2030. European Commission (EC) President von der Leyen committed to deepen this target to at least 55% reduction by 2030. This was further consolidated with the release of the Commission's European Green Deal on the 11th of December 2019, setting the targets for the European environment, economy, and society to reach zero net emissions of greenhouse gases in 2050, outlining all needed technological and societal transformations that are aiming at combining prosperity and sustainability.

To support EU countries in achieving the targets, the EU and European Commission (EC) recognise the need to support establishing the new European anthropogenic CO2 emissions Monitoring and Verification Support capacity (CO2MVS). To support the Commission and the CO2 Task Force with designing and ultimately building the CO2MVS, previous projects have been funded such as: the CO2 Human Emissions (CHE) project, the CoCO2 project (https://coco2-project.eu/) and recommendations from the VERIFY project (https://verify.lsce.ipsl.fr/). However, some of the recommendations from the CHE project were not available at the time of the definition of the CoCO2 project and could therefore not be fully considered. The EC, supported by the CO2 Task Force, took the various recommendations from the CHE project onboard as input to the Horizon Europe Work Programme and created two Calls. The CATRINE project addresses the requirements from one of those two resultant calls.

The Carbon Atmospheric Tracer Research to Improve Numerical schemes and Evaluation (CATRINE) project aims to evaluate and improve the numerical schemes for tracer transport in the new Copernicus anthropogenic CO2 emissions Monitoring and Verification Support capacity (CO2MVS) and more widely in the Copernicus Atmosphere Monitoring Service (CAMS). The research and development activities in CATRINE will focus on the priorities identified by these previous activities. The CATRINE project will contribute to the further development of the new Copernicus element for the monitoring of anthropogenic CO2 and methane (CH4) emissions and sinks.

The main objectives of CATRINE are to improve the methods used to represent resolved tracer transport by the winds, with a particular focus on mass conservation, and to identify other systematic errors associated with unresolved processes represented by parametrizations. The project will define protocols for evaluating tracer transport models at both global and local scales. Test beds based on field campaign case studies will be developed, along with suitable metrics for tracer transport evaluation, utilising a range of tracers and observations at both global and local scales. These metrics will be employed in the operational CO2MVS to evaluate the implementation of new transport model developments, characterise transport accuracy and representativity in data assimilation, and provide a quality control stamp of tracer transport accuracy. Lastly, CATRINE will provide clear recommendations to the CO2MVS and the Carbon Cycle Community which works with atmospheric inversion models for the evaluation and quality assessment of tracer transport models.

2.1 Scope of this deliverable

2.1.1 Objectives of this deliverable

This deliverable 9.5 provides the mid project update of the CATRINE project dissemination and exploitation.

2.1.2 Work performed in this deliverable

In this deliverable the work outlined in The Description of Action WP9 Task 9.4 is performed. The aim being to provide an update on the dissemination activities as well as identify the potential for exploitation and their routes.

Feedback from the partners pertaining to both dissemination and exploitation has been gathered through this first phase of the project and is presented in this document.

2.1.3 Deviations and countermeasures

No deviations have been encountered.

2.1.4 Reference Documents

[1] Project CATRINE Grant Agreement, Description of the Action (DoA)

3 Project Communication & Dissemination

3.1 Report on Dissemination activities

As a project, we have taken an active role in conferences, workshops and seminars explaining the project aims and initial results. International liaison work also continues to be an important aspect to the project.

In this first 18 months, CATRINE has been presented 19 times at conferences and workshops.

The project team has presented at ICOS Science conference, IWGGMS 20/ TransCom meeting, and ICDC11.

The project is liaising with other Horizon Europe Projects, (E.g. CORSO, CAMAERA and CAMEO amongst others) to ensure synergies are identified and developed. The project Coordinator Anna Agusti-Panareda presented the CATRINE updates recently at the EYE-CLIMA HE project GA and ESA SMART-CH4 GA. In addition, the CATRINE Project Coordinator is an invited observer to all the CORSO Executive Board meetings.

The project is also liaising with the Copernicus Services and CAMS and was represented at the CAMS annual General Assembly, 2024.

The first General Assembly of CATRINE was co-organised with General Assembly of the CORSO project to encourage the exchange of information between the two active projects.

This GA happened December 2024 and more information can be found here:

CATRINE and CORSO joint General Assembly 2nd and 3rd December 2024 in Bonn | CATRINE

Examples of interaction with external experts are Heather Graven, Imperial College London, who attended our CATRINE/ CORSO joint GA in December 2024 and with the international TransCom community in the joint CATRINE and TransCom workshop held on 28th May 2025.

The CATRINE website has provided regular updates and news items along with information on our recent publications; 1 has been published and a further 1 has been accepted.

Frédéric Chevallier, Grégoire Broquet, Atmospheric inversions for carbon dioxide and methane at a national scale, *National Science Review*, Volume 12, Issue 4, April 2025, nwaf063, https://doi.org/10.1093/nsr/nwaf063

As per the DoA, CATRINE's dissemination activities are designed around providing/disseminating information to the scientific communities and relevant stakeholders in three areas:

1. Scientific and technical results through
    a. Scientific Publications
    b. Conference Talks
    c. Participation at Workshops, webinars providing updates on the project results
    d. Reports to and feedback from Committees and Boards
2. Products through dissemination of
    a. Datasets and accompanying material (e.g. descriptions, metadata)
    b. Algorithms / Specifications
    c. Graphics and animations
3. Progress information through provision of
    a. News articles to relevant sources
    b. Public Deliverables
    c. Dissemination Materials (posters, flyers)
    d. Website and social media

3.1.1 Scientific and technical results

a) Scientific Publications – article in Journal

One article has been published and another accepted:

Table 1: Scientific publications

Atmospheric inversions for carbon dioxide and methane at national scale https://doi.org/10.1093/nsr/nwaf063 Frédéric Chevallier and Grégoire Broquet	National Science Review Oxford University Press	2025	Published
Offline atmospheric transport on a global mesh of hexagons. Frédéric Chevallier, Adrien Martinez, Zoé Lloret, Sakina Takache, Anne Cozic	Journal of Geophysical Research: Atmosphere Wiley		Accepted

b) and c) Conference and Organised Workshops Talks

Table 2: Conferences and workshops

Name	Date	Location	Presenter	Presentation title
IWGGMS-20/TransCom meeting, USA; cpaess.ucar.edu/meetings/iwggms-20	29 to 31 May 2024	Boulder, CO, USA	Frederic Chevallier	Introducing a high-resolution atmospheric transport model intercomparison
CAMAERA project kick-off meeting	29 January 2024	virtual	Anna Agusti-Panareda	Presentation of the CATRINE project
CAMEO General Assembly (https://www.cameo-project.eu/news/cameo-general-assembly-may-2024)	14-15 May 2024	Bonn, Germany	Anna Agusti-Panareda	Presentation of CATRINE
CAMS General Assembly	10-13 June 2024	Brussels, Belgium		Presentation of CATRINE
International conference on CO2 11th International Carbon Dioxide Conference (ICDC11)	Julv 29 to August 2nd, 2024	Manaus, Amazonas, Brazil	Anna Agusti-Panareda	The Carbon Atmospheric Tracer Research to Improve Numerical schemes and Evaluation (CATRINE) project
ICOS Science conference international science conference covering the carbon cycle	10-12 Sept 2024	Versailles, France	Anna Agusti-Panareda	Evaluation of atmospheric CO2 transport across scales from cities to continents
1st CIPM STG-CENV, Stakeholder meeting	16-18 September 2024	BIPM, Sèvres, France	Frédéric Chevallier	A world of hexagons on graphics processing units: new numerical paradigms for atmospheric inversion

Name	Date	Location	Presenter	Presentation title
OCO-2/3 Science Team telecon	3 December 2024	Video	Frédéric Chevallier	Recent updates of the CAMS CO2 inversion system
WMO G3W Global Data Providers workshop	5-7 March 2025,	Geneva	Anna and Frederic attended	
Urban Greenhouse Gas Conference and Stakeholder Summit 2025 Urban Greenhouse Gas Conference and Stakeholder Summit 2025 | World Meteorological Organization	7-9th April 2025.	Geneva, Switzerland	Maarten Krol	High-resolution modelling at urban scale Poster
CERISE GA	11 March 2025	Toulouse, France	Anna Agusti-Panareda	CAMS land surface activities for CO2MS
EYE-CLIMA and SMART-CH4 sister projects round table	2 April 2025	Paris, France	Anna Agusti-Panareda	An introduction to CATRINE project
Workshop on surface process coupling and its interactions with the atmosphere	9 - 10 April 2025	Bonn, Germany	Vincent S. de Feiter	Coupling Amazon Rainforest Fluxes to Clear-to-Cloudy Boundary Layer Conditions Using Integrated Observations and Large-Eddy Simulations
EGU	27 April–2 May	Vienna, Austria	Achraf Qor-el-aine	Comparative Analysis of Transport Trace Gases in High-Resolution Simulations from ICON-ART and IFS Models
Annual EGU meeting 2025	27 April–2 May	Vienna, Austria	Alohotsy Rafalimanana	Investigating the Benefits of Large-Eddy Simulation for Simulating Urban CO2 Emissions Using WRF-LES Over the Paris Area
Graduate School of Geoscience (GSGS)	Friday 23rd May	University of Cologne	Jordi Villa	
ICOS Cities General Assembly	27th May	Munich	Thomas Lauvaux and Jani Stromberg and Leena Jarvi and Alohotsy Rafalimanana and Andreas Christen	Atmospheric modelling over Paris: an overview

Name	Date	Location	Presenter	Presentation title
CATRINE and TransCom workshop	Wednesday 28th May 2025	online	Project team	
IWGGMS-21 annual meeting 2025 International Workshop	9-12 June 2025	Tokyo, Japan	Alohotsy Rafalimanana	Scale dependencies in urban CO2 inversions constrained by satellite remote sensing measurements

CATRINE and TransCom joint workshop 28th May 2025.

CATRINE project and the Transcom community came together on 28th May to discuss the CATRINE protocol; what it is and implementation and early feedback results. Over 40 attendees from Europe, US and Asia joined online for the presentations and discussions.

Agenda:

Time (CEST)	Duration	Presenter	Topic
16:00 – 16:05	5	Anna Agusti-Panareda (ECMWF)	Introduction and aims of the meeting
16:05 – 16:30	25	Britt Stephens	Invited talk on previous TransCom model intercomparison
16:30 – 16:55	25	Andrew Schuh	Invited talk on model transport errors
16:55 – 17:15	20	Anna Agusti-Panareda	Introduction to the CATRINE protocol
17:15 – 17:25	10	Chris Wilson	Feedback on Implementing protocol
17:25 – 17:40	*15*	*Break*	
17:40 – 18:10	30	Frederic Chevallier	Preliminary inter-comparison results
18:10 – 18:55	45	All	Discussion and Q&A • How can we qualify/rank the models with transport scores to guide model development of atmospheric inversions? • What is the maximum horizontal and vertical resolution that models can use? Sensitivity runs to assess impact of resolution. • Are the current diagnostics proposed appropriate? • Are the current tracers proposed appropriate? • What type of observations should we use? • Is there any need to revise protocol?
18:55 - 19:00	5	Anna Agusti-Panareda (ECMWF)	Concluding remarks and plans for next meeting

This was an important interaction with the potential users of the CATRINE protocol and provided relevant and pertinent feedback. This was also an excellent opportunity to highlight the aims of the CATRINE project and to further the interaction and outreach with a dedicated set of users and explore additional potential exploitation paths.

3.1.2 Products through dissemination of

a. *Datasets and accompanying material (e.g. descriptions, meta data)*
b. *Algorithms / Specifications*
c. *Graphics and animations*

Figure 1 shows the dedicated page on the CATRINE website for CATRINE produced public datasets

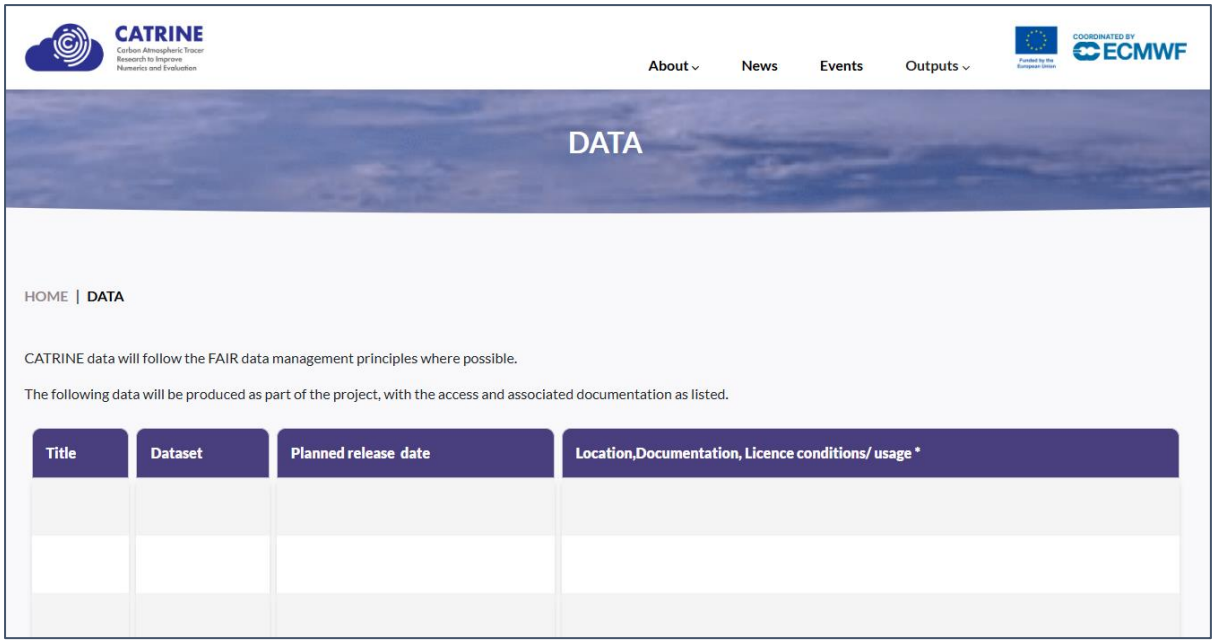


Figure 1: CATRINE Website: Data Page

These datasets will be uploaded when they are available for use/ made public. Algorithms, graphics and animations have not been produced yet.

3.1.3 Progress of dissemination information through website provision

The CATRINE website has been used for News items and public deliverables to date. (Figures 2 and 3). The scientific papers (Figure 4) are listed on a dedicated page.

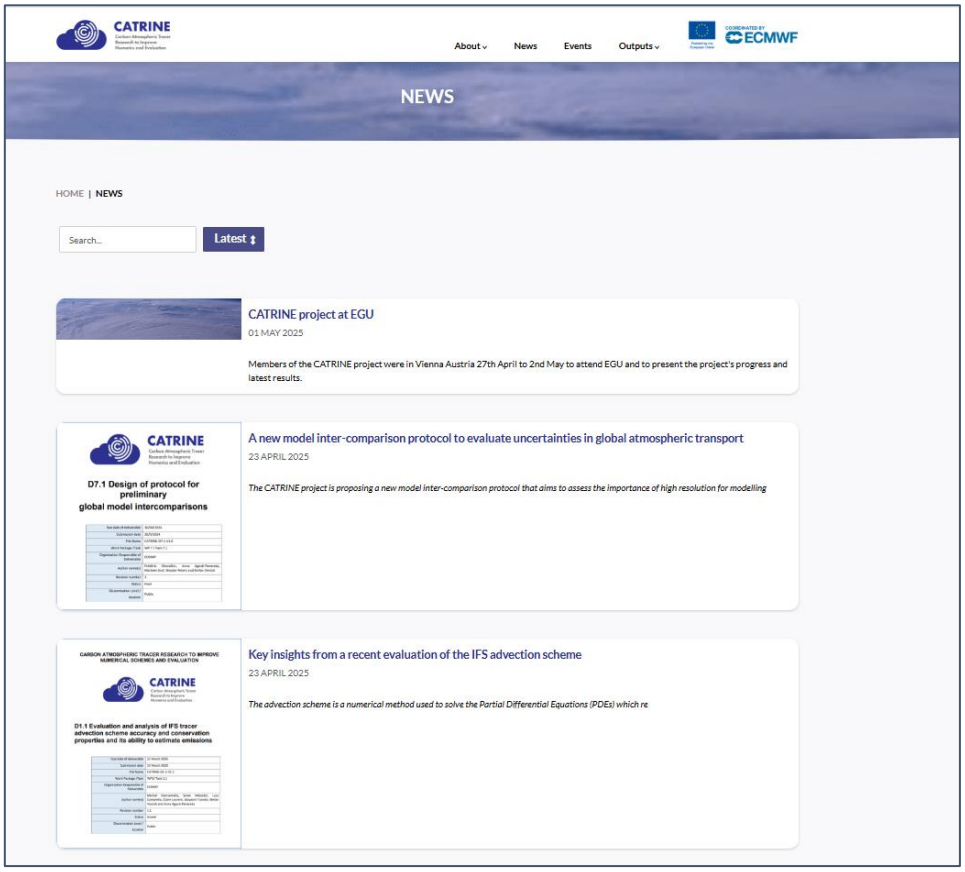


Figure 2: CATRINE Website: News Page

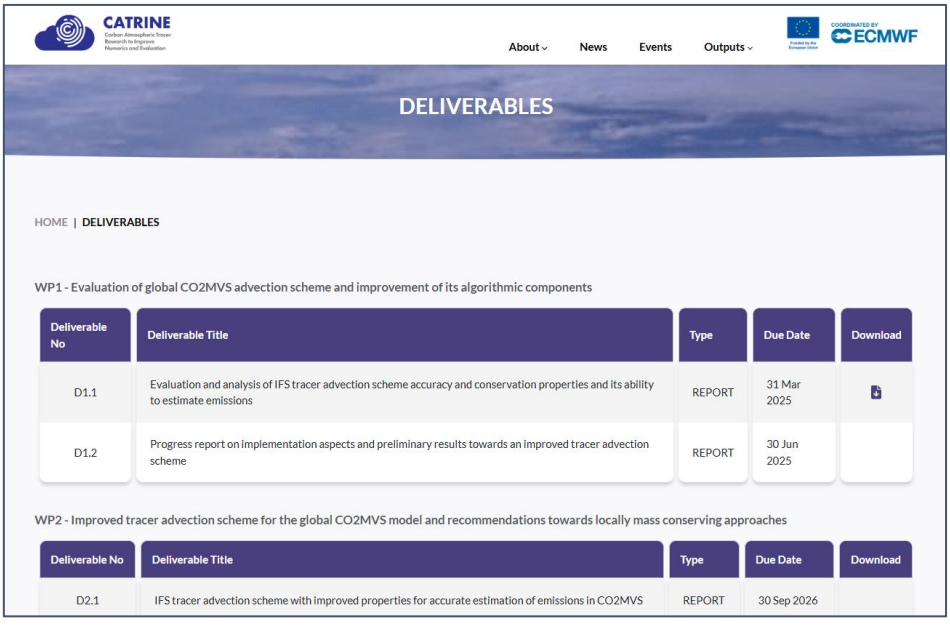


Figure 3: CATRINE Website: Deliverables Page

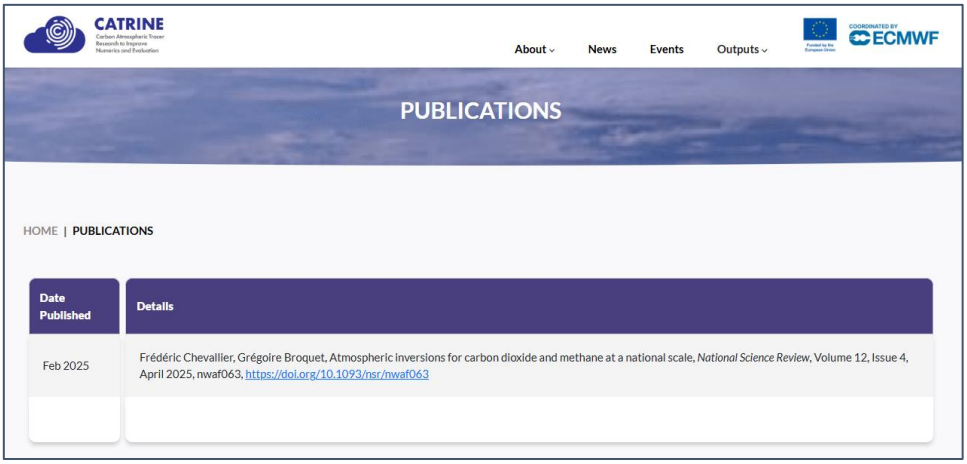


Figure 4: CATRINE Website: Publications Page

CATRINE uses the confluence pages for communication and dissemination within the project.

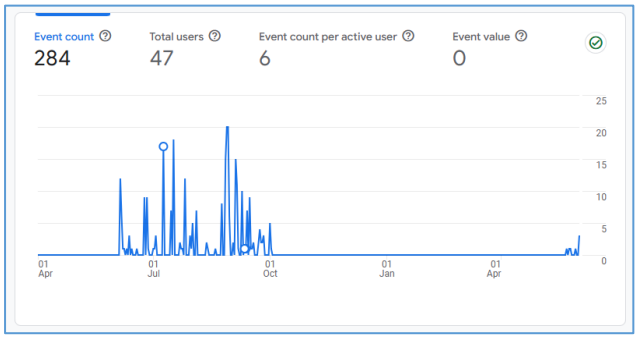
Social media, (Linkedin and X (formerly known as “Twitter”) are not used directly by CATRINE but instead we rely on the established communications channels of CAMS and ECMWF.

ECMWF and Copernicus social media accounts are being used to like/ follow project updates.

CATRINE was also one of the projects presented at the CAMS General Assembly June 2024.

Figure 5: CAMS General assembly Agenda extract; CATRINE project

The CATRINE website went live in June 2024. Using Google Analytics we can see the traffic and usage of the website. An example in Figure 6 below, shows the updates to early June 2025. Unfortunately, there was an error in the Analytics software setup which means they were not collected between Month 9 to Month 17. This error in the Java script has been corrected and we will be able to show a longer collection of user stats at the end of the project.



	Page title and screen class	Views	Active users
	Total	284 100% of total	47 100% of total
1	Home | CATRINE	78 (27.46%)	39 (82.98%)
2	Data | CATRINE	19 (6.69%)	9 (19.15%)
3	Deliverables | CATRINE	18 (6.34%)	12 (25.53%)
4	Objectives | CATRINE	17 (5.99%)	11 (23.4%)
5	Structure | CATRINE	17 (5.99%)	7 (14.89%)
6	news | CATRINE	16 (5.63%)	12 (25.53%)
7	Events | CATRINE	14 (4.93%)	7 (14.89%)
8	CATRINE project at CAMS General Assembly | CATRINE	13 (4.58%)	10 (21.28%)
9	Consortium | CATRINE	13 (4.58%)	12 (25.53%)
10	TEAM | CATRINE	13 (4.58%)	10 (21.28%)

Figure 6: Extract from google analytics

The website is easily findable from internet search as can be seen from Figure 7 and from a global audience:

	Session primary...channel group)	Sessions	Engaged sessions
	Total	102 100% of total	59 100% of total
1	Organic Search	54 (52.94%)	36 (61.02%)
2	Direct	35 (34.31%)	18 (30.51%)
3	Referral	8 (7.84%)	5 (8.47%)
4	Unassigned	5 (4.9%)	0 (0%)

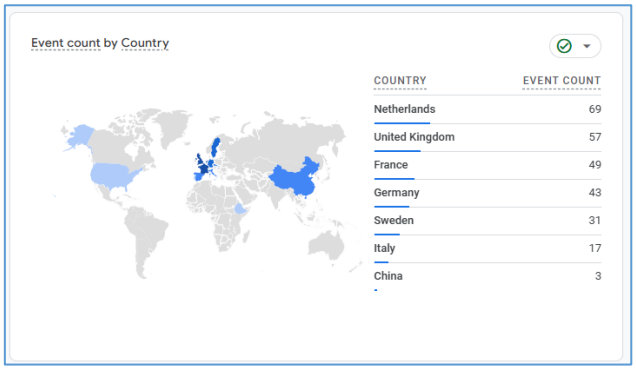


Figure 7: Site/ search acquisition and country access

4 Exploitation Plan

The earlier deliverable, D9.2, already outlined potential exploitation avenues, as per Table 3 below. The exploitation survey to partners, run as part of Deliverable D9.2, shows that the products and activities described remain relevant at this juncture.

Table 3: Summary of Exploitation Findings

Exploitable Products	• New benchmarking datasets based on computationally expensive schemes that will help evaluate and tune further numerical models • High-resolution multi-model multi-tracer simulations, which will extend into a new international TransCom tracer transport model inter-comparison exercise at local and global scales. • New metrics to assess tracer transport model errors • Test beds with detailed diagnostics and evaluation metrics, supported by field campaign observations and operational observing networks. • Reports with recommendations for the implementation of the Copernicus CO2MVS
Exploitation Activities during the Project	• Any dataset that has been identified as public has and will be made available to external scientists. Several of these datasets are innovative and should create significant interest. • Project reports with recommendations will support uptake/implementation activities in CAMS, C3S, and potentially other frameworks, already during the project.
Exploitation Activities after the end of the Project	• Any dataset that has been identified as public will be made available to external scientists. Several of these datasets are innovative and should create significant interest. • Project reports with recommendations will support uptake/implementation activities in CAMS, C3S, and potentially other frameworks.
Consortium-wide/Joint Exploitation	• While outputs will be shared publicly as much as possible through documentation and peer-reviewed literature, the project will also support its consortium members to be better prepared for any upcoming CO2MVS implementation ITTs.

(Any datasets and databases produced will follow the Data Management plan).

5 Conclusion

In this deliverable, the mid term update of the CATRINE dissemination and exploitation has been presented.

For the dissemination we have achieved our aims to disseminate via a set of identified instruments namely a website, news items, numerous scientific conference and workshop involvements and scientific papers. This task will continue for the remaining 18 months.

Exploitation updates were solicited from all partners and represents the current state of exploitation activities.

The Exploitation Plan will be revisited regularly and is thus to be understood as a living document, as developments during the course of the project may open up new avenues for exploitation.

Document History

Version	Author(s)	Date	Changes
0.1	Rhona Phipps (ECMWF)	May 2025	Initial version for internal review
1.0	Rhona Phipps (ECMWF)	June 2025	Issued version

Internal Review History

Internal Reviewers	Date	Comments
Sylvie Malardel (MF) and Maarten Krol (WU)	June 2025	No comments, only minor textual corrections.