Reinforcing the AI4EU Platform by Advancing Earth Observation Intelligence, Innovation and Adoption

D6.5: Service extensions and optimisations & policy guidelines for AI-adoption

Grant Agreement ID	101016798	**Acronym**	AI4COPERNICUS
Project Title	Reinforcing the AI4EU Platform by Advancing Earth Observation Intelligence, Innovation and Adoption		
Start Date	01/01/2021	**Duration**	36 Months
Project URL	https://ai4copernicus-project.eu/		
Contractual due date	31/12/2023	**Actual submission date**	28/12/2023
Nature	R = Document, report	**Dissemination Level**	PU = Public
Author(s)	Antonis Troumpoukis, Christos Perentis, Xenia Ziouvelou (NCSR-D)		
Contributor(s)	-		
Reviewer(s)	Philippe Fournand (BLS), Richard Hall (Equinor)		

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 101016798.

Document Revision History *(including peer reviewing & quality control)*

Version	Date	Changes	Contributor(s)
v0.1	21/11/2023	Deliverable Structure	Antonis Troumpoukis (NCSR-D)
v0.2	7/12/2023	Sustainability actions and Trustmark granting results	Antonis Troumpoukis (NCSR-D)
v0.3	19/12/2023	AI4Copernicus Service extensions and optimizations	Christos Perentis (NCSR-D) Antonis Troumpoukis (NCSR-D)
v0.4	19/12/2023	AI Ethics Sessions and Policy Recommendations	Xenia Ziouvelou (NCSR-D)
v0.5	20/12/2023	Final edits, sent for QA	Antonis Troumpoukis (NCSR-D)
v0.6	21/12/2023	Integrated feedback from QA	Antonis Troumpoukis (NCSR-D) Xenia Ziouvelou (NCSR-D)
v1.0	22/12/2023	Final version	Antonis Troumpoukis (NCSR-D)

Executive Summary

This deliverable concludes our activities for the AI4Copernicus Open Calls.

We provide a summary of the actions carried out during the sustainability phase of the 1st, 3rd, and 4th Open Calls aiming at the sustainability and commercialisation process of the Open Call projects. These actions include Sustainability workshops in the form of World Cafes, AI Ethics Assessment process, including Workshops and Assessments, Networking and Pitching sessions during a physical event in Athens, Greece, as well as a booklet for triggering VC investment for the AI4Copernicus winners. The actions are documented in detail in Section 2 of the deliverable.

Furthermore, we present an overview of the AI4Copernicus Trustmark granting results, a recognition awarded to projects that have demonstrated exceptional qualities in terms of innovation, technical performance, business potential, and ethical considerations. We present the projects that were awarded the trustmark, example trustmark badges, and we summarise the actions for conducting the trustmark awarding process. We discuss any feedback received during the AI4Copernicus incubation process through informal 1-on-1 communications and a short questionnaire.

In addition, we outline potential service extensions and optimizations for the AI4Copernicus services, drawing insights from feedback received from the Open Call projects. Initially, we present issues and recommended enhancements reported by the 5th Open Call projects during their final assessments. Subsequently, we analyse these recommendations in conjunction with additional feedback gathered from the Open Call projects through questionnaires or workshops within the work of WP2 and WP7, as detailed in D2.4 and D7.3 respectively. Finally, we offer insights into suggested optimizations and extensions for the Security, Agricultural, Health, and Semantic services, leveraging user feedback to improve the efficiency and functionality of AI4Copernicus services.

This deliverable ends with a set of comprehensive policy recommendations for the intersection of Artificial Intelligence (AI) and Earth Observation (EO) within AI4Copernicus. Spanning five levels, the proposed recommendations (20 in total) include open data policies, platform awareness, creation of an AI&EO marketplace, easy access to the AIoD platform, guidance for trustworthy AI implementation, educational initiatives, fostering research careers, investing in satellite launches, and promoting equal funding opportunities. These recommendations aim to enhance capabilities, foster collaboration, trustworthy AI practices as well as to support sustainability in the AI and EO ecosystem.

Table of Contents

1 Introduction **7**
1.1 Purpose and Scope 7
1.2 Approach for Work Package and Relation to other Work Packages and Deliverables 7
1.3 Organisation of the Deliverable 8
2 Sustainability phase actions for the Open Call projects **9**
2.1 AI Ecosystem Forum 9
2.2 AI4Copernicus Commercialisation services 10
2.3 AI-Ethics Workshops 10
2.3.1 Fostering Trustworthy AI in Earth Observation domain 10
2.3.2 Ethical & Trustworthy AI assessment per project 11
2.3.3 Key Findings & Recommendations from the AI4Copernicus Ethical & Trustworthy AI assessments 13
2.3.4 The AI4Copernicus AI Code of Conduct 14
2.3.5 ICT-49 Trustworthy AI Working Group 15
2.4 Sustainability mentoring 15
2.5 Venture Capital (VC) Booklet 16
3 AI4Copernicus Trustmark Granting Results Overview **18**
4 Feedback on AI4Copernicus Incubation **21**
5 AI4Copernicus Service Extensions and Optimisations **22**
5.1 List of AI4Copernicus Services 22
5.2 Feedback from the 5th Open Call Assessments & Reports 23
5.2.1 Security Services 23
Sentinel-2 pre-processing 24
Sentinel-1 change detection–ACD and MTC 25
Sentinel-2 change detection 25
5.2.2 Agriculture Services 26
Deep network for pixel-level classification of S2 patches 26
TimeSen2Crop Dataset 27
Harmonisation of pre-processed time series of Sentinel-2 data 28
Long Short-Term Memory Neural Network for NDVI prediction 28
5.2.3 Health Services 29
Probabilistic downscaling of CAMS air quality model data 29
5.2.4 General-purpose Semantic Services 30
Geotriples 30
Strabon 30
Sextant 31
5.3 Feedback from other sources 31

5.4 Proposed extensions and optimisations 32
5.4.1 Security Services Extensions and Optimizations 32
5.4.2 Agricultural Services Extensions and Optimizations 33
5.4.3 Health Services Extensions and Optimizations 34
5.4.4 Semantic Services Extensions and Optimizations 34
6 Policy Recommendations for AI & EO 35

List of Figures

Figure 1: AI4Copernicus Ethics-by-design approach 11
Figure 2: AI Ethics Assessment process across AI4Copernicus phases 13
Figure 3: AI4Copernicus Code of Conduct 15
Figure 4: Page Template for the VC Booklet 17
Figure 5: Example AI4Copernicus Trustmark Badges 19
Figure 6: AI4Copernicus Incubation Feedback 21

List of Tables

Table 1: Agenda for the first day of the AI Ecosystem Forum Event in Athens 9
Table 2: Catalogue of AI4Copernicus services 22
Table 3: Usage of AI4Copernicus services by the Open Call projects 22
Table 4: Feedback for Sentinel-2 pre-processing 24
Table 5: Feedback for Sentinel-2 change detection 25
Table 6: Feedback for Deep network for pixel-level classification of S2 patches 26
Table 7: Feedback for Long Short-Term Memory Neural Network for NDVI prediction 28
Table 8: Feedback for Probabilistic downscaling of CAMS air quality model data 29
Table 9: Feedback for Strabon 30
Table 10: Feedback for Sextant 31

List of Terms & Abbreviations

Abbreviation	Definition
AI	Artificial Intelligence
AIoD	AI-on-Demand platform
DAS	Data Access Service
DIAS	Data and Information Access Services
EO	Earth Observation
OC	Open Call
SME	Small & Medium Enterprise
VC	Venture Capital
WP	Work Package

1 Introduction

1.1 Purpose and Scope

The main purpose of this deliverable is to outline possible service extensions and optimisations along with appropriate policy guidelines for AI-adoption, based on feedback from the Open Call Projects obtained from various sources, such as workshops, reports and questionnaires. In addition to that, we provide an overview of the trustmark granting results and a summary of the actions carried out during the sustainability phase of the 1st, 3rd, and 4th Open Calls.

1.2 Approach for Work Package and Relation to other Work Packages and Deliverables

WP6 focuses on technology transfer via the AI4Copernicus Open Calls. In order for this to be achieved, the objectives of this task pertain to the (a) design, (b) implementation and (c) evaluation of the AI4Copernicus Open Calls for Projects (use-cases and small-scale experiments) and Open Calls for citizen-driven theme/social cause selection.

The AI4Copernicus Open Calls programme aims to bring together diverse communities, namely the Artificial Intelligence (AI) and AI-on-demand platform, tools and services, with the Earth Observation Communities and Earth Observation (EO) data as well as DIAS (Data and Information Access Services) tools and services, and offer the AI4Copernicus tools and services that aim to address the variegating market-driven challenges in diverse industrial domains and citizen-driven social challenges (via the AI4Copernicus Open Calls).

The AI4Copernicus Open Calls are organised in five distinct rounds, targeting SMEs and Individuals. In particular, these Open Call Rounds are:

- 1st Round of Open Calls for Use-Cases: consortia projects with a low-technology SME by default in 4 Industrial Domains: Energy, Security, Health, Agriculture
- 2nd Round of Open Calls for Citizen Social Challenges
- 3rd Round of Open Calls for Experiments: single company projects
- 4th Round of Open Calls for Use-Cases: consortia projects with a low-technology SME by default based on the identified Citizen Social Challenges (of the 2nd Round)
- 5th Round of Open Calls for Micro-Projects for testing the AI4Copernicus services: single company projects

The work plan of WP6 reflects the organisation of the Open Calls and includes the following tasks:

- Task 6.1: Open Calls Operational Planning and Management, running throughout the project's duration (M1-M36) and led by NCSR-D with CF contributing.
- Task 6.2: Open Calls for use-cases in the high-value domains: Energy, Security, Agriculture, Health, running from M7-M36 and led by NCSR-D, with UNITN, ECMWF, SatCen, UoA, INSEAD, and EQUINOR contributing.
- Task 6.3: Open Calls for small-scale experiments across all sectorial domains, running from M4 to M36 and led by NCSR-D, with ECMWF, UoA, INSEAD, UNITN, SatCen, and Equinor contributing.

- Task 6.4: Open Calls for citizen-driven themes and use-cases, also active from M4 to M36 and led by NCSR-D, with the contributions of SatCen, UoA, INSEAD, UNITN, EQUINOR and ECMWF.

Building up on top of Deliverables D6.2, D6.3, and D6.4, in which we reported on the progress of the 1st, 2nd, 3rd, 4th and 5th Rounds of Open Calls according to the methodology provided by Deliverable D6.1, in the present deliverable D6.5 we conclude our reporting with respect to the Open Calls. In particular, we provide our activities regarding the sustainability and commercialisation process of the projects, the results of the AI4Copernicus trustmark procedure, and we close with some recommendations for extensions and optimisations of the AI4Copernicus services, as-well-as policy guidelines for AI-adoption, obtained from the feedback gathered from the projects.

Since the activities of WP6 are the central focus of the AI4Copernicus projects, the tasks of WP6 are related to most WPs of the project, and in particular:

- WP2: "User requirements and acceptance" in which WP6 provides ongoing input from the Open Calls and feedback from the Project Winners in relation to AI4Copernicus services (in addition to other feedback);
- WP3: "Technical positioning and architecture", WP4: "Implementation, customisation, integration and testing" and WP5: "Bootstrapping AI4Copernicus with high-impact services" which provide a series of technical, bootstrapping, and cloud services to the Open Call Projects for helping the implementation of their solutions;
- WP7: "Exploitation, Communication and Dissemination", which are involved in the active promotion, communication and dissemination of the Open Calls and the organisation of relevant events across the lifecycle of the projects. In addition, WP7 provides assistance for the exploitation and sustainability of the Open Calls results and the knowledge transfer from the open calls.

1.3 Organisation of the Deliverable

In Section 2, we provide an overview of our activities during the sustainability phase of the Open Call winners, and in particular our activities regarding the sustainability and commercialisation process of the projects. In Section 3, we provide an overview of the AI4Copernicus trustmark granting results, and in Section 4 we outline feedback received during the AI4Copernicus incubation process. In Section 5, we outline potential service extensions and optimizations for the AI4Copernicus services, drawing insights from feedback received from the Open Call projects. Finally, in Section 6, we close the deliverable by proposing several policy recommendations for the intersection of AI and EO within AI4Copernicus.

2 Sustainability phase actions for the Open Call projects

The sustainability phase was the last phase of the projects of the 1st, 3rd and 4th Open Calls, and facilitated the sustainability of the selected projects. It was carried out for a 2-month period after the end of the final assessment of the projects, that is, June 2023 - July 2023 for the 1st Open Call, and November 2023 - December 2023 for the 3rd and 4th Open Calls. In this section we report the corresponding sustainability-related actions.

2.1 AI Ecosystem Forum

AI4Copernicus organised the "Artificial Intelligence Ecosystem Forum 2023" physical event. The event took place on June 28th-30th 2023 in Athens, Greece. On **Wednesday 28 June**, experts from the AI4Copernicus consortium presented to the Open Call Winners via a **dedicated workshop** the future of the European AI and EO landscape. The agenda of the first day was the following:

Table 1: Agenda for the first day of the AI Ecosystem Forum Event in Athens

Wednesday 28 June 2023		
Time	Description	Presenter
14:00 - 14:05	**Welcome and Introduction**	Vangelis Karkaletsis, NCSRD
14:05 - 15:00	**Unveiling the new AI-on-Demand (AIoD) Platform and the Data Access Service (DAS) (20 min)**	Iraklis Klampanos, NCSRD Monika Krzyżanowska, Cloudferro
	The European landscape and AI4Copernicus (20 min)	Philippe Fournand, BlueSight
	AI4Copernicus: the vision from an industrial standpoint (10 min)	Richard Hall, Equinor
15:00- 16:45	**Introduction to the World Café setup**	Philippe Fournand, BlueSight
	World Café 1: Data Services	*Moderator*: Monika Krzyżanowska, CloudFerro *Rapporteur*: Vasileios Baousis, ECMWF
	World Café 2: AI4Copernicus Services	*Moderator*: Michele Lazzarini/Omar Barillero, SATCEN *Rapporteur:* Eleni Tsalapati, UoA
	World Café 3: AIoD Services & AI/EO Node	*Moderator:* Philippe Fournand, BlueSight *Rapporteur*: Xenia Ziouvelou, NCSRD
16:45 - 17:15	**Coffee Break**	
17:15 - 18:15	**World Café Conclusions & Discussion**	Philippe Fournand, BlueSight & World Café Moderators

The remaining two days of the forum comprised the *public part* of the 3-day event (see here and here). The aim of the public event was to bring the stakeholders together, so as to exchange ideas and discuss the domains' future direction and emerging trends, policy and the needs of the market. The audience consisted of representatives of the European Commission, the AI4Europe project, and the ICT-49 project cluster. The Open Call Winners had the opportunity to present and discuss their work with a pitching event and follow-up networking sessions.

2.2 AI4Copernicus Commercialisation services

Regarding the sustainability of the winners of the open call, we have organised dedicated commercialisation mentoring services:

Technical Workshops:

- Technical Workshop: Unveiling the new AI-on-Demand (AIoD) Platform and the upcoming Data Access Service (DAS), The European landscape and AI4Copernicus and the vision from an industrial standpoint. AI Ecosystem Forum, June 28th 2023 (see above)

Business Services:

- Business Session: "*Accessing the market mentoring: Startup financing*" Date: November 17th, 2023. Speaker: Pal Boza (INSEAD).
- Pitching event, AI Ecosystem Forum, June 29th 2023 (see above). Representatives from the open call projects gave presentations about their ideas in brief 2-minute slots (one slot per project), in a dedicated Speed Pitching Session.
- Networking sessions, AI Ecosystem Forum, June 29th 2023 (see above).

Dissemination Services:

- In collaboration with WP7, all the videos produced in the context of the final assessment of the Open Calls projects have been uploaded on the AI4Copernicus website (under each project's profile) and on the dedicated AI4Copernicus YouTube Playlist.

For an extensive analysis regarding the dissemination & communication of the five rounds of the AI4Copernicus Open Calls can be found in D7.4 and D7.5.

2.3 AI-Ethics Workshops

2.3.1 Fostering Trustworthy AI in Earth Observation domain

Aiming to foster Trustworthy AI in the EO domain, the AI4Copernicus project adopted an "Ethics By Design'' approach (see Figure 1) for its funded AI and EO projectsThis approach included, the following aspects:

- The adoption of an ethically focused approach while designing, developing, deploying and/or using AI-based solutions for EO

- Addressing ethical issues across AI development life-cycle (ethics risks are different across each phase) and discussing the key characteristics of the AI-based system in order to preserve and promote trustworthy AI systems in the EO domain that adhere to the EU High-Level Expert Group (EC, HLEG, 2019[1]) seven key requirements:

    a. Respect for human autonomy - human agency and oversight
    b. Privacy, personal data protection and data governance
    c. Technical robustness and safety
    d. Fairness, diversity, non-discrimination
    e. Individual, social and environmental well-being
    f. Transparency,
    g. Accountability

	AI System Life cycle Phases[1]	Description	Assessment Period	Number of projects
Application Phase	Phase 1: Design	AI system concept stage including research and design activities	During the proposal application stage	92 European AI and EO project proposals
Support Phase 1 (M1-M6)	Phase 2: Development	AI system development phase (initial experimentation)	During the first part of the project's AI4Copernicus incubation	17 AI and EO funded projects
Support Phase 2 (M7-M12)	Phase 3: Deployment	AI system operationalisation and deployment	During the final phase of the project incubation	17 AI and EO funded projects

1: the post-deployment phase covered via the workshops

Figure 1: AI4Copernicus Ethics-by-design approach

2.3.2 Ethical & Trustworthy AI assessment per project

The AI4Copernicus ethics-by-design approach involved ethical and trustworthy AI assessments per project included the following aspects (depicted in Figure 2):

- **An *AI Ethics Session*** *was* provided to all projects as an introductory overview for the ethical and legal considerations of AI in the Earth Observation domain.
- **An "*Ethical & Trustworthy AI assessment*" tool:** this tool that was created by NCSR-D, was used by all projects to assess their projects (examining socio-ethical and legal aspects so as to identify appropriate technical and organisational configurations and

[1] https://digital-strategy.ec.europa.eu/en/library/ethics-guidelines-trustworthy-ai

reflect on various socio-technical scenarios, in order to anticipate possible uses and problems of the systems under review) across key phases of their life cycle: Phase 1: "Design Phase" (proposal phase), Phase 2: "development phase" and Phase 3: Deployment.

- Phase 1: Design Phase (proposal phase)
  - All interested parties filled in the AI Ethics Assessment table of the AI4Copernicus.
- Phase 2: Development Phase (first part of the AI4Copernicus incubation until the interim assessment)
  - *1st Open Call (OC) projects:* The tool was filled in by each project and each support officer separately (in order to have two distinct perspectives of the ethical and trustworthy AI challenges).
  - *3rd and 4th OC projects:* The tool was filled in by each project and each support officer separately (in order to have two distinct perspectives of the ethical and trustworthy AI challenges).
- Phase 3: Deployment
  - *1st Open Call (OC) projects:* updates (where needed) were made to the Phase 2 assessment tool
  - *3rd and 4th OC projects:* updates (where needed) were made to the Phase 2 assessment tool

- **Ethical AI workshops (1-on-1 workshops for each project)**: These meetings (2 meetings one for phase 2, and one for phase 3) include a discussion utilising as input the completed "*Ethical AI assessment*" tool of each project. The projects are encouraged to revise the tool after the discussion and share its updated version (when needed).
- **The *AI Ethics Assessment feedback*** for the open call projects was provided from NCSR-D to the projects via Nextcloud. The AI Ethics assessment documents provide feedback for all the assessment areas and conclude with a set of concrete recommendations that aim to help each project for the next phase based on the project-specific needs that have been identified.

The 5th Open Call projects were not included in this assessment process as this was not part of this open call design.

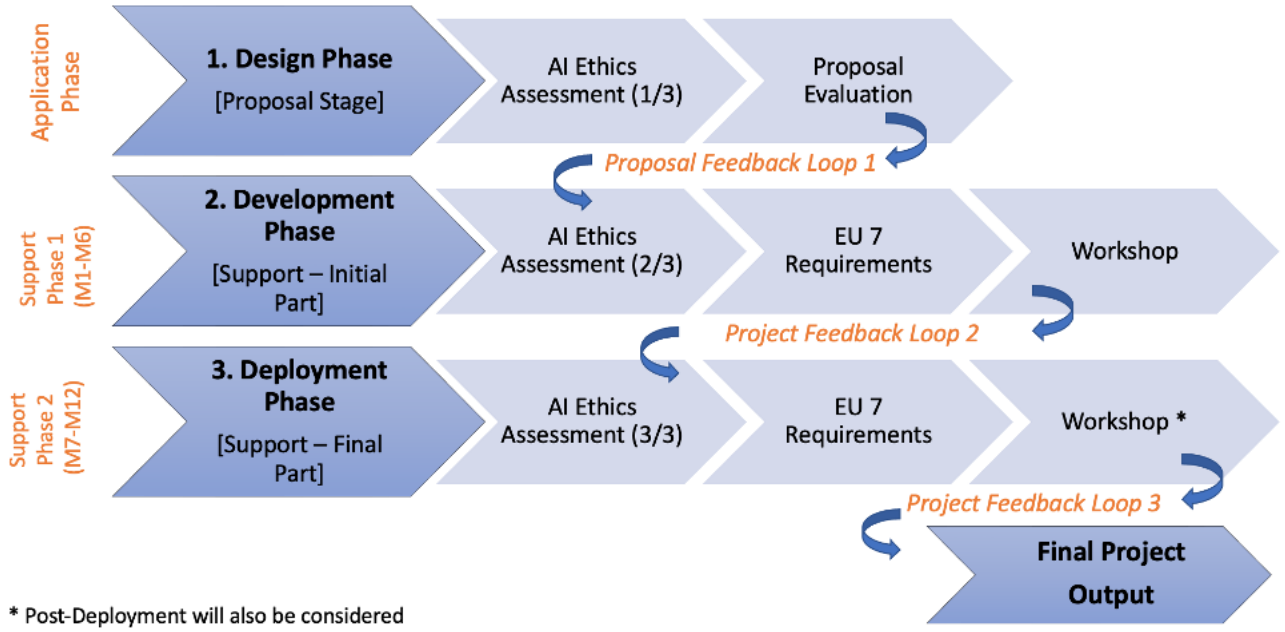

Figure 2: AI Ethics Assessment process across AI4Copernicus phases

2.3.3 Key Findings & Recommendations from the AI4Copernicus Ethical & Trustworthy AI assessments

Some of the key findings that came out of this process are as follows:

- **Significance of Trustworthy AI aspects for EU SMEs in the AI & EO domain:**
    - Trustworthy AI aspects were not (at the beginning of the projects at least) prioritised (as key areas of consideration).
    - A high level of responsibility was identified among the AI4Copernicus funded projects, which in turn facilitated the AI ethics assessment process.

Action Item/policy recommendation No.1: It is important to create awareness around Trustworthy AI aspects as well as the legal aspects that pertain AI practices (AI Act, Digital Services Act, etc) for European SMEs in this domain.

- **AI ethics literacy level:**
    - The Ethical AI literacy level, although in the beginning was low, the projects and companies made very good progress and enhanced their understanding significantly.
    - In order to foster Trustworthy AI, it is important to enhance the AI ethics literacy level of European micro-enterprises and start-ups.

Action Item/policy recommendation No.2: It is important to enhance European innovators' ethical AI literacy levels to realise Trustworthy AI practices

- **Trustworthy AI Assessment process:**
    - We consider that the AI4Copernicus ethics assessment process, essentially as a combination of assessment and training/education, helped companies evolve in this area. The training in the beginning and the tool helped them understand the different aspects and the workshops helped them understand the importance and reflect upon their responses.

Action Item/policy recommendation No.3: In order to successfully realise Human-centric, trustworthy AI practices in the AI & EO domain in Europe, it is important to foster holistic AI ethics assessments/self-assessments that go beyond "box ticking" but which integrate knowledge sharing components that enable innovators to expand their understanding around responsible AI practices. Practical guidelines and codes of conduct are needed by SMEs as well as automated practices to facilitate implementation.

- **Fostering cultural change:**
    - We witnessed a change in the mindset of European innovators we collaborated with. In the beginning, the vast majority had a "defensive" approach towards trustworthy AI perspectives. However, this changed during the last workshop of the phase 3, where we observed many participants expressing not only their interest but most importantly that they were "transferring knowledge" for trustworthy AI aspects that they learned, to other projects that they were implementing.

Action Item/policy recommendation No.4: In order to ensure trustworthy AI practices in the EO domain, it is important to foster a cultural change toward responsible AI & EO innovation. This necessitates, raising awareness, sharing best-practices and relevant case studies, creating tools to help innovators and creating a broader ecosystem around trustworthy AI for the EO domain, while providing relevant funding for realising trustworthy AI&EO practices. Creating a Trustworthy AI & EO label we believe that could act as a positive reinforcement, that would contribute further to the realisation of Trustworthy AI innovation in this domain.

2.3.4 The AI4Copernicus AI Code of Conduct

As AI has the potential to revolutionise geospatial data analysis, empowering responsible use of AI for start-ups in the AI-powered Earth Observation (EO) domain is AI4Copernicus mission. Towards this aim, a tailored Code of Conduct for Responsible AI in EO underscores our commitment to ethical innovation by emphasising in data integrity, environmental sustainability and societal well being, aligning with the very core of European values and empowering start ups to grow within this framework.

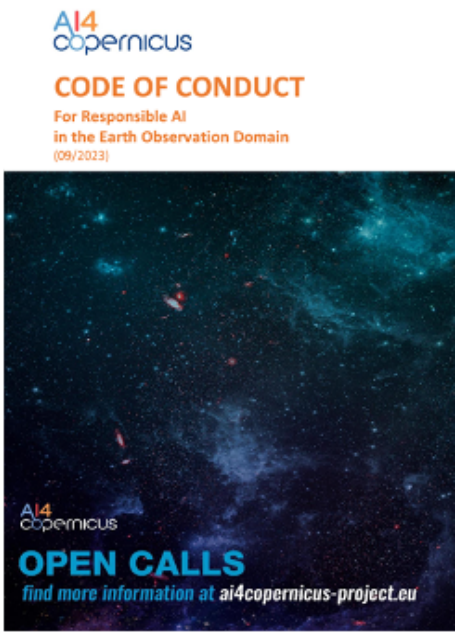

Figure 3: AI4Copernicus Code of Conduct

The provided AI4Copernicus Code of Conduct for Responsible AI in the Earth Observation domain is a direct product of AI4Copernicus project's internal ethics assessment procedures. This document synthesises the project's commitment to ethical guidelines into a formalised conduct framework, ensuring all selected projects align with established ethical benchmarks and the emerging normative frameworks as will be introduced by the upcoming AI regulatory package.

Aiming to help all AI and EO start-ups and SMEs we have created a special page on the AI4Copernicus website and interested parties can download and adjust it for their needs.

2.3.5 ICT-49 Trustworthy AI Working Group

AI4Copernicus actively participated in the ICT-49 work - Trustworthy A working group for ensuring that the experiences are shared among projects and that the AIoD ecosystem can benefit from the experiences of the ICT-49 projects in this area. Joint publications were prepared and presented by all working group members. These publications that integrate the AI4Copernicus trustworthy AI feedback can be found in the AIoD platform.

2.4 Sustainability mentoring

In line with our commitment to fostering sustainability within the AI4Copernicus and AIoD ecosystems, three dedicated workshops (World Cafés) were conducted with our projects during the AI Ecosystem forum event in Athens (see above). These workshops served as invaluable forums for the collection of user feedback, focusing on the assessment and testing of the existing AI4Copernicus and AIoD offerings.

The World Cafés were organised as follows: First, we have grouped the open call project representatives into 3 distinct groups:

- Group A: 1st and 4th open call winners (projects implemented by consortia that include at least one low-tech SME)
- Group B: 3rd open call winners (single partner projects, containing only high-tech SMEs)
- Group C: 5th open call projects (single partner projects in their first month of the incubation phase, just starting out)

The World Cafés process was the following: We had:

- 3 world-cafe tables
- 3 open call winning groups will pass from each world-cafe table
- each table had 1 moderator, and 2 rapporteurs

All participants will be guided by NCSR-D to each table based on their group. Each of the three World Café sessions, namely "Data Services", "AI4Copernicus Services", and "AIoD Services & AI/EO Node" had the following similar structure:

- *Topic presentation* (5'): Why the topic and the features proposed are important. What AI4Copernicus has done. What is the current landscape
- *User Journey situation and desired state of affairs* (15'): User Needs. Current: Experience and current user journey (gains and pains). Desired: Experience and desired user journey from the participants (gains creators and pain relievers).
- *Consolidation and prioritisation* (10'). Prioritisation on a matrix (impact & accessibility)
- *Policy recommendations* (5'): Proposed policy recommendations and Feedback.

The world cafes provided a dynamic session for engaging face-to-face discussions between AI4Copernicus and the funded projects. Participants actively contributed user-driven propositions, offering insights into potential optimizations and extensions for both the AI4Copernicus ecosystem and the AIoD platform.

Furthermore, the workshops facilitated the formulation of user-driven policy guidelines, addressing the complexities and challenges faced at both micro (platform-ecosystem level) and macro (generic level) scales. Particularly emphasised were the unique perspectives of European micro-enterprises and SMEs, shedding light on barriers and suggesting pathways for enhanced AI adoption. Additional details can be found in the Deliverable D7.3.

2.5 Venture Capital (VC) Booklet

Aligned with our commitment to providing robust commercialization support within the AI4Copernicus initiative, we are pleased to introduce the "Venture Capital (VC) Booklet." This comprehensive resource serves as a guide for projects seeking venture capital opportunities to propel their innovations to the market.

We allocated one page for each project to include the following information:

- Project name, Companies, Countries
- Vision, Mission, Values, & Achievements
- Problem & Solution
- AI services & Innovative aspects
- Target Markets, Competitors, Business model and Targets

A template for each of the project pages is illustrated in the following figure:

Figure 4: Page Template for the VC Booklet

We grouped projects in 5 categories based on their domain (security, agriculture, health, energy, and other domains), and we created 5 different booklets, one for each domain. The booklet is publicly available and can be downloaded from the AI4Copernicus website. The corresponding links can be found in the following list:

- Security https://ai4copernicus-project.eu/security/
- Agriculture https://ai4copernicus-project.eu/agriculture/
- Health https://ai4copernicus-project.eu/health/
- Energy https://ai4copernicus-project.eu/energy/
- Other domains https://ai4copernicus-project.eu/other-domains/

3 AI4Copernicus Trustmark Granting Results Overview

AI4Copernicus places emphasis not only upon the creation but also upon the sustainability of innovative data-driven AI services that create socio-economic value in the Earth Observation domain. Towards this end, we provide **Trustmarks** to the funded AI4Copernicus projects that successfully graduated from the **1st, 3rd, 4th Open Calls**, in order to support and empower their innovative and responsible AI practices further during the commercialisation process.

Aligned with the consortium's commitment for transparency and responsibility, the AI4Copernicus Trustmark takes into consideration the following criteria:

- Deliverable quality (30%)
- Technical performance indicators (30%)
- Business performance indicators (30%)
- Ethical AI Assessment (10%)

According with this final score we will have:

- **Best-in-class Projects (Graduates) having a score above 75%** will be awarded the AI4Copernicus Trustmark in order to support and empower them further during the commercialisation process.
- **Behind the Best-in-class.** For those beneficiaries who haven't reached the threshold, the Expert Advisory Board will consider all possible objective reasons for underperformance (i.e. external factors which might have influenced the beneficiaries' performance) and will provide suggestions for future improvement.

In the following, we provide a list of all third-party projects that are trusted by the AI4Copernicus project through the **AI4Copernicus Trustmark** process, grouped according to their domain:

Security

- SR4C3, implemented by SISTEMA GmbH and Conflict Management Consulting (CMC) as a part of the AI4Copernicus 1st Open Call.
- VALENS, implemented by Vake AS, North Sea Aviation Services and Shipdetection.eu as a part of the AI4Copernicus 1st Open Call.
- Humanitywatch, implemented by Pixstart and Key Aid Consulting as a part of the AI4Copernicus 1st Open Call.
- EO4NOWCAST, implemented by Artys as a part of the AI4Copernicus 3rd Open Call.

Agriculture

- SCAVIHO, implemented by Encore Lab SL and Castillo de Maetierra as a part of the AI4Copernicus 1st Open Call.
- Sen4Weeds, implemented by DigiFarm, Altyn, and Farmen Gard as a part of the AI4Copernicus 1st Open Call.
- ESFA, implemented by GEOSKOP SL as a part of the AI4Copernicus 3rd Open Call.
- PLANET, implemented by Neuralio A.I. as a part of the AI4Copernicus 3rd Open Call.
- FertiRec, implemented by Spacenus GmbH as a part of the AI4Copernicus 3rd Open Call.

- OPTIMAL, implemented by Xibli Sistemas de Informacion SL as a part of the AI4Copernicus 3rd Open Call.
- LIVE4ENV, implemented by Digitanimal as a part of the AI4Copernicus 3rd Open Call.
- AI4 E2O.Green, implemented by 3D Executive Management Systems, LIST LABS, and Profida as a part of the AI4Copernicus 4th Open Call.

Health

- LobeliaAir, implemented by Lobelia Earth as a part of the AI4Copernicus 3rd Open Call.

Energy

- SLIDE, implemented by SOLAÏS and Transvalor as a part of the AI4Copernicus 1st Open Call.

Other Domains

- ODFuse4Ship, implemented by AMPHITRITE as a part of the AI4Copernicus 3rd Open Call.
- Urbalytics, implemented by Latitudo 40 and LAND Italia Srl as a part of the AI4Copernicus 4th Open Call.

Each of the trusted projects were granted with a Trustmark icon/badge, so that projects can proudly display on their materials, websites, and promotional material. 3 example badges are shown in the illustration below.

Figure 5: Example AI4Copernicus Trustmark Badges

In addition, we have created an repository on the AI4Copernicus website dedicated to showcasing the "Trusted AI4Copernicus" projects. This repository provides information about each graduated project, and provides a list of the corresponding AI Assets and Case Studies. The repository can be accessed via the following page: https://ai4copernicus-project.eu/ai4copernicus-trustmark/

The projects that have successfully met the criteria for the, and as a result, have been awarded the AI4Copernicus Trustmark, were informed of this via email (December 4th, 2023 for the 1st Open Call, December 22nd, 2023 for the 3rd and the 4th Open Calls). Apart from their badge, the trusted projects have been given a certificate signed by the AI4Copernicus coordinator that certifies that the specific project *"has been awarded the AI4Copernicus Trustmark, a recognition awarded to projects that have demonstrated exceptional qualities in terms of innovation, technical performance, business*

potential, and ethical considerations", mentioning the name of the project, the companies that comprise the consortium, and the corresponding AI4Copernicus open call.

Finally, we have initiated discussions with the AI-on-Demand catalogue platform's development team to explore the seamless integration of the AI4Copernicus trustmark mechanism. Specifically, we have conveyed a set of requirements to the development team, outlining the necessary parameters for allowing the AI4Copernicus organisation (or any certification body or trustmark authority) to issue trustmarks within the platform. This crucial step is designed to streamline the integration of the AI4Copernicus trustmark mechanism into the platform's infrastructure. Beyond enhancing the overall transparency of the platform, this addition significantly improves the user experience, simplifying the process for stakeholders to identify and engage with trusted projects.

4 Feedback on AI4Copernicus Incubation

Informal feedback about the degree of satisfaction with the AI4Copernicus incubation process, was received throughout the incubation process of the Open Call Projects. In particular, feedback was acquired during the AI ecosystem forum and the workshops with the AI4Copernicus winners. This feedback was positive and constructive enabling the AI4Copernicus partners to adjust whenever possible.

Formal feedback at the end of the project was acquired using the short questionnaire illustrated in Figure 5. The questionnaire was sent to the 1st, 3rd and 4th Open Call projects on December 19, 2023.

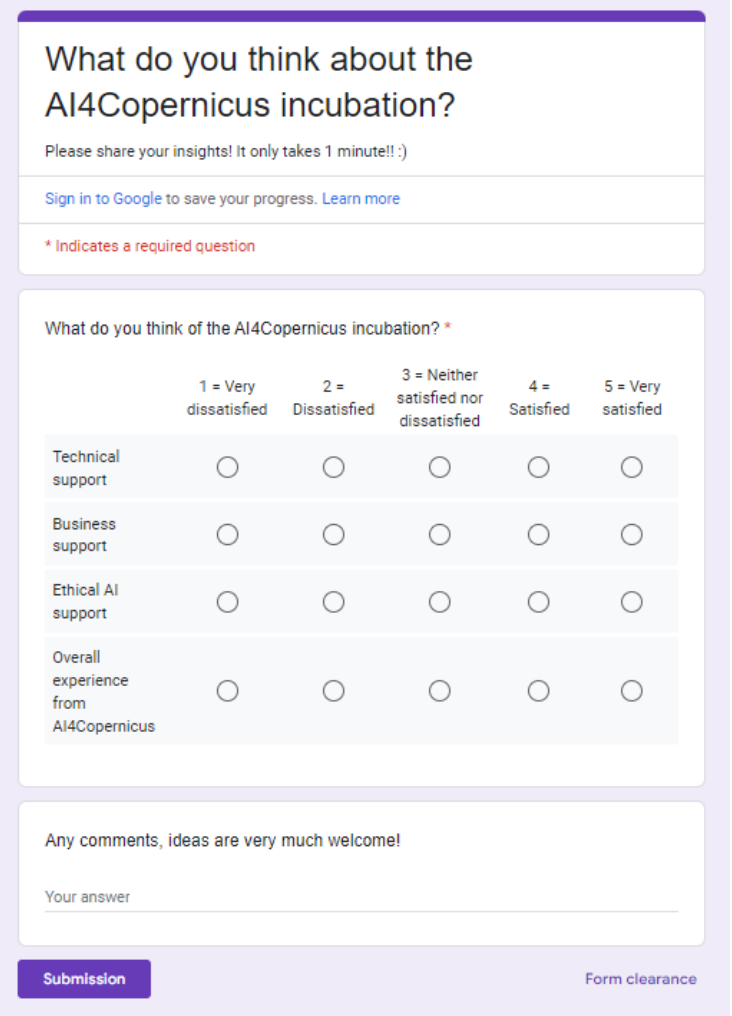

Figure 6: AI4Copernicus Incubation Feedback

5 AI4Copernicus Service Extensions and Optimisations

5.1 List of AI4Copernicus Services

In this section, we present a summary of the list of AI4Copernicus services and a summary of the usage of these services from the open call projects.

Table 2: Catalogue of AI4Copernicus services

Domain	Service	Responsible Partner
Security	Sentinel-1 GRD pre-processing	SatCen
	Sentinel-1 SLC pre-processing	
	Sentinel-2 pre-processing	
	Sentinel-1 change detection–ACD and MTC	
	Sentinel-2 change detection	
	Vector data of human features	
Agriculture	Deep network for pixel-level classification of S2 patches	THA
	TimeSen2Crop Dataset	UNITN
	Harmonisation of pre-processed time series of Sentinel-2 data	
	Long Short-Term Memory Neural Network for NDVI prediction	
	LST Memory Neural Network for Sentinel-2 for crop type classification	
	Pre-Trained LST Memory for crop type classification	
Health	Probabilistic downscaling of CAMS air quality model data	ECMWF
General Purpose, Semantic	EarthQA	UoA
	GeoTriples	
	JedAI	
	Strabon	
	Sextant	
	Semagrow	NCSR-D

Table 3: Usage of AI4Copernicus services by the Open Call projects

Service	number of projects using the service		
	1st Open Call	3rd/4th Open Call	5th Open Call
Security Services (SatCen)	used in final product: **2** used in experiments: **1**	used in final product: **2** used in experiments: **1**	expressed intention: **6** used in experiments: **4**
Agriculture Services (UNITN)	used in final product: **1** used in experiments: **1**	used in final product: **2** used in experiments: **2**	expressed intention: **4** used in experiments: **6**
Agriculture Services (Thales)	used in final product: **0** used in experiments: **2**	used in final product: **1** used in experiments: **1**	expressed intention: **7** used in experiments: **5**
Health Services (ECMWF)	used in final product: **0** used in experiments: **1**	used in final product: **0** used in experiments: **1**	expressed intention: **2** used in experiments: **3**

Semantic and Linked Data Tools (UoA)	used in final product: **0** used in experiments: **0**	used in final product: **0** used in experiments: **1**	expressed intention: **3** used in experiments: **2**

Details about the services are discussed in the corresponding deliverables of WP3 and the AI4Copernicus Technical Documentation. For a more comprehensive and analytical study of the usage of the services from the projects, please refer to Deliverable D2.4.

5.2 Feedback from the 5th Open Call Assessments & Reports

In this section, we collect and present the feedback and recommendation for our services reported by the 10 projects of the AI4Copernicus 5th Open Call. The scope of the 5th Open Call is AI4Copernicus services testing and feedback collection; we focus on the feedback leading to potential service extensions and optimization rather than reporting single technical issues faced. We present the feedback collected (i.e. positive comments, issues, resolved issues during Ai4Copernicus) as well as optimizations and extensions *proposed by the projects*.

The feedback reported here was collected during the final assessment of the 5th Open Call projects, carried out during November 2023. There were some cases though where the project had provided feedback to the corresponding service provider earlier (that is before the final assessment and during the testing phase). In these cases, the service provider had the opportunity to react to the feedback and provide some support on the service usage with the issue solved.

5.2.1 Security Services

The Security bootstrapping services have been tested by 6 projects out of the 10 in the 5th Open Call. Overall, the Security bootstrapping services received very positive comments and it was acknowledged the fact that their technological readiness level is quite high enabling the operational usage of the service in most cases.

The Security Services tested, concern the Sentinel 2 pre-processing, as well as the Change Detection for Sentinel 1 and for Sentinel 2 services. An optimization suggestion regarding the synergy among the Security Services has emerged from the projects' testing. Specifically, an issue has been identified concerning the disparity in default coordinate reference system (CRS) values across the image processing services. Notably, S2 pre-processing defaults to UTM CRS for its output, but when these pre-processed images are used as inputs for the S2 change detection service, the default output projection shifts to WGS84, prompting the need for alignment.

As far as it concerns suggestions for extensions, a use case focusing on solar panels maintenance, argued that an anomaly detection service would increase the value already found in S2 Change Detection Service. There's a gap between just finding changes in data and understanding if these changes require an action (e.g. maintenance). While information about the size and direction of the change has been considered, it's insufficient for certain decisions. Determining whether it's a minor or significant change and understanding if the angle information indicates a gradual or abrupt shift requires additional insights. Adding an Anomaly Detection Service could reduce a lot of duplicated work for developers working on different use cases, making the process more efficient for everyone.

Sentinel-2 pre-processing

We begin with the Sentinel-2 pre-processing service. The positive feedback of the service refers to:

- Overall functionality, usefulness, and ease of usage.
- Performance of the service has been found good, and the results are significant for users.
- Documentation, which has been found to be clear and comprehensive, containing examples for its execution.
- The deployment was found straightforward since its dockerized version enabled execution in different environments.
- Flexibility stood out, allowing users to specify parameters for several needs. For instance, one project found it very useful that users can select different Sentinel band combinations as well as utilise the mask usage feature.

At the same time users experienced a variety of issues that are summarised in the following Table 4. The table briefly labels the issues in the first column, while in the second contains the testimonial of the issues from the project. In the third column we document recommendations for future extensions and optimisations related to the specific issue. Any reaction from the service provider that occurred within the testing phase of the projects are included as well.

Table 4: Feedback for Sentinel-2 pre-processing

Issue Label	Issue Testimonial	Future Recommendations
High processing times	S2 images took hours for a small area like Málaga city, spanning around 50 km^2.	The service provider released a newer version with significantly reduced processing times. This version better optimised parameter values, yielding substantial results. Need for documentation update for parameters tuning.
	Computation time is approximately 2 minutes for a small AOI and around 17 hours for 510 AOI patch production, which is acceptable for dataset preparation.	
SAFE files retrieval	Retrieving SAFE source files for each AOI and target date is impractical and time-consuming for commercialization.	Automate file retrieval based on user-input AOI and date for SAFE files.
Very Large size of Docker	The initial version was already over 7GB. Constructing a service based on this large image posed various challenges.	The service provider acknowledged size limits, aiming to integrate essential components for diverse processes using GDAL and SNAP toolboxes. A deeper exploration is needed to optimise this, considering the suggestions.
	Another issue was the inclusion of SNAP's graphical interface, which further increased the image size.	The service provider released a new version V1.2.0 which speeds up processing with SNAP improvements and faster S2 pre-processing, but has a larger Docker image. Future users need to consider faster performance versus larger file size.
warnings	Concerns arose due to numerous warning messages during algorithm execution. While valuable for experts, these logs can overwhelm others, including us.	It would be beneficial to have a "silent" mode to streamline the output, which could also potentially boost performance by reducing on-screen log operations.

Sentinel-1 change detection–ACD and MTC

Concerning the Change Detection using Sentinel-1 SAR data, projects having tested the service recognised that it is:

- beneficial for timely monitoring of activities in forested areas.
- It operates independently of weather conditions, allowing periodic assessments without compromising data quality due to cloud cover. Sentinel-1 data offer remarkable sensitivity to surface roughness, allowing effective differentiation between water-covered and vegetated areas.
- It excels in providing clear distinctions across diverse surfaces, ensuring comprehensive coverage of forest canopies and clear-felling zones, enhancing its value in environmental monitoring.

However, the presence of speckles from volume scattering in forested areas poses a potential limitation to Sentinel-1 data. These speckles may hinder detailed analysis, especially for small features. Addressing these challenges could improve the tool's effectiveness and expand its applications. During tool testing, minor non-critical technical issues were identified and reported, all of which have been addressed by the developers in the latest version of the tool.

Sentinel-2 change detection

Projects appreciate the Sentinel-2 Change Detection tool for its

- effective contrast (e.g. identifying changes in forested areas). However, it has a limitation as the input data is sensitive to weather conditions.
- In different scenarios, like urban lakes, the tool successfully delivers the intended outputs, depicting changes in amplitude and angle between image pairs for each band. This feature proves valuable for qualitatively understanding changes within lakes.

In the following Table 5, feedback on issues regarding the tool, optimizations during AI4Copernicus and recommendations on Optimizations are being summarised.

Table 5: Feedback for Sentinel-2 change detection

Issue Label	Issue Testimonial	Future recommendations
Time-consuming processing for small AOI	Through extensive testing, we discovered the primary reason for the prolonged processing time of this service for small AOIs. It processes and temporarily stores the entire images of inputted SAFE files, taking over 2 hours on average.	No recommendations from the project
Limited Documentation-Connection cloud	Connection between the cloud machine and the docker containers.	For non-docker experts, it is important for the documentation to refer to several examples about the connection of the cloud machine and the docker container, e.g. example for storing the produced data of the docker service to the cloud machine

Limited Documentation-Sentinel products	Wrong input: we inserted L1C products instead of L2A.	Although the documentation refers to the recommended product as input, we think that it should be highlighted that the service doesn't accept other Sentinel-2 products
Limited Documentation-Coordinate System	Parameter "--AoI": Area of Interest.	The documentation should refer to the geodetic coordinate system that the "AoI" has to be defined, e.g WGS-84
Limited Documentation-bands selection	During the definition of the parameter "-- bands", the system raises the following error if there is a space among the bands, e.g B2, B3, B4, B8: unrecognised arguments: B02,B03	The documentation should highlight the right syntax in the band's definition

5.2.2 Agriculture Services

In this section we discuss each of the Agricultural Services, their positive and issue points as well as optimizations occurred during AI4 Copernicus and future recommendations, as indicated by the call winners. Specifically, they employed the Deep-network pixel-level classifier for Sentinel-2 patches, the Harmonization for S2, the Time2SenCrop dataset and the LSTM Neural Network from NDVI Prediction.

Deep network for pixel-level classification of S2 patches

The service has been employed to perform classification tasks in the forest, urban land cover understanding, biodiversity mapping and aquafarming location identification. On the positive side, the service has been characterised as easy to use. A significant performance improvement was achieved when the service upgraded the NVIDIA driver for the GPU, making the training and prediction processes at least 5-10 times faster than on a CPU. On the other hand the following Table summarises the issue feedback collected.

Table 6: Feedback for Deep network for pixel-level classification of S2 patches

Issue Label	Issue Testimonial	Future recommendations
Limited Documentation, licence	Technical documentation didn't mention that the service proprietary	Documentation should refer to the separable licence of the service, since without this licence, the service is not displayed in the docker
Compatibility and Restriction with Dockerized Application	The model is dockerized, restricting flexibility for testing new data loading and preprocessing. There were GPU compatibility issues with CUDA drivers for PyTorch version 1.10.2 when running the container locally.	To improve compatibility, consider offering a notebook or script for model training and inference tasks that seamlessly work with sample data, enhancing user experience.
Sample Data Inclusion within model	-	Consider including sample data with the model package, specifically a few TIFF images demonstrating both storage options. This could allow users to validate model loading and

		prediction before attempting training on a larger dataset, ensuring a smoother setup process.
Documentation Enhancement	Difficulties in using the service without easy to follow detailed examples.	Need for a more detailed explanation of the process and addition of more practical examples.
Limited Documentation, dataset format	Misunderstanding about the dataset format and structure due to limited documentation	No recommendations from the project.
GPU connection	Error related with the GPU connection with the docker container	The service provider updated the docker and the developers provided specific recommendations. No further recommendations from the project.
Limited Documentation, selected classes, image masks	The masks in the dataset should be in grayscale and not RGB. Also, the parameter "--selected classes" expects integer values where each value represents the pixel value of the corresponding class.	The service provided resolved the issues for us by specifying, but this information should be included in the documentation.
Sentinel band selection parameter	The names of the bands that are defined in the parameter "--bands", do not match the Sentinel-2 bands that the user utilises because the service expects the band names starting by 1	No recommendations from the project.
Trained model in docker image	Error due to the lack of the trained model from the docker image	The service provider removed the model weights from the Docker image to reduce size. The issue was resolved by receiving the trained model separately. Including the file with the weights needs to be updated to support users effectively.
Limited Documentation patch size,	Error after defining the patch_size = 512	The documentation should refer to the supported patch sizes which are: 256, 128, 64, 8

TimeSen2Crop Dataset

This pixel-based dataset contains more than 1 million crop type samples of Sentinel-2 time series. It includes information about the weather conditions, the spatial resolution, the chronology as well as the Sentinel-2 spectral bands and Tiles of each labelled unit. The projects that employed it found it as:

- an invaluable information source to perform classification of crops to identify the land cover for different tasks (e.g. crop type for biodiversity, algae blooms identification in lakes, etc).
- allowed the projects to easily apply new machine learning models since it is organised in time series and the crop type has been verified by external sources.
- easy to use as a sandbox

A suggestion for an extension emerged is that the CSV tabular storage selection might not be the best when it comes to tabular data, instead the Parquet file was recommended. Indeed, within the project one call winner reduced the file size by converting to 16 Parquet files, reducing the dataset

size to 700 MB from the expanded 4.62 GB CSV. On the other hand, Parquet is Apache proprietary, it might not be the best for data dissemination.

Moreover, another extension suggestion concerns separating crop type information into distinct tiff files per tile, allowing users to utilise other additional satellite sources during the training beyond of the provided Sentinel data.

Harmonisation of pre-processed time series of Sentinel-2 data

Projects measuring solar panels potential and identifying the new locations for sea-farming mainly employed the Harmonization of Sentinel-2 service. They find the service as:

- very fast
- well-performing
- very useful, since it mitigates cloud coverage, yielding more clear and consistent images, enabling accurate estimations.
- The service enables scalable, consistent land assessments across regions, ensuring comparability despite differing weather patterns and image schedules. This scalability is crucial for nationwide analyses.
- In addition, consistent, harmonised data allows accurate monitoring of long-term (e.g. solar) potential trends. This aids in planning solar energy infrastructure and policy making.

Minor issues that came up regarding the Docker image execution, have been resolved during the project execution with an updated container release.

Long Short-Term Memory Neural Network for NDVI prediction

The LSTM Neural Network for NDVI prediction has been employed by projects to compute vegetation indices for several tasks such as identifying crops status, vegetation in lakes and other. They reported that the service:

- works very well
- the training side is fast
- easy to prepare datasets
- classification accuracy was also very high

In the next Table feedback regarding issues and optimizations is described.

Table 7: Feedback for Long Short-Term Memory Neural Network for NDVI prediction

Issue Label	Issue Testimonial	Future recommendations
Geographic projection information specification	No CRS is assigned to the inference results, original CRS is lost. Coordinates are relative, and sub-tiling at 128 units.	Addressing the geographical projection issue will offer data accuracy, consistency and interoperability across GIS services.
Support data input	Documentation indicates that input data would be taken both from common folders and subfolders, yet only the latter seems to be working.	Update documentation to match the actual behaviour or support both data input modes.

Pretrained mode Error	Pretrained mode does not work (it seems to be impossible to continue training the model as it needs to be started over), error message is received once "—pretrained" parameter is on	Address the pretrained mode issue to fully enable users to exploit the service.
Limited Documentation, data input requirements	Misunderstanding of dataset format and structure. Understanding the meaning and format of the recommended dataset is challenging due to its spatio-temporal dimensions	Documentation should include detailed information about the recommended format of the required dataset and explain the meaning of data shapes.
Documentation update	The documentation refers that the exported weights file is in .h5 (Keras format) but the model is stored in .pb format (TensorFlow format)	Update the documentation accordingly

5.2.3 Health Services

Probabilistic downscaling of CAMS air quality model data

The service underwent testing in three projects: one for personal assistance, another for city-level predictions, and a third for identifying optimal sea farms, all with a focus on air quality. Overall, they found it the service as:

- well documented
- on-time support
- fast, the code runs quickly and all needed updates were made to the code base

On the other hand, there have been issues in the deployment such as setting up the dockers. The following Table 8 summarises the issues.

Table 8: Feedback for Probabilistic downscaling of CAMS air quality model data

Issue Label	Issue Testimonial	Future Recommendations
Deployment, outdated images	Docker and GitHub sources faced issues related to outdated base images and dependencies.	Provide details about prior tests and achieved resolution in the documentation.
Documentation, Availability of conducted tests	Lack of information on already conducted tests and achieved resolution in the documentation.	Consider publishing the trained model and utilised data to enhance reproducibility.
Documentation, examples, commands execution	Struggling to find the command for generating high-resolution frames in the technical documentation. Our initial expectation was to use an existing model and customise parameters.	The documentation needs practical examples to help users better understand and use commands effectively. Real-world use cases would improve comprehension
Prediction functionality not on service	We have to, by ourselves, find a way to load the model and apply it to the test dataset. Loading the model does not work.	The service needs further automation, otherwise it is not operational

CAMS data unavailability	CAMS data not available on EODATA but we need to use CDS (Climate Data Store)	The service should support the usage of Atmospheric Data using its autonomous sources.
air quality factors support	The service code is written for one chemical element	Need to support more chemical elements for Air Quality
Containers availability	Containers available on the platform do not match VM architectures available on Cloudferro.	We rebuilt the container from source code after suggestion from the service provider, but the service should support different VM architectures.

5.2.4 General-purpose Semantic Services

Three semantic tools have been finally tested during the AI4Copernicus by two projects. In the following section, we deliver feedback details and recommendations for all of them, namely Geoptriples, Strabon and Sextant.

Geotriples

Geotriples semantic tool proved:

- Very useful for transforming the input files.
- The generation of the mapping that contains the triples was reported to be quite fast.
- The integration also, was easy and smooth by employing the available docker image from Dockerhub.
- The documentation was adequate, however, additional detailed information and some examples of how to use it, would be beneficial.

There was no further issue feedback reported for the Geotriples.

Strabon

As far as it concerns Strabon:

- It handled all the SPARQL queries in a very satisfactory way, when tested in both small and larger scale experiments. One project plans to integrate it in its operational service.
- The documentation was found satisfactory
- The tool is user-friendly, however the command-line use can be challenging
- Seamless integration with pre-installed components in a Docker image, including Tomcat.

Storing triples through HTTP requests could be more efficient, with a suggested improvement of a progress bar on a separate page for large files.

Table 9: Feedback for Strabon

Issue Label	Issue Testimonial	Future Recommendations
Deployment	Deployment options include manual setup and Docker. Manual setup is complex; Docker setup is straightforward but requires caution with JDK versions.	Simplify deployment options, update Docker images, and offer clear version compatibility guidance.

Functionalities	Strabon provides geospatial support but can face stability issues with large queries. Some feature requests.	Address stability issues, introduce a "query interrupt" feature, and automate prefix integration in queries.
Documentation scattered and updates	Documentation is scattered to many documents, which are partly outdated. Documentation could be more comprehensive and include version requirements.	Maintain a single, regularly updated documentation source as the primary reference.

Sextant

Sextant semantic tool received positive evaluation such as:

- The web interface is user-friendly, with identified areas for feature enhancement based on user feedback.
- The documentation is comprehensive, however it could benefit from greater clarity regarding version requirements.
- The tool itself offers a robust feature set for geospatial Linked Data, and it provides both pre-built .war files and access to the source code for flexibility.

The projects have received valuable support from the development team when needed. The Following Table refers to a couple of issues found and relevant recommendations for optimizations.

Table 10: Feedback for Sextant

Issue Label	Issue Testimonial	Future Recommendations
Deployment	Offers pre-built .war files and source code. Version compatibility challenges.	Clarify version requirements for Maven and Tomcat.
Functionalities	Offers a rich set of features for geospatial Linked Data. Some feature requests for improvements.	Address feature requests for user experience improvements.

5.3 Feedback from other sources

Apart from the assessments and the reports-deliverables of the 5th Open Call projects, we collected feedback from various other sources. The sources are listed below:

- ***Feedback obtained from Questionnaires***: A series of questionnaires for collecting feedback for our services were sent to the Open Call projects as part of the evaluation conducted in the context of WP2. The feedback was collected in 3 stages. First, a questionnaire was sent to the 1st Open Call Projects on November 2022; then a second questionnaire was sent to the 3rd and 4th Open Call Projects on March 2023; and finally a third questionnaire was sent to the 5th Open Call Projects on October 2023; The questions and the analysis of the results are reported in high detail on Deliverable D2.4 (see Sections 3.1, 3.2, and 3.5 of D2.4).

- ***Feedback obtained from the World Cafes***: The comprehensive feedback collected during the World Cafe workshops (see Section 2.1 of the present deliverable) played a pivotal role in shaping the sustainability strategies and policy frameworks for the AI4Copernicus and AIoD ecosystems. In Deliverable D7.3 we provide a presentation on the collected feedback,

together with its contribution to the establishment of a future AI+EO Node (Sections 4.2 and 5.1 of D7.3).

We do not include the results of the feedback here for brevity, but we consider their outcomes in our proposed extensions and optimisations in the following section.

5.4 Proposed extensions and optimisations

Based on the valuable insights derived from the analysis of the feedback that we gathered from the Open Call projects, we recommend optimising and extending the AI4Copernicus services by integrating the crucial information generated and collected. These recommendations are informed by both our accumulated experience and the feedback collected, ensuring a comprehensive approach to enhance the efficiency and functionality of the AI4Copernicus services. In our recommendations, we include the feedback captured by the questionnaires sent to the Open Call Projects (reported on D2.4), by the reports and the assessments of the 5th Open Call (whose scope was to test the AI4Copernicus services, reported above), and by the discussions during the world cafe workshops in the Athens AI Ecosystem and Forum event (reported on D7.3).

5.4.1 Security Services extensions and optimisations

Several optimization opportunities emerged such as:

- The Coordinate Reference System (CRD) for input data and output results needs to be aligned to allow synergy among the Security and other services. In addition, it would be beneficial to provide users with the ability to select the system; this would enable the seamless integration of the services within the services as well as with other pipelines and tools.
- The size of the docker needs to be reduced, since it poses challenges for users. From the feedback received, we understand that the docker size depends also on the inclusion of graphical libraries (e.g. SNAP), which also increase the processing speed. We recommend that users be enabled to select between speed and size, weighting their own needs.
- Sentinel-2 Change Detection is a very effective tool for identifying changes, but the S2 data introduces a sensitivity for the service to weather conditions. Therefore, we conclude that a significant optimization would be to introduce strategies to address or mitigate this problem.
- The processing times of S2 pre-processing and Change Detection have been reported to be time-consuming even for small AOIs. We recommend employing methods to mitigate this phenomenon such as to document preset parameters tuning, sampling, tiling or storage alternative techniques or other that could be considered to reduce the execution duration.
- S1 Change Detection, provides excellent distinctions across different surfaces. However, speckles (e.g from volume scattering in forests) may limit detailed analysis of Sentinel-1 data. Addressing this challenge is a crucial optimization to enhance the tool's effectiveness and broaden its applications.

Potential Extensions:

- The suggestion for an extension involves enhancing the S2 Change Detection and the Security bootstrapping Services by incorporating an anomaly detection service (e.g. for solar

panel maintenance). While the current service identifies changes in data, it lacks the ability to assess whether these changes necessitate action, such as maintenance. Additional insights into the significance and nature of changes, including angles indicating gradual or abrupt shifts, are essential. Integrating an Anomaly Detection Service would streamline development efforts across various use cases, optimising efficiency for developers and enhancing the overall process.

- There's a need for an extension of the Security Services that can generate a timeline mosaic of tiles, offering a visual representation of the chronological evolution of data or images associated with these tiles. This tool could find applications in various domains, providing an intuitive way to observe changes over time.
- The introduction of services supporting land/sea and cloud masking is an extension request from users to the security services and geospatial tools. Land/sea masking involves distinguishing between land and water areas in satellite imagery, aiding in applications such as environmental monitoring and land cover analysis. On the other hand, cloud masking focuses on identifying and excluding cloud-covered regions, which is crucial for obtaining accurate and clear observations in various remote sensing applications.

5.4.2 Agricultural Services extensions and optimisations

We proceed with the recommendations for optimizations both for the Thales and UNITN developed Agricultural services:

- For the Thales Deep-network pixel-level classification service:
  - We recommend aligning the Sentinel band selection parameter with Sentinel-2 Bands actual names for seamless integration between the service and products, ensuring consistency and an enhanced user experience.
  - In addition, it is suggested to update the documentation to improve the ease of use for the service by providing clearer information on the dataset format structure.
  - It was indicated that there is the need to provide better documentation, and an easier deployment and unit testing of the service.

- For the UNITN services and particularly for the LSTM NN for NDVI prediction:
  - It is suggested to address the Coordinate Reference System (CRS) specification issue that emerged. The inference results do not carry the geographic projection information and the output coordinates are relative and not accurate. Resolving this issue could enable seamless integration with other geographical and other information systems and tools.
  - It is suggested that the provided documentation can be improved and one winner indicated that the overall quality of the services could be upgraded.

Potential Extensions:

- An extension based on the last optimization point would allow the user to select different CRS for input and output data. In this way integration with other services is further enabled.

- Supporting Parquet files is suggested as an extension, given their significant reduction in the size of tabular data, enhancing effectiveness for machine learning tasks. However, it's noted that the proprietary nature of Parquet files being associated with Apache poses challenges for dissemination in the context of TimeSen2Crop Dataset of the UNITN Agricultural services.
- It is proposed separating crop type information into individual TIFF files per tile. This enhancement enables users to incorporate additional satellite sources during training, expanding beyond the provided Sentinel data in TimeSen2Crop.
- It was indicated that it would be useful for users to have available other land cover classification pretrained models that use publicly available data.
- In the forestry sector, there is a need for EO-based tools designed by forest experts to assess forest resources. Currently, the AIoD platform lacks tools specifically tailored for the forestry sector.

5.4.3 Health Services extensions and optimisations

We proceed with the recommendations for optimizations for the Probabilistic Downscaling of CAMS service:

- The service encountered challenges in loading the model and supporting the prediction task. Addressing this issue is crucial for the development of an automated and functional operational service, and we recommend prioritising efforts to resolve it and optimise its functionality.
- Additionally, there's a mismatch between the containers on the platform and the VM architecture on Cloudferro. Optimising the integration with cloud infrastructure is necessary for smoother operation.
- The Health Bootstrapping Service will become increasingly popular since it offers Air Quality information at various levels that many services will use. The demand for being at an operational level will be increasingly high and we recommend moving in this direction.

Potential Extensions:

- Consider implementing an in-house Data Broker to seamlessly integrate data into the service. This is especially relevant given the increasing popularity of probabilistic downscaling for the CAMS service and the challenges in obtaining data expressed by call winners. Allow easy redirection or connection to the Climate Data Store (CDS) and other data stores.

5.4.4 Semantic Services extensions and optimisations

Based on user feedback, improvements are sought in documentation, ease of deployment, testing, and overall performance of the services. However, users express satisfaction with the overall quality and technical support provided.

6 Policy Recommendations for AI & EO

The AI4Copernicus policy recommendations have emerged both from:

- **(a) indirect input:** based on the AI4Copernicus Open Call applicants (AI & EO Innovation Index, D7.3) and funded projects (via the incubation process and workshops with projects). These recommendations (**4 policy recommendations**) can be found in Section 2.3.1 of this report.
- **(b) direct input:** SME propositions for relevant policy recommendations via the AI Ecosystem Forum (Summer 2023). These recommendations (**17 policy recommendations across 5 levels)** are presented below.

Integrated policy recommendations

The policy recommendations that emerged from the workshops that took place during the AI Ecosystem Forum are divided into 5 levels, as it can be seen in the sections that follow, which also integrate the indirect policy recommendations that emerged from the AI4Copernicus Incubation (in total 20 recommendations).

1. Infrastructure Level: Policy Recommendations

- **Data-centric:** It is important to keep data open and affordable via open data policies and regulations. Providing free data sets as for example for the (VHR) very high-resolution data, is important for European micro-innovators. In addition, providing full and open access to these free datasets, free of charge, assuming that the access is provided on-line will strengthen their innovation capacities. Thus open, free data and data access to them is crucial for European SMEs in the AI and EO domain, especially in the context of digital twins and access to public platform data.
- **Tools-centric:** Important to raise awareness around platforms and tools that aim to integrate knowledge and research around AI and EO. Furthermore, providing funds (at a European and national level) for such platforms would enhance this emerging innovation ecosystem in Europe.
- **An AI4EO marketplace:** The creation of an AI&EO marketplace for products and services in this industrial sector would provide numerous benefits especially for SMEs and micro-entrepreneurs that would be able to access it as “prosumers” (offering their services & buying other services). As such policy makers at an EU level could support the creation of such a marketplace at a European level, while ensure federated access to relevant marketplaces or label market places
- **AIoD platform:** It is highly important for the European innovators in this domain to have easy access and usage of the AIoD platform. Therefore, additional guidance and awareness raising programs for SMEs are crucial (see also D7.3).

2. Trustworthy AI Level: Policy Recommendations

- **Data-centric:** SMEs need guidance and support around the implementation of trustworthy AI in the EO context. Towards this aim, innovators need more

industry-friendly solutions such standard protocols for evaluation of AI solutions, data sources of official legal information, an AI act model documentation for EO applications, etc.

- **Trustworthy AI Seals/Trustmarks** *(this recommendation was also identified via indirect input, as presented in Section 2.3.3 of this report):* In order to ensure trustworthy AI practices in the EO domain, it is important to foster a cultural change toward responsible AI & EO innovation. This necessitates raising awareness, sharing best-practices and relevant case studies, creating tools to help innovators and creating a broader ecosystem around trustworthy AI for the EO domain, while providing relevant funding for realising trustworthy AI&EO practices. Creating a Trustworthy AI & EO label we believe that could act as a positive reinforcement, that would contribute further to the realisation of Trustworthy AI innovation in this domain. Towards this aim Europe should provide "Trustworthy AI seals of good practices/methods", as well as certification of trusted AI models, so as to ensure that the AI methods are not a black box. Such certification for AI models and tools would foster the deployment of trusted AI & EO solutions and ensure compliance for SMEs.
- **Awareness creation around Trustworthy AI in the EO domain** *(recommendation that emerged from indirect input, Section 2.3.3 of this report*): t is important to create awareness around Trustworthy AI aspects as well as the legal aspects that pertain AI practices (AI Act, Digital Services Act, etc) for European SMEs in this domain.
- **Trustworthy AI Assessment process for the EO domain** *(recommendation that emerged from indirect input, Section 2.3.3 of this report*): In order to successfully realise Human-centric, trustworthy AI practices in the AI & EO domain in Europe, it is important to foster holistic AI ethics assessments/self-assessments that go beyond "box ticking" but which integrate knowledge sharing components that enable innovators to expand their understanding around responsible AI practices. Practical guidelines and codes of conduct are needed by SMEs as well as automated practices to facilitate implementation. The AI4Copernicus Responsible AI Code of Conduct aims to actively contribute to Trustworthy AI & ERO practices.

3. Education/Skills Level: Policy Recommendations

- **Industrial Training**: Capacity building for industrial stakeholders is needed to advance the capabilities of European innovators and contribute to the innovation capacity of the domain. More open educational resources targeting SMEs should be designed and implemented providing up to date and hands-on knowledge targeting the needs of innovators in the AI and EO domain.
- **Graduate level education**: It is important to promote the use of remote sensing and EO in universities, to promote this innovative field while at the same time to bridge the gap between industrial demand and supply of human capital in Europe.

- **Interdisciplinary training**: Europe should invest in interdisciplinary training in the AI and EO domain. Thus, providing policies to provide the necessary interdisciplinary training (EO, AI).
- **AI Ethics literacy training***(recommendation that emerged from indirect input, Section 2.3.3 of this report*)**:** It is important to enhance European innovators' ethical AI literacy levels to realise Trustworthy AI practices. The AI4Copernicus Open Educational Program (see D7.3) provides a basis for such training programs that integrate Trustworthy AI training for industry in the EO context.
- **Educational and awareness creation programs for citizens:** European citizens should become aware of the possibility that the use of AI and EO technology as a service can bring to them and to the environment as well as the value that EO data can bring to the general public. As such policy makers should establish awareness raising campaigns and specialised educational programs that will be targeting the needs of the civil society.
- **Empower innovation co-creation between citizens and industry**: The AI4Copernicus project showcased successfully how innovation co-creation between citizens and industry can be implemented. As such citizens should be empowered and special innovation co-creation challenges can be designed to strengthen such activities. EC can support this further in the respective EU calls.

4. Research Level: Policy Recommendations

- **New research careers in the intersection of scientific fields linked with EO:** Design and implement policies that will promote new research careers in the intersection of EO, AI, climate modelling, etc. This should be aligned with the development of the relevant AI competencies as well as educational material that will empower young researchers adopting an interdisciplinary approach. These activities should be accompanied with analogous funding for relevant research positions and activities in the AI & EO domain.
- **Invest in launching new satellites:** Considering the critical value of data-driven innovation in the EO context, Europe should invest in launching new satellites aiming to enhance further its AI & EO-driven innovation.

5. Innovation Level: Policy Recommendations

- **Open-calls & EU-funded projects:** Taking into consideration the operational needs of early stage innovators in this domain, it is important for them to be able to have easy access to collaboration and funding opportunities that can be provided via open call and EU-funded projects. As such, bureaucratic "barriers to entry" can be reduced and the approach of these projects can be more focused on "results validation" (result-driven funding) rather than reporting.
- **Equal funding opportunities for AI and EO across EU:** Considering the importance of the EO domain for the European economy (and society/environment), it is imperative that the EC fosters and nurtures technology

& data-driven innovation across all EU member states. The immense potential of AI and EO technologies to address complex challenges across sectors makes it highly demanding for Europe not only to invest in this domain so as to unleash its full transformational potential but also to ensure equal funding opportunities across EU countries.

- **Adopting different funding models:** Acknowledging the successful funding process of the diverse AI4Copernicus innovation funding models, we believe that this creates a value-adding case study for considering the adoption of novel funding schemes, which may include:
  - *(1)* ***co-creation funds with high-tech and low-tech companies*** **(**i.e., users of the service to be developed): this scheme appeared to be highly successful not only for the design but also for reaching the market and commercialization the end solution;
  - (*2)* ***co-creation funds with citizens:*** this scheme was also successful and managed to provide innovative solutions with high economic viability and social impact;
  - *(3)* ***subsidies to large companies to collaborate with SMEs and micro-enterprises & blended finance for AI & EO innovations****:* this could be a novel scheme that would support companies to cross the 2nd valley of death that was identified in this domain (see Deliverable D7.3). Large companies with the resources and expertise can play a key role in mentoring SMEs while at the same time they can have access to advanced technologies. Subsidies could act as a powerful incentive to encourage industry leaders to collaborate with SMEs and micro enterprises in the AI and EO domain. Consequently the provision of blended finance, a combination of grants and private equity, could be beneficial for all involved parties. These financial schemes could also be linked with TEFs (Testing and Experimentation Facilities) as well as sandboxes.
- **Reconsider the ownership models for training datasets and for trained AI models**: The question of ownership of training datasets and trained AI models is important for European innovators in the AI & EO domain, as they are integral parts of emerging AI&EO applications. Large datasets used for training ML algorithms are usually owned by research organisations, public or private sector. In the EO domain, data originates from satellite observations and potentially more collaborative ownership structures could be considered (i.e., creating shared repositories by and for private and public entities, etc). For the ownership of trained AI models in the EO domain, more open-source licensing models and shared access models could be considered in order to support knowledge exchange among innovators.

------End of Document------