Destination – Climate sciences and responses for the transformation towards climate neutrality

Europe has been at the forefront of climate science and should retain its leadership position to support EU policies as well as international efforts for a global uptake of climate action in line with the Paris Agreement and the Sustainable Development Goals (SDGs), including biodiversity objectives. Advancing climate science and further broadening and deepening the knowledge base is essential to inform the societal transition towards a climate neutral and climate resilient society by 2050, as well as towards a more ambitious greenhouse gas reduction target by 2030. It will involve research that furthers our understanding of past, present and expected future changes in climate and its implications on ecosystems and society, closing knowledge gaps, and the development of the tools that support policy coherence and the implementation of effective mitigation and adaptation solutions.

The activities implemented under this section will enable the transition to a climate-neutral and resilient society and economy through improving the knowledge of the Earth system and the ability to predict and project its changes under different natural and socio-economic drivers. This includes a better understanding of society's response and behavioural changes, allowing a better estimation of the impacts of climate change and the design and evaluation of solutions and pathways for climate change mitigation and adaptation and related social transformation.

This Destination contributes directly to the Strategic Plan's **Key Strategic Orientation** D *"Making Europe the first digitally led circular, climate-neutral and sustainable economy through the transformation of its mobility, energy, construction and production systems"* and the **impact area** "Climate change mitigation and adaptation".

In line with the Strategic Plan, the overall **expected impact** of this Destination is to contribute to the *"Transition to a climate-neutral and resilient society and economy enabled through advanced climate science, pathways and responses to climate change (mitigation and adaptation) and behavioural transformations"*, notably through:

- Advancing knowledge and providing solutions in the any of following areas:
    - Earth system science;
    - Pathways to climate neutrality;
    - Climate change adaptation;
    - Climate services;
    - Social science for climate action; and
    - Better understanding of climate-ecosystems interactions.

- Contributing substantially to key international assessments such as those of the Intergovernmental Panel on Climate Change (IPCC), the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) or the European Environment Agency (e.g. European environment - state and outlook reports, SOER).
- Strengthening the European Research Area on climate change.
- Increasing the transparency, robustness, trustworthiness and practical usability of the knowledge base on climate change for use by policy makers, practitioners, other stakeholders and citizens.

Coordination and synergies should be fostered between activities supported under this destination and those under other destinations of cluster 5, as well as with other clusters of Horizon Europe.

In particular, complementarities with cluster 4 and cluster 6 should be taken into account by planning for adequate resources for co-ordination and clustering activities. Following a systemic approach, this destination concentrates on activities related to climate science and modelling, whereas cluster 4 supports activities in the area of low-carbon and circular industry, and cluster 6 contributes to R&I on the implementation of climate change mitigation and adaptation solutions in the areas covered by cluster 6 (notably Intervention Area (IA) 1 on biodiversity and nature-based solutions (NBS), Earth observation, IA 4 on seas, oceans and inland waters…).

Coordination and synergies are also encouraged with the activities funded under the work programmes on the Horizon Europe missions, in particular the Mission "Adaptation to Climate Change", the Mission "Climate Neutral and Smart Cities" and the Mission "Restore our Ocean and Waters by 2030". While this destination supports upstream research activities on climate science, the Missions focus on the testing, demonstration and scale up of solutions to address the challenges of climate change and environmental degradation.

Actions should envisage clustering activities with other relevant ongoing and selected projects for cross-projects cooperation, consultations and joint activities on crosscutting issues and share of results, as well as participating in joint meetings and communication events. To this end, proposals should foresee a dedicated work package and/or task and earmark the appropriate resources accordingly.

Synergies are also sought throughout this destination with the work of the European Space Agency (ESA), in order to ensure complementarity and mutual benefit regarding research and innovation actions conducted at the ESA.

The following call(s) in this work programme contribute to this destination:

Call	Budgets (EUR million)		Deadline(s)
	2023	2024	

HORIZON-CL5-2023-D1-01	107.50		18 Apr 2023
HORIZON-CL5-2023-D1-02	10.00		18 Apr 2023
HORIZON-CL5-2024-D1-01		103.00	05 Mar 2024
Overall indicative budget	117.50	103.00	

Call - Climate sciences and responses

HORIZON-CL5-2023-D1-01

Conditions for the Call

Indicative budget(s)[24]

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million)[25]	Indicative number of projects expected to be funded
		2023		
Opening: 13 Dec 2022 Deadline(s): 18 Apr 2023				
HORIZON-CL5-2023-D1-01-01	RIA	16.00 [26]	Around 8.00	2
HORIZON-CL5-2023-D1-01-02	RIA	14.00 [27]	Around 7.00	2
HORIZON-CL5-2023-D1-01-03	RIA	8.00 [28]	Around 4.00	2
HORIZON-CL5-2023-D1-01-04	RIA	16.00 [29]	Around 8.00	2
HORIZON-CL5-2023-D1-01-05	RIA	5.50 [30]	Around 5.50	1
HORIZON-CL5-2023-D1-01-06	RIA	10.00 [31]	Around 5.00	2
HORIZON-CL5-2023-D1-01-07	RIA	12.00 [32]	Around 12.00	1
HORIZON-CL5-2023-D1-01-08	CSA	3.00 [33]	Around 3.00	1

[24] The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.
The Director-General responsible may delay the deadline(s) by up to two months.
All deadlines are at 17.00.00 Brussels local time.
The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2023 and 2024.

[25] Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

[26] Of which EUR 9.00 million from the 'NGEU' Fund Source.

[27] Of which EUR 8.00 million from the 'NGEU' Fund Source.

[28] Of which EUR 4.00 million from the 'NGEU' Fund Source.

[29] Of which EUR 9.00 million from the 'NGEU' Fund Source.

[30] Of which EUR 3.00 million from the 'NGEU' Fund Source.

[31] Of which EUR 5.50 million from the 'NGEU' Fund Source.

[32] Of which EUR 6.50 million from the 'NGEU' Fund Source.

HORIZON-CL5-2023-D1-01-09	RIA	8.00 [34]	Around 4.00	2
HORIZON-CL5-2023-D1-01-10	RIA	5.00 [35]	Around 5.00	1
HORIZON-CL5-2023-D1-01-11	RIA	10.00 [36]	Around 5.00	2
Overall indicative budget		107.50		

General conditions relating to this call	
Admissibility conditions	The conditions are described in General Annex A.
Eligibility conditions	The conditions are described in General Annex B.
Financial and operational capacity and exclusion	The criteria are described in General Annex C.
Award criteria	The criteria are described in General Annex D.
Documents	The documents are described in General Annex E.
Procedure	The procedure is described in General Annex F.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G.

Earth system science

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D1-01-01: Further climate knowledge through advanced science and technologies for analysing Earth observation and Earth system model data

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a

[33] Of which EUR 1.50 million from the 'NGEU' Fund Source.
[34] Of which EUR 4.00 million from the 'NGEU' Fund Source.
[35] Of which EUR 2.50 million from the 'NGEU' Fund Source.
[36] Of which EUR 5.50 million from the 'NGEU' Fund Source.

	proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 16.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). [37]. Beneficiaries will be subject to the following additional obligations regarding open science practices: Open access to any new modules, models or tools developed from scratch or substantially improved with the use of EU funding under the action must be ensured through documentation, availability of model code and input data developed under the action.

Expected Outcome: Actions are expected to contribute to **all of the** following outcomes:

- Better knowledge of the past, present and future of the Earth System, relevant for regional or international assessments like those of the IPCC.
- Support to the development of targeted and cost-efficient climate mitigation or adaptation strategies in Europe.
- Advanced data science capacities and skills for climate data analysis, capacity building and training.
- Lasting cooperation between Earth System research, Earth Observation data providers, Data science and high-performance computing (HPC) infrastructures.

[37] This decision is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under 'Simplified costs decisions' or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

Scope: The EU and its Member States have invested massively in Earth Observation (EO), for example with the Copernicus Programme, the development of climate and Earth System Models (ESMs), and their contribution to the implementation of Global Earth Observation System of Systems (GEOSS), which are yielding unprecedented volumes of data. This topic aims at spurring the exploitation of these assets through advanced data technologies, including artificial intelligence techniques like machine learning or explainability, or new statistical approaches based on the cooperation between "big data" engineers, EO specialists and climate scientists.

Actions should create new insights in key processes of the Earth system and improve climate predictions based on advanced exploitation of EO data and their appropriate integration in existing or new data assimilation or modelling approaches. The activities should also lead to improved evaluation tools to facilitate the analysis of ESMs by developing new process-oriented diagnostics to better understand remaining biases and drifts, or unresolved processes or coupling in models, and improve model parameterisation and tuning. Actions should develop new tools or approaches to increase the efficiency (i.e. speed) in analysing model outputs to facilitate the study of such vast amounts of data. Actions should also distil more tailored, usable and reliable information from models and observations for assessing risks caused by extreme weather and climate events in Europe in the coming decades and contribute to an improved detection of climate change on varying space and time scales.

Actions should build on the results of, and cooperate with, past and ongoing scientific research related to EO and ESMs[38], as well as adaptation strategies at global and regional levels, e.g. the science base supporting the Copernicus Services, ESA data cubes, the relevant action within the GEO multiannual WP, the EuroHPC JU investments in HPC capabilities or Destination Earth.

When dealing with models, actions should promote the highest standards of transparency and openness, going well beyond documentation, as much as possible, and extending to aspects, such as assumptions, code and data that is managed in compliance with the FAIR principles[39]. In particular, beneficiaries of EU funding are required to publish results data in open access repositories and/or as annexes to publications, and provide full openness of any new modules, models or tools developed from scratch or substantially improved. Projects should take into account, during their lifetime, relevant activities and initiatives for ensuring and improving the quality of scientific software and code, such as those resulting from projects funded under the topic HORIZON-INFRA-2023-EOSC-01-02 on the development of community-based approaches.

HORIZON-CL5-2023-D1-01-02: Climate-related tipping points

Specific conditions

[38] E.g. projects NextGEMS, ESM2025 and projects funded under the call HORIZON-CL5-2022-D1-02-02

[39] FAIR (Findable, Accessible, Interoperable, Reusable).

Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 7.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 14.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). [40]. Beneficiaries will be subject to the following additional obligations regarding open science practices: Open access to any new modules, models or tools developed from scratch or substantially improved with the use of EU funding under the action must be ensured through documentation, availability of model code and input data developed under the action.

Expected Outcome: Actions are expected to contribute to **all of the** following outcomes:

- New or improved models for climate predictions or projections, which take into account climate-related potential tipping points and their impacts and are relevant for major assessments like those of the IPCC and IPBES.
- Better understanding of potential compound or cascading effects on climate, ecosystems and society as a consequence of crossing specific tipping points.
- Increased capacity to identify unknown tipping elements and early warning signals when a tipping point is approached.

[40] This decision is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under 'Simplified costs decisions' or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

- Contribution to mitigation policies with view to the Paris Agreement and the EU Biodiversity Strategy 2030, taking into account the precautionary principle, with respect to abrupt responses, hysteresis and other non-linear behaviour of the Earth system.

- Input to adaptation strategies for the most affected regions, globally, addressing the risks of crossing climatic tipping points and related impacts on ecosystems and biodiversity.

Scope: Elements of the Earth system, including ecosystems, can suffer relatively rapid transitions in response to small changes in forcings, a process known as crossing a tipping point. Such transitions are often irreversible: the system does not return to its original state even when the forcing that caused it is brought back to its original value. The transition to a new state would have a high (even catastrophic) impact across multiple regions, physical processes, ecosystems and biodiversity, and should therefore be avoided (in line with the EU's biodiversity strategy for 2030). Some of these tipping points may have already been crossed or have a high probability of being crossed during this century, like those caused in the ocean by warming, acidification and deoxygenation. Early warning signals, reversibility, hysteresis and resilience should be addressed through appropriate analysis methods. Mitigation pathways and safe operating spaces for humanity should be assessed and communicated to targeted audiences.

The ability and/or sensitivity of global Earth system models (ESM) to simulate tipping point crossings and other non-linear behaviour requires solid process understanding, firmly rooted in observational evidence, including from paleo-records. These processes need to be correctly represented in ESMs. The probability and impact of tipping point crossings and abrupt system changes need to be better quantified for a sound risk analysis (including aspects of irreversibility), addressing for example impacts on agriculture, fisheries, or health. Further, the approach to and crossing of tipping points lead to a loss of ecosystem resilience, causing a compounding effect in ecosystems already stressed due to non-climatic factors, and the potential for cascading impacts across trophic webs and ecosystems.

Projects should build on the results of and cooperate with, past and ongoing scientific research related to tipping points, abrupt ecosystems change and potential mitigation and adaptation strategies at global and regional levels.

When dealing with models, actions should promote the highest standards of transparency and openness, as much as possible going well beyond documentation and extending to aspects such as assumptions, code and data that is managed in compliance with the FAIR principles[41]. In particular, beneficiaries are strongly encouraged to publish results data in open access repositories and/or as annexes to publications. In addition, full openness of any new modules, models or tools developed from scratch or substantially improved with the use of EU funding is expected. Finally, projects should take into account, during their lifetime, relevant activities and initiatives for ensuring and improving the quality of scientific software and code, such as those resulting from projects funded under the topic HORIZON-INFRA-2023-EOSC-01-02 on the development of community-based approaches.

[41] FAIR (Findable, Accessible, Interoperable, Reusable).

HORIZON-CL5-2023-D1-01-03: Climate impacts of a hydrogen economy

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 8.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).

Expected Outcome: The objective of this topic is to achieve greater understanding among policy makers and stakeholders of the climate impact of large-scale deployment of hydrogen as an energy carrier or industrial feedstock, and options for addressing it. This will inform policy makers in the context of the European Green Deal, as well as alerting actors in the private sector to the environmental risks, including water and land use, opportunities and co-benefits associated with a hydrogen economy.

Actions are expected to contribute to **all of the** following outcomes:

- A rigorous assessment of the behaviour of hydrogen in the oxidizing cycles of the atmosphere related to methane, water vapour, carbon monoxide and ozone.
- A rigorous assessment of the ways in which large-scale production, distribution and use of hydrogen (e.g. as an energy carrier or industrial feedstock) can affect anthropogenic radiative forcing.
- Better monitoring tools (methodologies and instruments) for detecting and quantifying hydrogen leakage (in situ or through remote sensing).

In each case, it will be necessary to consider direct and indirect radiative forcing, both from hydrogen (e.g. potential leakages) and from other forcers associated with, or displaced by, its production, its transport and consumption.

Scope: Successful consortia should conduct **all of the** following activities:

- To provide a better knowledge in order to achieve deeper and more precise understanding of the overall mechanisms driving the hydrogen cycle and its future

development under concentrations higher than historically observed (with a specific focus on hydrogen sink processes).

- Thorough analysis of the radiative forcing impacts of hydrogen, specifically by investigating the mechanistic interactions of hydrogen with tropospheric gases, in particular methane, carbon monoxide, nitrous oxide and the potential to increase atmospheric water vapour.

- Assessment of **all of the** following aspects:

    - Direct and indirect effects in the atmosphere and their environmental implications (e.g. on the ozone layer).

    - The potential of systems, technologies and markets associated with large-scale hydrogen deployment to alter atmospheric hydrogen concentrations.

    - The channels through which large-scale deployment of hydrogen could reduce global warming (e.g. by replacing fossil fuels or storing energy to balance intermittent sources of renewables).

    - The channels through which large-scale deployment of hydrogen could contribute to global warming (e.g. through leakages in the supply chain, efficiency of production and conversion processes, creation of a market for natural gas, decommissioning, displacement of other low carbon technologies).

    - Options for mitigating any global warming risks associated with hydrogen deployment (e.g. through leakage detection technologies).

Proposals are also invited to:

- Identify any significant non-climate co-benefits or side effects of hydrogen deployment (e.g. on air, soil and water quality, as well as water resource availability).

- Consider the extent to which the risks of climate impacts from hydrogen deployment vary between different uses (e.g. energy, industry, transport).

- Consider opportunities for mitigating such risks.

- Disseminate their findings to relevant stakeholders such as national public authorities and the European Clean Hydrogen Joint Undertaking.

Projects are encouraged to seek, during their lifetime, collaboration with possible complementary projects funded by the Clean Hydrogen Joint Undertaking on determination of hydrogen releases from the H2 value chain.

When dealing with models, actions should promote the highest standards of transparency and openness, as much as possible going well beyond documentation and extending to aspects

such as assumptions, code and data that is managed in compliance with the FAIR principles[42]. In particular, beneficiaries are strongly encouraged to publish results data in open access databases and/or as annexes to publications. In addition, full openness of any new modules, models or tools developed from scratch or substantially improved with the use of EU funding is expected.

HORIZON-CL5-2023-D1-01-04: Improved knowledge in cloud-aerosol interaction

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 8.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 16.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). [43]. Beneficiaries will be subject to the following additional obligations regarding open science practices: Open access to any new modules, models or tools developed from scratch or substantially improved with the use of EU funding under the action must be ensured through documentation, availability of model code and input data developed under the action.

42 FAIR (Findable, Accessible, Interoperable, Reusable)

43 This decision is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under 'Simplified costs decisions' or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

Expected Outcome: This activity is expected to enhance our understanding of the cloud-aerosol interactions and their impacts in the Earth system and to include developing advanced algorithms as well as high-resolution models to better reproduce realistic cloud phase and structures, its interactions with different types of aerosols and their radiative impacts.

Project results are expected to contribute to **all of the** following outcomes:

- Enhanced large community effort in Europe to bring together the latest advances in science, modelling, in situ, ground-based, oceanic, and airborne remote sensing as well as satellite observations to tackle the complex cloud-aerosol interactions.
- Improved Earth systems models and better long-term climate projections, and/or climate prediction, in particular at seasonal and decadal time scales.
- Better understanding of convective systems leading to improved predictions of extreme events.
- Reduced uncertainties in climate models through a better representation of cloud formation, aerosol-cloud interaction, and their combined radiative properties.
- Use and assimilation of aerosol and cloud products from novel satellites (e.g. Earth CARE[44], MetOp-SG[45]) for climate model improvement and validation and/or weather predictions.
- Contribution to IPCC assessments and other outputs by addressing this major knowledge gap in the Earth system and important source of uncertainty in climate models.

Scope: The challenge of this topic is to improve the representation of cloud life cycle, aerosol-cloud interactions and chemistry, cloud vertical structures, and the radiative properties of the various aerosol and cloud types that is the largest source of uncertainty in today's climate models, and represent an important knowledge gap in Earth system and climate science, and in the Earth radiation budget in particular. This requires better understanding of multiple scattering of radiation within the three-dimensional structure of clouds and different direct and indirect effects of aerosols on radiative transfer. It will lead also to a strengthened understanding of mechanisms through which clouds and aerosols significantly modify the planetary albedo and Earth-radiation budget. The science of cloud formation and its impact on climate should be advanced through an integrated use of in situ and satellite observations in high-resolution models which reproduce realistic cloud structures and their radiative properties.

The projects should address this challenge through:

- Making use of new and existing, in situ and satellite measurements, including reanalysis, new parameters such as water isotope composition, and laboratory experiments, in

44 EarthCARE - Earth Online (esa.int)
45 Metop - Second Generation | EUMETSAT

combination with new analysis methods, to advance the scientific understanding of the complex interactions between aerosols, clouds and climate at a fundamental level.

- Developing novel descriptions of fundamental sub-grid scale aerosol and cloud processes in Earth System models to better represent the radiative and precipitation properties of various aerosol and cloud types in the models.
- Linking aerosol and cloud processes to hydrologic cycle and advancing understanding of their role for evaporation and precipitation in nature and models.
- Enhancing the systematic and coordinated collection and use of ground-based or airborne observing systems from relevant existing networks (e.g. Earlinet, Aeronet, ACTRIS). These datasets will also be critical to enhance satellite retrievals and validation of cloud and aerosols parameters.
- Coordinating with the satellite community where needed e.g. Metop-SG, especially for supporting the validation needs of new missions such as ESA's EarthCARE.
- Establishing in the course of the projects wide-open access to the observation data produced within relevant measurement network databases (e.g. ACTRIS).
- Contributing to assimilation of cloud data in climate models from the "40 years" record of satellite data available and other means of cloud observations.

This topic is part of a coordination initiative between the European Space Agency (ESA) and the EC on Earth System Science. Under the EC-ESA Earth System Science Initiative, both institutions aim at coordinating efforts to support complementary collaborative projects, funded on the EC side through Horizon Europe, and on the ESA side through the ESA FutureEO programme as part of the ESA Atmosphere Science Cluster[46] and relevant ESA activities related to the use of the EarthCARE mission.

Proposals should address the collaboration with ongoing or future ESA Atmosphere Science Cluster projects, including those that will be funded through dedicated coordinated invitations to tender, and should towards this end include sufficient means and resources for effective coordination.

When dealing with models, actions should promote the highest standards of transparency and openness, as much as possible going well beyond documentation and extending to aspects such as assumptions, code and data that is managed in compliance with the FAIR principles[47]. In addition, full openness of any new modules, models or tools developed from scratch or substantially improved with the use of EU funding is expected. Projects should take into account, during their lifetime, relevant activities and initiatives for ensuring and improving the quality of scientific software and code, such as those resulting from projects funded under

[46] https://eo4society.esa.int/communities/scientists/esa-atmosphere-science-cluster/
[47] FAIR (Findable, Accessible, Interoperable, Reusable).

the topic HORIZON-INFRA-2023-EOSC-01-02 on the development of community-based approaches.

Climate change mitigation, pathways to climate neutrality

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D1-01-05: Science for successful, high-integrity voluntary climate initiatives

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 5.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 5.50 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Beneficiaries will be subject to the following additional obligations regarding open science practices: Open access to any new modules, models or tools developed from scratch or substantially improved with the use of EU funding under the action must be ensured through documentation, availability of model code and input data developed under the action.

Expected Outcome: Projects results are expected to contribute to **all of the** following expected outcomes:

- Recommendations, guidance and capacity building to help governments and non-state actors ensure high integrity in voluntary climate change mitigation initiatives through enhanced evaluation, design, implementation and monitoring.
- Helping to translate scientific consensus and knowledge (e.g. IPCC reports) and government commitments (e.g. under the Paris Agreement), into meaningful corporate and other non-state climate strategies and actions.

- Contribution to the implementation of the Paris Agreement and the European Green Deal through support to development and scaling up of high-quality voluntary initiatives that deliver genuine climate benefits in Europe and globally.

- Development of a standardised framework for the assessment of carbon offsetting schemes.

- Reducing risks of greenwashing, including in the use of offsets, and also of technology-lock-ins.

Scope: To meet the goals of the Paris Agreement global GHG emissions should reach "net-zero" by mid-century and be halved by 2030 compared to current levels. This requires immediate, rapid and large-scale emissions reductions across all sectors of the economy. Voluntary initiatives and pledges by non-state actors, such as the private sector, financial institutions, civil society, cities and subnational authorities could help fill the gap, mobilise finance and accelerate the transformation process. However, the integrity-related concerns of these actions must first be overcome and require better understanding of the actual climate impacts and other potential side-effects.

This action should advance the knowledge about the role of voluntary initiatives in achieving the objectives of the Paris Agreement and the European Green Deal, including consistency and interactions with global/national government commitments, regulated markets and between each other. It should address barriers and weaknesses associated with voluntary initiatives, such as inconsistency of definitions and claims (e.g. net-zero, carbon positive, carbon negative, climate neutral, etc.), their environmental integrity, fragmentation, complexity, poor measurement, verification and reporting practices as well as concerns related to additionality, double counting, transparency, governance, and accounting of the wider social and ecological consequences.

The action should evaluate the role of compensation schemes in voluntary climate initiatives, and the implications for transition pathways. To this end, it should improve the understanding of the impacts of carbon offsets, assess their risks and limitations, investigate how offsets affect and interact with other emission abatement options, and under which conditions they could accelerate cost-effective mitigation. It should analyse the scientific integrity of various existing offsetting schemes, identify their strengths and weaknesses and develop clear scientific guidance about their proper use to safeguard climate-positive outcomes. This should include identification of synergies and avoidance of trade-offs with other policy objectives, such as biodiversity related ones, and full respect of the "do no significant harm" principle. Any promotion of offsetting schemes is out of scope of this call.

The action should also explore and assess different options for improved monitoring, reporting and verification of various voluntary climate initiatives, including through leveraging of satellite-based earth observation such as Copernicus/ Galileo/EGNOS.

Finally, it should enhance the modelling tools and integrated assessment frameworks to better integrate voluntary climate initiatives into transition pathway analysis and to address the specific needs of non-state actors (but not necessarily with a single model/tool).

Co-creation with various stakeholders in the private and public sectors, including actors from developing countries, is expected under this action to ensure that the outcomes produced remain relevant for the end-users.

Actions should envisage clustering activities with other relevant ongoing and selected projects for cross-projects cooperation and exchange of results, including as participation in joint meetings and communication events.

HORIZON-CL5-2023-D1-01-06: Broadening the range of policy options in transition pathway analysis

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 10.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Beneficiaries will be subject to the following additional obligations regarding open science practices: Open access to any new modules, models or tools developed from scratch or substantially improved with the use of EU funding under the action must be ensured through documentation, availability of model code and input data developed under the action.

Expected Outcome: Projects results are expected to contribute to **all of the** following expected outcomes:

- A broader range of policy options that reflect different visions of sustainability and resilience based on alternative economic, technological and societal futures and reflecting different perspectives from economics, (other) social and natural sciences.

- Assessment of long-term feasibility of reconciling economic growth with climate and other environmental objectives and consequences for mitigation pathways.

- More comprehensive understanding of the implications of Paris Agreement-aligned transformation for other (than climate) environmental thresholds and social outcomes, including equity, fairness and justice, as a basis for fostering synergies between climate action and other policy goals such as those embedded in the Sustainable Development Agenda.

- Increased diversity of frameworks and scenarios used in climate change mitigation modelling.

- Enhanced assessments of 1) energy and material demands and their links to the macro-economy, 2) behavioural and lifestyle changes, including sufficiency measures and their representation in integrated assessment models and 3) circular economy approaches to decrease the use of energy and materials.

- Development of knowledge to inform future major international scientific assessments such as reports by IPCC and IPBES.

Scope: There is an urgent need for a new paradigm that reconciles continued development of human societies with the maintenance of the Earth system in a resilient and stable state. Meeting the ambitious goals of the Paris Agreement while simultaneously respecting other environmental and social constraints would require not only rapid reductions of GHG emissions and other climate forcers, but also decoupling of economic output from material throughput, pollution and biodiversity loss. However, empirical evidence demonstrates a strong relationship between economic growth (expressed in GDP terms) and GHG emissions, energy use, demand for raw materials, land and other natural resources, as well as pollution. Projections indicate that, with existing growth trajectories, absolute decoupling on the scale required could prove extremely challenging.

Actions should advance knowledge on the feasibility of the green growth paradigm in the context of transition to climate neutrality, including improved understanding of underlying challenges and opportunities, and by building on the latest scientific evidence. They should explore alternative (to growth-oriented) socio-economic scenarios (such as, but not limited to, degrowth, postgrowth, or “Doughnut” economic models) which could support the transition to climate neutrality. Research should look well beyond general concepts and explore (where possible quantified) the practical implications, benefits, barriers, conditions for delivering strong social outcomes and feasibility of pursuing such alternative options as a viable policy choice within the EU and beyond. In their work, actions should examine the role of emerging/potential trends (such as digitalisation, circularity, structural changes in the economy, relocalisation of value chains), geopolitical events and shifts in societal values (e.g.

COVID related) in shaping future socio-economic development and assess their impacts on the achievement of climate policy objectives. The analysis should also account for the accelerating impacts of climate change and embrace interlinkages with other policy goals, notably biodiversity, resource conservation and human development related. Building on these results, actions should draw conclusions for Nationally Determined Contributions (NDCs) and long-term strategies under the Paris Agreement.

Actions should address some of the following aspects in their research:

- Improve the understanding of the dynamics between economic growth and energy, materials' use, pollution and land demand. This could include assessing whether shifts within a GDP-based system, such as a greater share of services and recognition of household labour in national statistics, affect the degree of compatibility of economic growth with climate and biodiversity goals.

- Advance knowledge about the role and potential of lifestyle changes and sufficiency-oriented measures in the overall strategies towards climate neutrality and in the context of other environmental goals, improve their quantification and representation in modelling frameworks and explore the socio-economic, cultural, institutional, infrastructural, regulatory and other conditions for scaling-up.

- Identify and explore the main barriers to adoption of alternatives to growth-based economic models. For example: How plausible is it for policy makers to embrace them? Are there real-world examples? Can a region such as Europe pursue alternative approaches unilaterally?

- Assess the relationship between continued economic growth and societal well-being. Investigate alternative approaches to delivering social progress and evaluate the well-being outcomes of measures to transform societies towards climate-neutrality, taking into account distributional and equity related considerations as well as a broad range of well-being indicators and differences between social and economic groups.

- Investigate how alternative economic approaches could be explained to and accepted by citizens and businesses concerned about both climate and their livelihoods/operating conditions. For example, which concrete day-to-day changes would be required? What are the implications for living standards? How would professions work? What dis/-incentives would firms face to compete, expand and innovate?

- Assess the risks of disruption to energy, food and other key commodity markets based on alternative future transition pathways and development paradigms.

- Explore potential future development paradigms in both high-income and developing economies, taking into account fairness dimension, and evaluate implications for the transition process towards climate neutrality.

The projects are expected to take a truly interdisciplinary approach, leveraging natural, economic and other social sciences to inform policies capable of delivering on multiple

environmental, economic and social objectives simultaneously while taking into account constraints related to feasibility and acceptability.

When dealing with models, actions should promote the highest standards of transparency and openness, as much as possible going well beyond model documentation and extending to aspects such as assumptions, code and data that is managed in compliance with the FAIR principles[48]. In particular, beneficiaries are strongly encouraged to publish data and results in open access databases and/or as annexes to publications.

Successful proposals should establish synergies with the projects resulting from the topic HORIZON-CL5-2021-D1-01-02: Modelling the role of the circular economy for climate change mitigation[49] as well as with the future project resulting from the topic "HORIZON-CL5-2024-D1-01-06: The role of climate change foresight for primary and secondary raw materials supply" as regards implications for resource demand and the associated GHG emissions.

This topic requires the effective contribution of SSH disciplines (e.g. sociology, economics, behavioural sciences, gender studies, etc.) and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise, in order to produce meaningful and significant effects enhancing the societal impact of the related research activities.

Climate change impacts and adaptation

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D1-01-07: Modelling for local resilience - Developments in support of local adaptation assessments and plans

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 12.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 12.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may

[48] FAIR (Findable, Accessible, Interoperable, Reusable).

[49] https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/horizon-cl5-2021-d1-01-02

	additionally be used).

Expected Outcome: Projects results are expected to contribute to **all of the** following expected outcomes:

- Support to the implementation of the EU Strategy on Adaptation to Climate Change and the Mission on Adaptation to Climate Change, by enabling better informed adaptation plans and strategies at the regional and local level.
- Strengthen science-based decision-making when it comes to resilience and disaster risk management, including on the role of nature-based solutions.
- Stronger local adaptive capacity.
- Improved synergies between national, regional and local Green Deal objectives, in particular adaptation action.
- Better coordinated and more impactful R&I activities on adaptation modelling and risk assessment.

Scope: The EU strategy on Adaptation to Climate Change[50] stresses the need to increase local resilience, as one of its key implementation actions. The Horizon Europe Mission on Adaptation to Climate Change has been launched in September 2021 with the aim to support at least 150 European regions and communities to become climate resilient by 2030. Yet resources and tools to address adaptation at the local level are often scarce. To improve the support to local adaptation action it is essential to increase the availability, reliability, accessibility and resolution of climate information, in combination with non-climatic natural and anthropogenic drivers, at local and regional scale considering local specificities.

Therefore, actions should:

- Develop and test user-friendly high-resolution climate physical risk assessments models. This could include improvements in data acquisition, modelling, tools and methods to increase resolution of global climate models and regional climate models in combination with local natural and anthropogenic stressors that underpin risk assessment modelling. Utilize and test relevant resilience models and assessment methods developed in previous R&I programme projects (including FP7 and Horizon 2020).
- Consolidate information and data on cost and effectiveness of adaptation actions (including from FP7 and Horizon 2020 projects[51]) at local level, in particular actions that integrate both adaptation and mitigation and in particular nature-based solutions that address both biodiversity and climate crisis. Carry out work to close the remaining knowledge gaps, particularly in bridging climate models with other earth system (natural and anthropogenic) processes. This should also feed into the knowledge basis of the

50 COM(2021) 82

51 Including projects under topic HORIZON-CL5-2022-D1-02-04: Supporting the formulation of adaptation strategies through improved climate predictions in Europe and beyond

Mission on Adaptation to climate change and be made available to all EU regions and communities. This work could include improvements in modelling, the design of adaptation pathways and other relevant tools in this domain.

- Facilitate quick access and operational guidance to knowledge from adaptation – including:
  - Economic and social implications associated to climate risks.
  - Cross-sectoral impacts of climate change and their associated uncertainties.
  - The cost-effectiveness of adaptation actions, and the co-benefits or regrets associated to the actions.
  - Impact and risk modelling for decision-makers and other stakeholders, in particular to support the development of robust decision-making under uncertainty.
- Draw-up a roadmap of R&I priorities on adaptation modelling and associated economic modelling, risk assessment, cost-effectiveness valuation and management tools towards a 2030-2035 timeframe.

To ensure assessments and tools developed by the projects are truly user-friendly, projects should consider participatory approaches to test such assessments and develop comprehensive and non-technical guides to use the results and outputs of the project(s), at regional and local level in representative cases of the climate regions of Europe[52].

The use of environmental observations and Earth systems models innovations funded by EU R&I programmes (FP7, Horizon 2020) is encouraged. This should include using data from the Copernicus Climate Change Services, and other relevant sources (such as GEOSS).

The project should closely coordinate with and integrate the results of the existing studies and evidence-based research, namely from projects from topic HORIZON-MISS-2021-CLIMA-02-03 "Towards asset level modelling of climate risks and adaptation"[53], HORIZON-MISS-2021-CLIMA-02-01 "Development of climate change risk assessments in European regions and communities based on a transparent and harmonised Climate Risk Assessment approach"[54], and the Study on Adaptation Modelling for Policy Support[55].

Proposals should include a mechanism and the resources to establish operational links with the Mission Adaptation to Climate Change Implementation Platform and Climate-ADAPT platform (run by the European Environment Agency (EEA) together with DG CLIMA) so

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52 As presented in the Working Group II IPCC Report, Chapter 13: *Climate Change 2022: Impacts, Adaptation and Vulnerability. Working Group II Contribution to the IPCC Sixth Assessment Report*

53 Funding & tenders (europa.eu)

54 https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/horizon-miss-2021-clima-02-01

55 https://op.europa.eu/o/opportal-service/download-handler?identifier=cfa86c26-764e-11eb-9ac9-01aa75ed71a1&format=pdf&language=en&productionSystem=cellar&part=

project results can be fed into the platform for them to be used by Mission participants, namely regions and communities.

Coordination with the Destination Earth initiative should be explored to ensure the timely development of "climate replicas" utilising the new state-of-the-art IT infrastructure, including access to EU high performance computing resources and an operational platform to upload and integrate the models and data developed in the course of the projects.

The participation of social sciences and humanities is key to address the socio-economic, decision-making and local governance aspects of this topic. Furthermore, projects should consider the involvement of citizens and societal actors, to produce meaningful and significant effects enhancing the societal impact of the related research activities.

Social science, citizen science and behavioural science for climate action

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D1-01-08: Solar Radiation Modification: governance of research

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 3.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 3.00 million.
Type of Action	Coordination and Support Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the

	Research and Training Programme of the European Atomic Energy Community (2021-2025). [56].

Expected Outcome: The purpose of the action is to explore conditions that could lead to the development of a possible governance framework for experimental research in the area of solar radiation modification (SRM), which is to be done on a case-by-case basis. SRM is defined as an approach to reduce solar radiative forcing through means other than through the reduction of net greenhouse gas emissions. The action should identify, on the basis of a comprehensive and balanced assessment of the best available scientific knowledge, as well as the perspectives of stakeholders, whether and how the governance of SRM field research could work in practice.

The IPCC 6th Assessment Report (Cross-Working Group Box SRM: Solar Radiation Modification[57]) concluded that SRM could offset some of the effects of anthropogenic warming on global and regional climate, especially if combined with emissions reductions, and with carbon dioxide removal, and phased out gradually. However, a number of risks are associated with its deployment, and the IPCC found that there is low confidence in our understanding of the climate response, especially at regional scales. At international level, its deployment is addressed (and strongly discouraged) by the Convention of Biodiversity due to its potentially substantial negative effects on biodiversity. Nevertheless, the topic continues to draw interest, including from non-state actors, as the effects of climate change itself become more evident.

This action should lead to a better understanding of what the risks and conditions are that would make field research acceptable or unacceptable to stakeholders. Such enhanced understanding is sought without prejudice to its potential use in policy-making or regulation.

Scope: In order to achieve the expected outcome, proposals should address **all of the** following:

- Synthesis of the state of the art regarding the potential contribution of SRM to climate stabilisation, and its associated risks.
- Clarification of what activities constitute SRM, and the extent to which SRM is permitted, prohibited and/or governed within the ERA at present.
- Proposal of principles and guidelines that could be used by a public authority for permitting, prohibiting or supervising SRM field experiments on a case-by-case basis. Factors to consider could include inter alia:

[56] This decision is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under 'Simplified costs decisions' or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

[57] Page 2473 of Climate Change 2022: Impacts, Adaptation and Vulnerability. Working Group II Contribution to the IPCC Sixth Assessment Report. Available: https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_FullReport.pdf,

  - Scientific and operational preconditions (e.g. monitoring mechanisms during and after research, time horizon, contingency planning).
  - Legal issues (e.g. liability for impacts).
  - Decision-making processes and ethical considerations (e.g. Who gets to decide? Procedural aspects such as how to ensure broad, informed stakeholder consultation).
  - Approaches to cost-benefit analysis and risk assessment in a context of uncertainty (risk of action, and risk of inaction).

- An inclusive expert and stakeholder dialogue process, aligned with the principles of Responsible Research and Innovation (RRI) should be organised in order to inform the analysis mentioned above.

The action is also encouraged to consider the following questions:

- Whether SRM field research under controlled conditions (e.g. within the ERA or like-minded jurisdictions) could lessen the risk of its unregulated deployment elsewhere in the world.
- Comparison of the risks of SRM with analogous risk management dilemmas faced by science and society.

The action should also identify what the characteristics of such a governance framework should be, taking into account issues such as scientific rigour, risk assessment and public legitimacy.

Promotion of SRM or conducting of SRM field experiments are outside of the scope of this action.

Actions are encouraged, where relevant, to explore synergies with other initiatives in Europe and beyond investigating Solar Radiation Modification from a technological, regulatory and/or ethical perspective.

This topic requires the effective contribution of SSH disciplines and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise, in order to produce meaningful and significant effects enhancing the societal impact of the related research activities.

HORIZON-CL5-2023-D1-01-09: Behavioural change and governance for systemic transformations towards climate resilience

Specific conditions	
Expected EU contribution per	The Commission estimates that an EU contribution of around EUR 4.00 million would allow these outcomes to be addressed appropriately.

project	Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 8.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).

Expected Outcome: Projects are expected to contribute to **all of the** following outcomes:

- Support to the implementation of the EU Adaptation Strategy and the Mission on Adaptation to Climate Change.
- Decision-makers at local, regional, national and European level are able to more effectively scale up and accelerate behavioural change for systemic transformations towards climate resilience, knowing more about relevant social tipping points, leverage points and key governance interventions in this context.
- Citizens and civil society have a better understanding of possible individual actions they may wish to undertake or how to contribute to strategic leverage points that bring about behavioural change supporting climate resilience at larger scale. This should also include knowledge or development of possible governance structures and organisational innovations that would help to galvanise the already existing knowledge and activities in many parts of society.
- Easier assessment of the potential of and progress in scaling up change in behaviour and creating multiple positive synergies of individual and organisational actions for directing governance to achieving systemic transformations towards climate resilience.

Scope: No matter how successful our efforts to mitigate further climate change will be, some impacts are or will be unavoidable in the future and we will have to adapt to a warmer world. The question is on what terms this adaptation will take place. With the new Strategy on Adaptation to Climate Change and the recently launched Mission on Adaptation to Climate Change on this issue, Europe has set out that the direction of this change will be systemic transformations towards climate neutrality and resilience, by 2050.

As nations, regions, cities and local communities are now developing their vision and pathways towards climate neutrality and resilience, increased importance is given to the role of behavioural change, and governance and organisational innovation in achieving the systemic transformations needed to regain resilience in a harsher climate future to events and hazards potentially attributable to climate change.

The objectives of this topic are to reach a better understanding on behavioural change and on how it could be scaled up and connected to the governance of the various drivers of and/or barriers to climate-friendly/climate-resilient behaviour (including EU, national and local policies) to reach the goal of climate neutrality and resilience by 2050.

The role of individual or community behavioural change in this societal transformation is to be approached as embedded in changes of informational, political, economic and technological systems. Shifts from individual values and community behaviour need to be seen as integrated with societal changes in governance, implying a combination of cultural changes and shifting social norms, alongside interventions by institutions and through the market, communications and media[58].

Within this scope, projects are requested to enhance the understanding of:

- **Social tipping points and leverage points in climate adaptation**: to better understand the social acceptability of non-adaptive behaviours or how new adaptive behaviour would become widespread (social tipping points); to better understand how a small shift in one part of a system would generate changes across the system as a whole (leverage points); to better understand how various systems' leverage points may eventually lead to deliberate transformative tipping points; to understand how increasingly serious threats or consequences of climate change lead to changes of individual and social perceptions and behaviours, and how it leads to changes in local adaptation policies, new social organisation forms and actions. This should also include analysis of incentives and barriers to behavioural change in different spheres of the population (according to gender, social conditions, educational level, etc.).

- **Features of good governance for systemic transformations to climate resilience**: to better understand features and structures of governance and institutions to ensure economically, socially and environmentally just transformations appropriate for the local conditions, e.g. mechanisms leading to most cost-effective solutions; a fair distribution of costs and benefits of the transformations; to better understand features and structures of governance and institutions that generate a high systemic adaptive capacity, e.g. the ability to effectively leverage public-private sector investment for adaptation actions; further operationalisation of the notion of equity and justice to support the required transformative systemic adaptations in governance and policy arrangements.

- **Transformative conditions, capacities and learning feedbacks needed for systemic change**: to better understand the conditions and capacities that would allow individual behaviour to fundamentally change the system in which they operate so that the system further accelerate new learning feedbacks and changes in individual behaviour, e.g. via experimentation and requiring further access to relevant knowledge and information or opportunities to engage in transformative decision-making.

[58] Changing our ways? Behaviour change and the climate crisis, 2021, Report of the Cambridge Sustainability Commission on Scaling Behaviour Change.

Projects should focus on all relevant aspects of society, in their interactions with biophysical and climate adaptation components, including, but not limited to, relevant economic sectors, education and up-skilling and re-skilling. Moreover, participatory co-creation approaches at policy making, community, and individual levels, including direct involvement of citizens, new sustainability-oriented business organisations and societal actors where relevant considering social innovation, is highly recommended in order to create robust results. Projects should investigate the dimension of lifestyles and habits and associated factors, motivators and barriers, and be aware of the role of gender and diversity among populations and groups of populations, and how various resources and power relations can influence people's decisions and willingness to change behaviour.

Projects are expected to contribute to and establish close coordination with the activities of the Mission on Adaptation to Climate Change. They are strongly encouraged to use the results of the Mission on Adaptation to Climate Change and the Copernicus Climate Change Service as testbed to underpin their findings.

Finally, projects are requested to develop the following outputs:

- Concrete recommendations of operational nature to accelerate systemic change in those regions and communities that served as their case studies.
- General guidance for all other actors at national, regional, or communal level about the most feasible and effective leverage point potentially leading to transformative tipping points, including aspects concerning interrelations, alignment and coordination of the actors/stakeholders.
- A science for policy operational framework and indicators for assessing the potential of and progress in scaling up change in behaviour and for directing governance to achieving systemic transformations towards climate resilience.

This topic requires the effective contribution of SSH disciplines and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise, in order to produce meaningful and significant effects enhancing the societal impact of the related research activities.

HORIZON-CL5-2023-D1-01-10: Improving the evidence base regarding the impact of sustainability and climate change education and related learning outcomes

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 5.00 million.

Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).

Expected Outcome: Project(s) are expected to contribute to **all of the** following expected outcomes:

- A better understanding of which interventions and measures are effective to produce intended but also novel learning outcomes needed for the green transition of our society and economy.
- Improved methods for measuring impact and implementation of sustainability and climate-related education.
- Better feedback-loops between improved output-oriented monitoring of sustainability and climate-related education and education policy-related decision-making, including planning and reorienting curricula and programmes, to ensure that policy and programmes remain relevant and effective.

Scope: The dimension of "sustainability and greening of education and training systems" is still relatively new in the EU context[59]. Through the Commission's proposal on learning for environmental sustainability[60] as well as European sustainability competence framework[61] – both published in 2022 – EU Member States/Associated countries have received new impetus to implement education and training related to the environment and sustainability. For effective policy-making, including development and revision of curricula and study programmes, it is necessary to assess and monitor the impact that sustainability-related education has. The objective of this project is therefore to better understand and to provide recommendations on how to measure what learners actually learn and how this influences mind-set and actions on sustainability at the individual and collective level.

Projects should therefore:

- Address both inputs to and outcomes of learning[62] and the processes that link them: Methods that address impact assessment of learning outcomes require taking into

59 EU Green Deal and other key EU initiatives highlight the importance of education and training for the green transition.

60 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2022:11:FIN)

61 https://publications.jrc.ec.europa.eu/repository/handle/JRC128040

62 Learning outcomes relate to what learners know and can do after a "learning intervention", usually after an extended period of time (like a study programme). Learning interventions themselves depend on a range of inputs (inducing investments, policies, curricula design). Learning outcomes are usually described as knowledge, skills and attitudes that learners have developed in a specific area.

account commitment (e.g. legislation, policy measures, top-level strategies and action plans), context (governance, structure of education system) implementation (e.g. funding, governance, curricula, teacher training, sustainable infrastructure and resource management) and results (e.g. learning outcomes in terms of skills and competences).

- Capture the lifelong learning scope and ambition of learning for sustainability: to do so, it will be important to widen the current focus of monitoring pupils and students (mainly at secondary level) to both younger and older generations. Moving beyond formal learning and even beyond education to measuring impact in the wider economy and society requires taking into account contextual factors - both education-related and non-educational - that might influence learning outcomes.

- Address novel concepts and competences put forward in sustainability and climate change education, such as participatory and challenge-based education, living labs, exploratory and futures thinking. Such approaches encourage learners to imagine and create what does not yet exist, yet they are difficult to capture with pre-defined targets and indicators. Research should therefore go beyond test-based student assessment, which often serves to monitor and measure impact and progress in the area and include aspects such as links with the local community or interdisciplinary, hands-on and socio-emotional approaches, which are crucial for effective learning for sustainability.

Actions should envisage clustering activities with relevant projects and initiatives, such as the two Horizon 2020 projects ECF4CLIM and GreenSCENT, the GreenComp (the European sustainability competence framework developed by the JRC) for cross-projects cooperation, consultations and joint activities on crosscutting issues, to share their results, as well as to participate in joint meetings and communication events. To this end, proposals should foresee a dedicated work package and/or task and earmark the appropriate resources accordingly.

Projects are requested to develop the following outputs:

- A set of indicators to monitor progress in implementing such education measures.

- A mapping of policy evaluation methods, monitoring frames and indicators and their relation with approaches and programs in the area of sustainability and climate change education, in EU Member States/Associated countries and internationally, with the objective to identify best practices and reproducible solutions. This should build on work developed during the UN Decade in Education for Sustainable Development (DESD) and the Global Action Programme for Sustainable Development (GAP), which include a "Global Monitoring and Evaluation Framework" as well as evaluation and assessment of impacts through large-scale testing (including international assessments, such as PISA, TIMSS, PIRLS), project-based monitoring/assessment, surveys, etc.

- Definition of suitable areas for assessment of the impact of education policies/interventions (e.g. measurement of skills/competence of learners, educators; investment in green education; link between education and engagement in sustainability and climate action; effective communication strategies; training of professionals).

- A comprehensive assessment model on the basis of a wide range of indicators (e.g. capturing commitments, implementation and results).
- A methodology tailored for conducting impact assessments and evaluations of policies on learning for sustainability (taking into account inputs, processes, context, outcomes), addressed to and adaptable to different education and training approaches and levels in a life-long learning context (i.e. early childhood education and care, school, vocational education and training (VET) and higher education, citizen science, non-formal learning).
- Running of minimum 2 case studies using the developed methodology.

This topic also requires the effective contribution of SSH disciplines and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise, in order to produce meaningful and significant effects enhancing the societal impact of the related research activities.

International cooperation

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D1-01-11: Needs-based adaptation to climate change in Africa

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 10.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: The following additional eligibility criteria apply: Consortia must include at least 3 entities established in at least 2 different Sub-Saharan African countries[63]. If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).

[63] Sub-region 202, as defined by the United Nations Statistics Division: https://unstats.un.org/unsd/methodology/m49/overview/.

Expected Outcome: Project results are expected to contribute to **all of the** following expected outcomes:

- Accelerated deployment of climate services to build climate resilience.
- Better informed climate adaptation policy response, stronger adaptive capacity and climate resilience in Africa, with a focus on the Sub-Saharan region.
- Improved synergies between adaptation action and other policy objectives, notably the Sustainable Development Goals agenda.
- Contribution to the international dimension of the EU Adaptation Strategy and to the Africa-EU Partnership.
- Knowledge base to underpin major international scientific assessments such as the IPCC Assessment Reports.

Scope: The African continent is on the frontline of the climate emergency; it is highly vulnerable and adaptation to both present and future impacts of climate change is urgent and crucial to secure its long-term resilience and prosperity but it is challenging in the current economic context. While the demand for high-quality, actionable climate information and services is growing, there is a need for more holistic, better connected, more interactive and more user-oriented approaches across the entire adaptation value chain from knowledge production to users. This ranges from improved knowledge base, through increased accessibility, up to enhanced uptake of information and climate services by end-users spanning policy makers, governmental agencies, local authorities, civil society and the private sector. The focus of this topic is on countries in Sub-Saharan Africa – given the region's limited response capacities coupled with high vulnerability to climate change impacts that range from droughts, through rising sea levels, cyclones, and floods to rising temperatures and rainfall anomalies with serious implications, notably, for food and water security.

Actions should:

- Improve the understanding of current and future climate related threats (and opportunities) in Africa in the context of socio-demographic developments, extending into sectors/domains that are underexplored from climate-risk perspective and including dynamics between climate, biodiversity, and political/economic risks such as migration, food security and urbanisation patterns. Actions may address improvements in accuracy and skill of forecasts/projections, in particular as regards the sub-seasonal-to-seasonal time scale.
- Identify key adaptation challenges, needs and gaps in the broader socio-economic context, including intersection with other policy objectives such as biodiversity protection, increase in agricultural productivity and reduction of inequalities.
- Enhance planning, implementation and evaluation of climate adaptation strategies and measures (including ecosystem-based adaptation and nature-based solutions, as well as

integrated adaptation and mitigation actions) and the understanding of their socio-economic determinants and benefits.

- Improve and upscale existing and/or develop and test new climate services/tools that bridge the gap between information availability and uptake by end-users in different sectors, including through capacity building and addressing issues such as access, uncertainty, trust, risk perception and management, and other barriers. In either case, actions should demonstrate a clear path towards broader deployment of the services developed.

- Promote better understanding and enhanced cooperation between various actors such as regional climate centres, national meteorological services, intermediaries, and end-users. Direct participation of relevant entities in the projects is strongly encouraged.

- Explore and leverage opportunities associated with the digital revolution (including progress in automation, artificial intelligence, and communications) to improve diffusion of climate knowledge and promote more efficient service delivery.

- Advance knowledge on value assessment of climate services and apply it to the services developed within projects.

Projects may focus on a specific country/region in Sub-Saharan Africa for more customised activities but should evaluate and disseminate information on the broader relevance of their outcomes and options for replication also in other locations.

Actions should pursue active engagement and consultation with relevant stakeholders such as African government agencies, civil society organisations and citizen groups to harness local knowledge and to better account for end-user needs, taking into account the gender dimension. This should include research on co-production of climate information and user engagement models themselves to define which approaches are most suitable for adaptation purposes. Moreover, social innovation should be considered in order to achieve the expected outcomes.

Actions should build on previous work and established structures in the region. Participants should make use of the latest socio-economic, geophysical, and other relevant data, leveraging by rapid progress in digital technologies. This should include observational data from the Copernicus part of the EU Space Programme and other relevant sources (such as in the context of GEOSS Global Earth Observation System of Systems).

Actions should also take into consideration the results of relevant Horizon 2020 projects, such as FOCUS-Africa, Down2Earth, CONFER or HABITABLE, in view of progressing the state of the art and taking the already developed services/tools to the next level.

In line with the Strategy for EU international cooperation in research and innovation (COM(2021) 252), international cooperation is encouraged and projects should aim at comprehensive involvement of African researchers and organisations, in view of maximising the impact and relevance of the projects.

This topic requires the effective contribution of SSH disciplines and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise, in order to produce meaningful and significant effects enhancing the societal impact of the related research. Applicants should ensure that their project and activities do not exacerbate tensions in the region and may consider guidelines to integrate conflict sensitivity in climate action projects.

Call - Climate sciences and responses

HORIZON-CL5-2023-D1-02

Conditions for the Call

Indicative budget(s)[64]

Topics	Type of Action	Budgets (EUR million)	Expected EU contribution per project (EUR million)[65]	Indicative number of projects expected to be funded
		2023		
Opening: 13 Dec 2022 Deadline(s): 18 Apr 2023				
HORIZON-CL5-2023-D1-02-01	RIA	5.00	Around 2.50	2
HORIZON-CL5-2023-D1-02-02	RIA	5.00	Around 5.00	1
Overall indicative budget		10.00		

General conditions relating to this call	
Admissibility conditions	The conditions are described in General Annex A.
Eligibility conditions	The conditions are described in General Annex B.
Financial and operational capacity and	The criteria are described in General Annex

64 The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.
The Director-General responsible may delay the deadline(s) by up to two months.
All deadlines are at 17.00.00 Brussels local time.
The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2023 and 2024.

65 Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

exclusion	C.
Award criteria	The criteria are described in General Annex D.
Documents	The documents are described in General Annex E.
Procedure	The procedure is described in General Annex F.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G.

International cooperation

Proposals are invited against the following topic(s):

HORIZON-CL5-2023-D1-02-01: EU-China international cooperation on data and model development for pathways to carbon neutrality: focusing on decarbonisation, energy efficiency and socio-economic implications of the transition

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 2.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 5.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used). In order to achieve the expected outcomes and to implement the Climate Change and Biodiversity Flagship in compliance with the provisions of the Administrative Arrangement between the European Commission and the Ministry of Science and Technology of the People's Republic of China (MOST) on a Co-funding Mechanism for the period 2021-2024 to support Collaborative Research and Innovation projects under the "Food, Agriculture and Biotechnologies", and the "Climate Change and

	Biodiversity" Joint Flagship Initiatives", and in accordance with the requirements of the Inter-governmental Science and Technology Innovation (STI) Cooperation Special Programme of MOST. 1. Consortia must also include as associated partners at least three independent legal entities established in China. 2. Legal entities established in China can only participate as associated partners; and 3. Chinese participants must be awarded co-funding by MOST *. *This condition will not be fulfilled if, at the time of grant agreement signature, the Chinese participants have not concluded a grant agreement with MOST.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Grants awarded under this topic will be linked to the specific grants awarded by the Ministry of Science and Technology, China (MOST) to the Chinese partners. The respective options of the Model Grant Agreement will be applied.

Expected Outcome: The EU and China have committed to become climate neutral (by 2050) and carbon neutral (by 2060), respectively. Successful proposal(s) will support the transition to a climate neutral and resilient society as part of the EU-China Climate Change and Biodiversity Research Flagship (CCB Flagship).

Actions are expected to contribute to **all of the** following outcomes:

- Improved knowledge and mutual learning in potential pathways towards carbon neutrality and renewable transition to support achieving both regions' climate targets.
- Overview of promising options and associated benefits and challenges in the short, medium and long-term that are necessary to achieve these climate goals.
- Achieved joint of state-of-the-art modelling and dialogue among relevant experts in the two regions.

Scope: The topic aims at developing a state-of-the-art modelling framework that includes up-to-date representation of technologies and policies in different pathways that lead to climate neutrality from a holistic and sectoral perspective. Successful proposal(s) should include joint work by European and Chinese experts aimed at informing the achievement of each country's long-term decarbonisation goal. Actions under this call should consider deep reductions and pathways to net zero incorporating mitigation of both CO_2 and other greenhouse gas emissions.

Actions should focus on **all of the** following main areas (the individual bullets are indicative suggestions for focus within each area):

a) Energy efficiency and decarbonisation

- Adapted models to reflect state-of-the-art greenhouse gas emission data.
- Opportunities for decarbonisation of industry and agriculture, for reducing net emissions related to land use, and for mitigation of non-CO_2 greenhouse gases. Evaluate the mitigation potential, co-benefits and side effects, and cost-effectiveness of selected technologies in key industries and their potential contribution to a sustainable, secure and affordable transition.
- Improving energy efficiency, including through electrification in industrial processes, transport and heating systems, as well as for buildings (including through improved design and construction, retrofitting, establishing or improving energy management systems).
- Transformation of energy and transport infrastructure to accommodate zero-carbon technologies and smart demand and to guarantee the reliability of the energy and manufacturing systems.
- CCUS technology to improve the efficacy of CO_2 capture and the understanding of storage potential and security in key regions and in industries.
- Improved knowledge concerning the policies needed to ensure the transformation of the different sectors from fossil fuel-based to net-zero carbon emitters.

b) Socio-economic implications

- Socio-economic challenges and opportunities in the transition to climate neutrality, including the transformation of the labour market and the distributional repercussions for different sectors, social groups and regions.
- Consequences of the green transition for human welfare, including on health.
- Opportunities and challenges related to consumer behaviour and lifestyle changes (e.g. consumer choices, changes in ways of living and working).
- Global implications of EU and China decarbonisation (e.g. through trade and commodity markets, impacts on climate action in third countries).

c) Dissemination and stakeholder engagement

- Strong component of engagement, in terms of co-design and co-creation of the pathways, with public and private sector stakeholders in both regions, in particular with groups whose actions will be key to implementing and achieving the transition.

This topic is part of the EU-China flagship initiative on Climate Change and Biodiversity, which will promote substantial coordinated and balanced cooperation between the EU and China, and is within the scope of the Administrative Arrangement between the European Commission and the Ministry of Science and Technology of the People's Republic of China (MOST) on a Co-funding Mechanism for the period 2021-2024 to support collaborative research projects under the Climate Change and Biodiversity (CCB) and the Food, Agriculture and Biotechnologies (FAB) flagship initiatives.

Interactions with other actions developed under the EU-China Climate Change and Biodiversity Research Flagship and/or the Flagship on Food, Agriculture and Biotechnologies are encouraged.

The envisaged knowledge relates only to policy, modelling and pathways definition and planning. Development of specific technologies above TRL 4 are out of the scope of this topic.

Actions should:

- Build on existing modelling work in both regions that has identified credible pathways to net zero emissions, continuing to develop and refine such pathways.
- Ensure that EU and China pathways fit into a consistent global framework (e.g. in terms of global carbon budget and use of scarce commodities).
- Focus on key milestones and enabling conditions needed in the short-term (e.g. by 2030, 2035) and medium-term (e.g. by 2040) to achieve each region's net zero goals. Such milestones and conditions are not limited to emissions levels but can include technological roadmaps for key regions and industries, as well as, regulatory, market penetration and socio-economic developments.
- Consider different geographical scales and the role of cities in the transition pathways.
- Feature a combination of integrated assessment modelling (to demonstrate that pathways are coherent and comprehensive) and other more granular techniques to explore specific transformation options in detail.
- Include stakeholder engagement activities aimed at linking the vision set out in pathways with the actions needed to achieve them (e.g. How mature does a certain technology have to be by when? Is this achievable?).

When dealing with models, actions should promote the highest standards of transparency and openness, as much as possible going well beyond documentation and extending to aspects such as assumptions, code and data that is managed in compliance with the FAIR principles[66]. In particular, beneficiaries are strongly encouraged to publish results data in open access databases and/or as annexes to publications. In addition, full openness of any new modules, models or tools developed from scratch or substantially improved with the use of EU funding

[66] FAIR (Findable, Accessible, Interoperable, Reusable).

is expected. Projects should take into account, during their lifetime, relevant activities and initiatives for ensuring and improving the quality of scientific software and code, such as those resulting from projects funded under the topic HORIZON-INFRA-2023-EOSC-01-02 on the development of community-based approaches.

This topic requires the effective contribution of SSH disciplines and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise, in order to produce meaningful and significant effects enhancing the societal impact of the related research activities.

HORIZON-CL5-2023-D1-02-02: EU-China international cooperation on blue carbon

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 5.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used). In order to achieve the expected outcomes and to implement the Climate Change and Biodiversity Flagship in compliance with the provisions of the Administrative Arrangement between the European Commission and the Ministry of Science and Technology of the People's Republic of China (MOST) on a Co-funding Mechanism for the period 2021-2024 to support Collaborative Research and Innovation projects under the "Food, Agriculture and Biotechnologies", and the "Climate Change and Biodiversity" Joint Flagship Initiatives", and in accordance with the requirements of the Inter-governmental Science and Technology Innovation (STI) Cooperation Special Programme of MOST. 1. Consortia must also include as associated partners at least three independent legal entities established in China. 2. Legal entities established in China can only participate as associated partners; and

	3. Chinese participants must be awarded co-funding by MOST *. *This condition will not be fulfilled if, at the time of grant agreement signature, the Chinese participants have not concluded a grant agreement with MOST.
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Grants awarded under this topic will be linked to the specific grants awarded by the Ministry of Science and Technology, China (MOST) to the Chinese partners. The respective options of the Model Grant Agreement will be applied.

Expected Outcome: Blue carbon, understood as coastal marine ecosystems such as seagrass, saltmarshes and mangroves are reported under the chapter of the IPCC inventory guidelines devoted to wetlands. The project aims to investigate this reporting and whether other ecosystems could be included.

Actions are expected to contribute to **all of the** following outcomes:

- An understanding of how the different elements of blue carbon in coastal waters of European countries and the People's Republic of China contributes to greenhouse gases in the atmosphere.
- Better knowledge of how human activity in managing, destroying or regenerating blue carbon affects its emissions and sequestration of greenhouse gases.
- Measurement techniques for calibration, validation and monitoring blue carbon sequestration and emissions.
- A preliminary estimate of the actual and potential contribution of greenhouse gas emissions and removals by blue carbon ecosystems for the EU and the People's Republic of China.

Scope: The project(s) should:

- Classify the main parameters that affect emissions and sequestration.
- Develop and test methods for measuring, modelling, and monitoring emissions and removals of greenhouse gases.
- Propose and test a portfolio of methods for managing blue carbon to reduce emissions and increase sequestration.
- Cover representative sample sites on European coasts and those of the People's Republic of China.

- Assess the current and potential contribution of blue carbon to national greenhouse gas inventories and reporting to UNFCCC and determine how the verification and monitoring could be improved.
- Identify whether and how net carbon removals through algae cultivation and human activity in other coastal ecosystems could be quantified.
- Engage with international bodies and researchers tackling the same issue.

Development of specific technologies above TRL 4 are out of the scope of this topic.

This topic is part of the EU-China flagship initiative on Climate Change and Biodiversity, which will promote substantial coordinated and balanced cooperation between the EU and China, and is within the scope of the Administrative Arrangement between the European Commission and the Ministry of Science and Technology of the People's Republic of China (MOST) on a Co-funding Mechanism for the period 2021-2024 to support collaborative research projects under the Climate Change and Biodiversity (CCB) and the Food, Agriculture and Biotechnologies (FAB) flagship initiatives.

Interactions with other actions developed under the EU-China Climate Change and Biodiversity Research Flagship and/or the Flagship on Food, Agriculture and Biotechnologies are encouraged.

Actions should, during their lifetime and within the framework applicable to the cooperation with Chinese entities, establish synergies with relevant Horizon Europe projects and initiatives, such as under cluster 5 destination 1 topic D1-5: Enhanced quantification and understanding of natural and anthropogenic methane emissions and sinks, as well as under cluster 6, in particular topic HORIZON-CL6-2023-CLIMATE: Ocean and coastal waters carbon- and biodiversity-rich ecosystems and habitats in Europe and the Polar Regions, Copernicus Marine Services and the Mission Restore our Ocean and Waters by 2030.

Call - Climate sciences and responses

HORIZON-CL5-2024-D1-01

Conditions for the Call

Indicative budget(s)[67]

Topics	Type of	Budgets (EUR	Expected EU contribution per	Indicative number

[67] The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.
The Director-General responsible may delay the deadline(s) by up to two months.
All deadlines are at 17.00.00 Brussels local time.
The budget amounts are subject to the availability of the appropriations provided for in the general budget of the Union for years 2023 and 2024.

	Action	million) 2024	project (EUR million)[68]	of projects expected to be funded
Opening: 12 Sep 2023 Deadline(s): 05 Mar 2024				
HORIZON-CL5-2024-D1-01-01	RIA	15.00	Around 15.00	1
HORIZON-CL5-2024-D1-01-02	RIA	22.00	6.00 to 7.50	3
HORIZON-CL5-2024-D1-01-03	RIA	15.00	Around 15.00	1
HORIZON-CL5-2024-D1-01-04	RIA	12.00	Around 6.00	2
HORIZON-CL5-2024-D1-01-05	RIA	14.00	Around 4.50	3
HORIZON-CL5-2024-D1-01-06	RIA	5.00	Around 5.00	1
HORIZON-CL5-2024-D1-01-07	RIA	20.00	Around 10.00	2
Overall indicative budget		103.00		

General conditions relating to this call	
Admissibility conditions	The conditions are described in General Annex A.
Eligibility conditions	The conditions are described in General Annex B.
Financial and operational capacity and exclusion	The criteria are described in General Annex C.
Award criteria	The criteria are described in General Annex D.
Documents	The documents are described in General Annex E.
Procedure	The procedure is described in General Annex F.
Legal and financial set-up of the Grant	The rules are described in General Annex G.

[68] Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.

Agreements	

Earth system science

Proposals are invited against the following topic(s):

HORIZON-CL5-2024-D1-01-01: Enhanced quantification and understanding of natural and anthropogenic methane emissions and sinks

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 15.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 15.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Beneficiaries will be subject to the following additional obligations regarding open science practices: Open access to any new modules, models or tools developed from scratch or substantially improved with the use of EU funding under the action must be ensured through documentation, availability of model code and input data developed under the action.

Expected Outcome: This activity is expected to foster and enhance collaboration between the modelling and observing (satellite, ground-based, airborne) communities and advance towards an enhanced global and regional assessment of the methane sources and sinks from land and the ocean, their short and long-term evolution as well as the related natural and anthropogenic processes and impacts on atmospheric chemistry and dynamics and on Earth radiation

budgets. The expected outcomes hereafter are complying with the recommendations formulated by the user community during the ESA ATMOS-2021 conference[69].

Project results are expected to contribute to **all of the** following outcomes:

- A significant European effort to develop an enhanced methane assessment capacity including extensive advanced in situ data at multiscale and from multi-platforms, novel satellite observations, and enhanced modelling efforts to quantify and understand hotspots and background for natural and anthropogenic methane emissions with unprecedented resolution in space and time.

- An increased coordination of in-situ observations of methane emissions including enhancing communication and networking between the relevant observation communities.

- Enhanced science base in Europe to perform global and regional (European) scale high-resolution assessment of the methane sources and sinks in relevant environments, their short and long-term changes, the related natural and anthropogenic sources, and impacts on atmospheric chemistry and dynamics.

- Clear policy advice on current and future climate contributions of methane on global and regional (European) scale, including elaboration on effective mitigation options.

- Provision of a significant contribution to IPCC and related scientific efforts regarding reducing methane emission uncertainties similar to those of the Global Carbon Project[70].

- Contribution to achieve the goals of the COP26 Glasgow agreement on methane emission reductions and to the EU methane strategy[71].

Scope: The challenge of this topic is to further quantify and understand natural and anthropogenic methane emissions based on carefully selected European land sites and European sea sites with unprecedented resolution in space and time that should leverage the latest advances in observations from satellite, ground-based, and airborne, together with advances in reconciling inverse and bottom-up modelling approaches.

The proposal will address this challenge through:

- Deploying large coordinated in situ, ground-based and airborne observation monitoring campaigns over different Earth's ecosystems (terrestrial, terrestrial-aquatic continuum, and marine sub-seafloor) and key anthropogenic sources (e.g. agriculture, waste, mining, oil and gas industry) with comparable and scalable measurement approaches.

- Running these campaigns during an extended period of time and planning them beyond the duration of the projects, building on existing measurement infrastructures and

69 https://atmos2021.esa.int/
70 https://www.globalcarbonproject.org/
71 https://ec.europa.eu/energy/sites/ener/files/eu_methane_strategy.pdf

initiatives, in order to support the validation of satellite products, but as well to support the development of new and enhancement of existing models and data assimilation techniques.

- Evaluating temporal change in methane release over centuries at selected, relevant sites from existing long-time series.
- Advancing towards an integrated methane observing system (on "facility scale") that capitalises on the latest advances in observations from satellite, in situ, ground-based remote sensing and airborne instruments as well as results from citizen observations.
- Advancing the capacity of models and data assimilation techniques, related to methane emissions through specifically exploiting novel medium and high-resolution satellite data (e.g. GHGSat, PRISMA, Sentinel-2, Landsat-8/9, Worldview-3).
- Delivering inverse modelling to separate methane sources and sinks and to attribute inverse modelling estimated fluxes to specific processes building on sufficient spatial resolution to identify the origin, for instance, of large local emissions.
- Advancing towards an enhanced spatially and temporary high-resolution global and regional assessment of the methane sources and sinks and its dynamics over time, the related natural and anthropogenic processes, and impacts on climate.

This topic is part of a coordination initiative between the European Space Agency (ESA) and the EC on Earth System Science. Under the EC-ESA Earth System Science Initiative, both institutions aim at coordinating efforts to support complementary collaborative projects, funded on the EC side through Horizon Europe, and on the ESA side through the ESA FutureEO programme as part of the ESA Atmosphere Science Cluster[72] and relevant ESA activities related to the use of the TROPOMI and other relevant missions.

Proposals should address the collaboration with ongoing or future ESA Atmosphere Science Cluster projects, including those that will be funded through dedicated coordinated invitations to tender, and should towards this end include sufficient means and resources for effective coordination.

ESA will contribute to this effort by providing a dedicated Earth observation satellite scientific component to complement, collaborate and coordinate with this activity. In particular, ESA will contribute with dedicated set of complementary scientific activities with special focus on exploring and exploiting the new capabilities offered by TROPOMI in combination with other relevant European and international satellite missions including novel very high-resolution observations.

When dealing with models, actions should promote the highest standards of transparency and openness, as much as possible going well beyond documentation and extending to aspects

[72] https://eo4society.esa.int/communities/scientists/esa-atmosphere-science-cluster/

such as assumptions, code and data that is managed in compliance with the FAIR principles[73]. In particular, beneficiaries are strongly encouraged to publish results data in open access repositories and/or as annexes to publications. In addition, full openness of any new modules, models or tools developed from scratch or substantially improved with the use of EU funding is expected.

Projects should take into account, during their lifetime, relevant activities and initiatives for ensuring and improving the quality of scientific software and code, such as those resulting from projects funded under the topic HORIZON-INFRA-2023-EOSC-01-02 on the development of community-based approaches.

HORIZON-CL5-2024-D1-01-02: Inland ice, including snow cover, glaciers, ice sheets and permafrost, and their interaction with climate change

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of between EUR 6.00 and 7.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 22.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).

Expected Outcome: Actions are expected to contribute to **all of the** following expected outcomes:

- Advanced knowledge on the impacts of climate change and different natural and socio-economic drivers on inland ice and permafrost, and its global repercussions, including climate-ecosystem interactions, which is relevant to international initiatives, such as the World Climate Research Programme (WCRP)[74]'s Climate and Cryosphere Project, or the IPBES.

- Further developed and improved climate and Earth System Models (ESMs) that inform the international climate assessments (e.g. CMIP models, CORDEX) and support the

[73] FAIR (Findable, Accessible, Interoperable, Reusable).
[74] https://www.wcrp-climate.org/

development of "digital twins" under the Destination Earth Initiative and the evolution of Copernicus.

- Advanced provision and use of observations, including in-situ, of complex processes with focus on dynamic and vulnerable regions that may lead to high impact changes.
- Supported climate change adaptation strategies including, where relevant, the development of solutions to enhance the resilience of local communities.

Scope: Snow cover, ice sheets and glaciers affect not only the Earth radiation balance and the global climate, but also continental climate systems, the weather of circumpolar regions and their terrestrial and oceanic carbon dynamics, ecosystems, and sea level. Snow and ice cover regulate the properties of the ground underneath and are interlinked with permafrost in areas where average ambient air temperature is below 0°C.

The research actions should contribute to observing, modelling, and projecting the characteristics, volume, and dynamic of inland ice and permafrost in relevant regions, impacting regional and global climate, taking inter-seasonal, annual, decadal, as well as long-term (centuries) changes into account.

The actions should enhance the understanding of the ice sheet or glacier dynamics and evaluate reversibility or irreversibility of changes on multi-decadal to centennial timescales. Furthermore, actions should quantify other impacts caused by the thawing of the inland ice or permafrost at regional or global levels, like the contribution to sea level rise and stratification or impact on biogeochemistry and ocean currents.

Actions should assess the impact of changing land ice, snow cover, or permafrost on local or regional water cycle and economic supplies and services, evaluate the impact of ice processes on human livelihood and cultures, and identify imminent, medium and long-term potential impacts on ecosystem shifts at local and regional scale.

The actions should provide data, tools, and assessments relevant at regional and local scales to support climate change adaptation and explore, identify and verify ecosystems management techniques to allow better adaptation and maintenance of ecosystem services in a changing land-ice landscape.

International cooperation is strongly encouraged.

Actions should build upon and cooperate with relevant Horizon funded projects (e.g., Arctic PASSION, OceanIce, PolarRES, CRiceS, iCUPE), the EU Polar Cluster, the Copernicus Climate Change Service, the Copernicus Marine Environment Monitoring Service, the Copernicus Land Monitoring Service and the GEO initiative.

This topic is part of a coordination initiative between the European Space Agency (ESA) and the EC on Earth System Science. Under the initiative, both institutions aim at coordinating efforts to support complementarities between the Horizon Europe and ESA FutureEO programme.

ESA will contribute to this topic with existing and planned projects focused on improving the observation, understanding and prediction of inland ice, including snow cover, glaciers and ice sheets and permafrost thaw, and their interaction and feedbacks with the Earth and climate system. Relevant ESA activities will be implemented under the Polar Science Cluster[75].

Proposals should address the collaboration with ongoing or future ESA Polar Science Cluster projects, including those that will be funded through dedicated coordinated invitations to tender, and should towards this end include sufficient means and resources for effective coordination.

When dealing with models, actions should promote the highest standards of transparency and openness, as much as possible going well beyond documentation and extending to aspects such as assumptions, code and data that is managed in compliance with the FAIR principles[11]. In addition, full openness of any new modules, models or tools developed from scratch or substantially improved with the use of EU funding is expected. Projects should take into account, during their lifetime, relevant activities and initiatives for ensuring and improving the quality of scientific software and code, such as those resulting from projects funded under the topic HORIZON-INFRA-2023-EOSC-01-02 on the development of community-based approaches.

Synergies and complementarities should be ensured with the HORIZON-CL6-2024-CLIMATE: Closing the research gaps on Essential Ocean Variables (EOVs) in support of global assessments, HORIZON-CL6-2024-CLIMATE: Ocean models for seasonal to decadal and local to regional climate predictions, and HORIZON-CL6-2024-ZEROPOLLUTION: Tackling human and climate change induced pollution in the Arctic - building resilient socio-ecological systems.

HORIZON-CL5-2024-D1-01-03: Paleoclimate science for a better understanding of the short- to long-term evolution of the Earth system

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 15.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 15.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of

[75] https://eo4society.esa.int/communities/scientists/esa-polar-science-cluster/

	Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Eligible costs will take the form of a lump sum as defined in the Decision of 7 July 2021 authorising the use of lump sum contributions under the Horizon Europe Programme – the Framework Programme for Research and Innovation (2021-2027) – and in actions under the Research and Training Programme of the European Atomic Energy Community (2021-2025). [76]. Beneficiaries will be subject to the following additional obligations regarding open science practices: Open access to any new modules, models or tools developed from scratch or substantially improved with the use of EU funding under the action must be ensured through documentation, availability of model code and input data developed under the action.

Expected Outcome: The projects funded under this topic will assess climate variability building on past climate and environmental datasets.

Project results are expected to contribute to **all of the** following expected outcomes:

- Better process understanding of past climate changes, their variability and interactions with ecosystems, leading to improved Earth system models based on paleoclimate data.
- Assessment of driving and feedback mechanisms (e.g., the carbon cycle evolution and water cycle process), and precise timing and dynamics of deglaciation and glaciation.
- Future climate change scenarios produced in light of documented past changes in climate and ice sheets, in particular warm climates/high sea-level situations, and abrupt transitions.
- Strengthened Earth system models integrating paleoclimate data, *e.g*. models of ice sheet, ocean, ecosystem and atmospheric components, enabling understanding of future climate.
- Identification of thresholds in Earth system components, including the biosphere, and feedbacks that may be responsible for non-linear behaviour of the climate system to certain forcings.

[76] This decision is available on the Funding and Tenders Portal, in the reference documents section for Horizon Europe, under 'Simplified costs decisions' or through this link: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ls-decision_he_en.pdf

- Development, review, and improvement of indicators of abrupt changes, or early warning signals, and tipping points within paleoclimate records.

- Synthesis of climate variations that will serve as fundamental bases for IPCC future assessment and benchmarks for model inter-comparisons.

Scope: The geological and ice-core records provide long-term information on the conditions and processes that can drive physical, ecological, and social systems during interglacial periods, deglaciations and abrupt climatic events. The challenge of the research under this topic is to test Earth system models over selected past climate scenarios, outside the range of variability recorded over the past centuries.

This challenge will be tackled through the following activities:

- Producing and aggregating in databases high-resolution, well-dated, interoperable paleoclimatic records on climate changes from the past (e.g., temperature, GHG concentrations, sea level, ocean circulation variability, seasonality, and precipitation).

- Using paleo-archives at high resolution to extend the instrumental time series for better understating of the proxy records and for improved quantification of their uncertainties.

- Development of Earth system models with outputs that allow a more direct comparison to paleo-data, modelling climate variability, thresholds, and impacts across timescales from years to millennia (e.g., isotope-enabled general circulation models with dynamic ice sheet components that represent relevant feedbacks).

- Describing short- to long-term climate evolution using quantitative reconstructions from different proxies of past climate periods that are of particular relevance with respect to the current climate change scenario.

- Identification of climate tipping points, cascading effects, and environmental limits using paleo data and model experiments.

- Comparing changes in marine, terrestrial and glacier settings to evaluate ocean–land–cryosphere interactions.

- Documenting and quantifying the natural climate variability, in terms of amplitude, time (onset, duration, frequency) and space (location, extension).

- Allowing for consistent integration of large-scale and more regional/local factors to be reproduced by climate models using natural forcings.

Synergies with projects resulting from the topic HORIZON-CL5-2023-D1-01-02: Climate-related tipping points should be established.

The projects should rely on paleoclimatic data from scientific drilling campaigns, and other appropriate sources.

When dealing with models, actions should promote the highest standards of transparency and openness, as much as possible going well beyond documentation and extending to aspects such as assumptions, code and data that is managed in compliance with the FAIR principles[77]. In addition, full openness of any new modules, models or tools developed from scratch or substantially improved with the use of EU funding is expected.

Climate change mitigation, pathways to climate neutrality

Proposals are invited against the following topic(s):

HORIZON-CL5-2024-D1-01-04: Improved toolbox for evaluating the climate and environmental impacts of trade policies

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 6.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 12.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).

Expected Outcome: Project results are expected to contribute to **all of the** following outcomes:

- Enhance our knowledge and inform policy makers on the positive and negative impacts of trade and trade policy on the climate. Additionally, where relevant, broader effects on the environment, in particular biodiversity, pollution and natural resources depletion may also be considered.
- Improve and enlarge the toolbox of models and other research techniques as well as available data and its processing to analyse the impact of trade and trade policy on the climate.

Scope: Actions are expected to cover **all of the** following areas:

- **Study and quantification of the effects of trade on the climate and the environment**

[77] FAIR (Findable, Accessible, Interoperable, Reusable).

- In-depth study/quantification of the technique and composition effects: in addition to the scale effect of increasing production, trade also has an impact on the sector composition of economies and the technologies used for production. The project(s) should quantify and decompose these effects, including their underlying mechanisms/causes.

- Growth projections of trade related emissions in developing countries and newly developed countries: it can be expected that most of future trade-related emissions will take place in these countries. The project(s) should therefore estimate and quantify these future emissions under different scenarios, including the extent to which this is related to pollution offshoring and pollution haven effects.

- Estimate the net effect of trade: clarify/quantify how much of trade related emissions would still take place in the context of the domestic economy without international trade. While trade-related emissions are an important part of total world emissions, not enough is known about the counterfactual, i.e. emissions profiles in the absence of international trade.

- Study the effects stemming from changes in the use of resources attributable to international trade, both in terms of efficiency gains (e.g. in energy and material use) and in terms of changes in the climate impacts associated with production and consumption, and whether externalities are likely to be internalised. For specific sectors, the action should look into emissions linked to the production in different countries versus transport emissions in trade to those countries.

- Study trade-related climate and environmental impacts in key sectors like agriculture and livestock, including linkages to regional land use change, water resources and differences in agricultural production techniques worldwide. Specific tools and methodologies for agriculture and livestock should also be proposed and refined to be able to give sector-specific advice to policy makers.

- Study the public perception vs. the reality of trade impacting on the environment and climate: while in the public debate trade is often associated with increased emissions related to the scale effect, technique and composition effects point to positive impacts in certain cases. Case studies should also include concrete examples of cases where public perception of trade effects on emissions and real effects diverge.

- **Study and quantification of the effects of trade policy on the climate and the environment**

  - In-depth study/quantification of trade creation and trade diversion effects in relation to the climate and the environment: trade liberalisation affects trade flows through the diversion of such flows as well as inducing additional trade. The project(s) should study the net effect of these phenomena on the climate and the environment.

- Impact of environmental/climate regulation on trade and competitiveness: it can be assumed that in some cases tightened environmental legislation can lead to compliance costs and competitiveness effects. It should be empirically studied to what extent this assumption is correct and to what extent the so-called 'Brussels Effects' impacts these cost and competitiveness effects.

- What do the expansion of global value chains, offshoring and their fragmentation (and a possible reversal of such trends) mean for the climate and climate-related trade policy: the project(s) should analyse the effectiveness of climate and trade policies in such an international economic context.

- Effects of openness to trade on environmental and climate policy: trade and international exchanges lead to the diffusion of technology and ideas. To what extent do these effects influence emissions and global climate/environmental policies?

- The role of trade policy as a tool to address the free rider problems in climate policies: since addressing climate change is a global public good, free-rider problems persist. To what extend can trade incentives and the trade policy toolbox help overcoming these?

- Analyse the coherence between trade policies, climate policies and other policies such as nutrition-food, resources policies and development policies that affect the impacts on the climate and the environment. Analyse how these policies affect the trade-off between food security and conservation of natural resources (such as forests and water resources).

- **Methodology and toolbox related aspects**

  - Impact of trade and foreign direct investment (FDI) on the productivity of sectors (do more productive sectors/producers tend to be cleaner?): the project(s) should endogenise (Global Trade Analysis Project (GTAP) sector productivity to trade beyond a Melitz-type of framework, including the separation of energy efficiency effects among the productivity effects. Currently since, technological change is mostly exogenous or only roughly calibrated in Computable General Equilibrium (CGE) models, technique effects on carbon leakage cannot fully be captured.

  - Impact of trade on land use (overall and composition), in particular on deforestation: the project(s) should study methodologies that can be used to better understand the effects of trade and trade policy on land use. Actions should also create/update a trade induced land use/land use change matrix for GTAP sectors.

  - Transport-related pollution: the project(s) should create a transport mode matrix for GTAP sectors per countries and their related emissions.

  - Enlarge/split the GTAP sectors list for emission-intensive sectors: the project(s) should create/improve the GTAP sector matrix for emission-intensive sectors.

Actions are also encouraged to explore and promote synergies between the use of modelling approaches in international trade analysis and in comparable macroeconomic modelling in climate policy, for example, in Integrated Assessment Modelling.

International cooperation with research clusters, which have specific knowledge in areas of this call, is encouraged.

The project should also include dissemination and capacity-building for the findings and tools created among policy makers at the EU and Member States/Associated countries level.

HORIZON-CL5-2024-D1-01-05: Next generation low-emission, climate-resilient pathways and NDCs for a future aligned with the Paris Agreement

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 4.50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 14.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).
Legal and financial set-up of the Grant Agreements	The rules are described in General Annex G. The following exceptions apply: Beneficiaries will be subject to the following additional obligations regarding open science practices: Open access to any new modules, models or tools developed from scratch or substantially improved with the use of EU funding under the action must be ensured through documentation, availability of model code and input data developed under the action.

Expected Outcome: Projects results are expected to contribute **to all of the** following expected outcomes:

- Methodologies and approaches to promote improved transparency, consistency, and clarity of Greenhouse Gas (GHG) emission reduction commitments.

- Production of more diversified, granular, and customised state-of-the-art pathways consistent with the objectives of the Paris Agreement at global, national and sectoral levels in a diverse selection of countries, better reflecting different national circumstances and constraints and promoting synergies between climate action and other policy objectives.

- Science-based evaluation of selected existing pathways, policies, and measures to implement NDCs and Long-Term Strategies to achieve the goals of the Paris Agreement.

- Extended use of modelling, climate change scenarios and mitigation pathways based on provision of tailor-made tools, trainings, and services to end-users.

- Enhanced international cooperation on identification and implementation of effective mitigation strategies that are aligned with the objectives of the Paris Agreement.

- Improved knowledge base to inform the UNFCCC processes, including the design and revision of post-2030 NDCs and the Global Stocktake in 2028, as well as major international scientific assessments such as the IPCC and IPBES reports.

Scope: As showcased by various independent assessments, the current Nationally Determined Contributions (NDCs) and climate policies fall short of reaching the long-term goals of the Paris Agreement. Strengthening is necessary to close the ambition and implementation gaps, and to align national climate action with global objectives, while simultaneously achieving the broader Sustainable Development Goals and social welfare.

Moreover, while countries have put forward plans, strategies, and announcements to reach "net-zero" targets, these commitments are hard to compare due to varying definitions, ranging from "zero-carbon" to "net-zero CO2" and "net-zero greenhouse gases" whereas choosing different gases, different (time)scales and different aggregation methods can lead to very different climate outcomes. To address these concerns, actions should define principles for high-integrity, more coherent climate commitments and review processes.

Projects should contribute to strengthening of national climate policies, NDCs and long-term strategies, by developing next generation low-emission transformation pathways, with increased sectoral detail, and fostering more holistic and more integrative approaches that promote synergies and minimise trade-offs between mitigation, adaptation, biodiversity and other policy objectives. They should support the creation of tools that evaluate the existing NDCs and facilitate monitoring processes.

Projects should address some of the following aspects in their research:

- Development of sectoral climate transition scenarios (energy production, transport, industry, buildings, food/agriculture etc.).

- Increase the understanding of the role of ecosystems, in particular land use, in NDCs and other climate commitments identifying options for enhancing transparency and coherence with global models and pathways.

- Enhance knowledge about the role of non-CO2 gases in meeting the temperature goals of the Paris Agreement and the implications for the transition pathways of countries and sectors.

- Improve the integration of climate impacts and risks in mitigation pathway analysis, including cost-benefit analysis.

- Advance knowledge on adequacy and fairness of climate commitments and strategies, taking into consideration feasibility of actual deployment. This should include, but not be limited to, the analysis of the role and effectiveness of international financial flows in delivering on climate goals together with identification of most impactful approaches.

- Improve understanding of how corporate and non-state commitments could affect national/regional mitigation pathways, for example through their effect on global supply chains.

Co-creation with various stakeholders in the private and public sectors is expected under this topic to ensure that the outcomes produced remain relevant for their end-users. Actions should contribute to improving accessibility of climate change scenarios and models by non-specialist audiences, for example through development and delivery of dedicated services and tools that facilitate user-friendly access and proper use.

Actions may cover a set of regions or be focussed on a specific one and explore it in greater detail. However, in all cases consortia should benchmark their results with global mitigation pathways.

International cooperation is encouraged, in particular with countries of the African Union[78] and least developed countries[79] requiring support for the design and implementation of their NDCs and long-term strategies, as well as with countries making part of the global top ten emitters[80].

Synergies with projects resulting from the topic D1-9. 2023 - *Science for successful, high-integrity voluntary climate initiatives* should be established as regards the role of non-state voluntary climate initiatives in achieving the objectives of the Paris Agreement, and with projects resulting from the Horizon 2020 topic LC-CLA-02-2019 -Negative emissions and land-use based mitigation assessment[81] as regards latest methodological developments.

This topic requires the effective contribution of SSH disciplines including ethics and the involvement of SSH experts, institutions as well as the inclusion of relevant SSH expertise, in order to produce meaningful and significant effects enhancing the societal impact of the related research activities.

78 "African Union member states" includes countries whose membership has been temporarily suspended.
79 https://www.un.org/development/desa/dpad/wp-content/uploads/sites/45/publication/ldc_list.pdf
80 as per, for example, http://www.globalcarbonatlas.org/en/CO2-emissions
81 https://cordis.europa.eu/programme/id/H2020_LC-CLA-02-2019

When dealing with models, actions should promote the highest standards of transparency and openness, as much as possible going well beyond model documentation and extending to aspects such as assumptions, code and data that is managed in compliance with the FAIR principles[82]. In particular, beneficiaries are required to publish data and results in open access databases and/or as annexes to publications. Projects should also take into account, during their lifetime, relevant activities and initiatives for ensuring and improving the quality of scientific software and code, such as those resulting from projects funded under the topic HORIZON-INFRA-2023-EOSC-01-02 on the development of community-based approaches.

HORIZON-CL5-2024-D1-01-06: The role of climate change foresight for primary and secondary raw materials supply

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 5.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 5.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used). The Joint Research Centre (JRC) may participate as member of the consortium selected for funding.

Expected Outcome: The successful proposal will support the transition to a digital and low carbon society in the context of the European Green Deal with a particular emphasis on climate change and raw material value chains. In particular, it should contribute to **all of the** following expected outcomes:

- Short-, medium-, and long-term scenarios of changes in the type, origin and quantity of raw materials (metals/minerals) required for the twin transition.
- Geo-referenced projections for the changes to the greenhouse gas and energy footprint associated with the supply of these primary and secondary raw materials with a view to facilitating their use in integrated assessment models.

[82] FAIR (Findable, Accessible, Interoperable, Reusable).

- Models and data contributing to the development of the European Commission's Raw Materials Information System[83].

- Inputs to international scientific assessments such as reports by IPCC, the International Resource Panel and IPBES.

Scope: Achieving enhanced digitalisation and a low carbon society will involve a change in the type and quantity of the raw materials required by the economy. This can result in geopolitical shifts in extraction and processing, as well as an increase in the extraction, processing, and recycling of many minerals and metals, including ones that have so far been only marginally important. Materials are likely to be extracted from increasingly lower grade ores and hostile environments, from mining wastes, as well as through recycling. Ceteris paribus, this would involve a general increase in the energy required to supply raw materials, as well as associated greenhouse gas emissions and changes in some other environmental impacts (such as related to transport and land take for mineral extraction and waste disposal). It will also involve changes in technologies and substitution to materials with lesser environmental impact, some of which not sufficiently well understood. This can include consideration of substitution and circular use of materials.

This action will improve knowledge concerning the options, and challenges, in the short, medium, and long-term associated with the provision of raw materials required for the twin transition with a focus on interlinkages with climate change.

Sectors, technologies and material value chains to be analysed will be selected on a justified basis. The project will analyse changes to the carbon footprint associated with supply options for a justified selection of primary and secondary raw materials for short, medium and long-term time horizons. Options analysed will relate to raw materials likely to have large changes in supply due to the twin transition, where important geopolitical and technological changes are likely in relation to the twin transition and circularity.

The analyses should build on established life cycle assessment and product environmental footprint requirements, as relevant, and contribute to their further development. Modelling should be detailed to account for geo-political/site-specific changes in supply, technologies, and e.g. energy consumption. Scenarios will build on, as far as available, existing demand scenarios from European Commission modelling activities, and are expected to take into account the relevant EU policies (Fit-for-55 package, carbon neutrality by 2050). Scenarios are expected to account for the foreseen variation and innovation advances in extraction, processing, recovery, recycling and other technologies along the value chains, including changes to the energy mixes involved at specific locations.

The proposal will include the involvement of experts for the different technologies related to the primary and secondary raw material options selected as well as representatives of the integrated assessment modelling community.

[83] https://rmis.jrc.ec.europa.eu/

This action will develop state-of-the-art knowledge (models and databases) in relation to climate change and the implications of different options associated with the twin transition and the related increases in supply of some raw materials.

The action will build on existing modelling work for the supply and demand of primary and secondary raw materials and expand them to reflect typical transition pathways, to highlight the implications on climate change.

The action will align to established requirements of existing methodological and data frameworks such as for life cycle assessment and product environmental footprint.

While focusing on selected technologies and site-dependent modelling, conclusions should provide insights related to opportunities and challenges for sectors associated with the twin transition.

Proposals should consider the involvement of the European Commission's Joint Research Centre (JRC) whose contribution could consist of interacting in relation to the EC's Raw Materials Information System and its underlying sectorial value chain analyses in the contexts of geopolitical foresight, life cycle assessment, and circular economy.

Stakeholders are to be selected on a justified basis to be consulted at key steps to provide informed feedback on the modelling, data and analyses.

Climate-ecosystem interactions

Proposals are invited against the following topic(s):

HORIZON-CL5-2024-D1-01-07: Quantification of the role of key terrestrial ecosystems in the carbon cycle and related climate effects

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 10.00 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 20.00 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	The conditions are described in General Annex B. The following exceptions apply: If projects use satellite-based earth observation, positioning, navigation and/or related timing data and services, beneficiaries must make use of Copernicus and/or Galileo/EGNOS (other data and services may additionally be used).

Expected Outcome: A comprehensive assessment and quantification of the role of terrestrial biogeochemical dynamics and the role of vegetation in the carbon cycle, compared to the pre-industrialisation situation, building on dedicated in situ data collection, novel satellite data development, and advanced carbon cycle modelling.

Project results are expected to contribute to **all of the** following outcomes:

- Enhanced understanding and characterisation of the terrestrial carbon pools and fluxes, including through taking account of hydrological exchanges, with unprecedented accuracies and spatial scales, building on the advent of a new generation of satellite missions (e.g., ESA's BIOMASS, FLEX, Sentinel missions, NASA's NISAR, GEDI, ICESat-2 etc…), that radically change the way the terrestrial carbon cycle can be observed.

- Improved methods for the monitoring of key ecosystems state in Europe, regarding terrestrial carbon, including e.g. forestry, croplands, peatlands, inland water, extensive grasslands, tundra, tidal marshes, seagrass, and mangroves, and tackling key gaps in observations, e.g. age-structure, species richness, canopy structure (including use of Terrestrial Laser Scanning), observations of wood density, interaction with hydrology and exchange with the atmosphere in particular observations of biological volatile organic compounds, CO2, CH4, N2O, and black carbon/particulates emissions.

- Improved handling of anthropogenic management practices (land use including forestry) in terrestrial carbon modelling, including lateral transfers of carbon (notably in the form of harvested biomass including exports, imports, and use as well of land-water exchange).

- Improved understanding of impacts on the carbon cycle of extreme events (wind throw, drought, pest outbreaks, fire), and of the impacts of anthropogenic disturbance including degradation and behaviour and recovery of forest post-disturbance.

- Improved consistency between top-down methods such as atmospheric inversions and bottom-up approaches based on land-surface models, in-situ and satellite observation, flux measurements, and national and global statistics.

- Assessment of the consistency of observation and advanced models through benchmarking activities at multiple scales including point measurements, and satellite observations at multiple temporal and spatial resolutions.

- Novel monitoring frameworks combining remote and proximate sensing techniques with machine learning and edge computing.

Scope: The main challenge of this topic is to develop an enhanced capacity to better characterise and reduce uncertainties of the carbon cycle related to key terrestrial European ecosystems as a function of anthropogenic emissions, environmental forcing conditions, and management practices. In order for this challenge to be met, actions should be performed at spatial resolutions required to represent the mechanisms by which human interventions

necessary to move towards net-zero carbon balance, can be quantified. Further, the dynamics and response of vegetation to climate change, short- and long-term stress, natural dynamics (e.g. fire), and especially change in frequency, form and severity of extreme events, need to be better understood and quantified.

Proposals should address the above challenges through:

- Coordinated European effort to expand dedicated campaigns to collect in situ-data, including from citizen observations, on land cover, land use and related changes, and on the main processes caused by these, to support the modelling of these changes based on current and historical trends, and to develop empirically based scenarios connecting land use and land cover change to carbon emissions, and sequestration potential.

- Advances in land surface and carbon modelling supported by high-performance computing capacity, allowing models to be run at unprecedented resolutions, and accuracy, through improved data assimilation workflow from remotely sensed data and vegetation models. The emphasis should be on area wide effect of the ecosystem's microbiome, and consistency across spatial and temporal resolution and with satellite observation processes.

- Extending and complementing satellite observations with elements linked to the LUCAS survey of Eurostat, to the EU Soil Observatory (EUSO) initiatives on integrated soil monitoring systems, and to research infrastructure e.g. eLTER and ICOS, as well as through comparison with past data and through coordination with Earth observation efforts (spectral signature characterisation, biophysical and biogeochemical observations commensurate with satellite resolutions, aircraft / unmanned aerial vehicle campaigns).

- Specific efforts to develop carbon and land surface models consistent with specific variables or outputs that can be directly interfaced or compared with satellite observations e.g. above ground biomass, soil moisture, solar induced fluorescence, disturbance dynamics e.g. fire, and inclusion of additional key processes (coupling with Nitrogen and Phosphorus cycles and water, CO_2 fertilisation, assimilation of photosynthesis rates from global observation for direct gross primary production estimation).

- A significant coordination effort and collaboration with the relevant activities of major international scientific groups (e.g., IPCC, Global Carbon Project), the Copernicus Atmosphere Monitoring Service and the ESA Carbon Science Cluster[84].

This topic is part of a coordination initiative between the European Space Agency (ESA) and the EC on Earth System Science. Under the EC-ESA Earth System Science Initiative, both institutions aim at coordinating efforts to support complementary collaborative projects, funded on the EC side through Horizon Europe, and on the ESA side through the ESA FutureEO programme as part of the ESA Carbon Science Cluster.

[84] https://eo4society.esa.int/communities/scientists/esa-carbon-science-cluster/

Proposals should address the collaboration with ongoing or future ESA projects, including those that will be funded through dedicated coordinated invitations to tender, and should towards this end include sufficient means and resources for effective coordination.

Applicants should ensure coordination with complementary projects funded under the ESA Carbon Science Cluster of the FutureEO programme including relevant ESA activities related to the use of the novel BIOMASS[85] and FLEX[86] missions and potentially the Copernicus CO_2M[87] mission in the future.

85 https://earth.esa.int/eogateway/missions/biomass

86 https://earth.esa.int/eogateway/missions/flex

87 https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Copernicus_Sentinel_Expansion_missionshttps://www.eumetsat.int/copernicus-co2m-science-support