2023 Google Carbon Removal Research Awards

Google is committed to supporting efforts to combat climate change across the world. The United Nations' Intergovernmental Panel on Climate Change (IPCC) has identified carbon removal as a way to limit global warming to 1.5 degrees Celsius. Today, there is a scarcity of mature technologies with the requisite potential for scale. Google is looking to fund and actively collaborate with the research community, exploring opportunities and pathways to reduce anthropogenic carbon through mechanisms of carbon removal. These 2023 Google Carbon Removal Research Awards aim to fund selected research efforts to better characterize and accelerate the development of new carbon removal approaches.

We believe that the following four areas of investigation would benefit from additional scientific support:

- Seaweed or other organic matter sinking
- Tropical afforestation/reforestation
- Blue carbon
- Enhanced weathering

Additional guidance, including particular questions, for these four areas can be found under the *Guidance for emerging research areas* section.

Proposals should address the following:

- Feasibility of approach for applications available within the next 3-5 years
- Scalability of approach over time, including cost considerations (i.e., $/t$CO_2$ removed)
- Considerations for maximizing carbon removal
- Considerations for optimizing ease of implementation, including construction
- Methods & scientific standards for measuring success
- Considerations for minimizing externalities, including responsibility considerations for ecological & human impact, including but not limited to:
  - [Seaweed sinking] Nutrient depletion
  - [Reforestation] Atmospheric chemistry effects/implications, economic leakage
  - [Enhanced weathering] Heavy metals contamination

Award information

The Google Carbon Removal Research Awards will fund research projects of up to three years duration, requiring up to three Ph.D. students or equivalent support (i.e., post-docs). Funding can also be considered for cloud credit availability for computational work on the Google Cloud Platform. Awardees will have the opportunity to participate in check-ins with Researchers at Google with relevant field expertise.

Guidance on proposals

We request submitted research proposals to use the format below, outlining the research goals, resource estimates and proposed modalities and be no longer than three pages in length (including references).

We believe strongly in open access and in supporting projects whose output will be made available to the public and to other researchers. For this reason, we ask applicants Principal Investigators to include a brief statement about what they intend to do with the output of their work, and we strongly prefer projects that intend to publish and/or contribute to the academic community.

How to apply

The program is open to active researchers at degree-granting universities and academic research institutions who are advising students and conducting research. Apply by completing the application by **Friday, April 28, 2023**.

Proposal in PDF format must include these items and be no longer than 3 pages:

- Proposal title
- Principal Investigator (PI) full name, contact information
- Co-PIs' full names, contact information
- Affiliation (university, school, college, and/or department)
- Research objectives and expected results with timeline (i.e., Year 1, Year 2, etc.)
- Statement of prior work, including a list of relevant publications
- Benefit to the research community
- Budget: amount and cloud credits (pricing calculator) requested
- Disclosure policy: a short description of what you intend to do with the output of your project (e.g., publications, open-sourcing code, making data sets public, etc.)
- Emerging research areas: if submitting a proposal in one of the four emerging research areas, please provide answers to the questions provided below in your proposal or topic review

We request all applications be submitted in English. We expect to send out decision notifications no later than Monday, June 5, 2023. Do not submit any confidential or proprietary information through this application as the details of your project proposal will be shared with internal and external experts for evaluation.

We look forward to receiving your proposal and collaborating with you on this exciting new program.

Guidance for emerging research areas

Specific questions for areas that we feel would benefit from additional scientific support can be found below. We would also accept a review paper on any of these topics, rather than entirely new research.

Seaweed or other organic matter sinking

Identify the most promising versions of this approach, taking into account:

- Maximizing carbon dioxide removal (including species selection, e.g., kelp vs. sargassum vs. plankton, farm geometry, location, sinking method, etc.)
- Minimizing negative environmental externalities
- Maximizing energy and/or infrastructure efficiency, e.g., through nutrient recycling
- Ecological & human impact, including nutrient depletion

For specific proposals, what is the full life cycle analysis, including:

- Nutrient depletion from surrounding ecosystem and resulting reductions in growth
- Construction of scaffolding
- Methods for permanent sinking
- Impact of anoxic decomposition of sunk seaweed or processed biomass

Tropical afforestation/reforestation life cycle analysis

What is the total life cycle analysis for tropical forest afforestation/reforestation, including:

- Impact of albedo reduction and evapotranspiration (if any)
- Economic leakage to other forested regions
- Any other atmospheric chemical effects
- Ecological & human impact, including atmospheric chemistry effects/implications, economic leakage

Blue carbon life cycle analysis

To aid in the evaluation of blue carbon options. What is the total life cycle analysis for coastal blue carbon projects, including:

- Impact of disturbance and other factors on rate/extent of buried carbon
- Impact of organic and inorganic carbon cycles on net CO_2 flux
- Methods/standards for measuring organic matter in sediments
- Impact of different management approaches

Enhanced weathering life cycle analysis

To aid the evaluation of enhanced weathering options. What is the total life cycle analysis for ~3 promising types of rock weathering projects (excluding ocean alkalinity enhancement), including:

- Methods/standards for measuring and verifying CO_2 uptake predictions
- Impact (if any) of trace metals
- Impact of grain size variations
- Mining and transportation impacts
- Ecological & human impact, including heavy metals contamination

FAQ

I am employed full-time at a university, but I am not a professor. Can I apply?

The program is open to active faculty members at degree-granting institutions who are advising students and conducting research and Principal Investigators employed at universities and academic research institutions.

What is the disclosure policy for the proposals?

Our goal is to support work where the output will be made available to the broader research community. To that end, we ask that you provide us with a few sentences sharing what you intend to do with the output of your project (e.g., publications, open-sourcing code, making data sets public, etc.).

Are these awards related to the Google.org Impact Challenge on Climate Innovation?

These awards are separate and distinct from the Impact Challenge, focusing specifically on accelerating academic research focused on areas of opportunities for carbon removal.

Can I submit a proposal outside of the four emerging research topics?

Yes, proposals directly applicable to carbon removal research and the goals of the program will be accepted.

Will feedback be provided on the proposal that we submit?

Reviewers will do their best to provide limited feedback on submitted proposals.

How are applications evaluated?

Applications are evaluated on the strength of the research proposal, research impact, feasibility, and responsible research. Research proposals are evaluated for innovative concepts that are relevant to Google's research areas, as well as aspects of robustness and potential impact to the field. Proposals should include the direction and any plans of where your work is going, in addition to a comprehensive description of the research you are pursuing.

Incomplete proposals will not be considered.

Is it possible to receive an extension?

No, all applications must be submitted by 11:59 pm PST, Friday, April 28. Late submissions will not be reviewed.

How can GCP credits be used?

GCP credits can be used for most computing services on the Google Cloud Platform, such as storage, compute, and data analysis. The credits cannot be used for Maps Platform products. Credits may not be used for Google Cloud support packages. Credits must only be used for the research described in the abstract section of the application.

How can I ask additional questions?

We will be providing limited email support via google-cdr-awards@google.com. Due to the volume of emails we receive, we may not be able to respond to questions quickly.

Open advice to proposal writers

Here's some guidance on how you strengthen your short proposal. A good research grant proposal:

- **Clearly specifies a problem.** Good research is driven by a great problem or question, and a good proposal starts with a clearly specified one.

- **Describes a specific, credible, relevant outcome.** Try to identify a specific and appropriately sized outcome to give us a clear notion of what the research award would be enabling. What will likely come to be that might otherwise not happen? While this outcome should be a decisive step toward achieving your vision, it generally won't be adequate to completely achieve it. It often helps to describe both the minimum that is likely to be accomplished and a potential best case. Since picking the right datasets and test cases is often important, tell us which ones you plan to use.

- **Crisply differentiates the proposed contribution from prior work.** Please apply normal practices (citations, etc.) for documenting how your work will materially advance the state of the art. Make it clear how your work will be changing the state of the art and not simply trying to match it.

- **Tells us how the research challenge(s) will be addressed.** Successful research projects combine a great problem with ideas for solutions, too. We recognize that all the answers won't be known yet, but we'd like to feel that the direction has been established and a plausible path has been identified. (Try to avoid proposals of the form "We want to look at problem X".) It's hard to have a big impact without taking risks, but please identify what the difficulties are likely to be and how you plan to mitigate them. It may help to explain how you succeeded in addressing analogous problems in other projects.

- **Puts the proposed work in context.** Most projects we fund also have support from other sources. To help us understand the expected impact of Google support, please explain what funding you already have for this area of research and how the proposed work relates to your existing plans. Do you plan to build a capability for other research, provide a tool, reproduce a prior result, collaborate with others to try something out, follow up on a promising idea, or explore a new one? All are potentially of interest; we just want to know.

- **Makes the case to a non-expert.** While we try to have your proposal reviewed by a Google expert in your field, it will also be read by non-experts, so please make at least the motivation and outcomes broadly accessible.

- **Tells us how this research impacts an underserved community and why you are qualified to do this research.** It can be through social, cultural, or regional expertise specifically related to the research to conduct successful work.

- **The proposal should show promise that it will benefit society** or advance desired societal outcomes.