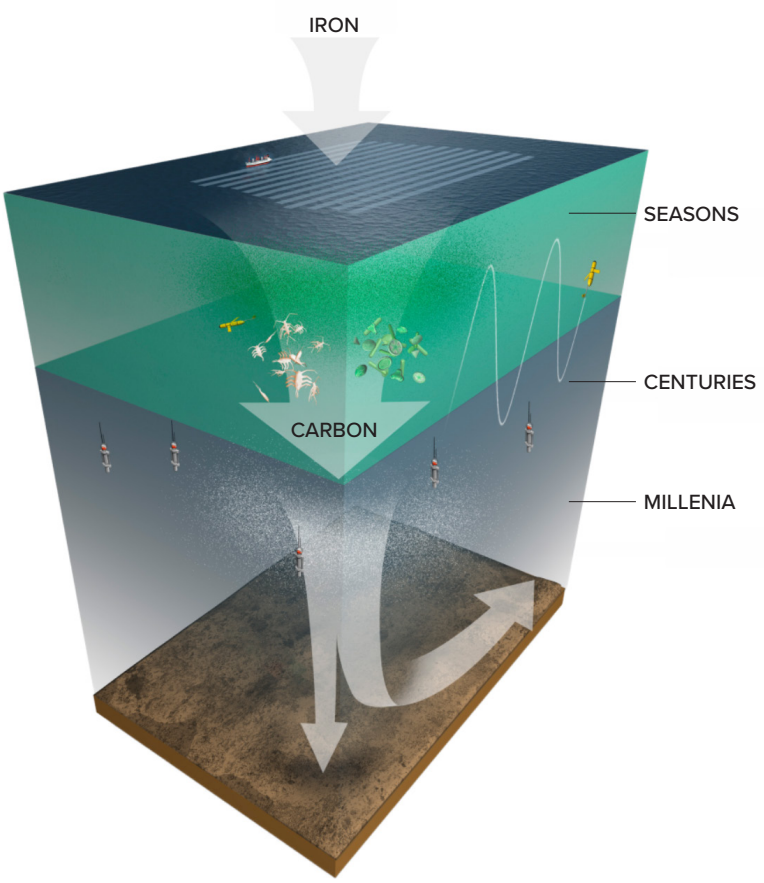
EXPLORING OCEAN IRON SOLUTIONS

North Pacific Carbon Study

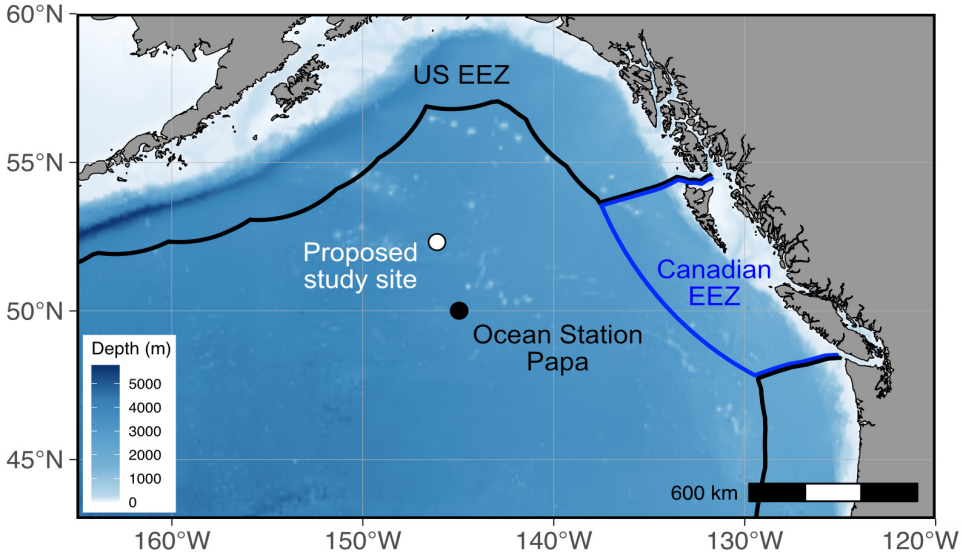
Field experiment

The North Pacific Carbon Study (NPCS) consists of two proposed, identical experiments at the same offshore study site, about 400 nautical miles (nm) off the coast of Alaska and about 500 nm from British Columbia. Pending a permit from the U.S. EPA, these experiments could take place in 2027 and 2028 . During each experiment, a 30 x 30 km (16 nm x 16 nm) patch of ocean will be fertilized with a relatively small amount of solid iron in the form of iron sulfate heptahydrate dissolved in acidified seawater. This bioavailable iron form is similar to the type used in iron supplements for treatment of anemia. The iron-seawater solution will be released into the propeller wash of moving ships for quick dilution. The iron dispersal will last 7-10 days and the evolution of the fertilized patch will be observed for up to 3 months, with return to baseline environmental conditions expected during that time.

From previous experiments and numerical ocean models, a relatively small increase in iron is expected to stimulate significant phytoplankton growth. Such a bloom not only supports the base of the marine food web but also removes carbon dioxide from the seawater, generating large amounts of organic material. This biomass eventually sinks to the deep ocean to store carbon away from the atmosphere for 100 years or more and removes carbon dioxide from the atmosphere. Over the course of the experiment, iron concentrations will increase by only about 1-2 nanomolar (nM) after accounting for some loss of iron attached to sinking particles.



The total added iron would be the equivalent of dissolving a paper clip in an Olympic-sized swimming pool.



The map shows the proposed study site in the offshore Gulf of Alaska. U.S. and Canadian EEZ's are shown in black and blue, and the location of a multidecade ocean observing site, Ocean Station Papa, is about 250 km (135 nm) from the study site. Vessels for iron release and monitoring will leave from a U.S. port. Since the site is in international waters, permitting will follow international frameworks under the London Convention and London Protocol.

Research site selection

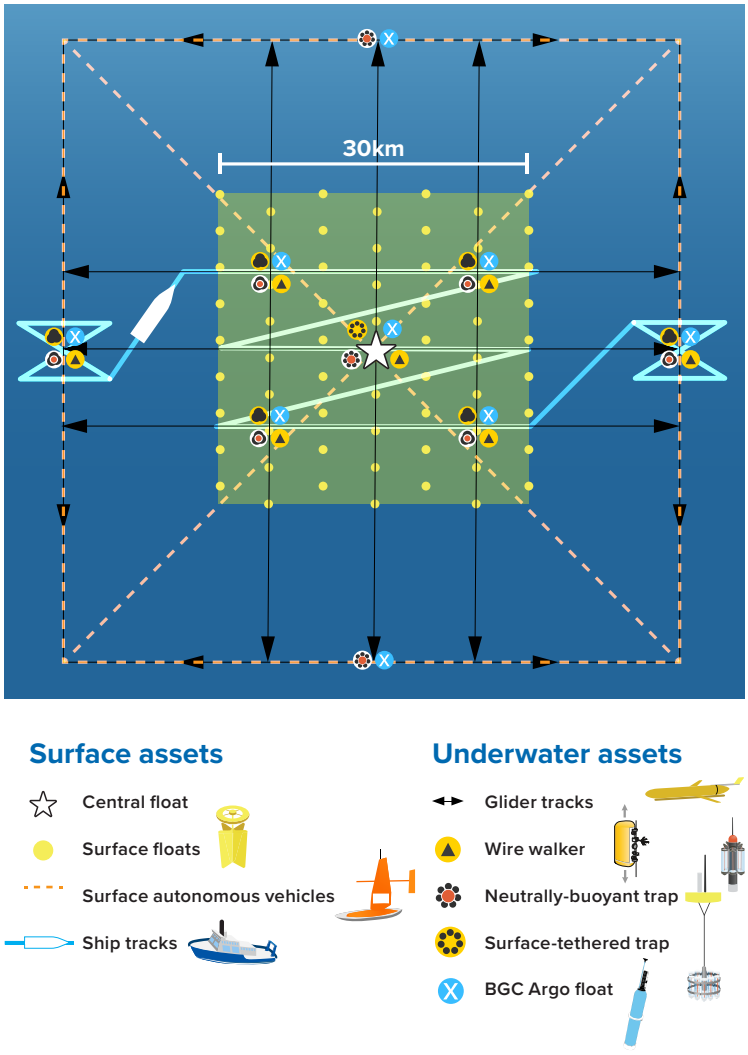
The study site was selected for several reasons, and insights learned there can be applied to other iron-limited, high-nutrient regions like those in the Equatorial Pacific and the Southern Ocean.

- **Scientific baseline understanding:** The research site is located about 250 km (135 nm) NNW of Ocean Station Papa, a long-running ocean observing site with decades of baseline data.
- **Iron & nutrient conditions:** Iron is naturally scarce in this region, so a small addition should stimulate a significant phytoplankton growth response, with adequate concentrations of other essential nutrients to support the enhanced growth (e.g., nitrogen & phosphorus).
- **Water movement:** Surface water movement is slow compared to other regions, allowing sufficient tracking of the patch with ships and autonomous vehicles.
- **Shallow depth for carbon storage:** Carbon sinking to 500 meters is likely stored for more than 100 years, compared to 1000-2000 meters in other parts of the ocean.
- **Distance offshore:** The distance from shore reduces interactions with coastal fisheries and communities.

Carbon & environmental monitoring

Monitoring of both carbon removal and potential environmental impacts is key to assessing whether OIF could be safely scaled up and used as a viable mCDR method. The proposed experiment will include a wide range of state-of-the-art scientific tools to collect these measurements, including ship-based water sampling, towed instruments, satellite-based observations, and an array of autonomous vehicles with a number of different ocean observing sensors. Some key measurements include:

- **Carbon:** Surface carbon dioxide (CO_2) drawdown, carbon export to depth, and models of CO_2 re-equilibration between the atmosphere and surface ocean
- **Phytoplankton:** Growth proxies via chlorophyll, particulate organic nutrients, and satellite remote sensing; community composition via microscopy, imaging, and DNA analysis
- **Biogeochemistry:** iron and macronutrient concentrations, carbonate system parameters such as pH, dissolved inorganic carbon, alkalinity
- **Ocean physics:** Patch spread and movement via inert tracer, physical water properties including temperature, salinity, and currents
- **Potential environmental impacts:** oxygen depletion, non-CO_2 greenhouse gas formation (CH_4, N_2O), harmful algal blooms and toxin generation (e.g., domoic acid), and nutrient robbing



We want to hear from you!

Our research plan is still in the design phase as we seek funding and an EPA permit. If you have questions or suggestions, or you want to get involved, we want to hear from you. Read more about our plans on our website and contact us at info@oceaniron.org.

READ MORE! Dialogues on Climate Change

"The case for ocean iron fertilization field trials"