Integration of the Submersible Under-Ice Mass Spectrometer (SUIMS) with the Icefin ROV for Dissolved Gas Measurements at the Grounding Zone of a Marine-Terminating Glacier

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Abstract

The grounding zones of marine-terminating glaciers represent one of the most dynamic and inaccessible interfaces in the cryosphere, where subglacial freshwater mixes with ocean water beneath thick ice cover. Understanding the fluxes and biogeochemical transformations that occur in these environments is critical for constraining meltwater contributions to ocean circulation, carbon cycling, and ice sheet stability. However, direct observations of dissolved gases—key tracers of subglacial hydrology and microbial activity—remain virtually nonexistent in these regions due to extreme access limitations.

To address this gap, we have developed and deployed the Submersible Under-Ice Mass Spectrometer (SUIMS), a compact in-situ membrane inlet quadrupole mass spectrometer designed for harsh polar environments. SUIMS is currently being prepared for integration into the forward payload bay of Icefin, a remotely operated vehicle (ROV) developed for glacial and under-ice exploration. Once integrated, SUIMS will enable real-time, co-located measurements of dissolved gases alongside Icefin's suite of environmental sensors, including conductivity-temperature-depth (CTD), dissolved oxygen (DO), and acoustic Doppler current profiling (ADCP).

Field tests were conducted at marine-terminating glaciers in Northwest Greenland, where SUIMS operated as a standalone unit beneath seasonal sea ice. Future deployments will use Icefin's mobility and navigational capabilities to generate high-resolution, spatially resolved maps of grounding zone discharge plumes—revealing how gas distributions evolve with flow, mixing, and subglacial source variability.

This work lays the foundation for long-duration chemical sensing in extreme under-ice environments, with applications to both Earth system science and planetary exploration.

Biography - Jorge Coppin-Massanet

Jorge Coppin-Massanet is a Ph.D. student in Geological Sciences and Astronomy at Cornell University, where he develops and deploys scientific instrumentation for harsh and remote environments. His work bridges glaciology, oceanography, and planetary science, with a focus on sensor integration, field-deployable platforms, and in-situ chemical measurements beneath ice. He has contributed to under-ice robotics efforts in polar regions and is actively involved in advancing instrumentation for subglacial and grounding zone research.

Keywords

Polar Oceanography, Cyrospere-ocean interface, Robotic exploration, Membrane-inlet mass spec