DRAFT abstract for AGU 2025

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Poster requested. Venky will present. If he cannot make it to the meeting, Rob will present.

Iron sources and biogeochemistry in the Amundsen Sea, West Antarctica: ice shelf processes and glacial meltwater

Melting of the West Antarctic Ice Sheet has been accelerating recently, likely since the 1940s. The Amundsen Sea (AS) embayment has received most of the increased meltwater flux, which has been thought to be a major source of bioavailable iron (Fe), a critical limiting micronutrient for phytoplankton that sequester atmospheric carbon dioxide (CO_2). The summertime polynya in the Amundsen Sea has the highest productivity in the Southern Ocean, supporting a rich ecosystem, yet phytoplankton growth appears to be modulated by the supply of Fe. High-resolution regional circulation models simulate Fe supply pathways and suggest as well that Fe can be exported off the shelf into the open waters of the Antarctic Circumpolar Current. Our recent measurements of Fe distributions and stable isotopic ratios in the AS suggest that glacial meltwater itself contributes only about 10% of the dissolved Fe in the meltwater-laden outflow from the Dotson Ice Shelf cavity, with 90% sourced from off-shelf deepwater and on-shelf benthic sources. Fe isotopes are near crustal (+0.12‰) in the warm waters flowing into the cavity, but negative (-0.21‰) in the outflow, and dissolved manganese is enriched, implying a source of reduced metals within the cavity. We propose that most of the meltwater-sourced dissolved Fe is derived from anoxic regions within the poorly-studied subglacial hydrologic system on the continent, discharging small meltwater volume fluxes but high dissolved Fe concentrations at the grounding line. Elsewhere on the continental shelf, particularly in deep troughs under the western polynya, high Fe concentrations with negative Fe isotopes are found in bottom waters overlying ephemeral phytodetrital fluff layers containing anoxic microzones. Because the Dotson inflow advects along shallower isopycnals, it is not affected by this reductive source. These findings suggest that predictive models of future biogeochemical changes under accelerating glacial melting need to recognize that the impact of basal ice shelf melt does not lie in its Fe content, but in the buoyancy it provides to bring Fe from deepwater, sedimentary, and subglacial sources to surface-dwelling primary producers. Proposed mechanisms linking glacial melting to the productivity of proximal Southern Ocean waters need to accommodate these new observations.