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Iron fertilization of the Southern Ocean: Synergy between sea ice, icebergs and ice shelves

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Glacial iron (Fe) sources associated with continental ice (ice shelves and icebergs) and sea ice have recently been suggested as important to Southern Ocean (SO) biogeochemistry, where Fe limits primary production. Icebergs and ice shelves act as fully external sources of Fe while sea ice, which has a great Fe storage capacity, efficiently conveys Fe from the coasts to offshore locations. Large Fe concentrations in sea ice are typically explained by a sedimentary origin, however recent observations suggest an additional contribution from continental ice to the sea ice Fe inventory. Here, to further explore this hypothesis, we analyze factorial simulations performed with an ocean sea-ice biogeochemical model (NEMO-LIM3-PISCES version 3.6) in which interactive Fe sources from continental and marine glacial sources are activated, separately and in concert. Our simulations indicate that (i) about 15% of the iron content of sea ice comes from icebergs and ice shelves, (ii) sea ice motion conveys this extra Fe to regions where it limits productivity, which results in (iii) a modest increase in primary and export production, reaching ~1% of the SO total, or ~10% of the contribution of the SO cryosphere.