

Human-made iron inputs to the Southern Ocean ten times higher than previously estimated

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Iron is released by burning biomass as well as fossil fuel combustion into the atmosphere and then transported to oceans. Credit: Reiko Matsushita

Although it is important to control emissions of CO₂ to mitigate global warming, atmospheric levels of the gas are also related to how quickly it is removed from the air by the means of land and ocean storage. The micronutrient iron is crucial for oceanic carbon storage because it can support the production of chemical energy in marine ecosystems by photosynthesis (known as iron fertilization). This process converts CO₂ into O₂ and organic compounds.

It is generally thought that iron inputs from the atmosphere to the ocean primarily come from [natural sources](#). However, a study reported in *npj Climate and Atmospheric Science*, led by Associate Professor Hitoshi Matsui and Mingxu Liu of the Graduate School of Environmental Studies, Nagoya University, in collaboration with Cornell and Colorado Universities, found that the contribution of human-made iron in the Southern Ocean is probably much larger than previously thought. It may, in fact, be up to ten times higher. This may have implications for future environmental management.

The human-made contribution to iron is mostly produced by [fossil fuel combustion](#), in which iron is released into the atmosphere and then transported to remote oceans. To better understand how human activities affect iron concentration levels, the scientists combined data obtained by aircraft measurement with an advanced global atmospheric model.

They found that human-made iron is a major contributor to the iron supply from the atmosphere to the ocean in the Southern Ocean region, with a percentage contribution as high as 60%. In contrast, previous studies estimated that only 10% of iron was from human-made iron and thus strongly underestimated the contribution of human-made sources.

The model also found that the supply of iron from the atmosphere to the ocean in this region is projected to decline significantly, which may have unexpected consequences for the future climate. With less iron in the

atmosphere, the amount of photosynthesis of phytoplankton may fall, causing a decrease in the oceanic uptake of atmospheric CO₂. Increased levels of CO₂ have been associated with global warming.

"Iron is a crucial micronutrient to sustain ocean phytoplankton growth and primary production in the Southern Ocean where it modulates atmospheric CO₂ levels," Dr. Matsui said. "A potential decline in iron availability, with the tightening controls on global fossil fuel emissions in the coming decades, may limit carbon storage in [marine ecosystems](#) and actually exacerbate [global warming](#)."

Meeting the target of achieving global carbon neutrality by cutting fossil fuel consumption in the coming decades would substantially reduce human-made emissions. Coupled with the warming of the atmosphere, it could have an impact on the climate. Future models must fully consider the role of human-made sources in [iron fertilization](#) in the Southern Ocean.

More information: Mingxu Liu et al, The underappreciated role of anthropogenic sources in atmospheric soluble iron flux to the Southern Ocean, *npj Climate and Atmospheric Science* (2022). [DOI: 10.1038/s41612-022-00250-w](#)

Provided by Nagoya University

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