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New study helps better understanding of the role sea-ice extent in global climate system

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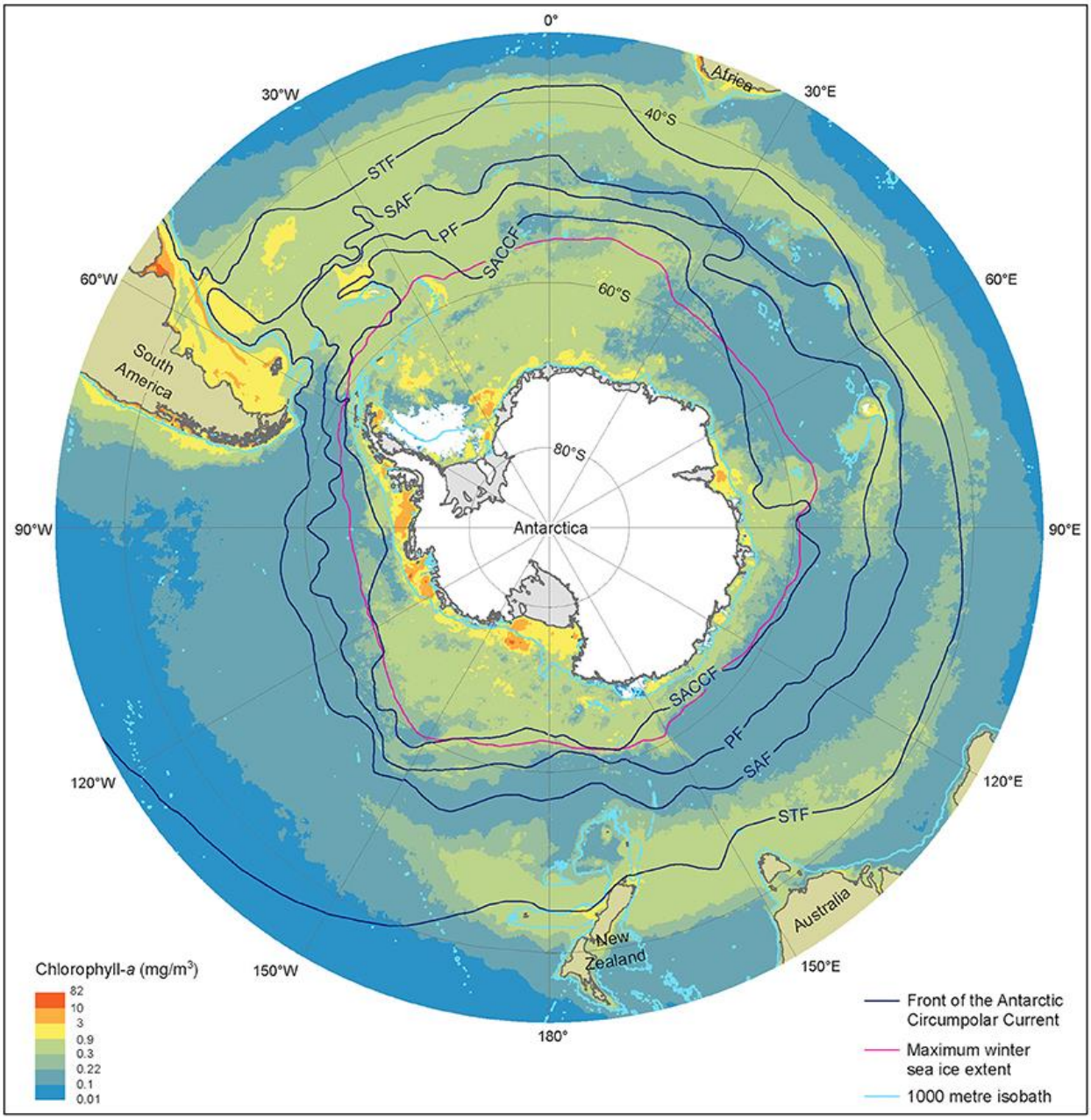
Mohammad Faiyaz Anwar

NCPOR climate scientist Dr. Rahul Mohan and his team has arrived at a new theory which could help a better understanding of the transient role of the sea ice in the global climate at different timescales over the glacial-interglacial cycles. The study was based on certain key observations of the history of the Antarctic sea ice extent over the last 156,000 years in the Indian region of the Southern Ocean (SO) that affected the paleoprductivity. Paleoproductivity is the study of productivity in the geological past studying the important constraints in past ocean circulation, nutrient distributions etc. which can help mitigation measures to be taken to improve the ocean ecosystem.

The researchers suggest that the decrease in paleoproductivity in the Permanently Open Ocean Zone (POOZ) of the South Western (SW) Indian sector was in response to a greater sea ice cover associated with hydrological changes leading to a reduced phytoplankton growing season, greater surface water stratification and lower nutrient input. Despite the challenge to study paleoceanographic chronologies in a robust way, the study found that the ancient sea ice records can provide crucial evidence to obtain a more exhaustive view of sea-ice dynamics. This study conducted by NCPOR in the Permanently Open Ocean Zone (POOZ) would give better insights in this rather under-studied zone.

Paleoproductivity is related to production of biogenic substances in the past, i.e. substances made by or different life forms encompassing a large constituents from the secretion and metabolism of plants or animals which includes biomolecules like macronutrients and micronutrients synthesized in the past where sunlight also plays a role. Changes in both quantities and systems of production could influence the global climate through the regulation of atmospheric carbon dioxide content.



Representative Image of Antarctica: Courtesy: https://www.frontiersin.org/

Sea ice sheets play a critical role in the climate system, regulating the flux of heat, gases, and momentum between the atmosphere and the ocean. Sea ice also plays a fundamental role in polar ecosystems. When the ice melts in the summer, it releases nutrients into the water, stimulating the growth of phytoplankton, the center of the marine food web. As the ice melts, it exposes ocean water to sunlight, spurring photosynthesis in phytoplankton. When ice freezes, the underlying water gets saltier and sinks, mixing the water column and bringing nutrients to the surface. The ice itself is a habitat for animals such as seals, Arctic foxes, polar bears, and penguins. The ice sheets control

the sea level, store the amount of ice whose melting would raise the sea level to 61 meters.

Antarctic sea ice further influences the climate system by regulating heat and carbon dioxide export from the atmosphere to the ocean. The Southern Ocean currently absorbs about one-sixth of annual human emissions of CO_2 and is responsible for a disproportionate amount of the global ocean uptake of heat. However, the stability of polar regions is critical to maintaining a planet with the conditions favourable to the existence of the flora and fauna.

The researchers suggest that oceanic and atmospheric temperature changes determined the pacing of sea-ice history over the last 156,000 years. Winds and ocean currents drove the amplitude of the changes between the basins. Whereas, there was higher amplitude change in sea ice in the Atlantic sector compared to the other sectors during the last climate cycle.

NCPOR study also revealed a higher amplitude change in sea ice in the Atlantic sector compared to the other sectors during the last climate cycle and Sea Surface Temperature (SST) of ~1–2 °C and Winter Sea-Ice Concentration and Duration (WSID) of ~2 months/year during each glacial period, with very little difference in between the mean values during each glacial period.

NCPOR team provides new quantitative records of Winter Sea-Ice Concentration (WSIC) and duration (WSID), sea-surface temperatures (SST), and productivity in Sediment Core (SK) 200/33 (55°S – 45°E) from the POOZ over the last 156,000 years. The combined new and published SST and WSI data suggest that hydrological features migrated northward by a few degrees of latitude during each glacial period placing the Southern Antarctic Circumpolar Current Front (SACCF) at ~55°S, the WSI edge close to 49°S and the mean Antarctic Polar Front (APF) at 46°S.

Led by Dr. Rahul Mohan, the research team comprised of Pooja Ghadi, Abhilash Nair, and Thamban Meloth of NCPOR, Ministry of Earth Sciences, Xavier Crosta of UMR-CNRS 5805 EPOC, Université de Bordeaux, Pessac, France and M.C. Manoj of Birbal Sahni Institute of Paleosciences, Lucknow, India. The research paper is published in the Journal of Marine Micropaleontology (Accepted from 25 June 2020).