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TOOLS OF THE TRADE

Exploring the Antarctic waters with seals in electric hats

The production of Antarctic Bottom Water (AABW) is a key part of the global ocean circulation that distributes heat and regulates the Earth's climate. The formation of AABW is dependent on enhanced sea-ice production, which influences water salinity and temperature, in specific coastal regions around Antarctica called 'polynyas'. Investigating the delicate balance between AABW formation, sea-ice production and the impact of Antarctic ice sheet melting in polynyas has traditionally been an extremely difficult endeavour, particularly during winter when ship logistics are affected by both sea-ice growth and poor weather conditions. To overcome the physical challenges of studying these under-ice and coastal processes, scientists have recruited special oceanographer helpers, elephant seals.

A Conductivity-Temperature-Depth Satellite Relay Data Logger (CTD-SRDL), or 'electric hat', is epoxy-glued to elephant seals immediately after their moult season. As the seals dive under the sea ice, the CTD records conductivity–temperature–depth profiles at 1 Hz, transmitting in near-real-time their deepest dive within a 6 h period. The location of the individual profiles is provided by the Advanced Research and Global Observation Satellite (ARGOS) system, and the salinity and temperature data are estimated to be accurate within ~0.003 and ~0.002 °C, respectively. Since the first elephant seals were equipped with electric hats in 2004, more than 100,000 vertical profiles have been collected from East Antarctica alone.

Instrumented seals are an important tool in determining AABW production shutdown and its climatic impacts. For example, the elephant seals have been paramount to discovering two new AABW sources in Cape Darnley and Vincennes Bay. Indeed, seal CTD data show that offshore warm water intrusions (Circumpolar Deep Water) over the continental shelf threaten AABW production by delaying sea-ice production in Vincennes Bay. Moreover, multiple freshwater sources have been identified, including faster melting local glaciers and freshwater input from the upstream Totten Glacier. Beyond AABW investigations, the electric hat technology can be used with different seal species and in both poles, from Weddell seals for shallow data near the Antarctic sea-ice, to bearded seals for open ocean Arctic surveys. Instrumented marine mammals are providing essential oceanographic observations that allow an improved understanding of global climate processes.

Credit: Clive R. McMahon, IMOS Animal Satellite Tagging, Sydney Institute of Marine Science

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