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Evolution of dissolved inorganic radiocarbon in the eastern Atlantic sector of the Southern Ocean

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The Southern Ocean plays an important role in the Earth's climate system with its large productivity belt and vigorous circum Antarctic circulation patterns. However, our knowledge of temporal evolution of the Southern Ocean circulation including its carbon redistribution is poorly constrained by in situ observations in this vast remote region. Here, we used radiocarbon measurements of Dissolved oceanic Inorganic Carbon (DIC) in order to provide powerful means to describe and quantify the movement of the water masses as well as the uptake of anthropogenic CO_2. We investigated the spatio-temporal variability of radiocarbon in the Southern Ocean during the last 40 years.

Recent radiocarbon measurements were performed on DIC of five depth profiles off the Southwestern of Africa coast between 33.58˚S 17.14˚E towards 57.33˚S 00.02˚W obtained during Bonus-Goodhope cruise in 2008. We compare these results with those obtained from earlier cruises, GEOSECS and WOCE-France CIVA1. Within surface waters, observed ^{14}C gradients between north and south are consistent with previous observations. However, the absolute values of $\Delta^{14}C$ are slightly depleted compared to previous studies most likely reflecting the decrease of bomb ^{14}C in the atmosphere, the northward displacement of surface waters and replacement by old deep waters upwelled at the Antarctic Divergence. Our observation of arrival of deep waters is consistent with the observed oversaturation in CO_2 of subsurface waters compared to the atmosphere and the depleted $\delta^{13}C$ signature of DIC. In contrast, within the deep ocean, we observe a basin scale dramatic fall of $\Delta^{14}C$ values since the early 1970s, which may reflect strong invasion of ^{14}C depleted Pacific Deep Waters into the Circumpolar Deep Water (CDW). The origin of this remarkable replacement of water masses may be attributed to atmospheric climate dynamics over the last 40 years or may reflect other ocean interior processes.