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Anthropogenic and natural changes in mode waters of the South West Indian Ocean

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The ocean carbon cycle is closely linked to climate. Ocean's uptake of anthropogenic CO2 regulates atmospheric CO2 and thus climate. In turn, the rate of oceanic uptake of CO2 is affected by climate-induced changes in biogeochemical and physical ocean processes. The Southern Ocean is of particular interest here, both because it is where a large portion of anthropogenic CO2 enters the ocean and because it will be most sensitive to future climate change. Subantarctic Mode Water (SAMW) provides a privileged pathway for the transport of heat, salt and anthropogenic CO2 into the ocean interior. We investigate the carbon cycle decadal variability within SAMW in response to environmental changes based on historical and recent datasets from the INDIGO1 (1985) and OISO1-6 (1998-2001) oceanographic campaigns conducted in the South West Indian Ocean, an important zone for mode water formation. The observed change in dissolved inorganic carbon (DIC) over the 15-years period was about 7 μmol/kg in SAMW, which is less than the anthropogenic carbon increase alone (about 14 μmol/kg). This difference being significant, it should be explained by natural or climate-induced variability. A reduction of the biological activity would be the best candidate, as suggested by changes in biogeochemical properties. Our observations are also compared with simulations from a global ocean-carbon model (OPA-PISCES forced with 1948-2003 NCEP reanalyzes). The model simulates low natural DIC variability in SAMW over the last three decades which does not counterbalance the invasion of anthropogenic CO2 (about 10 μmol/kg in the model over the 15-years period). This suggests that surface and interior biological processes which could be responsible for a decrease in DIC may not be adequately represented in the model.