EGU22-6683, updated on 18 Aug 2022
https://doi.org/10.5194/egusphere-egu22-6683
EGU General Assembly 2022

Deep ocean steady-state transport and decadal variability inferred from 1980-2020 CFCs and SF6 observations

Laura Cimoli[1], Sarah Purkey[1], Jake Gebbie[2], and William Smethie[3]
[1]Scripps Institution of Oceanography, UC San Diego, San Diego, California, U.S.
[2]Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, U.S.
[3]Lamont-Doherty Earth Observatory, Columbia University, Palisades, New York, U.S.

What are the time-mean pathways and the decadal variability of the deep ocean circulation? To answer this question, we conduct a global tracer analysis with a newly developed approach, the "Time-Correction" method. This novel method leverages the information of four decades of anthropogenic transient tracer observations (1980-2020) to reconstruct their propagation in the global ocean. The Time-Correction method solves a modified least-squares problem that accounts for the uncertainty in the observations, propagates this uncertainty in our solution, and uses prior information about the system in the final solution. The method takes into account the statistical information used in the Maximum Entropy Method but is designed to be more computationally efficient.

We apply the Time-Correction method to chlorofluorocarbons (CFC-11 and CFC-12) and sulfur hexafluoride (SF6) observations to reconstruct the time evolution of their concentrations in the deep ocean. Their propagation is reconstructed at annual resolution and permits CFC snapshots from multiple decades to be put into a common context. The reconstructed tracer concentrations capture the pathways of AABW and NADW, highlighting (i) the southward flow of the different NADW components (upper, middle and lower NADW) and their equatorial recirculation in the Atlantic Ocean, and (ii) the spreading of CFC-rich AABW in the North Pacific Ocean through the Samoan Passage, its bottom-driven northward circulation in the East Indian Ocean, and its northward flow in the West Atlantic Ocean and recirculation around the Equator. These reconstructed tracer concentrations reflect the tracer distribution for time-mean ocean transport and can be used to investigate the non-steady ocean circulation decadal variability. In locations with multiple occupations of tracer data where no steady-state solution can be found, we conclude that the circulation has changed and show regional patterns of increased and decreased ventilation over the last four decades. Additional research is underway to investigate NADW formation rate variability over the 1980-2020 period at decadal and inter-annual resolution depending on the number of available occupations.