Interannual variability of Chlorofluorocarbon-11 absorption by the ocean: An offline model study.

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The global ocean Chlorofluorocarbon (CFC-11) was simulated in an offline model driven by re-analysis ocean currents in order to identify the mechanisms of interannual to interdecadal variability of air-sea CFC fluxes. The model was forced with the observed anthropogenic perturbations of atmospheric CFC-11 from the post industrial period (1938) following the OCMIP-II flux protocols along with the observed winds from 1960 to 1999 in the formulation of surface gas exchanges. The model ocean CFC-11 inventories, at the end of 1990s, accounted approximately 1% of the total atmospheric CFC-11, which is consistent with the corresponding observations. The mid-to-high latitude oceans were venue for strong (weak) oceanic sinks (sources) of CFC-11 during the winter (summer) months. The Southern Ocean (south of 40^0S) and the North Atlantic (north of 35^0N) provided two largest sinks of CFC-11, through which 31.4% and 14.6% of the global ocean CFC-11 entered, respectively. The eastern tropical Pacific Ocean exhibited large interannual variability of CFC-11 flux with a strong (weak) sink during La Nina (El Nino) years and represented 36% of the global CFC-11 flux variability. The North Atlantic and Southern Ocean were found as regions of large sink efficiency:- a capacity to sink more CFC than outsource, although it reduced by 80% and 70%, respectively, in the last 40 years compared to 1960. The sink to source ratio of global ocean CFC-11 fluxes were reduced from 90% to 50% in the last 40 years. This indicates a saturation of CFC in the above-thermocline subsurface that makes the upper ocean less efficient in absorbing CFC in recent decades. A positive trend in CFC sink is now limited to the Southern Ocean, central tropical Pacific and western boundary current regions which possess active upwelling of old water with long time since last atmospheric contact. However, a globally averaged trend was a reduced CFC-11 sink, by emitting 30% of the total ocean CFC-11 that was absorbed during last 40 years.

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