Simulations of chlorofluorocarbon uptake in a model of the North Pacific

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Abstract

A regional ocean general circulation model with three different parameterizations of subgrid mesoscale mixing of tracers is used to study the general circulation and the distributions of water masses and chlorofluorocarbons (CFCs) in the North Pacific under the forcing conditions of both annual mean climatology and perpetual wintertime (March) climatology. With horizontal mixing scheme (HOR), the model cannot well simulate formation of the North Pacific Intermediate Water (NPIW). The NPIW is well simulated in the model with isopycnal mixing scheme. Changes in the surface forcing from the annual mean climatology to the perpetual wintertime climatology generally lead to the improvement of water mass distributions. This study takes CFC-11 as a representative of passive tracers to discuss the influences of three different parameterizations of mixing of tracers and of the formation of NPIW on its distribution in the North Pacific. The simulated results, including the vertical structure and column inventories of CFC-11, from the perpetual wintertime forcing are better than those from the annual mean forcing, compared with observations. With HOR, the model underestimates the oceanic uptake of CFCs in the North Pacific. Under the perpetual wintertime forcing, the isopycnal mixing scheme with and without eddy-induced transport velocity gives reasonable agreement with observed results. However, a large difference still exists in some areas, particularly in the western North Pacific, which is probably an important sink of atmospheric CFCs.