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## Time scales for correcting the interior oceans to the atmosphere

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To fully describe interior ocean variability, a description is needed of variability that occurred in the oceans often considerable space and time scales away from the interior location of interest. CFC ages are an important tool for understanding ocean variability and the time scales for spreading of climate anomalies. Here we present ages for waters filling the global ocean, and we include a rigorous error analysis. Comparison of CFC ages between WOCE era (mid-1990) observations and 1/10 degree POP show excellent agreement giving broad validation of the model. The age maps provide information on the time scales for connections of different interior regions of the ocean to the surface of the ocean and thus the atmosphere. The time scales may vary over hundreds of years. Utility of the CFC age maps is limited to interior regions of the ocean that span inter annual to multi-decadal time scales. While obvious areas that fit these time scales include the ocean thermoclines, this does not include parts of the North Indian Ocean thermocline where the time scales are longer. In the opposite vein, there are vast areas of the interior oceans where intermediate, deep, and bottom water connect to the surface ocean formation regions on time scales of less than several decades. In addition, the age maps highlight areas of the ocean that need more frequent monitoring for changes in climatically important properties such as heat, salt, and carbon. Furthermore, they highlight areas of the deep ocean that are important for decadal prediction. Estimates of the uncertainty in the age maps associated with under-sampling of mesoscale features by the relatively coarse observational array are derived from the standard deviations of simulated CFC ages across five ensemble members. The largest mesoscale variability in age occurs in regions of large mean gradients, fronts and high eddy kinetic energy. On upper surfaces these large errors are mostly found near western boundary currents, along the boundary between the ventilated and unventilated portions of the subtropical gyre, and eastern boundary upwelling regions; on deeper surfaces these are mostly in the Antarctic Circumpolar Current.