



Age Spectra in Upper North Atlantic Deep Water, 10°N - 30°S

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Observations of the transient tracers CFC-11, CFC-12, CCl₄, and tritium have been used to determine age spectra in Upper North Atlantic Deep Water (UNADW) along the western continental margin between 10°N and 30°S. This implied deducing the free parameters (mean age or transit time τ , age dispersion σ , and dilution factor by tracer-free water f) of a transit time distribution (TTD) of the common functional form by minimizing the differences between TTD-based tracer concentrations, and observed ones along about 20 hydrographic sections. Novel, observation-based NADW tracer concentration histories in the source region were employed that account for mixing in the source area between contributions of successive years and for enhanced halocarbon input during convective activity in winter; an added condition was minimized biases between observed and TTD-based tracer concentrations in downstream NADW. The more common boundary condition based on time-invariant apparent saturations gave inconsistent results. The TTD parameter fits covered the entire region and used all tracer data jointly. Prescribing the parameters to increase linearly along-stream and the Péclet number ($Pe = 2 \tau^2 \sigma^{-2}$) to be constant, their values at the equator were $\tau = 54$ years, $\sigma = 33$ years, and $f = 1.4$, with uncertainties of about $\pm 20\%$. The deduced age spectra correspond to large-scale diffusivities on the order of $10^4 \text{ m}^2 \text{ s}^{-1}$, and to mean UNADW flow velocities of less than 1 cm s^{-1} . The RMS scatter between observed and TTD-based concentrations is far outside the observational uncertainties. This finding implies significant scatter in the tracer fields, and it cautions against deducing values of individual TTD parameters from limited data sets. On the other hand, the age spectra as such, which depend on the parameter values combined, appear to be comparatively

robust. The relative southward increase of the TTD-based ages exceeds that of CFC-11 to CFC-12 ratio ages about threefold, indicating that the age dispersion causes the ratio ages to be severely biased.