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Sensitivity of simulated deep ocean natural radiocarbon to gas exchange velocity and historical atmospheric Δ^{14}C variations

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Simulated deep ocean natural radiocarbon is frequently used to assess model performance of deep ocean ventilation in Ocean General Circulation Models (OGCMs). It has been shown to be sensitive to a variety of model parameters, such as the mixing parameterization, convection scheme and vertical resolution. Here we use three different ocean models (MIT2.8, ECCO, UVic) to evaluate the sensitivity of simulated deep ocean natural radiocarbon to two other factors, while keeping the model physics constant: (1) the gas exchange velocity and (2) historic variations in atmospheric Δ^{14}C boundary conditions. We find that simulated natural Δ^{14}C decreases by 14-20 ‰ throughout the deep ocean and consistently in all three models, if the gas exchange velocity is lowered by 30 % with respect to the OCMIP-2 protocol, to become more consistent with newer estimates of the oceans uptake of bomb derived ^{14}C. Simulated deep ocean natural Δ^{14}C furthermore decreases by 3-9 ‰ throughout the deep Pacific, Indian and Southern Oceans and consistently in all three models, if the models are forced with the observed atmospheric Δ^{14}C history, instead of an often made pragmatic assumption of a constant atmospheric Δ^{14}C value of zero. Applying both improvements (gas exchange reduction, as well as atmospheric Δ^{14}C history implementation) concomitantly and accounting for the present uncertainty in gas exchange velocity estimates (between 10 and 40 % reduction with respect to the OCMIP-2 protocol) simulated deep ocean Δ^{14}C decreases by 10-30 ‰ throughout the deep Pacific, Indian and Southern Ocean. This translates to a ^{14}C-age increase of 100-300 years and indicates, that models, which in former assessments (based on the OCMIP-2 protocol) had been identified to have an accurate deep ocean ventilation, should now be regarded as rather having a bit too sluggish a ventilation. Models, which on the other hand had been identified to have a bit too fast a deep ocean ventilation, should now be regarded as rather having a more accurate ventilation.