What can age biases tell us on the long-term transport simulated by OGCMs?

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Radiocarbon and other tracers (radioactive or not) are commonly used to evaluate OGCMs' ability to reproduce long-term transport in the ocean, which is due to the combined effects of advection and diffusion. Diagnosing the relative predominance of advection or diffusion in specific oceanic areas and in models is of crucial importance.

Whenever diffusion is present in a flow the ages obtained from radioactive tracers underestimate the true ventilation age, i.e. the age of the surface water. This age bias may give indication as to the relative predominance of advection or diffusion in the circulation.

To set the ground of this approach we analyze the analytical solutions for an idealised model, in which the water circulates along a loop. All ages are reset to zero at a point, which represents the ocean surface. For this simple configuration it is easy to determine how the relative importance of advective and diffusive transports affects the age biases.

We then compute the surface water ages and radioages with two different 3D OGCMs. We performed several experiments in which the velocity or the diffusivity fields or both are modified.

For a given change in the velocity and diffusivity the evolution of radioactive tracers distribution predicted by the 1D model agrees rather well with that obtained in the 3D simulations.

The conclusions from the 1D model may then be used to interpret the age biases from the 3D simulations. It is seen that diffusion, especially numerical diffusion, is the dominant transport process in the whole ocean interior in one of the OGCMs. In the

other one, diffusion is dominant in several ocean basins, while advection is the most important transport process in the Pacific.

While more analytical work would be needed our conservative conclusion is that analysing tracer age biases helps understanding the relative importance of advection and diffusion. This is why we suggest that this technique should be considered as a diagnostic tool for model intercomparison projects.