Tracer applications of anthropogenic radionuclides in the global ocean

JOHN N. SMITH[1*]

[1]Bedford Institute of Oceanography, Fisheries and Oceans Canada, Dartmouth, NS, Canada. (*correspondence: john.smith@dfo-mpo.gc.ca)

Since their introduction into the environment from atmospheric nuclear weapons tests in the 1950s, artificial radionuclides have proven to be useful global tracers of water circulation and ventilation of the deep ocean. Skillful applications of radionuclide tracers are favored by strong, rapidly time varying sources and accurate knowledge of their input functions, conditions that are satisfied by discharges from the Sellafield, UK and La Hague, France nuclear fuel reprocessing plants and the 2011 Fukushima, Japan nuclear reactor accident. Discharges of ^{129}I and ^{137}Cs from European reprocessing plants are transported through the Nordic Seas and Arctic Ocean and are then injected into Denmark Strait Overflow Water south of Greenland which flows equatorward and supplies the deep waters of the North Atlantic. During the past 35 y, time series measurements along this northern arm of the global overturning circulation have revealed that radioactive tracers from the North Sea take about 10 years to reach the North Pole, an additional 5 years to return to the Nordic and Labrador Seas and a further 8 years to reach deep ocean locations off Bermuda.

The Fukushima nuclear reactor accident resulted in the discharge of large quantities of radioactivity into the western North Pacific that was transported northeastward towards North America by the Kuroshio Current. A Canadian monitoring program was established for the detection of ^{134}Cs and ^{137}Cs on an oceanographic section (Line P) extending 1500 km westward from Victoria, British Columbia. The initial arrival of the Fukushima signal on Line P occurred in June, 2012 and by June, 2013 the Fukushima signal had spread along the entire length of Line P onto the Canadian continental shelf. By August, 2014, the Fukushima-derived ^{137}Cs signal on Line P of 3 Bq/m^3 was twice as great as the prevailing fallout signal. These ^{137}Cs concentrations are far too low to be a threat to the environment or human health, but they are providing well constrained estimates of water circulation time scales and mixing rates in the eastern North Pacific.