REGIONAL ADVANCED SCHOOL ON PHYSICAL, ANALYTICAL AND MATHEMATICAL TOOLS FOR THE STUDY OF MARINE PROCESSES OF COASTAL AREAS

Lecture 6

Transient tracers for oceanic processes: Potentiality & examples, in a climatic context.

Roberta Delfanti
ENEA, Marine Environment Research Centre,
La Spezia, Italy

In recent years, several chemical (radioactive) compounds have been introduced into the environment as a result of anthropogenic activities and, through different pathways, they have reached the oceans. Once there, they are mixed, advected or scavenged through oceanic processes. If their input function is known, we can use their distribution in the oceans to "trace" a variety of processes. It is like adding a dye to the ocean surface and see how it is re-distributed in the different compartments. This is the basis of what we call tracer oceanography.

In this lecture the "transient tracer concept" is first illustrated: what they are, what information we can derive from their distribution and what kind of processes they can trace. Their input functions will be shown and discussed. The criteria for the selection of the best tracer for a given process will be illustrated. We will then focus on the typical tracers used in physical oceanography and discuss some examples of their use in the Atlantic ocean, mainly in connection with the definition of the characteristics of the thermohaline circulation.

The tracers most widely used in physical oceanography are Chlorofluorocarbons (CFCs) and a series of radioactive elements (14C, 3H, 137Cs, 90Sr, 125Sb, 129I, 99Tc) deriving from atmospheric weapon testing or from the discharges of the nuclear industry. All of them are "conservative", soluble in seawater, and constitute a powerful tool for the study of circulation and ventilation of the oceanic waters. Their distribution in the oceans has been determined through several extensive oceanographic campaign, carried out in different periods, and at some fixed stations where time series have been collected.

Examples will be shown on the use of 3H and CFCs to trace the spreading of dense waters formed in the North Atlantic and to define water mass "ages". The use of 137Cs and 99Tc will be discussed to estimate the transit time of water masses in the N-Atlantic and Arctic oceans, and to validate circulation models. The last part of the lecture will be devoted to ^{129}I, a powerful tracer, whose use has become recently possible thanks to the increasing availability of Accelerator Mass Spectrometry systems, allowing its precise determination on small water samples.

LAYOUT OF LECTURE 6

1. The transient tracer concept:

   What they are
   Which processes they can trace

2. Criteria for selection:

   Input function
   Biogeochemical characteristics
   Concentration/dynamic range
   Time scale
   Analytical techniques

3. Examples:

   3H, CFCs – Characteristics of Thermohaline circulation
   137Cs, 99Tc – transit time of water masses
   129I circulation in the Arctic ocean and NAtlantic

4. Conclusions