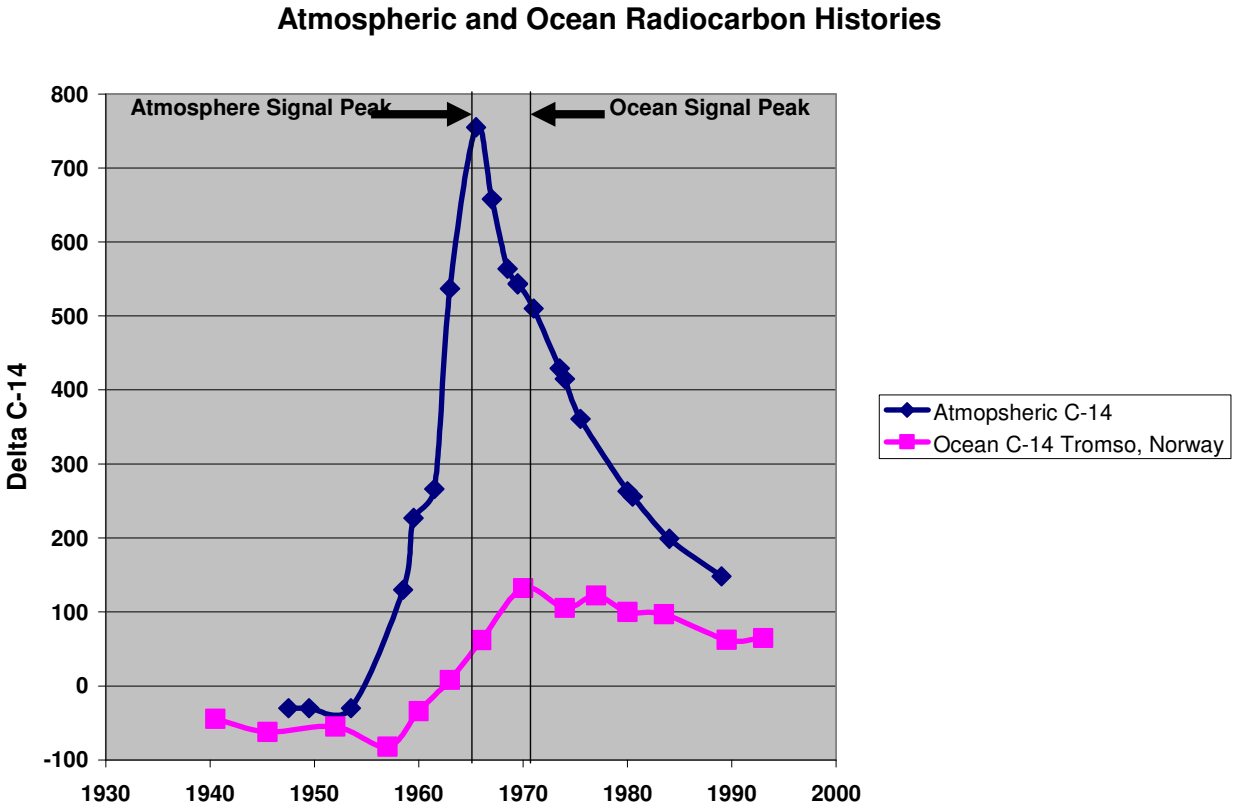
Radiocarbon Time Histories for the North Atlantic

Ocean radiocarbon, the rare carbon isotope ^{14}C tied up in the vast reservoir of dissolved inorganic carbon (DIC) in the ocean, is one of the most important oceanographic tools for studying ocean circulation, greenhouse gas carbon dioxide (CO2) gas exchange between the atmosphere and ocean, the aging of long-lived (and carbonate bearing) sea organisms, and, of course, the dating of (carbon bearing) fossils over the past twenty-thousand years or so. Radiocarbon is continuously produced in earth's upper atmosphere, from the cosmic ray bombardment of nitrogen atoms, which turns some ^{14}N into ^{14}C. At the same time ^{14}C is continuously lost through radioactive decay, so that an equilibrium is reached and a relatively constant amount of ^{14}C remains in the atmosphere (in the form of gaseous CO_2), oceans (in the various forms of DIC) and biosphere (in the various forms of organic C and $CaCO_2$). An important wrinkle (and scientific opportunity) in this physical process occurred with the onset of nuclear weapons testing in the atmosphere after 1945, which by 1963 (when the atmospheric nuclear weapons-testing ban went into effect) nearly doubled the amount of ^{14}C in the atmosphere. This extra ^{14}C is referred to as bomb-radiocarbon.

Radiocarbon time histories are simply the record, or time-series, of ^{14}C in the various carbon reservoirs – particularly in the atmosphere and the oceans. By using paleo-chronological methods on sediment cores, grow rings in trees, corals, fish otoliths and mollusk shells, detailed time series of radiocarbon can be reconstructed. As noted above, such records have many potential scientific uses. My own work (Chris Weidman) has involved aging long-lived mollusk species such as the Atlantic Ocean Quahog and the Pacific Geoduck. Another interest is using the radiocarbon variations of seawater, as recorded in bivalve shells, as an indication of variations in ocean circulation. Below are shown two example of radiocarbon histories. The first is from the atmosphere and shows the bomb-radiocarbon signal. The second is an ocean radiocarbon time history that also shows the bomb signal – but note its much more delayed peak –owing to the slow exchange of CO2 between the atmosphere and ocean as well as the dilution of this signal by vertical mixing in the ocean.


Atmospheric and Ocean Radiocarbon Histories
Atmosphere Signal Peak
Ocean Signal Peak
Delta C-14
800
700
600
500
400
300
200
100
0
-100
1930
1940
1950
1960
1970
1980
1990
2000
Atmopsheric C-14
Ocean C-14 Tromso, Norway