



Ocean Circulation and Climate: Chapter 10. Deepwater Formation (International Geophysics)

John L. Bullister, Monika Rhein, Cecilie Mauritzen

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Formation of the deepest waters of the World Ocean occurs in limited regions of the global ocean, primarily in the northern North Atlantic where North Atlantic Deep Water (NADW) is formed, and at a number of sites around the continental margins of Antarctica where Antarctic Bottom Waters (AABW) are formed. The deepwater formation processes play a significant role in determining the large-scale physical and biogeochemical properties of the deep ocean. These limited regions provide a conduit from the surface into the vast volumes of water in the deep ocean. We report in this chapter on observed physical and biochemical changes in the deep ocean and discuss these in the context of deepwater formation. Intensive observation programs in the North Atlantic during the past decades have demonstrated that there have been significant changes in the volumes and properties of Upper and Lower NADW as well as AABW. Studies have found systematic warming of AABW during the past two decades along a number of its major flow pathways, as well as evidence for a reduction in overall volume of AABW in the global deep ocean. Lower NADW, on the other hand, has been undergoing systematic cooling for the past four decades, whereas Upper NADW (primarily Labrador Sea Water) has been exposed to large decadal variability, both in properties and formation rates. In total, the deepwaters of the World Ocean (beneath ca. 2000–3000m) have warmed during the past two decades. Changes in the deep ocean can have enormous influence on Earth's climate. Warming of the deep ocean makes a significant contribution to global sea level rise. The capacity of the deep ocean to take up and store anthropogenic CO₂ has and will have a major impact on the CO₂ content of the atmosphere now and far into the future. Paleoceanographic studies have provided evidence that despite the century-long timescales associated with renewal of deepwater, rapid, major changes in deepwater formation and deep ocean circulation have occurred in the past, resulting in rapid changes in Earth's climate. Continued monitoring and analysis are necessary to follow and understand the changes in the deep ocean—this is a very important component of Earth's climate.

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