

The Water Mass Transformation Framework for Ocean Physics and Biogeochemistry

In 1750 Captain Henry Ellis lowered a bucket into the subtropical Atlantic and discovered that seawater at depth is relatively cold. The scientist Rumford hypothesized that this water is cold because it moves equatorward at depth from its colder high latitude origin. Rumford was one of the first oceanographers to use a "tracer", in this case temperature, to define a "water mass" and trace it back to its origin and as a result, estimate a circulation (without a single measurement of the circulation itself). Since then, many oceanographers have studied how water masses are modified (transformed) by as mixing, air-sea interaction and biogeochemical activity. With this understanding, one can derive circulation, without a single measurement of the circulation itself, like Rumford did. This water mass transformation analyses have resulted in many important discoveries, including the concept of a global interconnected ocean circulation, also known as the thermohaline circulation or the global conveyor belt circulation.

This study provides both a historical summary and arguments to promote the use of the water mass transformation framework to study the ocean's uptake, transport and storage of important "tracers" such as heat, carbon and oxygen. When using the water mass transformation framework that way, it may provide new understanding far beyond its original use, which was already impressive.