Abstract

The now ten year long record of satellite sea surface height measurements (altimetry) has provided revealing information on how moon influences our planet. The ocean tides appear to have an earlier unnoticed impact on Earth's climate. Before open ocean altimetry was acquired, sea surface records were mainly from coastal areas. It was believed that the major part of the energy loss from the tide (tidal dissipation) took place in shallow areas due to high tidal velocities and bottom friction. However, ocean tidal energetics is now undergoing major revisions: tidal modelling using altimetry shows that a large part of the tidal dissipation actually occurs in the open ocean.

Internal waves of tidal frequencies (internal tides) are generated when tidal currents interact with bottom structures. This causes a drag on the tide (baroclinic wave drag). Tidal dissipation estimates via alitmetry does not reveal the mechanisms behind the dissipation, but have provided completely new possibilities for verifying models for baroclinic wave drag. If the energy lost in the open ocean is due to internal wave generation, it is a potential energy source for the vertical mixing of the deep ocean, thereby maintaining the deep reaching thermohaline global circulation. The latter is an important component in Earth's climate machinery.

In this thesis, estimates of the energy flux from the tide via baroclinic wave drag in the world ocean are presented. Bottom topography is described by depth on a grid, and the internal wave response is calculated in terms of normal modes. The model (hereafter step model) is applied to the complete deep ocean floor using tidal velocities from a state-of-the-art tidal solution derived via satellite altimetry. The calculated global energy flux to internal tides and its spatial distribution agrees well with estimates of open ocean tidal dissipation from altimetry. The results indicate that internal tide generation indeed is an important power source for vertical mixing in the deep ocean. It turns out that only a few percentages of the bottom stands for the major part of the global flux, something that should be taken into account in ocean circulation models.

In addition to the step model, a couple of other internal wave generation models exist. The models differ mainly in the way in which parts of the bottom are assumed to work in generating the internal wave. The physical assumptions behind the different models and how they respond to forcing are investigated. It is suggested that baroclinic wave drag is a local process where different parts of the bottom works as independent internal wave generators.

The work driving the thermohaline circulation of the ocean can be described as expansion work. It is shown how pV-diagrams can be used to determine ocean circulation rates or, alternatively, how much power that is needed for a certain circulation rate. The analogy with the conventional concept of vertical eddy diffusivity is presented. Numerical examples are given by applying different types of models to simplified circulation cells of the North Atlantic. In addition to tides and winds, geothermal heating seems to be a potential power source for the thermohaline circulation.