Abstract

Comprehending the governing physical processes in the ocean is imperative in order to understand the ocean's role in the variable climate system. This thesis focuses on some major components of the global meridional overturning circulation and on the wind driven water exchange of the Baltic Sea.

The influence of large-scale topography on the flow in a stratified ocean is studied using an analytical model including continental slopes and a mid-oceanic ridge. The conservation of potential vorticity controls the pathways of the fluid but areas with jet currents and strong dissipation are identified. Large meridional excursions of the flow when crossing topography contrasts to the flat-bottom case and illustrates the leading role of topography for abyssal water pathways.

The Indonesian Throughflow (ITF) is an important link in the global "conveyor-belt" circulation. Hydrographic data are used to demonstrate that low-salinity water from the North Pacific fills the upper 1200 meters of the Indonesian Seas. It is argued that the Indonesian Seas should be viewed as a part of the North Pacific that ends in a downstream buoyant pool in the eastern Indian Ocean. A model of the ITF verifies that the steric height of the pool, set by the estuarine character of the North Pacific, relative to the Indian Ocean controls the magnitude of ITF.

Effects of a varying North Atlantic wind climate on the water exchange of the Baltic Sea are examined. The North Atlantic Oscillation (NAO) is the dominating wintertime mode of atmospheric circulation in the North Atlantic. Its impact on the winter mean Baltic Sea level is significant due to the effect of NAO on the North Sea zonal winds. It is shown that the low-frequency part of the sea level variability in Kattegat and the Baltic Sea is driven by the zonal winds over the North Sea. A model is used to couple atmospheric variability over the North Sea to volume flows into the Baltic Sea. A direct relationship between events of large low frequency variations in the zonal wind over the North Sea and large flows of sea water into the Baltic Sea is evident. These events are crucial to prevent oxygen depletion in the deep water of the Baltic. A strong coupling between the NAO and these events is, somewhat surprisingly, not evident. However, there are indications that conditions are more favorable for inflows with a positive phase of NAO, i.e. with a more maritime climate in the Baltic region.

Keywords: Ocean circulation, thermohaline circulation, climate variability, Indonesian Throughflow, NAO, Baltic Sea, sea level, major inflows