Master Thesis Projects

I study ocean mixing processes, ocean dynamics and the enclosure of the North Sea (NEED). On all these subjects I have Master Thesis projects available. Below is a description of various projects for these different subjects.

Subject: Ocean Mixing and tracer transport

Ocean mixing is intermittent and spatially variable, and on top of that it is very difficult to measure. Let alone on the scales with which mixing changes in time and space. Hence, we need to develop alternative ways to estimate mixing from variables that we can measure globally, such as temperature and salinity or sea surface height. The resulting mixing estimates are combined with theoretical parameterizations to be implemented in numerical models. Having the mixing estimates, we can start to quantify ocean transport of tracers such as oxygen, nitrates, and CO_2, and analyze the influence of mixing on circulation and climate.

Subject: Northern European Enclosure Dam

To protect 15 northern European countries against sea level rise, a highly ambitious plan was put forward to build massive sea dams across the North Sea and English Channel, which will cut off the North Sea from the rest of the Atlantic Ocean. Because of the scale of this idea, it has captured the imagination of many, and has attracted quite some media attention. Although we desperately want this plan never to become a reality, future projections of high-end sea level rise and related uncertainty may warrant a solution of this proportion. Considering the high risks of such scenarios and the long lead time for adaptative solutions to be put in place, it is essential to plan for solutions in case the high-end scenario's do become a reality.

Some of the projects are related to simulate sea surface high, ocean circulation or changes in atmospheric weather patterns, because of constructing NEED. Other projects are more based on design, innovation and impacts on shipping industry, ecology, and economy. While other projects are more related to comparison against alternative protection measures against sea level rise.

Subject: Marsdiep ferry-based velocity record

The NIOZ has a 20-year record of velocity measurements obtained with an ADCP under the TESO ferry that operates between Texel and Den Helder. This part is called the "Marsdiep" and is a tidal inlet characterized by strong tidal velocities combined with freshwater discharge from Lake Ijssel. As a result, this inlet has highly complicated dynamics that include many interesting features left for us to understand. Using (part of) this data, we can understand all kinds of mixing processes and estuarine dynamics. Although these observations are very local, they often provide insights that apply to phenomena found around the globe, and altogether may impact ocean circulation and climate.

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Detection of topographic waves for purposes of suppressing ocean mixing

Oceanic topographic Rossby waves, or "topographic waves" remain a somewhat ill-described phenomena but have been observed on multiple occasions. We found their characteristics can tell us something about suppression of ocean mixing. Therefore, in this project, we will approach scientist around the world that are willing to share data and help to detect TW in their observations. We can analyze the characteristics of the TW and understand their mixing suppression effect, such that this can be generalized into mixing theory.

Calculating oxygen transports in and out of an oxygen minimum zone, using observations.

Using estimates of mesoscale and small-scale mixing, combined with eddy parameterizations and mean-flow estimates, we will attempt to understand the transport into and out of oxygen minimum zones in the world ocean. Such OMZ's influence marine life and the fishing industry and need to be understood in general, but also in light of climate change. Identifying what triggers their volume variability and oxygen concentrations is key and we will have a go in doing so.

Predicting subsurface velocity from satellite measurements

Velocities are hard to measure on global scales. Hence, to have global estimates of the 3D velocity field, we need to be able to estimate velocities from variables that we can measure globally. Such variables are temperature, salinity, and satellite-based sea surface height. Using oceanographic theories about the vertical structure of the flow, we can use this data to predict the vertical shape of the ocean currents, ad subsequently compare these to actual velocity measurements. These observations are based on ship borne ADCPs or moored buoys and will help validate our methods.

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Half NEED

Professors at TU Delft have suggested to build only half of NEED to reduce tidal amplitude and storm surges, such that dikes can still have the same protection level with some extra sea level rise. In a way, this may buy us time to mitigate climate change, while also reducing impact of the construction as originally proposed. In this project you will run numerical simulation to calculate maximum sea level heights in the North Sea basin, for different version of NEED. With these results e can see if this half-NEED is a realistic option.

NEED compared to coastal dikes

Although we think NEED is probably a least bad option that huge dikes along coastlines, this is still to be investigated. This requires the use of a model that calculates costs of coastal dikes and compare the issues with such a European project, to that of NEED. This is a combination of a multidisciplinary thought processes, some numerical modeling and back of the envelope calculations.

Miscellaneous NEED projects

There are many more project one can do, taking the concept of building NEED. Think of studying the impacts on:

- Conceptual Dam Design.
- Regional Ocean Circulation changes.
- Regional weather and climate change.
- Large scale ocean and atmosphere changes.
- National, European, and International political and policy challenges.
- International law and Legal Challenges.
- Ecosystem Dynamics.
- Maritime Shipping Industry.
- Technology of the pumps.
- Freshwater reservoir.
- Renewable energy and CO_2 drawdown.
- Terrorism and Earthquakes.
- Economy.

Yet for all these subjects, I'm excited to have a role in bringing the project to a good end, but I won't be available for the daily supervision as they are often not in my area of expertise.

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Correction for ship-induced vertical velocity

When the ship moves through the water, it pushes water down. This is measured by the ADCP under the hull of the ship, dominating the measurements of the vertical velocities, and possibly influencing the horizontal velocities as well. We have clear evidence for this effect but have not found a single study addressing this issue. Understanding how this affects the measurements and how we can correct for this effect, could become a widely used influential study to correct ship based ADCP measurements with.

Detection of Internal Waves and “SlibKoeien”.

In the Marsdiep, Internal waves and Slibkoeien have been observed. Internal waves (IWs) are waves under the surface between different density layers. We are certain that the TESO crosses these internal waves, and we should be able to find signal of IW’s in the TESO data. By identifying and isolating their signal in the TESO ADCP data, we can start understanding what type of Internal waves there are, with what frequency they occur, where they occur and what their impact is.

Simultaneously, we also see features in the Marsdiep where there are clear signals of “mud” near the surface, spreading in a circular shaped way over tens of meters. These slibkoeien are probably related to tides flowing over topography, causing strong vertical upwelling that reaches the surface. These features are frequently observed by TESO captains, especially near Den Helder during flood. We would like to detect these features in the TESO data, therewith collect observational based evidence of their existence and start to describe them and understand their dynamics.

Sediment transport changes

The Marsdiep is a highly dynamical inlet, featuring strong tidal velocity and related transport of mass and sediment. Yet, averaged over many tides, we see a net transport of mass and sediment into the Wadden Sea. We would like to understand changes in these transport rates. For example, the detection of the construction of the Sand Motor, or the Prins Hendrik dikes on the east side of Texel. How do these features change sediment transport in the Marsdiep, and thus around the Dutch coast?

Estuarine Circulation.

First detect and identify the tidal component in the Marsdiep. Once understood and described, subtract these from the obtained dataset and look at the residual or estuarine circulation. That is, the circulation not caused by the tides, but by all the nonlinear behavior, density gradients and other processes. These have an important impact on the long term, net mass exchange between Noord Sea en Wadden Sea.

Meteo Tsunami’s

Meteo Tsunami’s are tsunami-like features on scales of tens of kilometers wide, induced by atmospheric weathers phenomena. Such features have been observed near Texel and in the Marsdiep. We would like to combine TESO data, sea surface height data at the NIOZ and air-pressure data from Rijkswaterstaat to first detect these features. If detected, we would like to see if we can also find their signal in the TESO data to understand how much transport is associated with such a Tsunami and what consequences this may have.