Msc project/internship: Particle modeling for salinity intrusion

Where a river flows into the sea, the buoyant water of the river flows over the denser saline water of the sea. On the other hand, saline water intrudes into the estuary along the bed. A complex interplay of this estuarine circulation with the tidal mixing and dispersion determines the distribution of salinity in an estuary. When river discharges are low, like in this summer of 2022, the saline water can move further upstream and reach the freshwater intake points for drinking water or agriculture and cause considerable difficulties. With the ongoing climate change the number of draughts is expected to increase. For this purpose, the SaltiSolutions project is currently developing numerical models and data-assimilation tools to make accurate forecasts possible to support an optimized management of the limited fresh-water and to investigate the possibilities of measures.

In this project we aim to build upon an existing particle model and existing flow data to create a simulation of the intrusion of salt in the Rhine-Meuse delta. This is very challenging, since:

1. The numerical flow model is a very large model running in parallel on hundreds of domains on a supercomputer. The particle model has not been optimized and parallelized to this scale. So we have to scale from large models with 20 domains to very large models with hundreds of domains. The particle model is written in Julia, which is a modern high-performance language that supports parallel computing.
2. The difference in density between the fresh waters floating on top of more saline waters suppresses turbulence near the interface, so the fresh and salt water do not mix very well. Accurate modelling of the vertical diffusive exchange with diffusion coefficients is crucial for an accurate simulation. We have partial results available from the work of students before you, but an integration into a single 3D partical model for salt intrusion is lacking.
3. With a working simulation one can study the time it takes salt parcels of water to reach the the tip of the salt intrusion. This can further our understanding of the processes that lead to salt intrusion and help find ways to reduce the impact.

The precise topic will be decided together with the student.

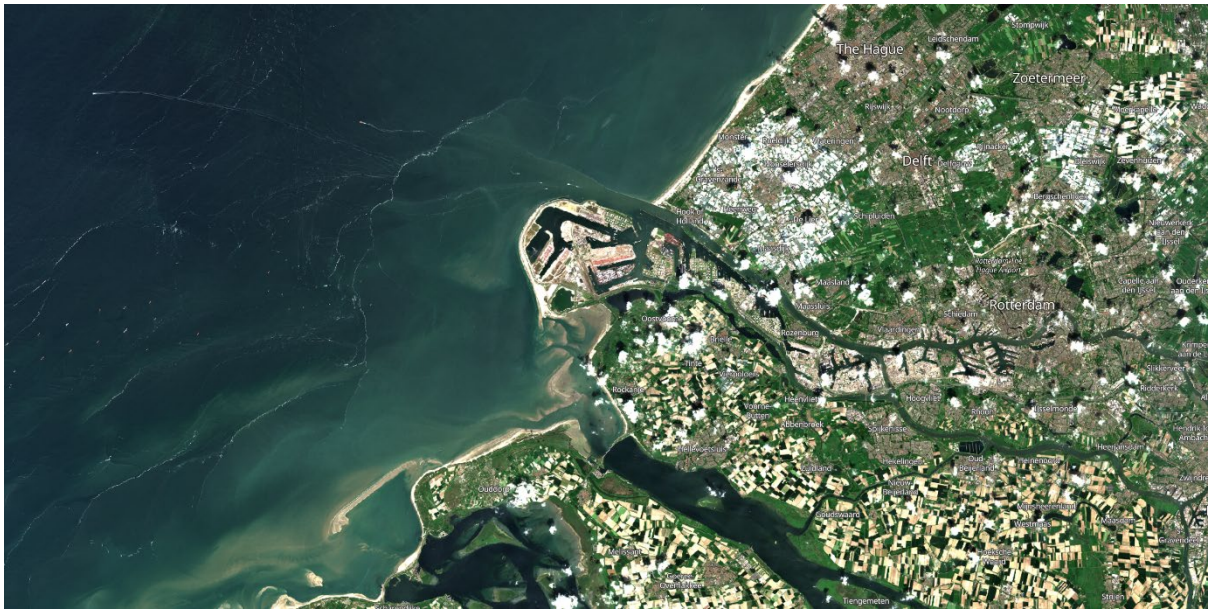

Figure 1 Satellite image of Rhine-Meuse river plume near Hoek van Holland