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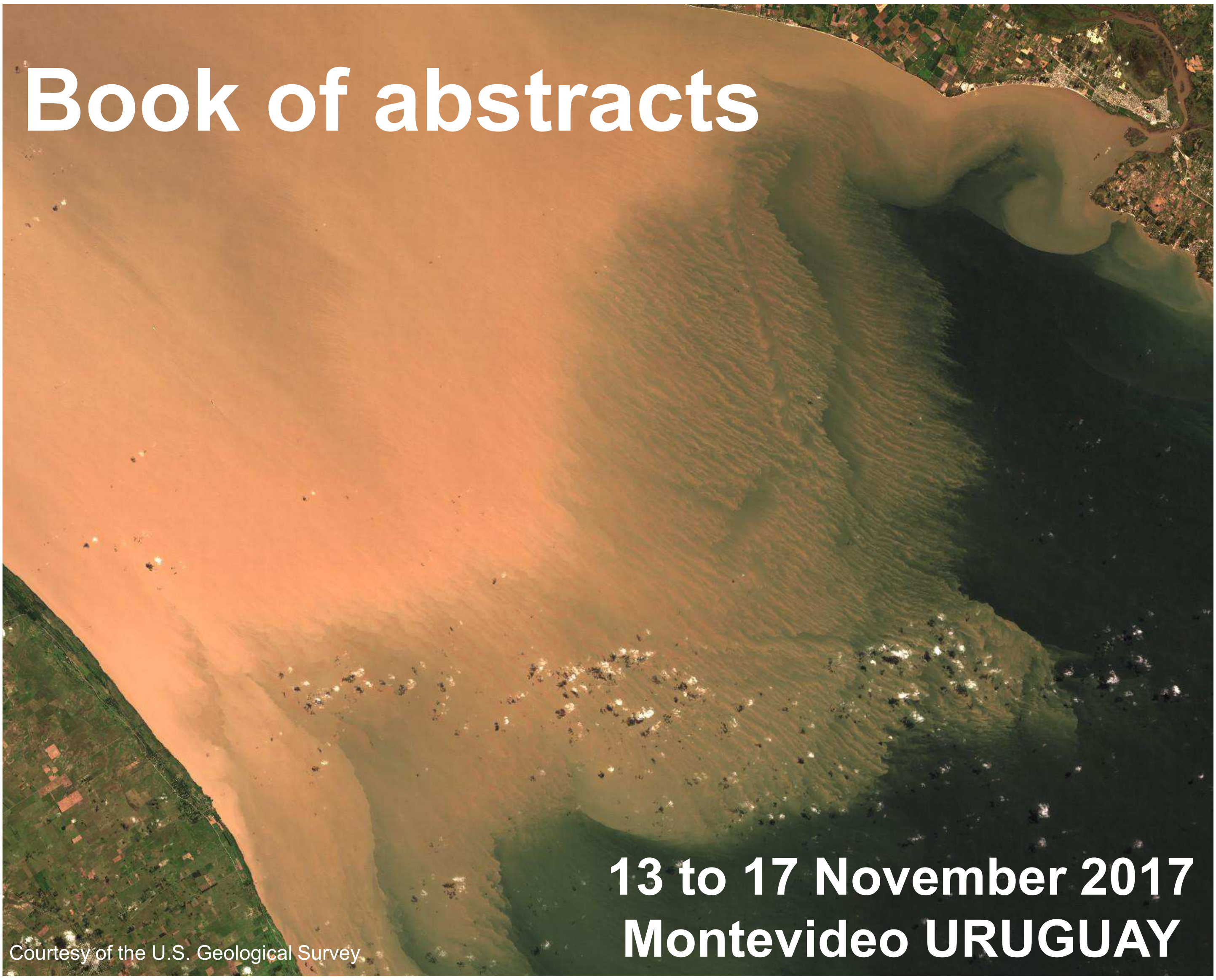

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Influence of Salinity on the Coastal Turbidity Maximum in the Southern Bight of the North Sea

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Introduction

In the Southern Bight of the North Sea, a Coastal Turbidity Maximum (CTM) can be observed in the Belgian coastal area around the port of Zeebrugge. Understanding the dynamics of this turbidity maximum is of great importance in coastal zone management. Our research studies the CTM with a numerical process model (model domain shown in Fig. 1).

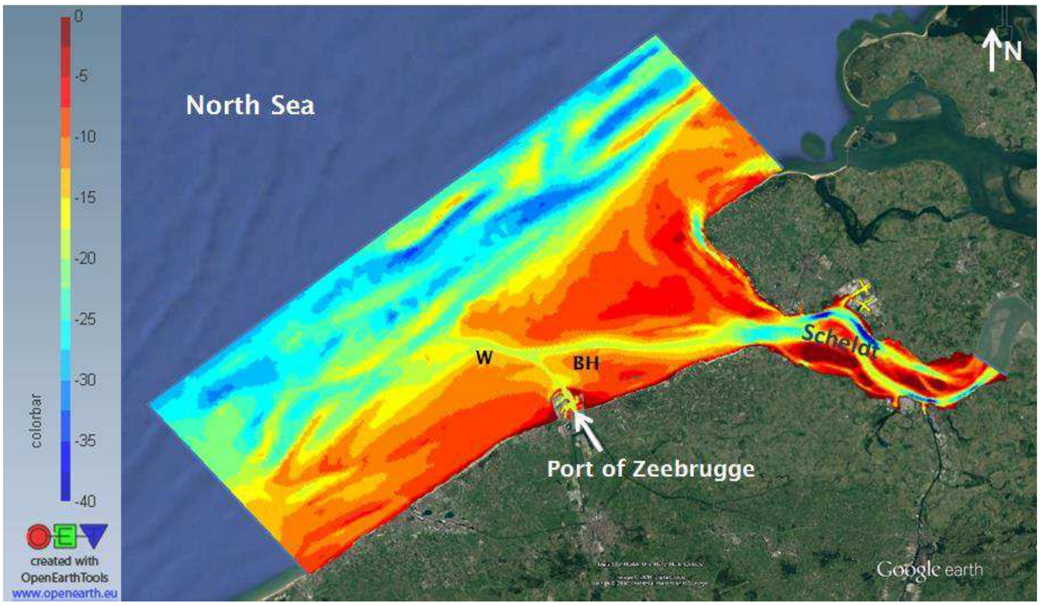

Fig. 1: Model domain and bathymetry. Letters W and BH indicate the location of the observation stations Wandelaar and Bol van Heist

Methods

The hydrodynamics is simulated using a 3D hydrodynamic model, developed within the Delft3D model suite (Deltares, 2011) and is then passed on to a sediment transport model implemented in Delwaq (Deltares, 2014). In this way the sediment dynamics in the area is modelled in an 'offline' mode. Two methods of taking into account the effect of waves are examined: importing the calculated wave field and applying a simple fetch length approach. The sediment transport is modelled using a two-layer bottom model as described in van Kessel et al. (2011).

The model starts running without prescribed initial sediment, neither in the bed nor in the water column. The sediment supply comes from the model boundaries and the model gradually builds up to a dynamic equilibrium. This modelling approach is suitable for studying CTM (and ETM) dynamics, as the resulting turbidity maximum is not forced through the provided initial condition, but is an internal solution of the system.

Results

The turbidity maximum in front of the port of Zeebrugge is found to be robust to a wide range of parameter settings (e.g. Fig. 2). The mechanisms controlling the suspended sediment concentration are studied in detail.

This paper focuses on the effects of salinity on the formation of the CTM. The results of suspended sediment concentration obtained from the simulations in baroclinic mode (with salinity) and barotropic mode (without salinity) are compared (Fig. 2a,b). The density-induced residual circulation due to salinity (Fig. 3a,b) causes more sediment being trapped within the turbidity maximum.

Due to the feedback mechanism of the system, the change of the model settings leads to the change in the sediment pattern of the whole system. As the result of the change in the turbidity maximum pattern in the vicinity of the port of Zeebrugge, the exchange of sediment through the port, the dredging (and thus dumping) amount are affected. These, in turn, modify the turbidity maximum in the area. This feedback intervention will be thoroughly discussed.

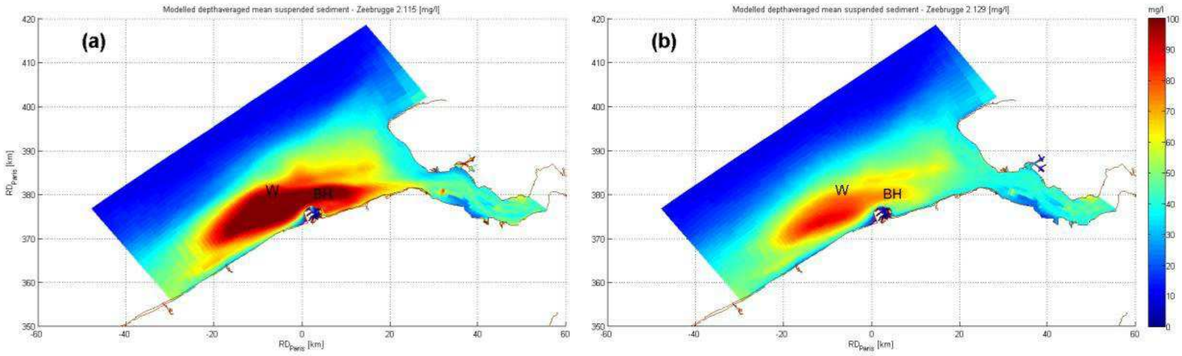

Fig. 2: Depth-averaged suspended sediment concentration (averaged over a spring-neap cycle) computed (a) with salinity and (b) without salinity

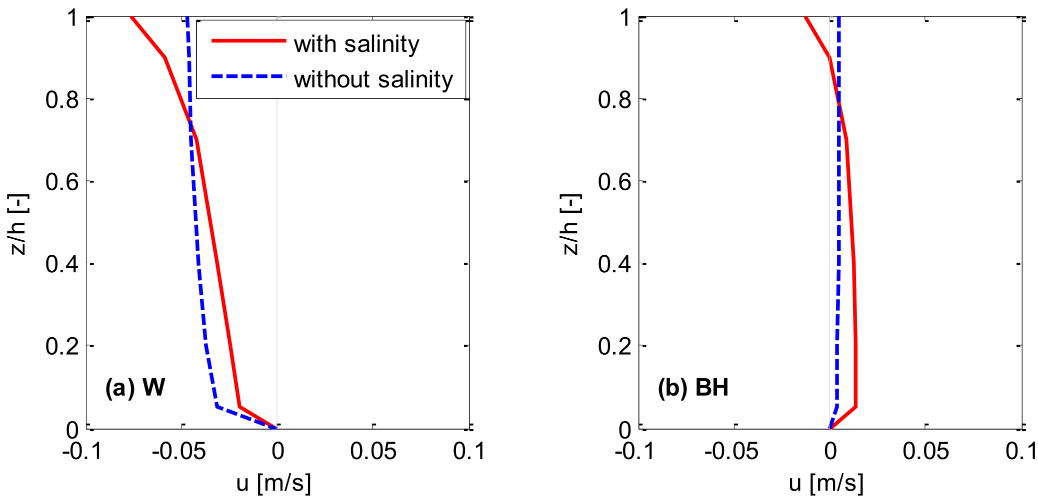

Fig. 3: Spring-neap averaged current velocity profiles computed at (a) Wandelaar (W) and (b) Bol van Heist (BH) (see Fig. 1& 2 for the locations). Positive values indicate currents directed landward

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