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Numerical modelling of groundwater and surface water flow including salt transport in a restored coastal fen

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The human use of coastal areas and wetlands often have led to the installation of branched drainage systems in these areas. In many cases this changes substantially the hydrological system characterized by interaction of surface water and shallow groundwater, and thus also groundwater discharge to the sea in coastal areas. In our study area a coastal wetland has been restored to more natural conditions leading to changes in the flow system and the possible input and output of salt from the sea and to the sea, respectively.
In our investigation study at the coast of the southern Baltic sea in Germany we have set up a three-dimensional and transient groundwater model with a coastal boundary in FEFLOW and a one-dimensional surface water model in MIKE 11 to simulate flow patterns and salt transport in a restored low-lying coastal fen with a ground sill at the exit of the drainage system ditches. Inclusion of salt transport is performed exclusively for a real storm surge event. The Interface-Manager IfmMIKE11 is used to couple both models. Calibration has been done automatically with FePEST for the FEFLOW model and manually for the coupled FEFLOW-MIKE 11 model.
Results of the calibrated transient model show a good agreement between observed and simulated hydraulic heads. The results indicate that the flow patterns in subsurface and surface water have a strong seasonal variation. Thus, ditch discharge overall is substantial for the water flow balance but stops in the summer and groundwater discharge to the sea and evapotranspiration are the main processes. During the storm surge brackish water is entering via the ground sill and the salt transport into the area occurs preferentially in the ditch system. According to the results of the model, the different time scales of subsurface and surface water movement influence the flow pattern at the study site also after the restoration. And in future storm surge events may lead to a direct entry of seawater and substantial salinization of soil and groundwater of the fen.