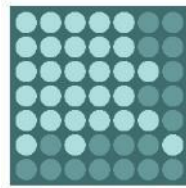


Funded by:



on the basis of a decision  
by the German Bundestag



TrilaWatt

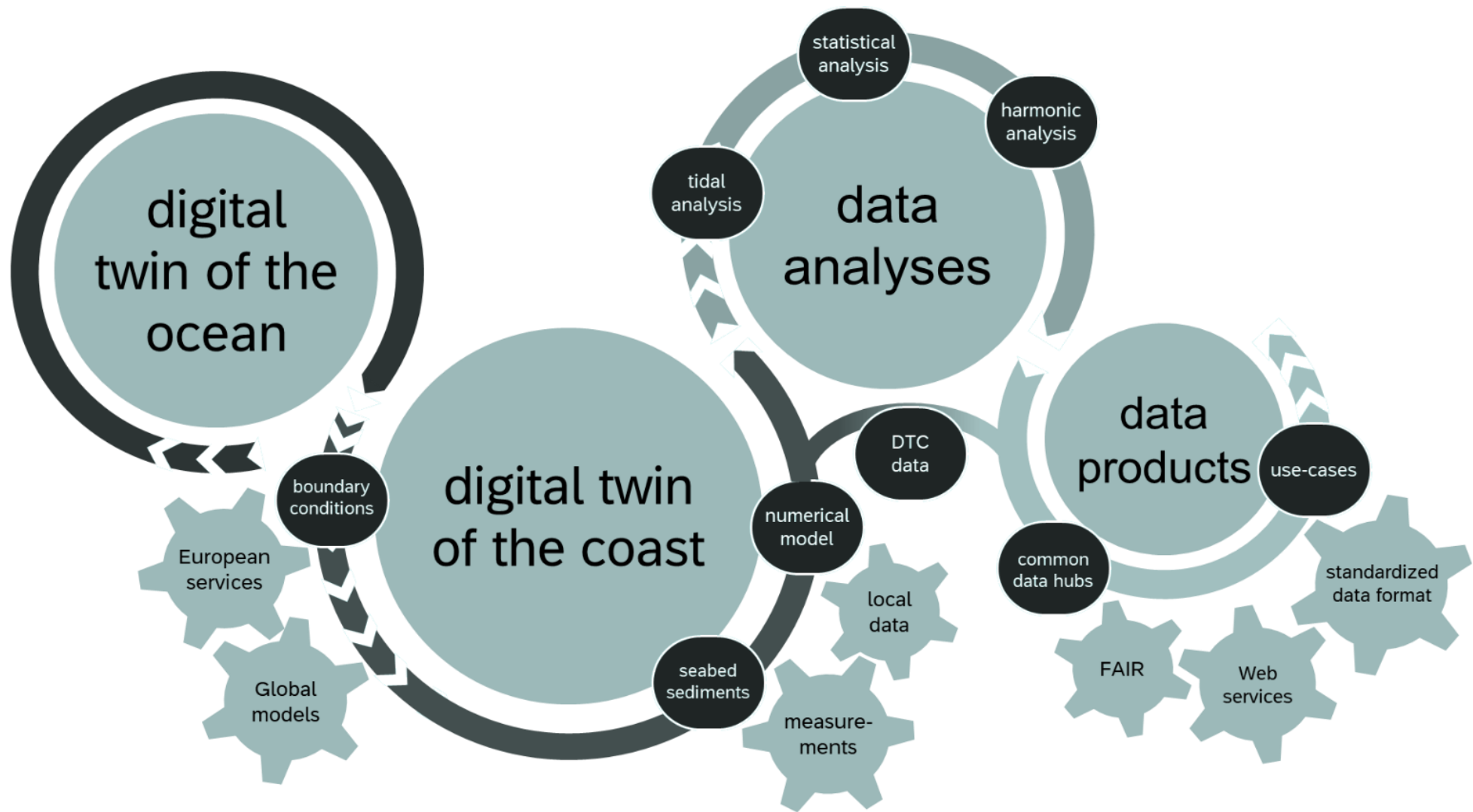
Markus Reinert

# Hydrodynamics, Sediment Transport and Tidal Analyses

TrilaWatt Final Result Presentation

6 February 2025

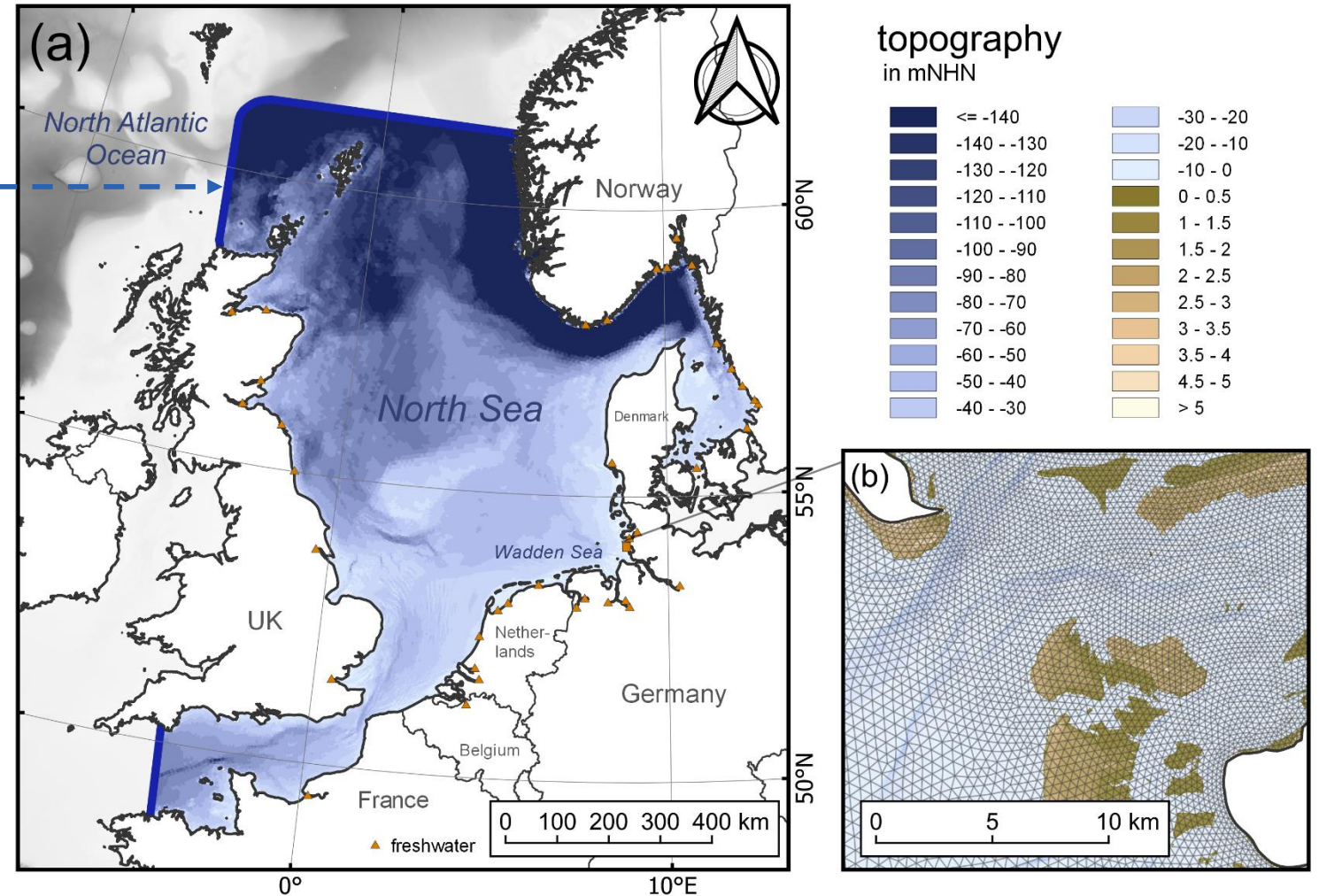




Global / European Scale Local Scale

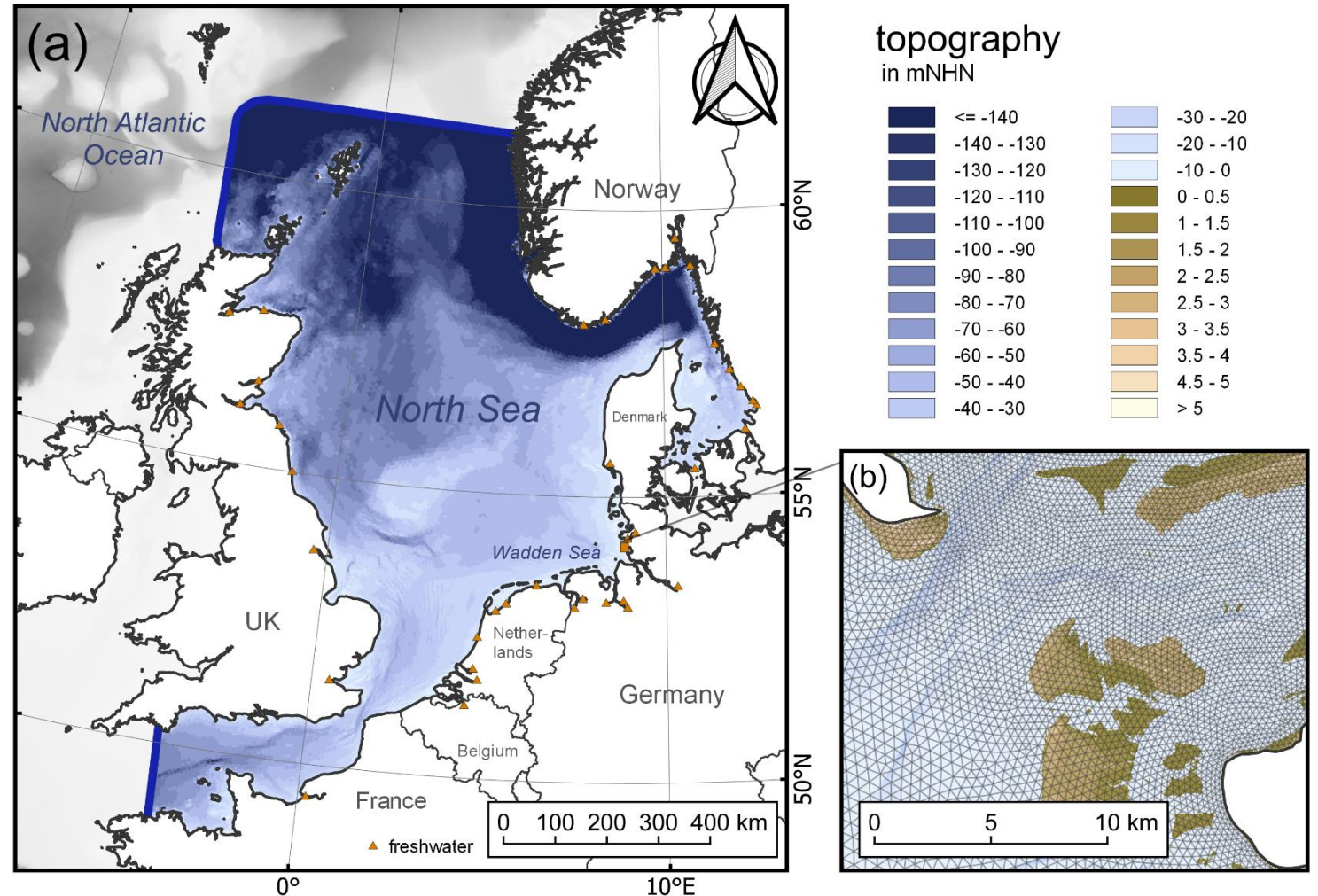
# Digital Twin of the Coast

- Hydrodynamic model UnTrim:
  - unstructured grid of ca. 350,000 cells ( $\Delta$  and  $\square$ ) covering the North Sea
  - high horizontal resolution of about 200 m in the Wadden Sea
  - refined topography resolution with 16 million subgrid elements
  - 70 z-layers with 0.5 m vertical resolution near the sea surface
  - 2 operational flood barriers (Ems, Eider)
- Sediment model SediMorph
- Spectral wave model (“k-model”) by Schneggenburger et al. (2000)



# Connection to the European Digital Twin of the Ocean

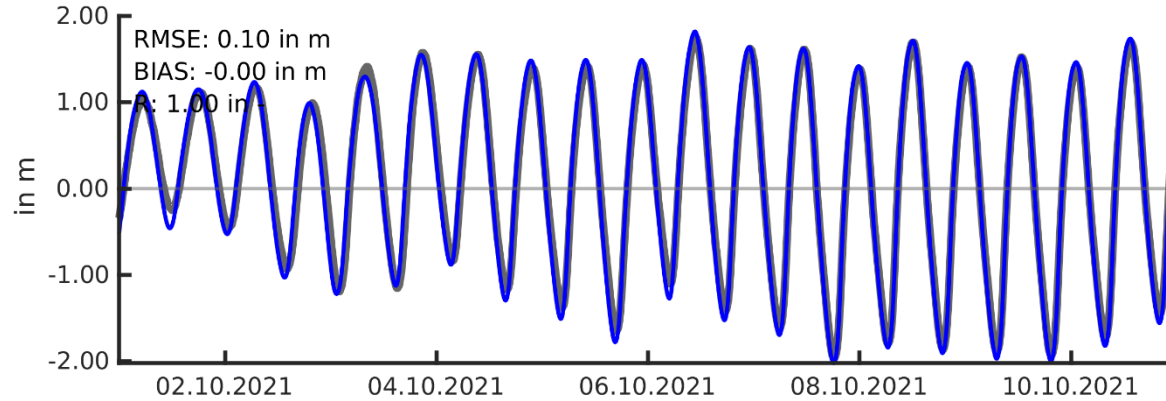
- Boundary data (3D) from NEMO ocean model provided by Copernicus Marine Service (CMEMS)
- Tides at open boundaries from FES2014b global tide model of CNES
- Atmospheric data from ICON-EU model of DWD
- River discharge from measurements
- Measurements from tide gauges, wave rider buoys and ship campaigns used for model validation



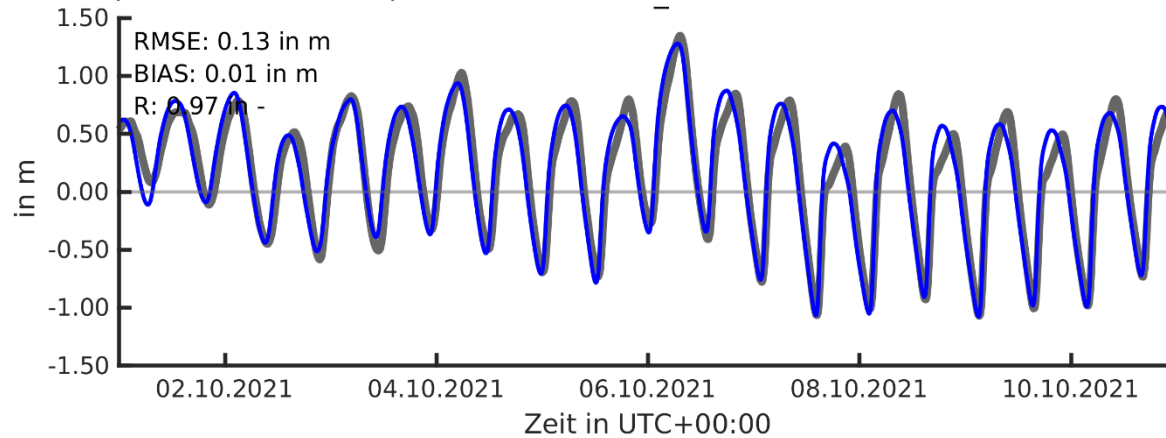
# Validation of Sea Level by Tidal Characteristics

Sea level (model and measurement) at two tide gauges:

## 1. Alte Weser Lighthouse



## 2. Oudeschild (island of Texel)



— Modell — Messung

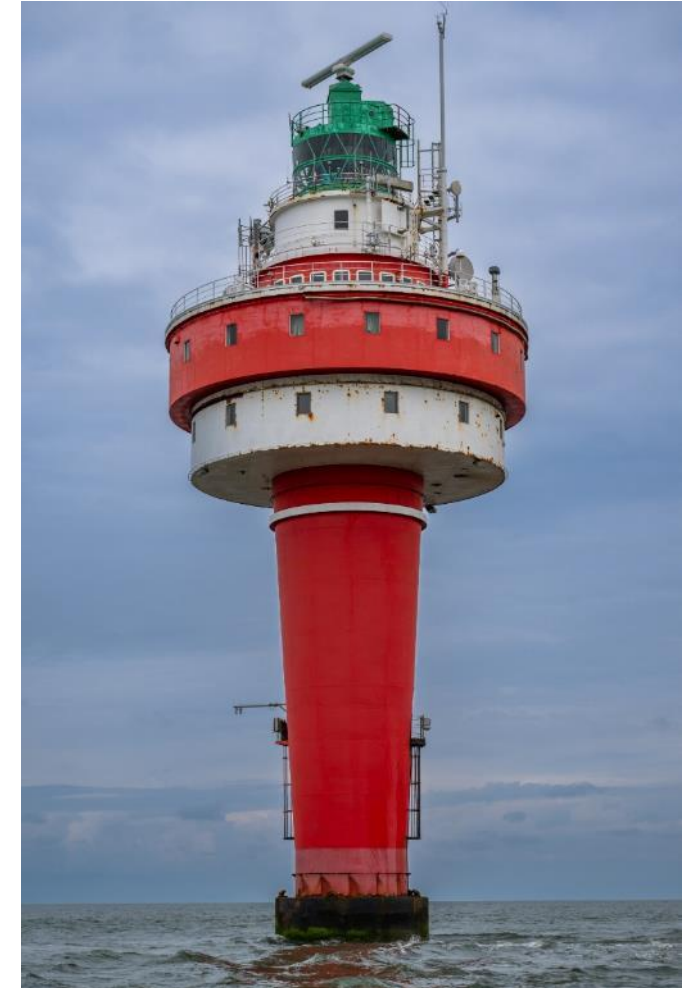
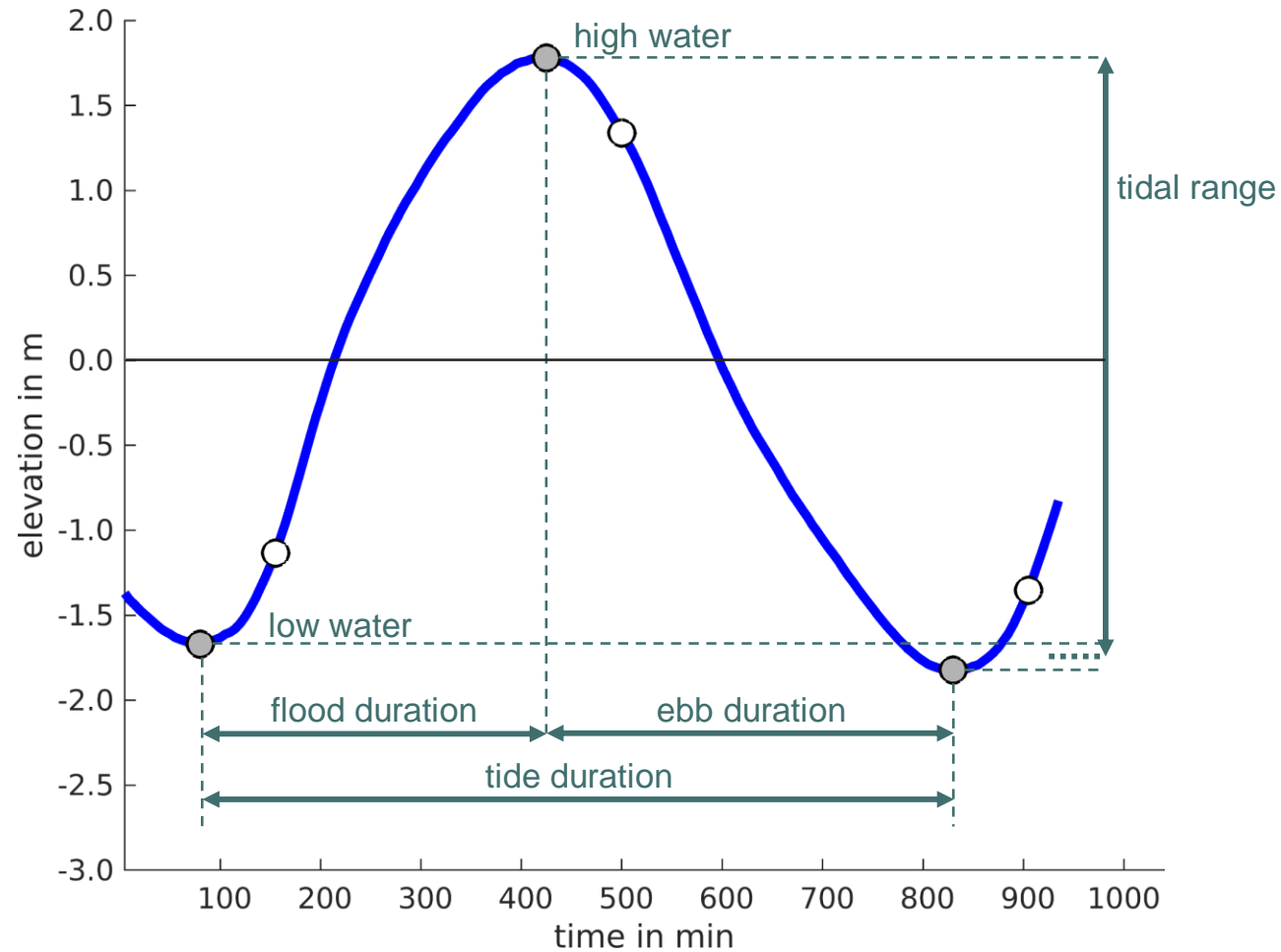


Photo of the Alte Weser Lighthouse  
by Stefan Brending, [CC-BY-SA-3.0 de](https://creativecommons.org/licenses/by-sa/3.0/de/)

# Validation of Sea Level by Tidal Characteristics

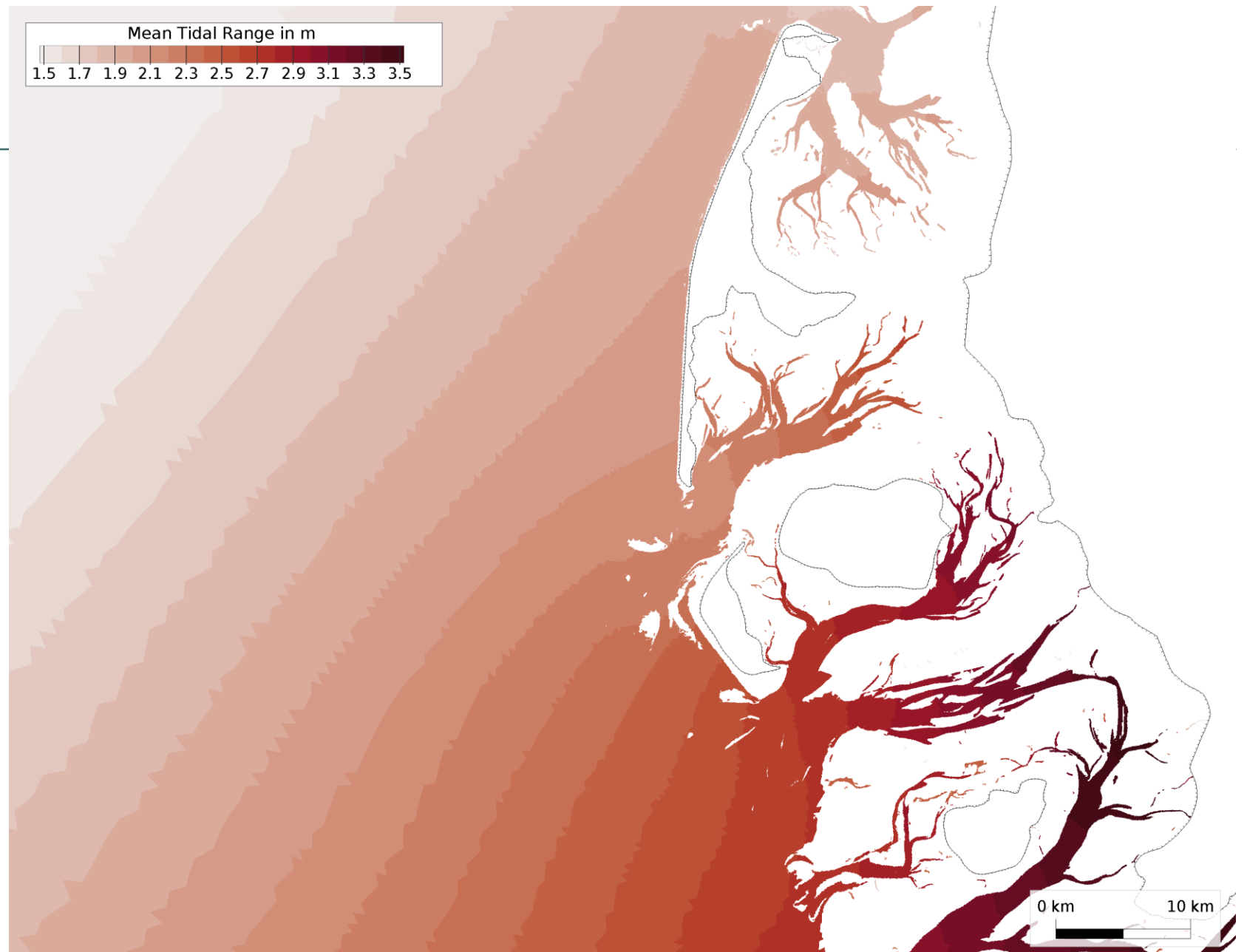




# Tidal Characteristics

Mean Tidal Range 2021

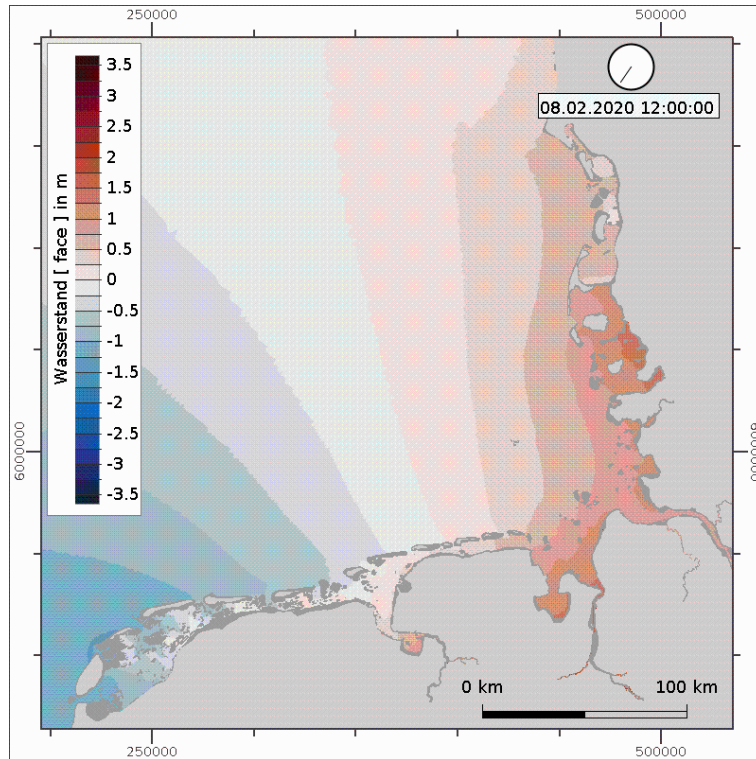
North Frisia



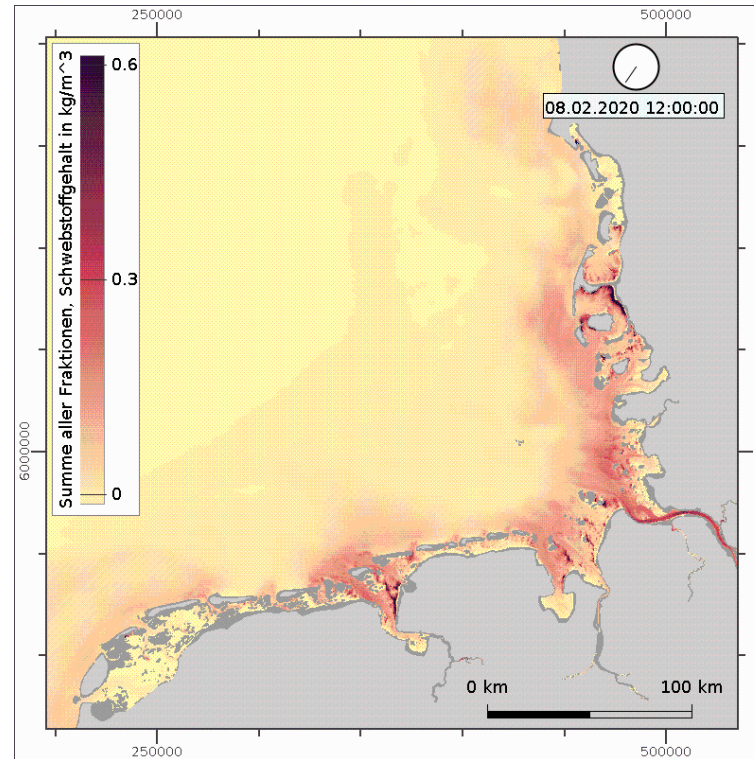


# Simulation Data

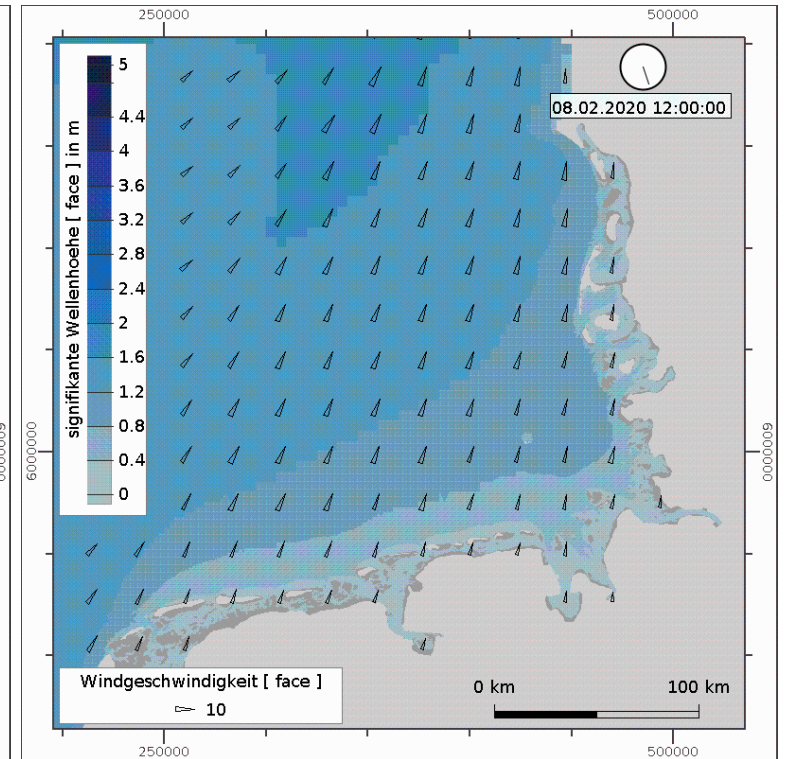
## Water level



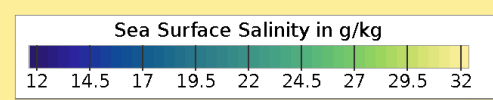
## Suspended sediment concentration



## Significant wave height



Graphics by Julietta Weber (BAW)

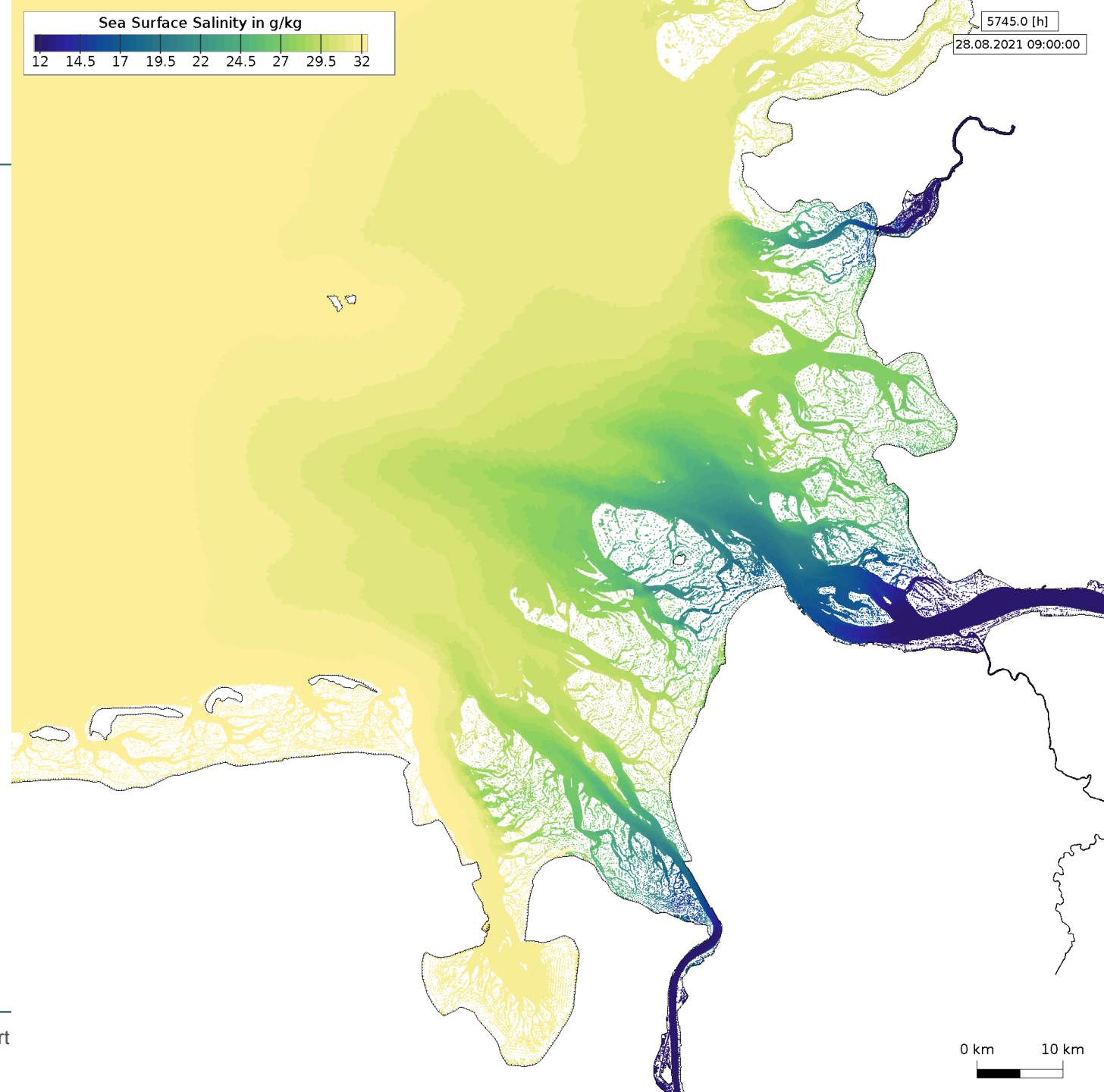


5745.0 [h]  
28.08.2021 09:00:00

# Simulation Data

Salinity near the sea surface  
on a summer day in 2021 at low tide

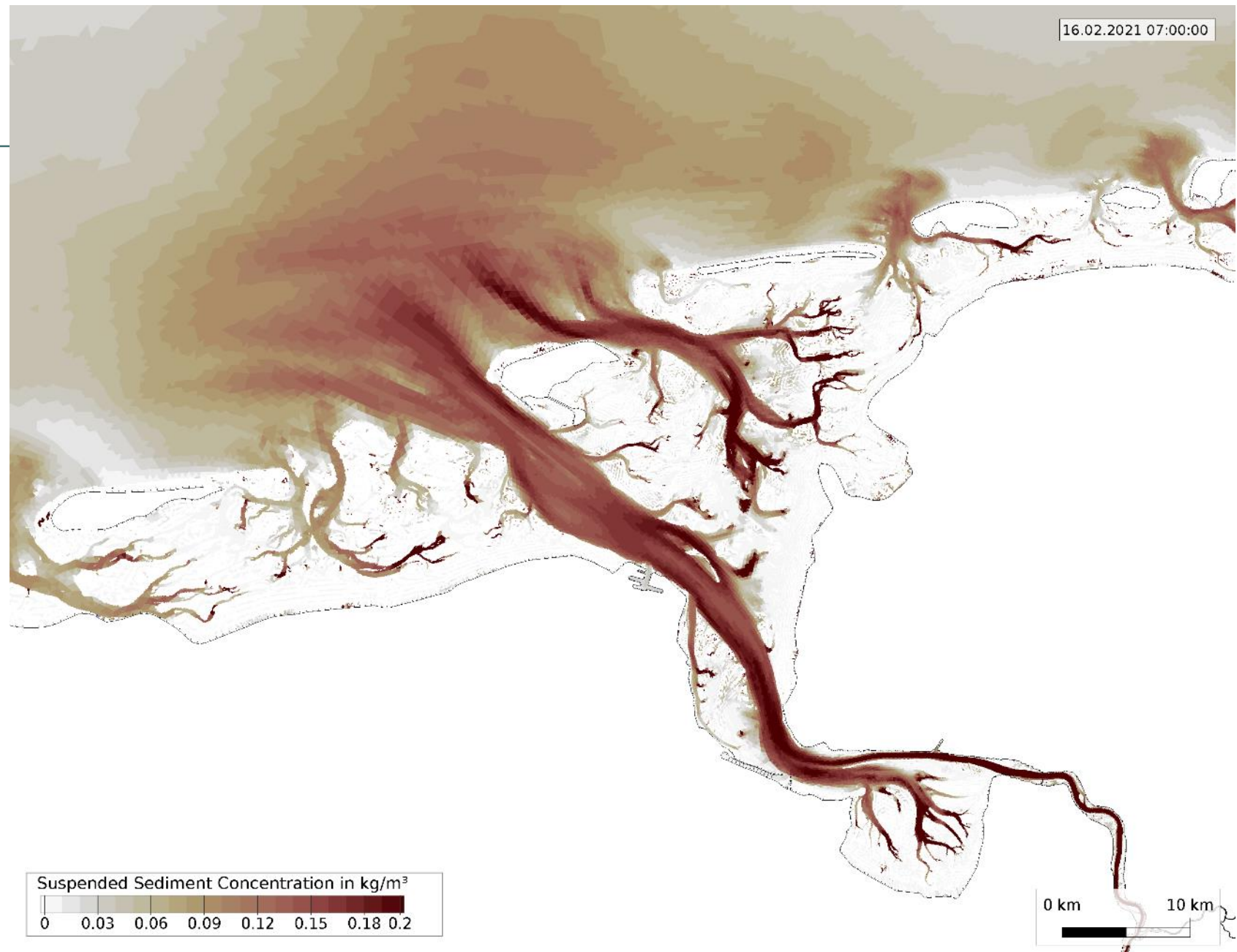
Region of fresh water influence  
of Elbe and Weser



# Simulation Data

Suspended sediment concentration on a winter day in 2021 at low tide

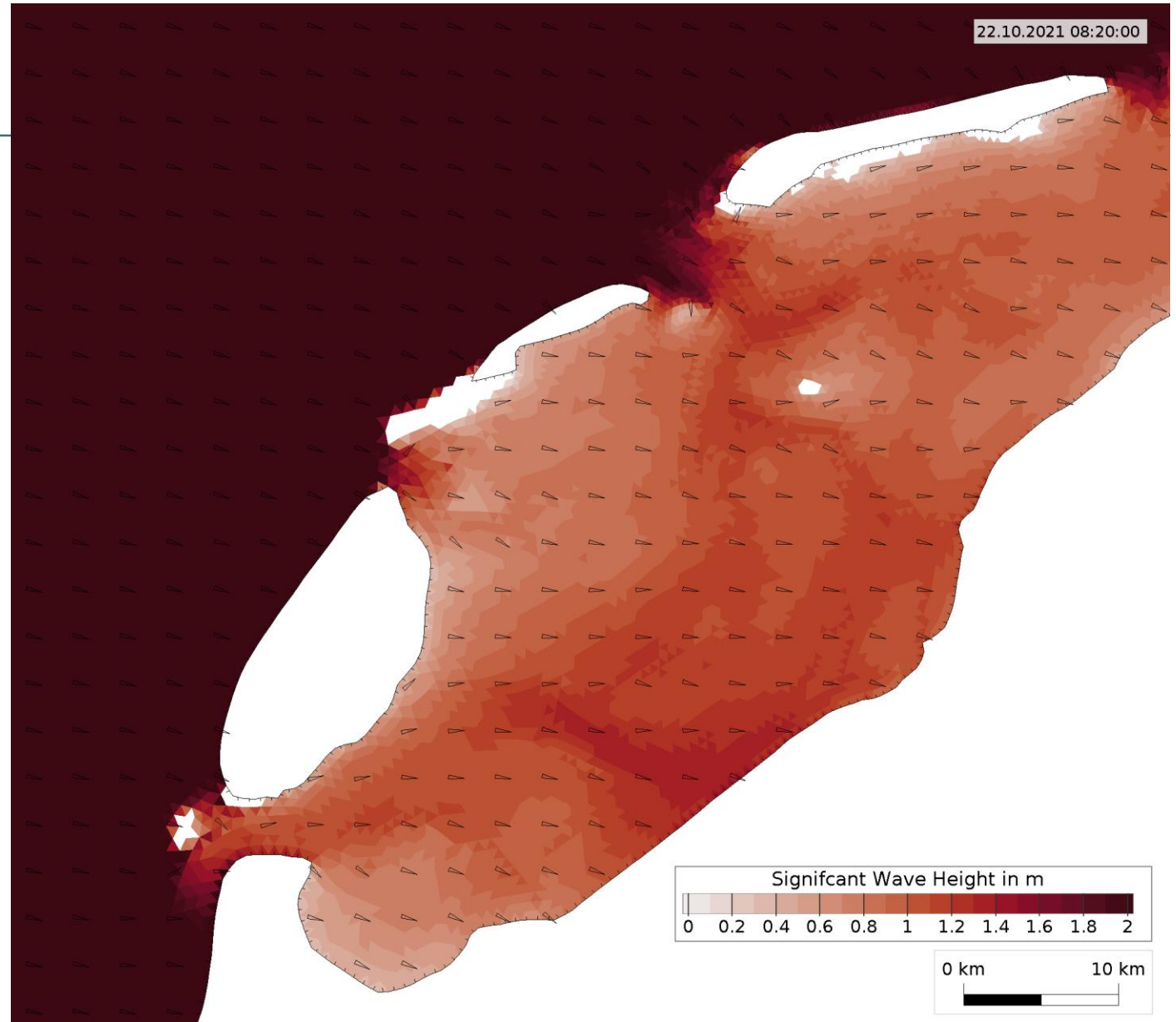
Ems river plume



# Simulation Data

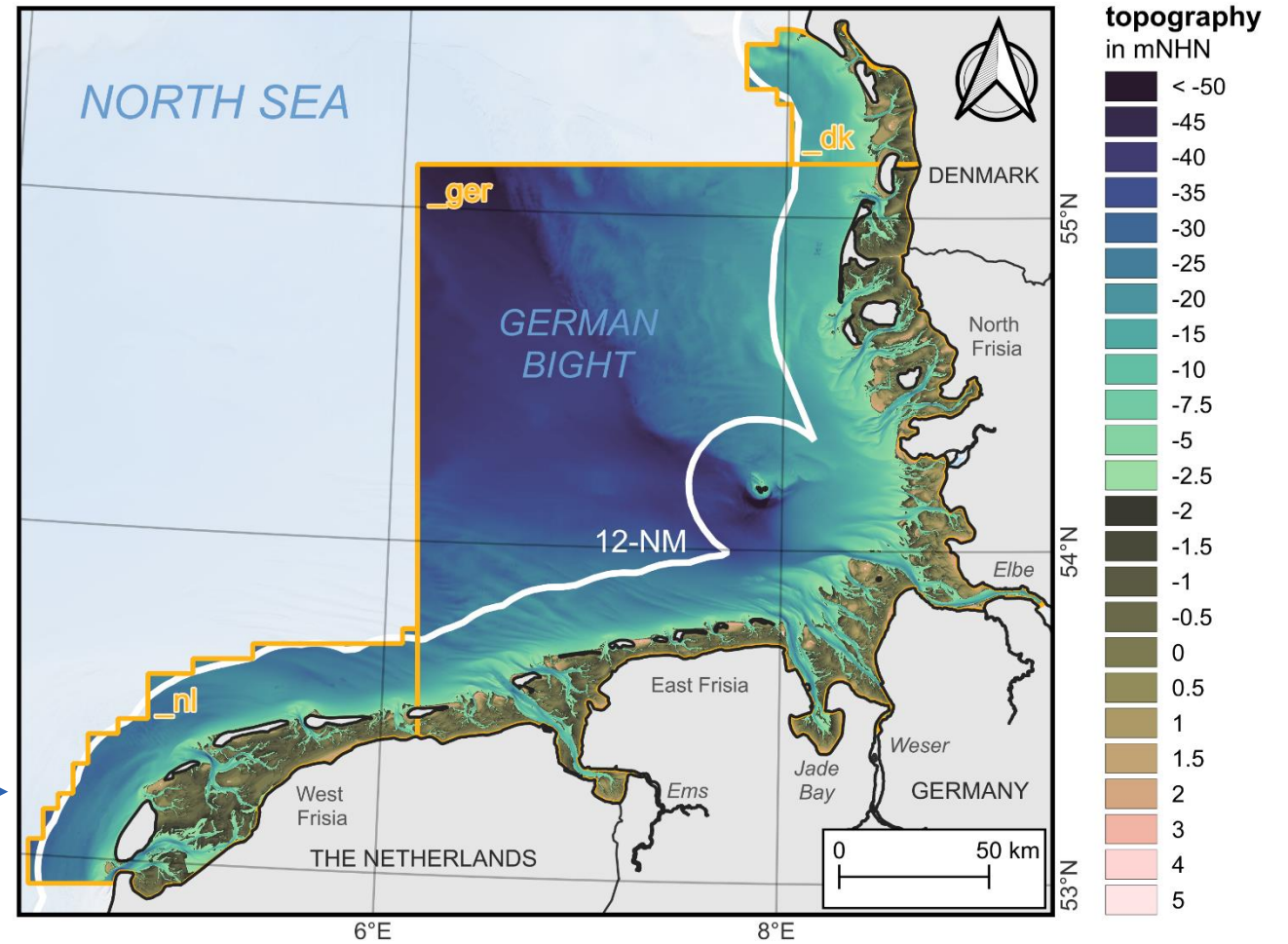
Significant wave height and wave direction during an autumn storm in 2021 at high tide

West Frisia



# Data Products

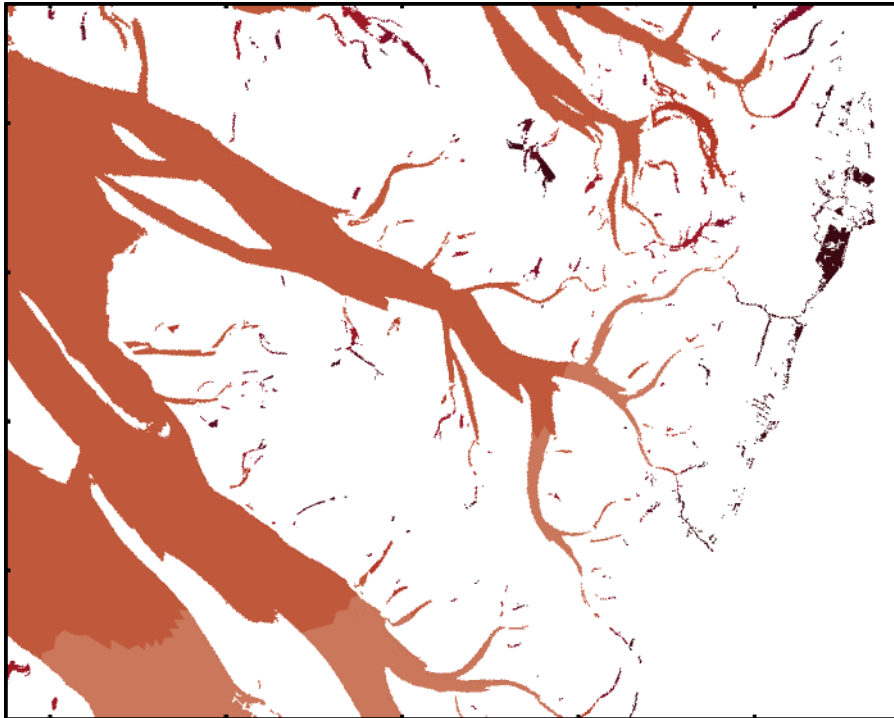
- **Simulation output** (20 minute timestep, 500 m resolution, NetCDF format)
  - currents and surface elevation
  - salinity and temperature
  - suspended sediment concentrations
  - surface wave characteristics
- **Long-term characteristics** (20 m res., GeoTIFF)
  - annual averages
  - yearly extremes (1<sup>st</sup> and 99<sup>th</sup> percentiles)
- **Tidal characteristics** (20 m resolution, GeoTIFF)
  - M2 amplitude/phase
  - percentiles of high/low water and tidal range
  - timing of tidal high/low water
- Temporal coverage: 2015 to 2021
- Spatial coverage



# Data Products with Improved Drying & Flooding Mask

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TrilaWatt mask improved by subgrid



Mask in the previous project (EasyGSH)

