Baltic Earth
Earth System Science for the Baltic Sea Region


# Natascha Oppelt

Professor for Physical Geography, Kiel University


## Where Land and Ocean Meet: Remote Sensing of Baltic Coastal Zones

Coastal regions of the Baltic Sea are among the most dynamic and optically complex environments on Earth. They form rapidly changing interfaces where physical, biogeochemical, ecological, and societal processes are tightly coupled and are highly relevant for climate mitigation, biodiversity conservation, and coastal adaptation. Yet, observations and models still struggle to consistently capture coastal dynamics across spatial and temporal scales, particularly in shallow, turbid waters.

Over the past two decades, advances in Earth Observation (EO), data processing, and computing power have opened new possibilities for monitoring water quality, coastal morphology, and vegetated habitats, particularly seagrass meadows and other blue-carbon systems. Recent developments in optical, hyperspectral, and radar satellite missions, complemented by UAVs and in situ observations, increasingly help to close the long-standing gap between terrestrial and marine monitoring in the Baltic Sea.

This keynote synthesizes experiences and lessons learned from remote sensing applications for Baltic coastal mapping and monitoring, ranging from satellite-based retrievals of water constituents and benthic vegetation to hyperspectral in situ networks and AI-supported data fusion across sensors and scales. Particular emphasis will be placed on: (i) the challenges of observing shallow, optically complex coastal waters; (ii) the value of harmonized, long-term EO data for detecting trends and extremes; and (iii) pathways for integrating remote sensing products into ecosystem models, blue-carbon assessments, and coastal adaptation planning.

Looking ahead, the talk outlines a vision for “seamless” coastal sensing in the Baltic, combining satellite, airborne, and in situ observations in the coastal zone. This perspective directly links core Baltic Earth priorities on sea-level and coastal change, biogeochemistry, and micro- to basin-scale processes with emerging concepts such as digital coastal twins and nature-based climate solutions in coastal and marine environments.