NorthSat-X: The North Sea from space – Using explainable artificial intelligence to improve satellite observations of climate change

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ABSTRACT

Satellite-borne coastal monitoring of Sea Surface Salinity (SSS) and Sea Surface Temperature (SST) is still limited. Challenges include land contamination, Radio Frequency Interference, and validation due to the mismatch between measurement depths of satellite-borne and reference data (e.g., microwave radiometer penetration depth ~1cm). Conventional ocean monitoring with moorings and Argo floats does not measure the uppermost ocean skin layer separately, but a section that includes surface and bulk water. Previous work has shown SST and SSS anomalies at the skin layer that differ from conditions in the underlying bulk water. Therefore, we aim to measure SST and SSS directly at the sea surface using a remotely operated catamaran and a surface-buoy-sensor-system, both equipped with oceanographic and meteorological sensors. To better understand the effects of precipitation, evaporation, and wind on SSS and SST, the spatial and temporal variability within the satellite's footprints will also be investigated. Eventually, in cooperation with the German Research Center for Artificial Intelligence (DFKI), remote sensing of essential climate variables (ECVs) in coastal waters will be fundamentally improved using machine learning methods.

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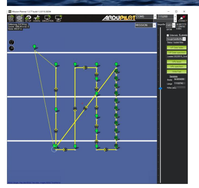
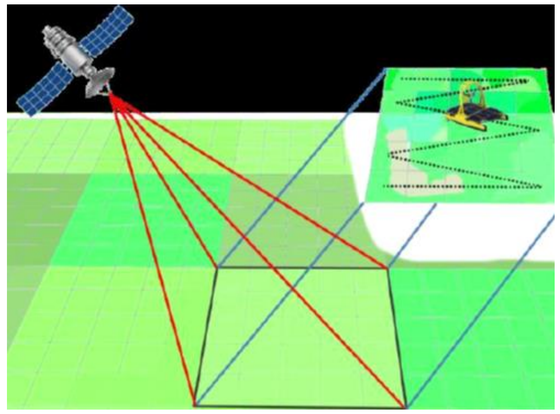
WORKFLOW

In situ SST and SSS, evaporation, precipitation and hydrodynamics within the satellite's footprints will be measured. Skin layer and bulk are sampled with an autonomous catamaran and a surface buoy sensor system. Hydrodynamic conditions are investigated with drifters. Until 2023, four cruises are planned (one completed on 23 May 2022)



Autonomous catamaran 'HALOBATES' with grid of waypoints during cruise HE598 (30 April to 23 May 2022)



Surveying satellite's footprint

Investigation of: (i) spatial and temporal distribution of ECVs, (ii) Controlling processes of ECVs distribution and variability, (iii) effects of evaporation, wind speed, precipitation on skin layer and bulk variables, and (iv) interactions of atmospheric forcing and oceanic mixing on ECVs variability.

Comparison of satellite data products (e.g. SMOS data) to reference data and variability analysis.

In cooperation with SMOS Barcelona Expert Centre

Development of XAI (explainable AI) for better comparison and to make satellite-based measurements from coastal regions usable in the future. This should make it possible to record climatic changes faster and more accurately, such as precipitation in the North Sea region.

German Research Center for Artificial Intelligence