Current topic for a Master's Thesis

Detection of storm surges with satellite altimetry

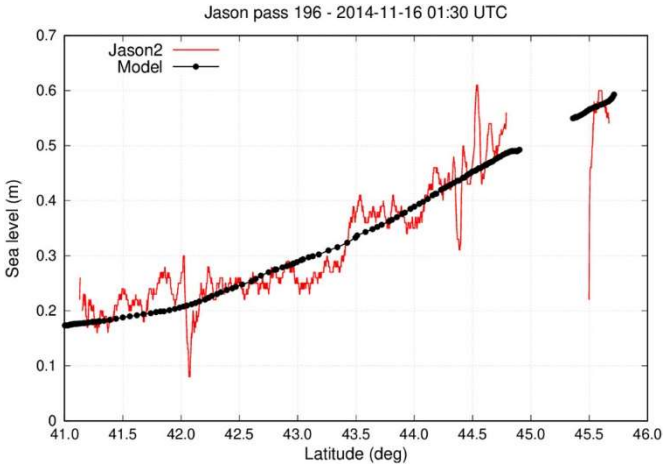

Figure 1: sea level during a storm surge detected by Jason-2 altimeter and verified using model forecasts (Cavaleri et al., 2021)

Satellite altimetry has provided a continuous record of sea levels for over 30 years. Significant progress and refinements in data processing have made it possible to extend these records to within just a few kilometers of the coast. At DGFI-TUM, we apply algorithms to the original waveforms from satellite altimetry missions, enabling further improvements. One particularly relevant technique is the application of the ALES algorithm (Passaro et al., 2014), which has been widely used and has facilitated various coastal applications, including a global coastal sea-level trend analysis conducted as part of the European Space Agency's Sea Level Climate Change Initiative.

In this context, the dataset has been enhanced with specific corrections to produce sea-level time series at fixed points along the altimetry tracks (XTRACK/ALES, Birol et al., 2021).) The objective of this thesis is to utilize this dataset for an innovative application: the detection of storm surges using satellite altimetry. Storm surges are destructive phenomena observed as a sudden rise in sea level, driven by wind pushing water toward the coast. They can also be recorded by in-situ stations, such as tide gauges, which provide valuable data for validation.

To date, studies of storm surges using satellite altimetry are limited to a few examples in the literature, primarily focused on specific storms (e.g., Andersen et al., 2015). This research takes a reversed approach: the student will develop a procedure to identify storm surges directly from coastal altimetry records and then validate the results using external data. The North-East Atlantic European coast will serve as a testbed for this analysis. For selected examples, the sea-level information will be combined with estimates of ocean wave heights at the same locations. This step will improve comparisons with tide gauges, whose sea-level measurements are also influenced by wave setup—i.e., the rise in water level caused by waves breaking near the shore.

Main tasks:

- Develop an algorithm to identify storm surges along the European coast in the altimetry record
- Validate the retrieved sea level using in-situ data from tide gauges
- Experimental: couple the events with the sea state measurements from the ESA Sea State CCI project and bathymetry data, and compute the wave setup

References:

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Birol F., Léger F., Passaro M., Cazenave A., Niño F., Calafat F.M., Shaw A., Legeais J.-F., Gouzenes Y., Schwatke C., Benveniste J.: The X-TRACK/ALES multi-mission processing system: New advances in altimetry towards the coast. Advances in Space Research, 10.1016/j.asr.2021.01.049, 2021

Cavaleri L., Bertotti L., Ferrarin C., Passaro M., Pezzutto P., Pomaro A.: Synergic use of altimeter and model sea level data in inner and coastal seas. Remote Sensing of Environment, 261, 112500, 10.1016/j.rse.2021.112500, 2021

Institute: Deutsches Geodätisches Forschungsinstitut der TUM (DGFI-TUM)
Supervisors: Marcello Passaro, Michael Hart-Davis
Contact: Marcello.passaro@tum.de, michael.hart-davis@tum.de