Tidal Bore Dynamics in Bristol: Insights from SWOT

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DTU Space
National Space Institute
EGU, Vienna, April 14th – 19th, 2024

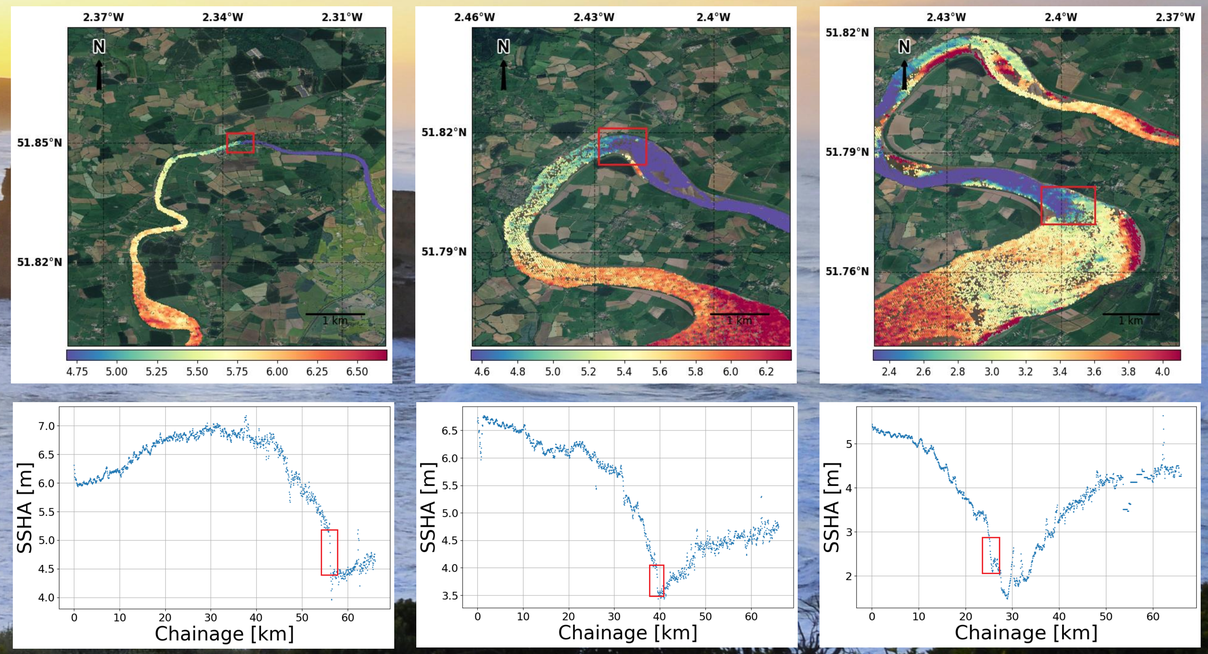
Bristol Channel

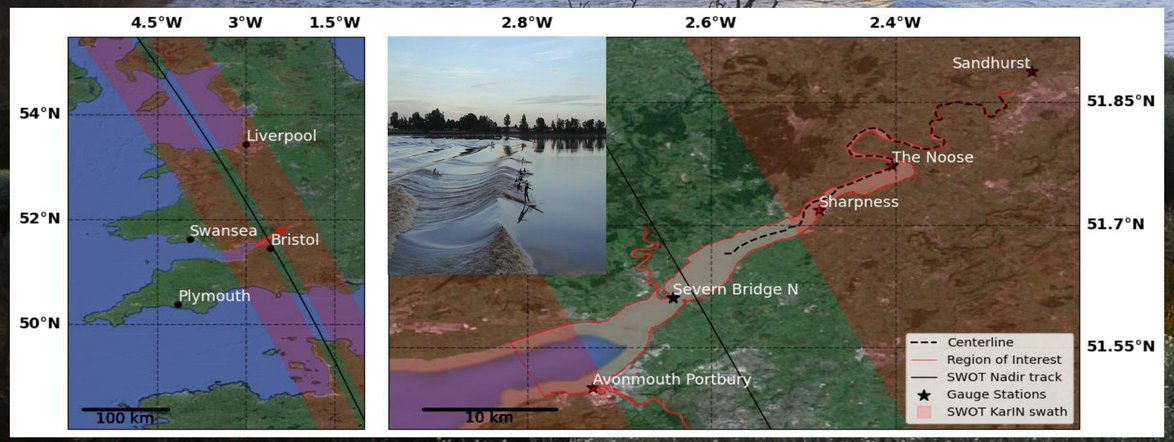
The advent of the SWOT mission marks a revolution in satellite altimetry with its unprecedented spatial resolution, unlocking a myriad of new applications. The Bristol Channel stands out as an exceptional case study for evaluating the SWOT mission's capabilities in coastal areas, primarily due to the high tidal range of up to 12m, the intricate complex patterns of wetting and drying, and the availability of data from tide gauges. Fortunately, SWOT provided high-resolution data over 19 days in April, enabling the observation of tidal bore.

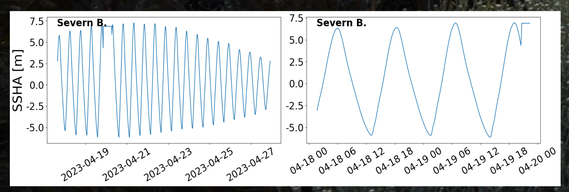
Tidal Bore

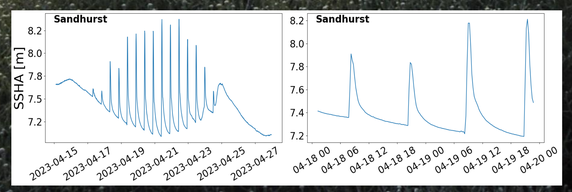
A tidal bore is a fascinating hydraulic event where a strong tide results in a swift rise in river water levels, forming a moving wavefront or a series of waves known as a surge. This event occurs under specific conditions: a substantial tidal range and a long, shallow, converging channel, both features typical of the Bristol Channel. The vast Atlantic tides are funneled into the narrowing Bristol channel, intensifying the tidal ranges. As it ascends the Severn River, the tidal wave undergoes distortion due to nonlinear effects, resulting in the tidal bore.

April 19th, 2023 | April 20th, 2023 | April 21st, 2023









Methodology

We predicted the tidal bore's arrival times at various Severn River locations using an official timetable [1]. Tracing the centerline of the Bristol Channel and Severn estuary, we marked it with points spaced every 5 meters. We then calculated the average Sea Surface Height Anomaly (SSHA) at each point, using data from the nearest 10 points after removing any errors. This enables precise monitoring of SSHA variations along the channel and accurately identifies the tidal bore's location which aligns with that of the timetable within the uncertainty of the prediction.

Conclusion

The high spatial resolution and 2D coverage of SWOT observations enable the observation of geophysical features previously inaccessible with conventional altimetry. Capturing the tidal bore, a feat not previously accomplished, highlights the exceptional capabilities of SWOT data in exploring dynamic coastal phenomena. This breakthrough extends beyond oceanic studies, opening avenues for comprehensive investigations into the hydrology shaping transitions between inland water systems and oceanography in estuaries and deltas worldwide.

References: [1] https://www.severn-bore.co.uk/2024_times.html