Assuring safe port navigation by assimilating from data sources with different spatial and temporal scales

Ben Phillips[1], Jonny Higham[1], Andy Plater[1], Nicoletta Leonardi[1], Daniel Arribas-Bel[1], Cai Bird[2] and Alex Sinclair[2]

1. University of Liverpool.
2. Marlan Maritime Technologies Ltd.

19th May 2021

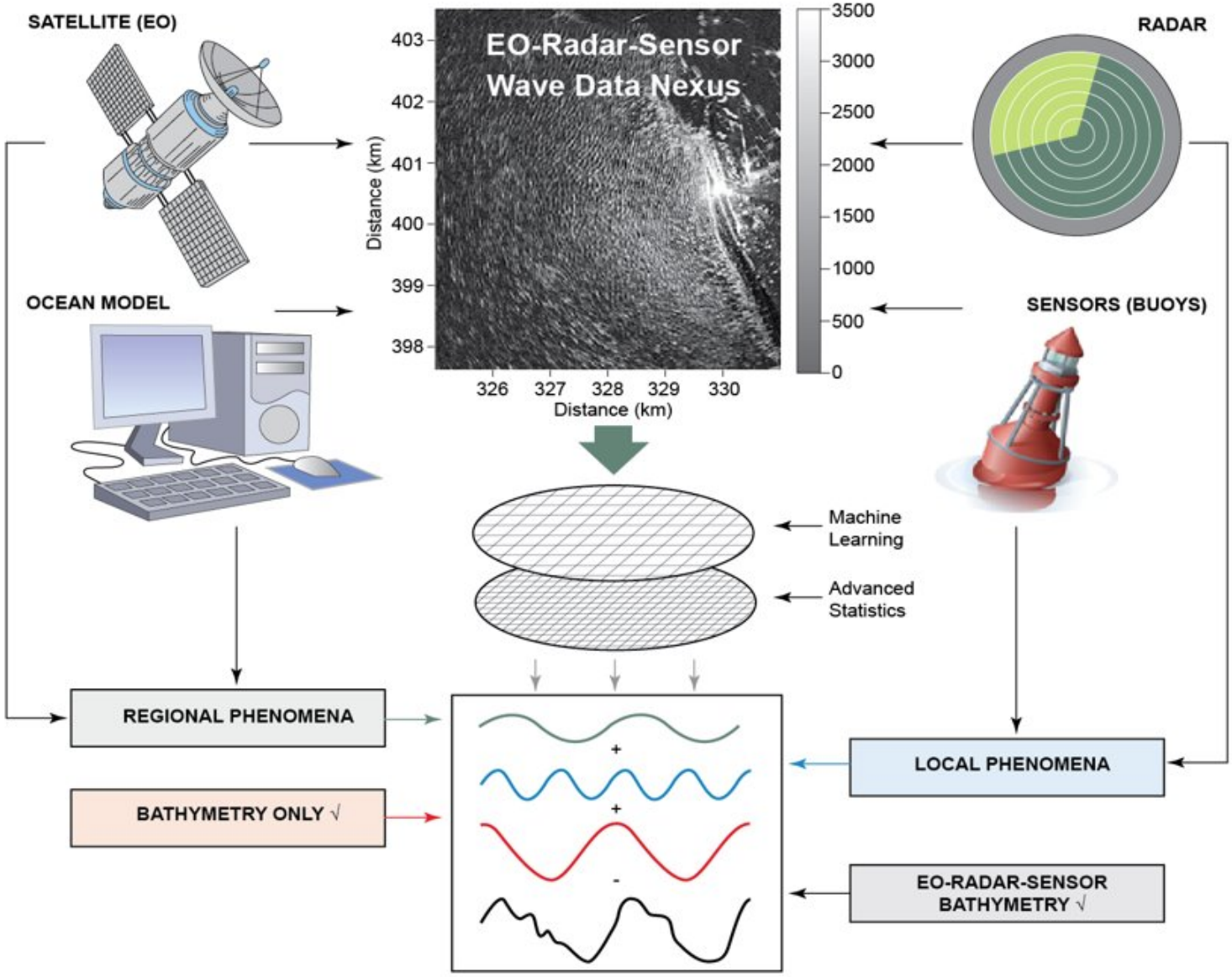
Take Home Messages

- Modal decomposition can help infer processes that one technology cannot resolve in isolation.
- We use it to isolate 'modes' of behaviour that are attributed to changes in bathymetry.
- This will form a near real-time, shore-based, cost effective system for ensuring safe port navigation.

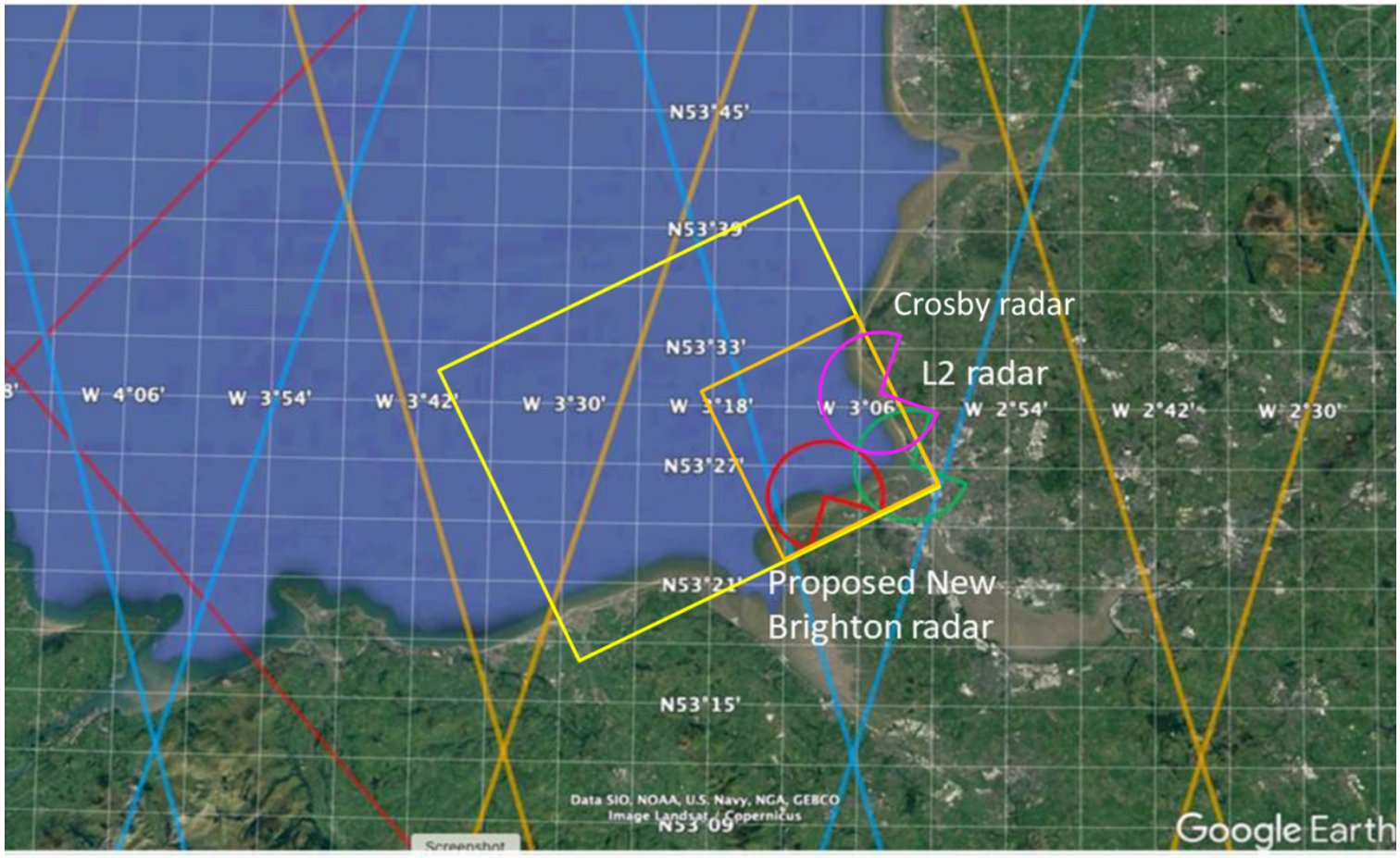
The Problems

1. Changes to sub-tidal and intertidal bathymetry can be missed.
2. Bathymetric surveys do not necessarily reveal the cause of morphological change.
3. Unnecessary dredging can be carried out at great financial and carbon costs.

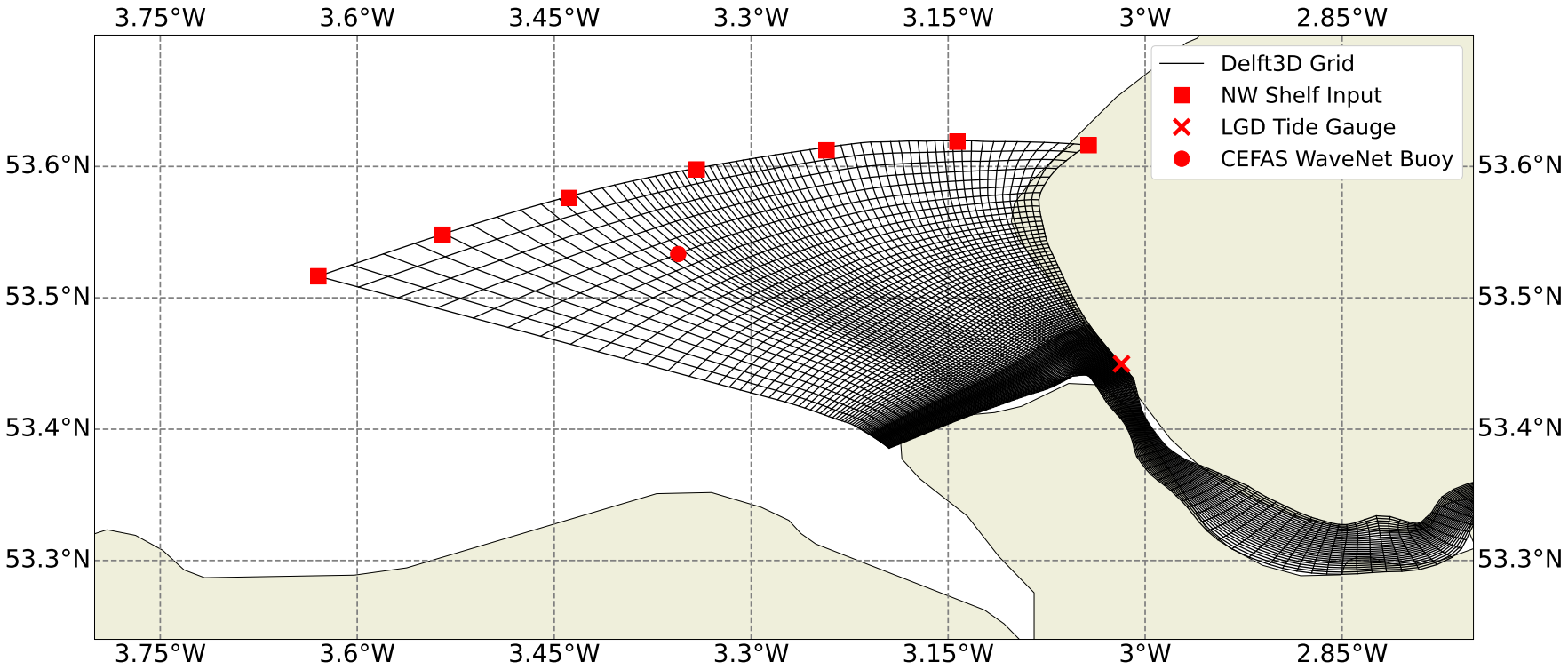
The Aim: Near Real-Time Bathymetry Data Nexus



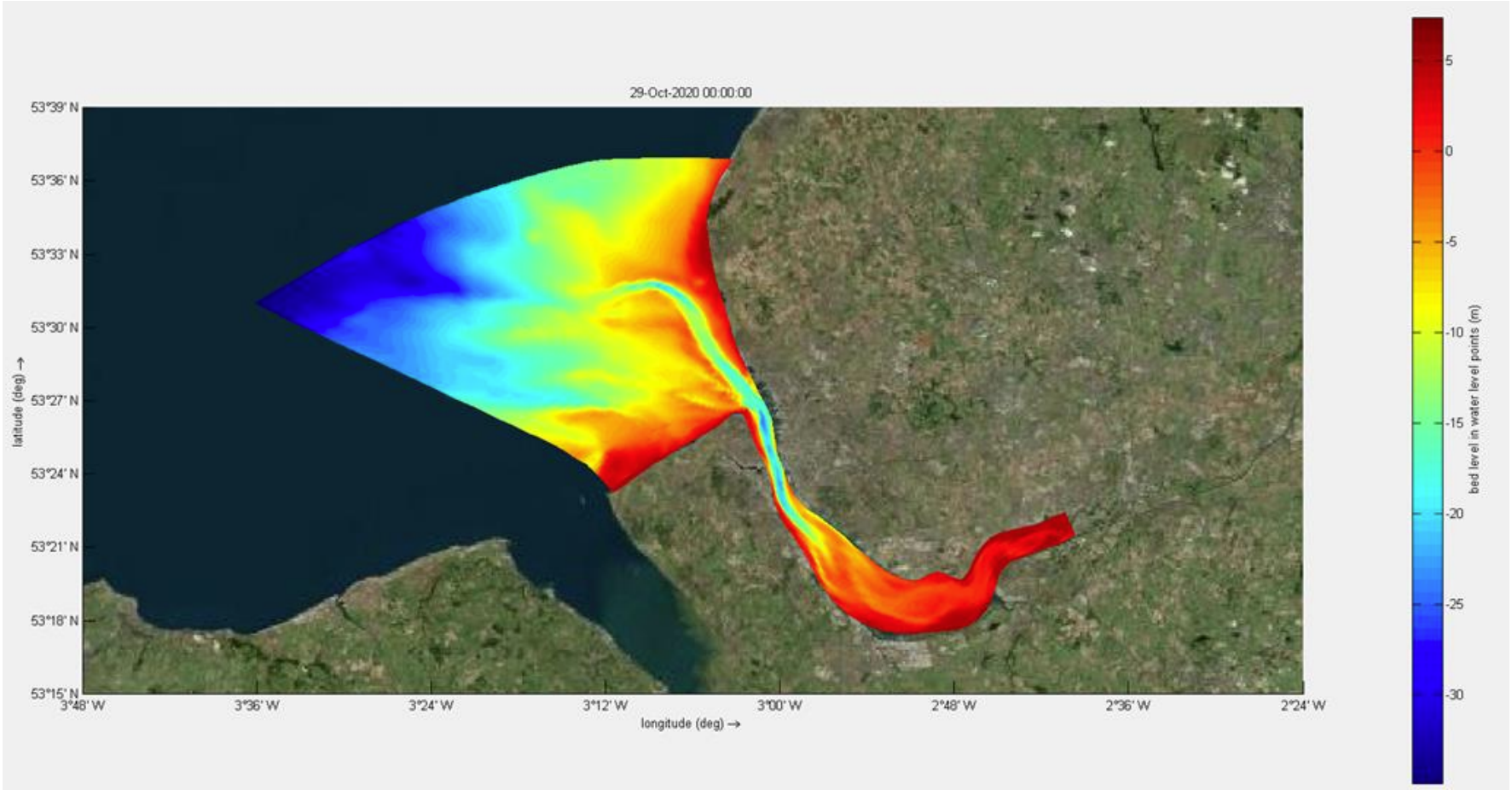
Study Area


N53°45'
N53°39'
N53°33'
N53°27'
N53°21'
N53°15'
N53°09'
W 4°06'
W 3°54'
W 3°42'
W 3°30'
W 3°18'
W 3°06'
W 2°54'
W 2°42'
W 2°30'
Crosby radar
L2 radar
Proposed New
Brighton radar
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat / Copernicus
Google Earth

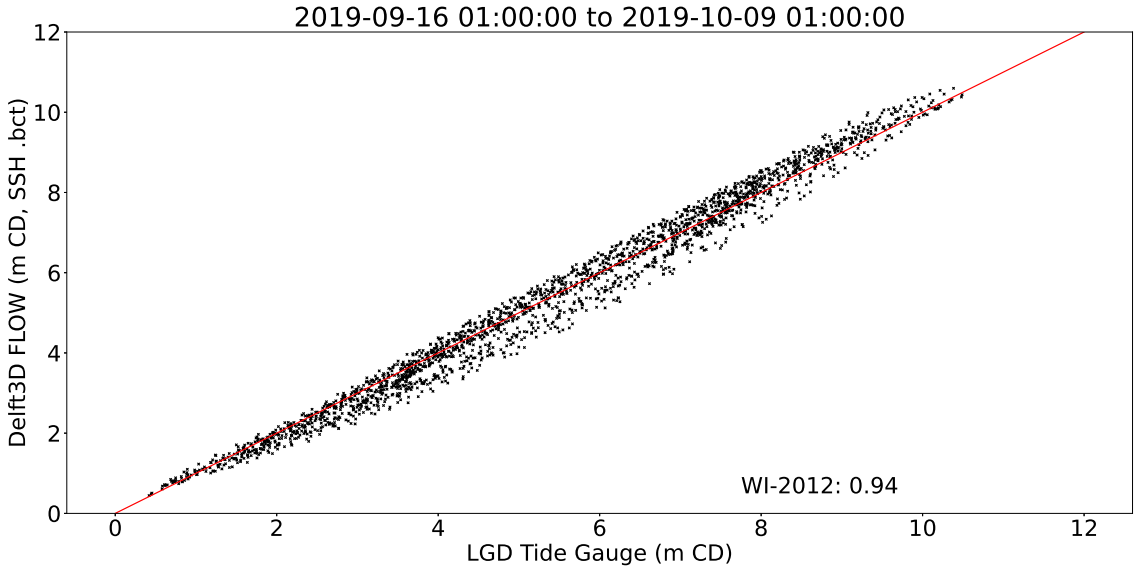
Delft3D: Liverpool Bay Curvilinear Grid

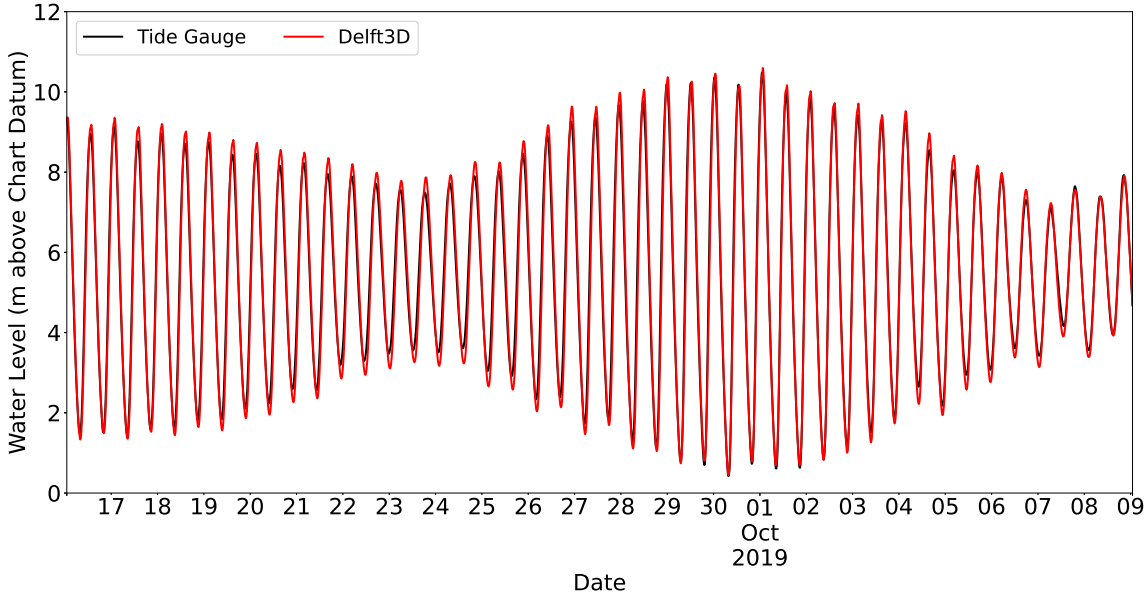


Delft3D: Bathymetry (EDINA)

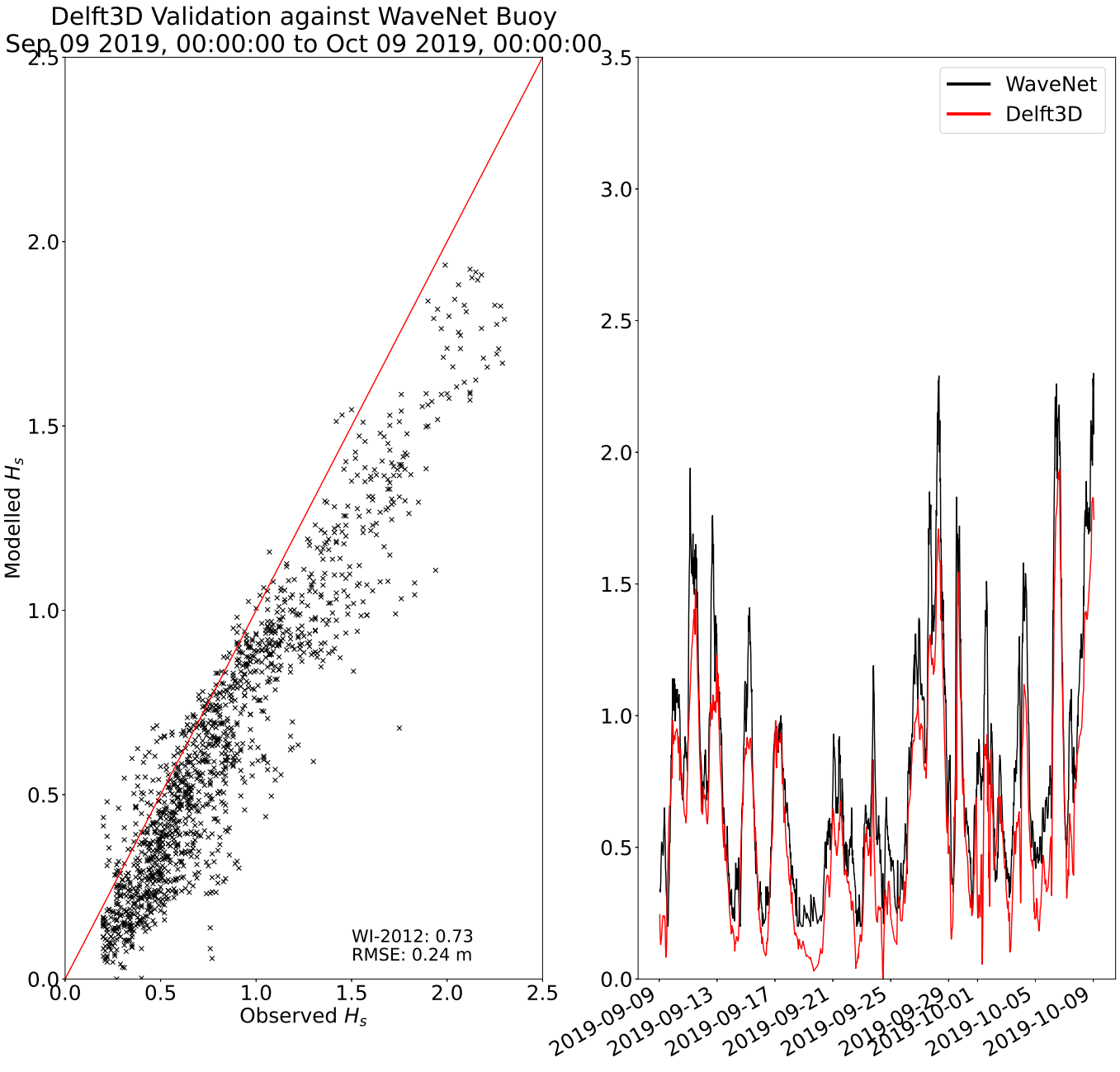


FLOW Validation: Sea Surface Height

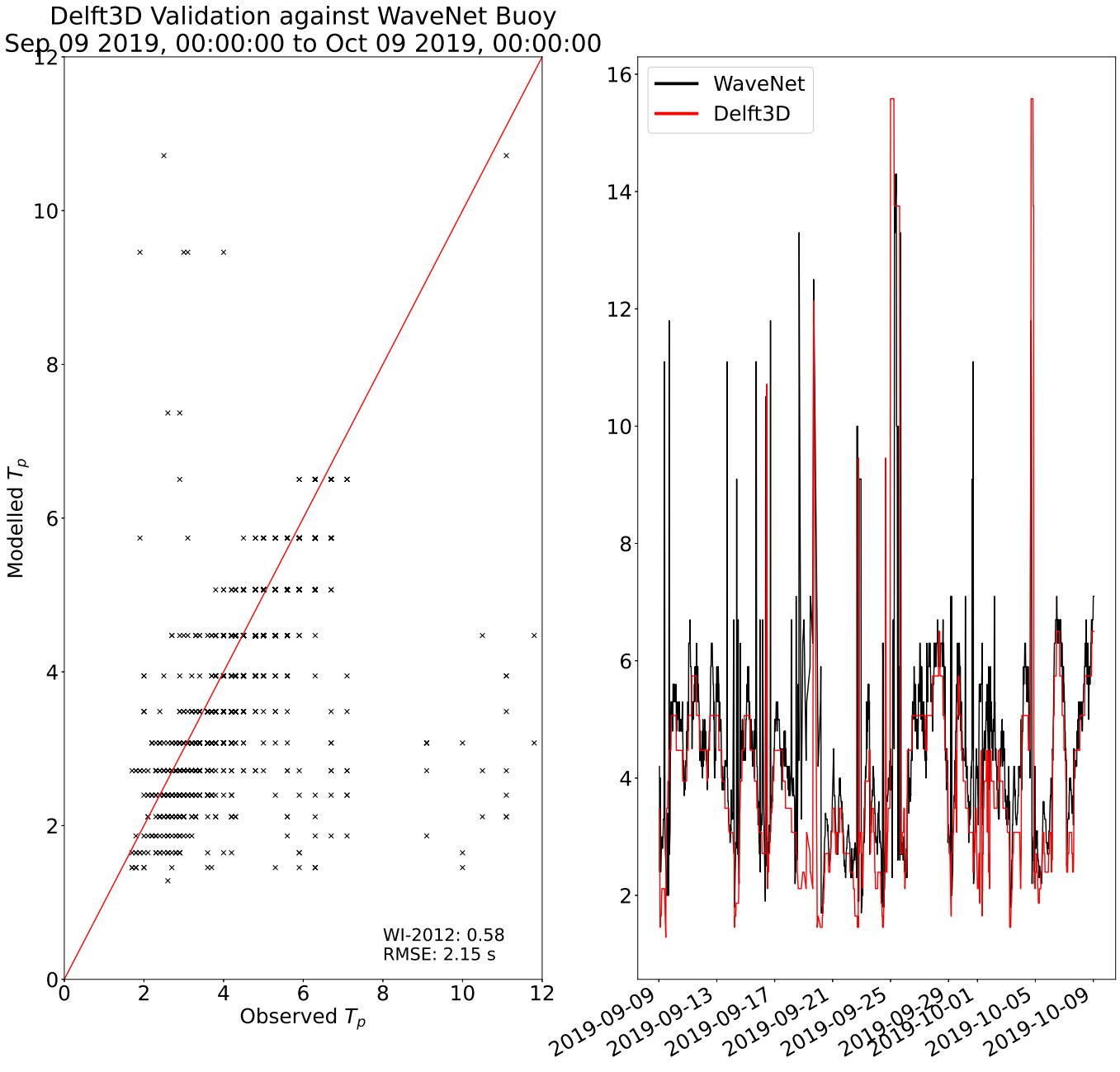




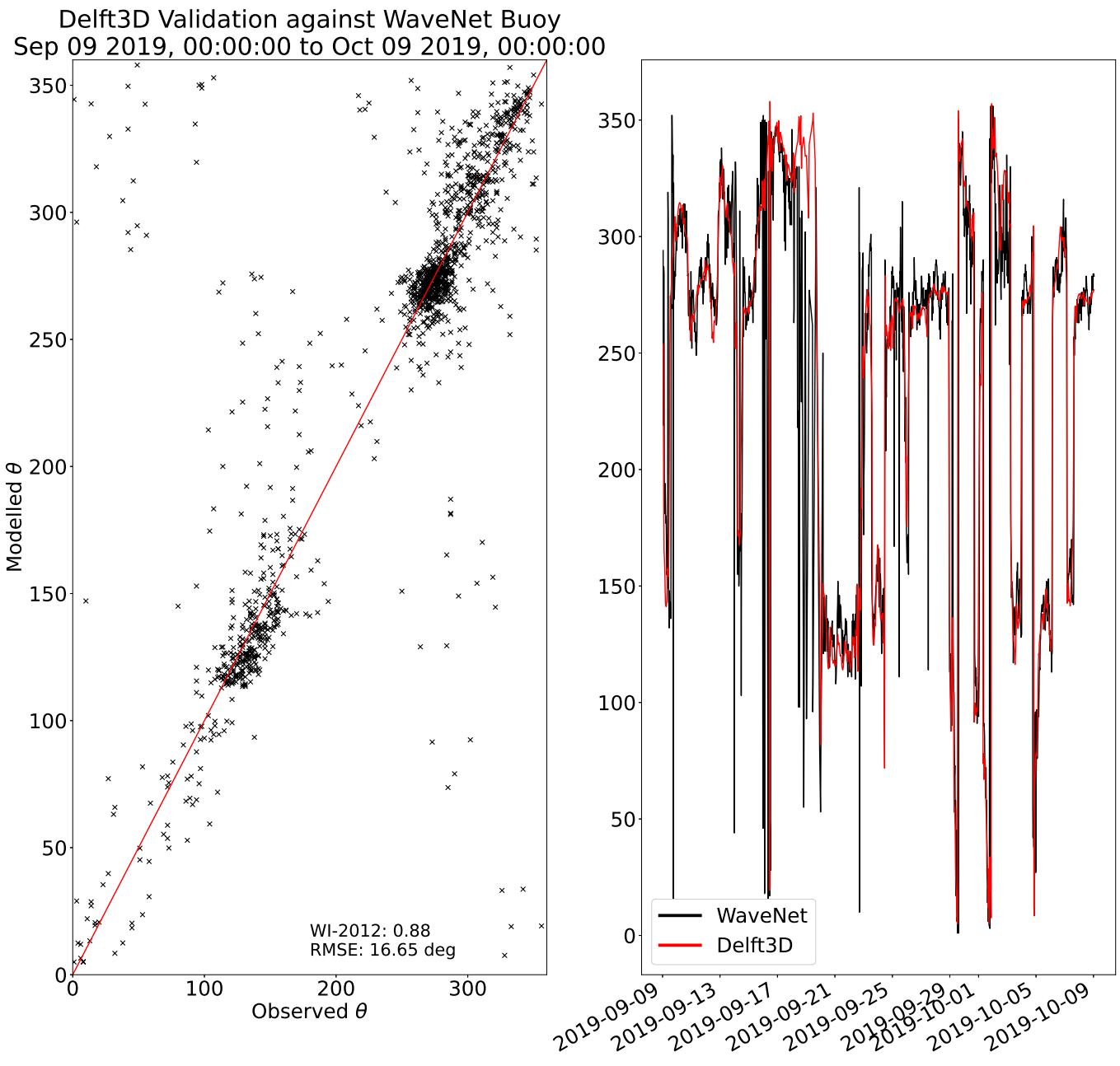
WAVE Validation: Significant Wave Height



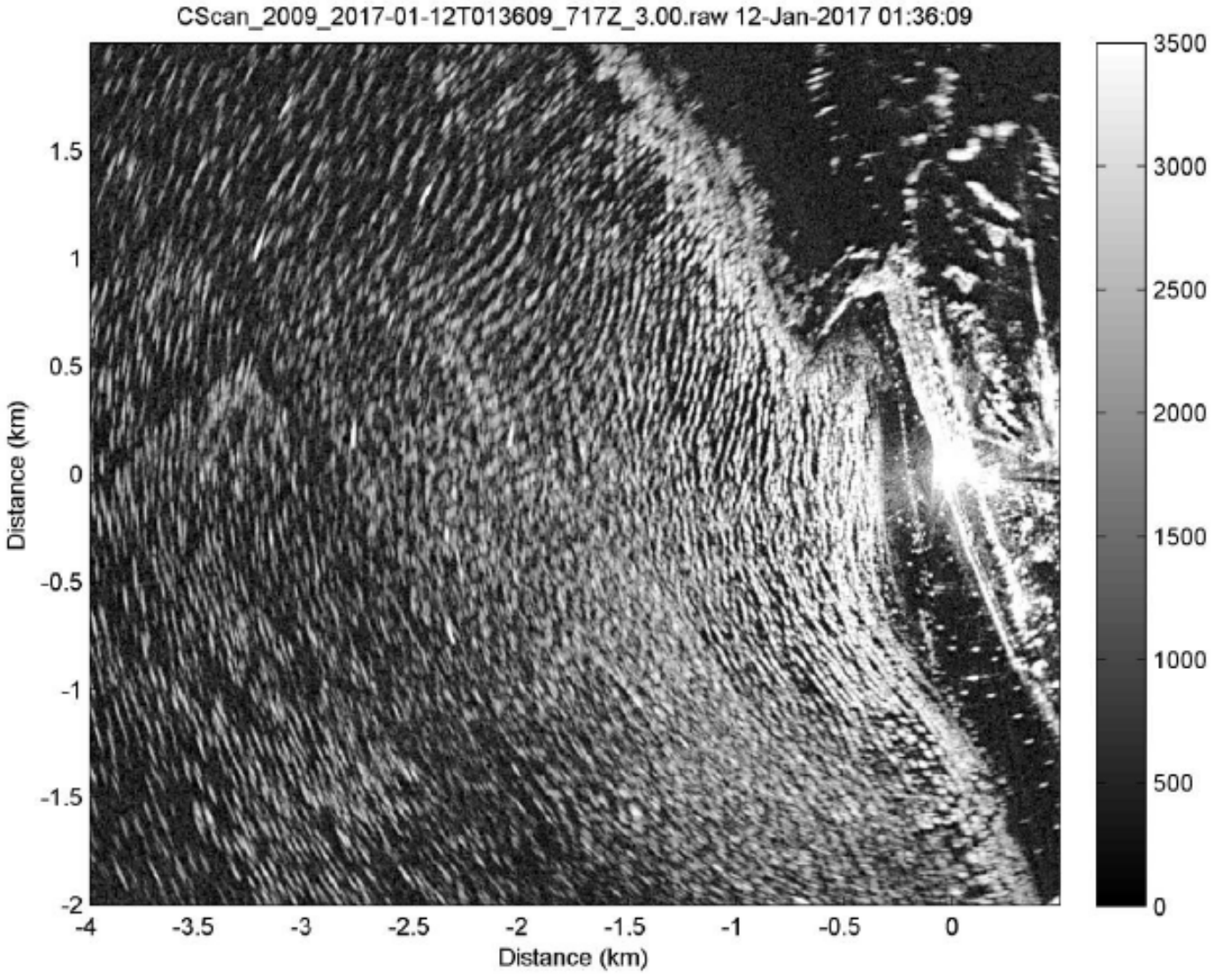
WAVE Validation: Peak Period



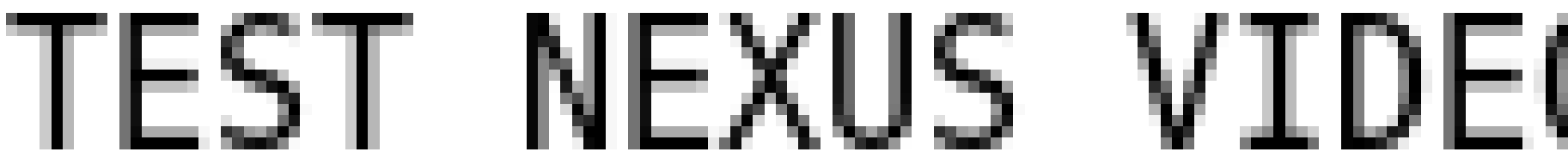
WAVE Validation: Peak Wave Direction



Radar


CScan_2009_2017-01-12T013609_717Z_3.00.raw 12-Jan-2017 01:36:09
Distance (km)
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-4
-3.5
-3
-2.5
-2
-1.5
-1
-0.5
0
Distance (km)
3500
3000
2500
2000
1500
1000
500
0

Wave Velocity Maps



Modal Time Series

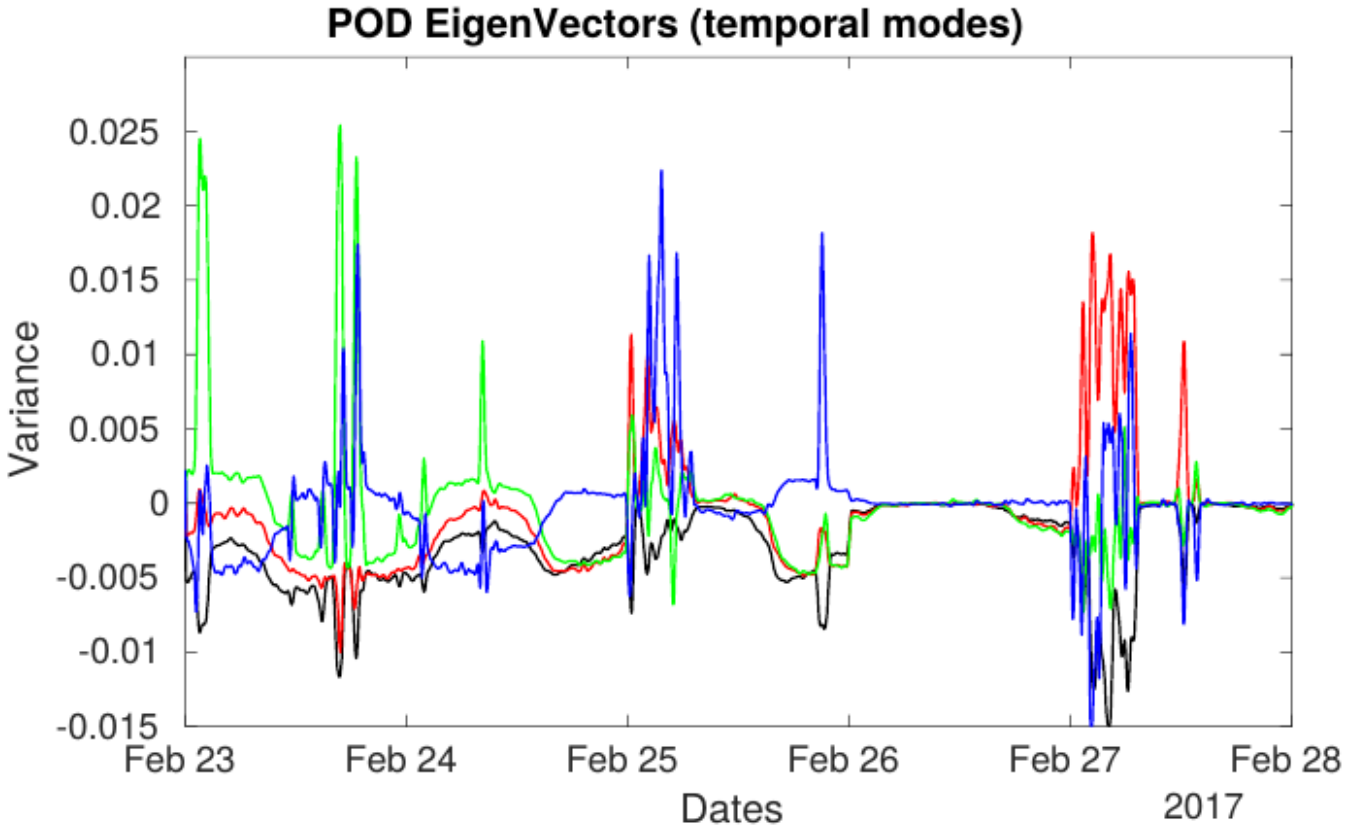


Figure 8: Time-series of first four leading POD Eigenvectors ('Temporal Modes') for the Data Nexus test period (23rd-27th Feb 2017). In order of significance, these are mode 1 (black), mode 2 (red), mode 3 (green), mode 4 (blue).

Take Home Messages and Future Work

- Modal decomposition can help infer processes that one technology cannot resolve in isolation.
- We use it to isolate 'modes' of behaviour that are attributed to changes in bathymetry.
- Future work will use machine learning to forward project bathymetric changes based on phenomena identified from the modal decomposition.
- This will form a near real-time, shore-based, cost effective system for ensuring safe port navigation.