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Determining Tidal Phase Differences from X-Band Radar Images

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Introduction

Previous work by Bell et. al. (2016) has developed a method using X-band marine radar to measure intertidal bathymetry, using the waterline as a level over a spring-neap tidal cycle. This has been used in the Dee Estuary to give a good representation of the bathymetry in the area. However, there are some sources of inaccuracy in the method, as a uniform spatial tidal signal is assumed over the entire domain.

Motivation

The method used by Bell et. al. (2016) applies a spatially uniform tidal signal to the entire domain. This fails to account for fine-scale variations in water level and tidal phase. While methods are being developed to account for small-scale water level variations using high resolution modelling, a method to determine tidal phase variations directly from the radar intensity images could be advantageous operationally.

Methods

The tidal phase has been computed using two different methods, with hourly averaged images from 2008. In the first method, the cross-correlation between each raw pixel time series and a tidal signal at a number of lags is calculated, and the lag with the highest correlation to the pixel series is recorded. For the second method, the same method of correlation is used on signals generated by tracking movement of buoys, which show up strongly in the radar image as they move on their moorings with the tidal currents. There is a broad agreement between the two methods, but validation is needed to determine the relative accuracy. The phase has also been calculated using a Fourier decomposition, and agrees broadly with the above methods. Work also needs to be done to separate areas where the recorded phase is due to tidal current (mostly subtidal areas) or due to elevation (mostly the wetting/drying signal in intertidal areas), by classifying radar intensities by the phases and amplitudes of the tides. Filtering out signal variations due to wind strength and attenuation of the radar signal will also be applied.

Validation

Validation will be attempted using data from a POLCOMS-WAM model run for Liverpool Bay at 180m resolution for February 2008 (Brown, 2011), and ongoing work to develop a model at 5m resolution using DELFT3D-FLOW. There are also a series of ADCP and other direct measurements of tidal current and elevation available, although periods of measurement do not all overlap. However, this could still be used for some validation.

Conclusion

While this work is in very early stages, it could present a method to determine fine-scale variations in tidal phase without a network of current recorders, and an improvement in the accuracy of bathymetric methods using X-band Radar.

References

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