Swansea University
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WTIMTS

Wave and turbulence interaction and measurement at tidal sites

End of project summary

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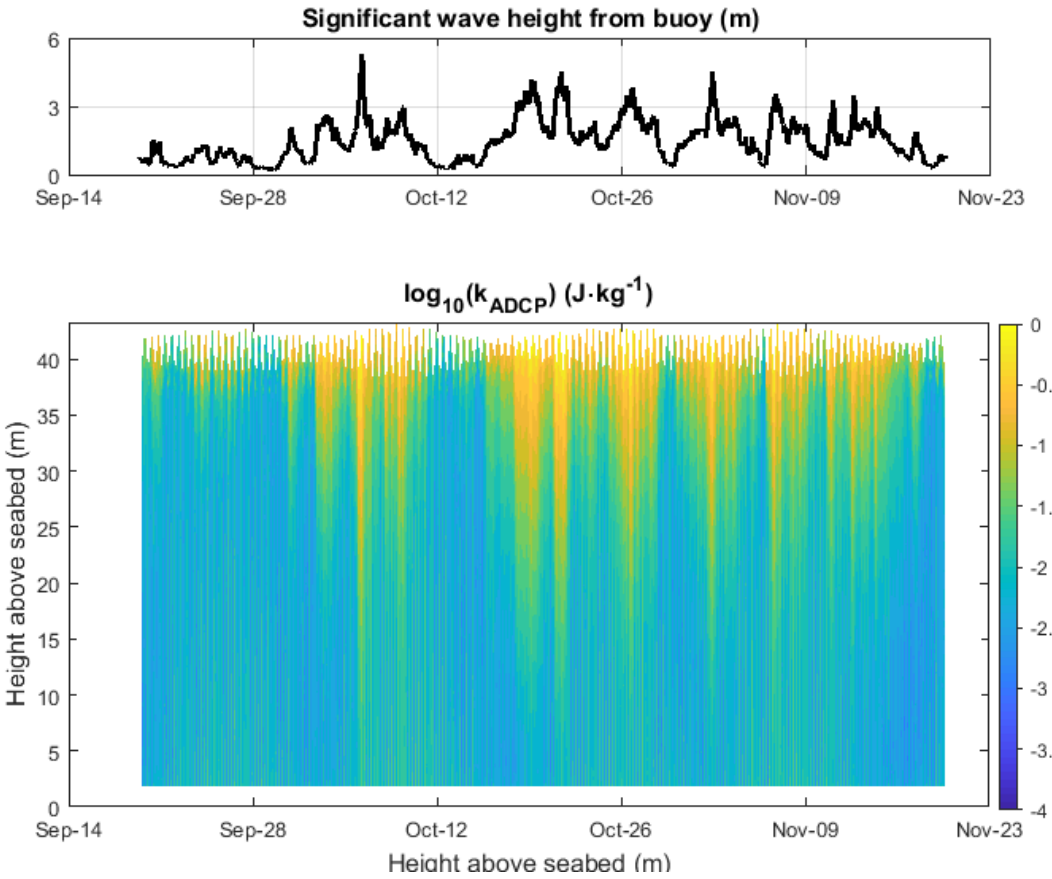
What need does WTIMTS address?

- ADCPs are the most important tool for measuring turbulence at tidal energy sites
- However, it is difficult for an ADCP to distinguish real turbulence from wave-related pseudo-turbulence
- At sites with significant waves, estimates of turbulent kinetic energy *k* can be two orders of magnitude above the true level
- WTIMTS addresses the need for a consistent, broadly-applicable method to separate wave & turbulence effects



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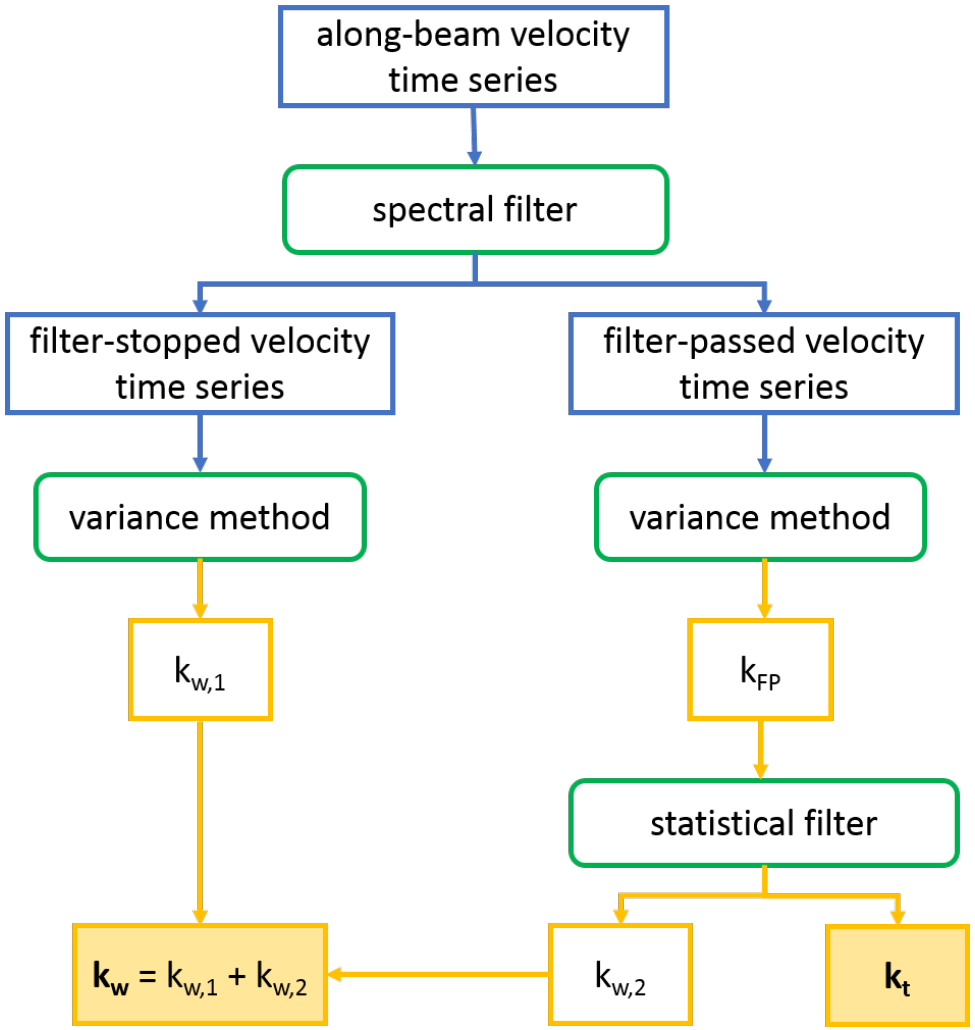
How does WTIMTS address this?

- Previous solutions have used one of two properties of waves measured by ADCPs:
  - They are spectrally local, *OR*
  - They are correlated with other wave estimates
- This has motivated either a *spectral* or *statistical* filtering approach
- However, there is no technical barrier to using both types of filter: WTIMTS improves on past efforts using a combined filter
- A spectral filter partially isolates wave activity from velocity records, then a statistical filter is applied to the whole record of *k* values



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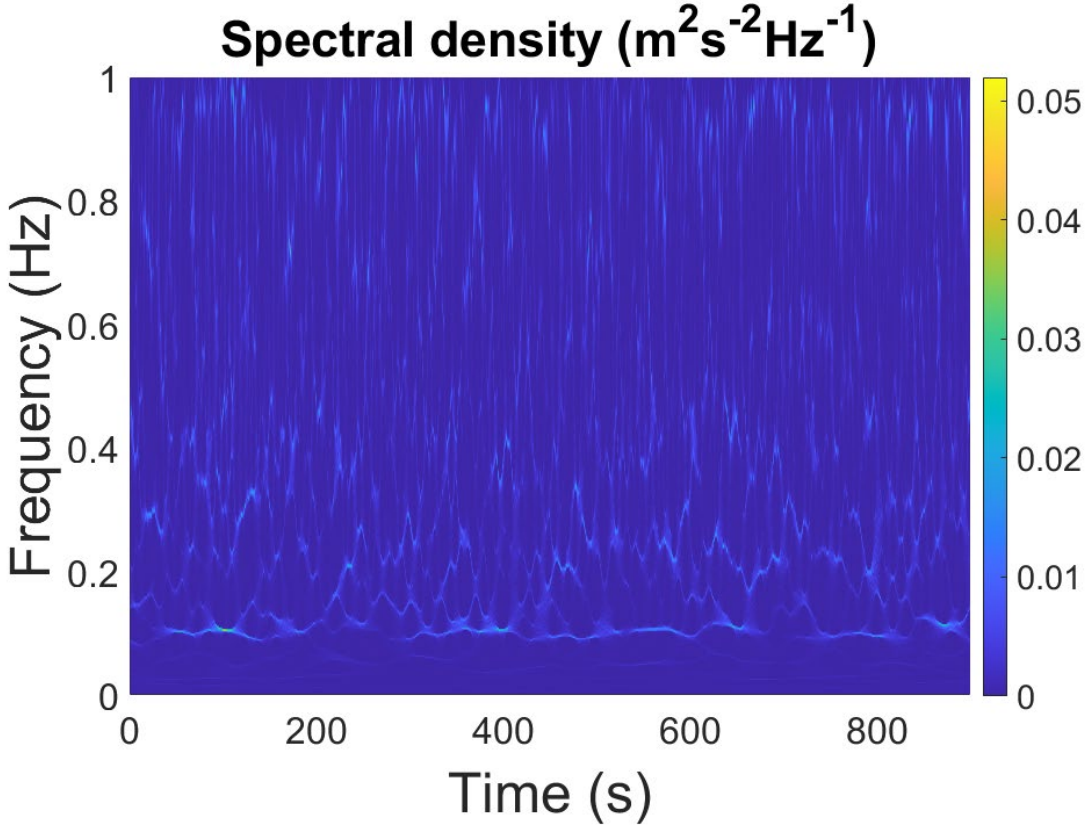
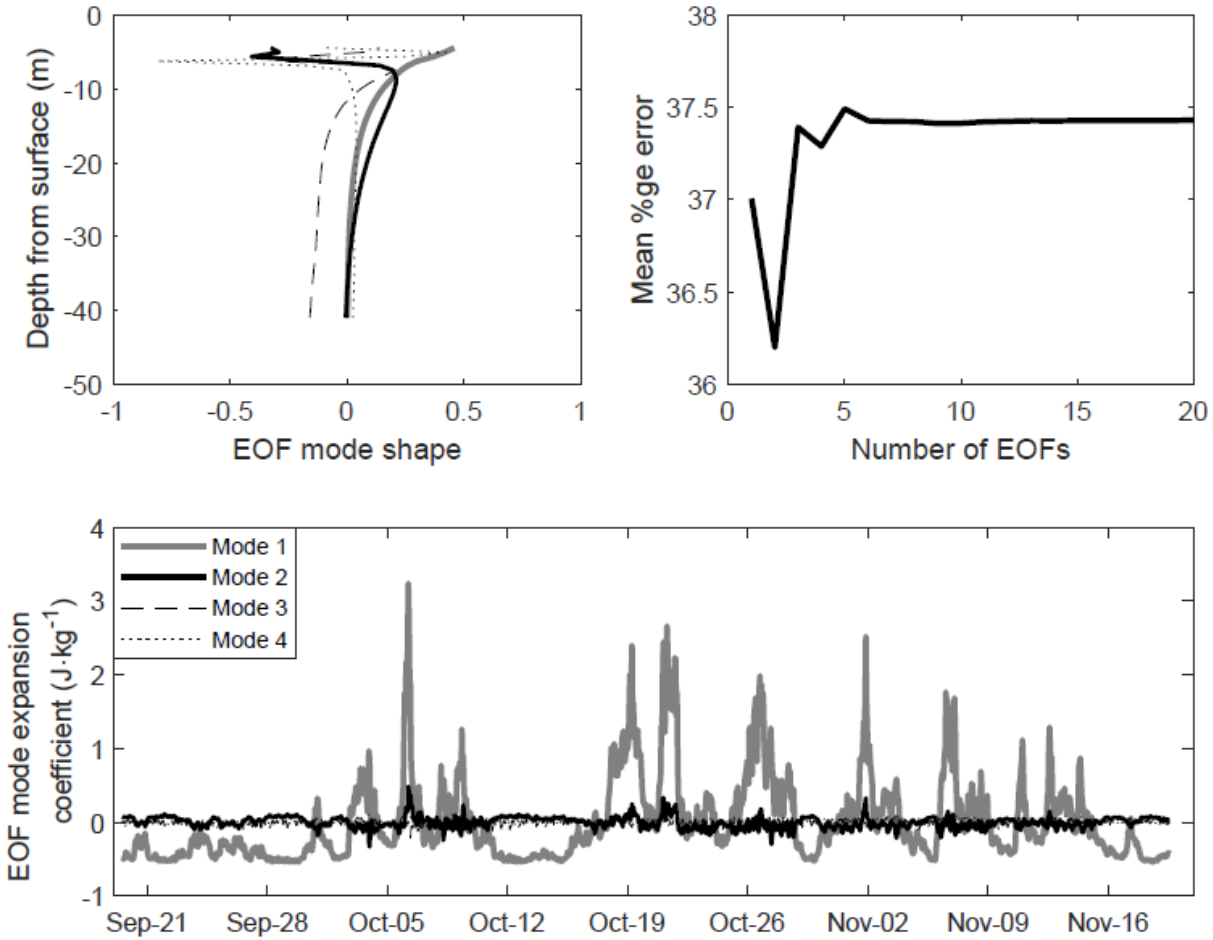
How does the spectral filter work?

- A wavelet synchro-squeeze transform is used to obtain a periodogram-like representation of the spectral peaks for short bursts of velocity measurements (typically 15 minutes)
- We find the peak at each moment in time, decide if it is wave-related, and if it is we apply a band-stop filter at that frequency
- The stopped velocities contain only wave activity, the passed velocities contain turbulent activities with a remainder of waves



How does the statistical filter work?

- Empirical orthogonal function analysis separates the calculated *k* values into a sum of space and time modes
- The largest modes explain the largest proportion of the autocovariance
  - If waves dominate, they will be very strongly associated with the first mode
  - This can be confirmed by correlation of first mode with other wave measures
- Subtracting the first mode therefore removes most remaining wave effects



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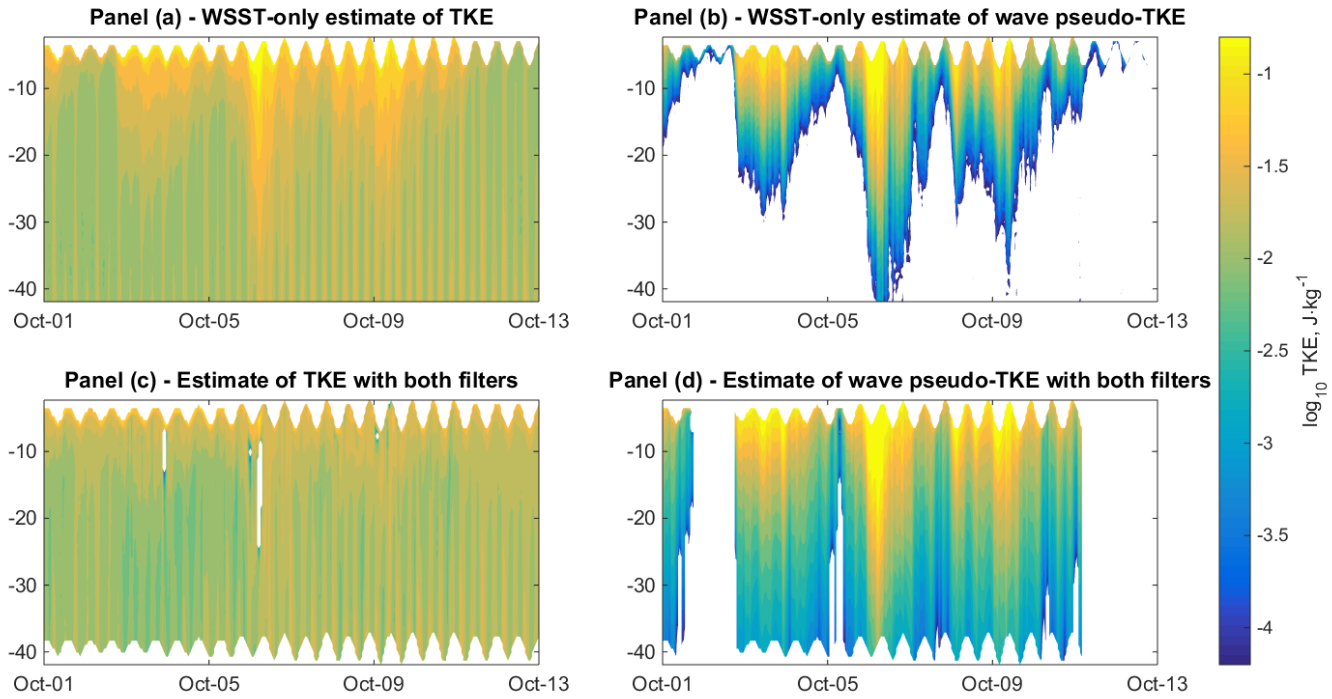
How well does the filter perform?

- Compared to both single-filter methods, the combined filter clearly improves removal of wave influence from estimated *k*:
  - Near-surface maxima are reduced
  - Removal of strong wave events is more complete
- Wave-driven pseudo-*k* is also more satisfactory:
  - No significant semidiurnality
  - Correctly vanishes at times of low wave action



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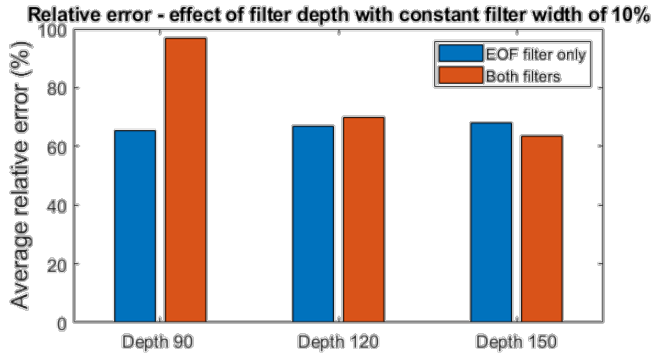
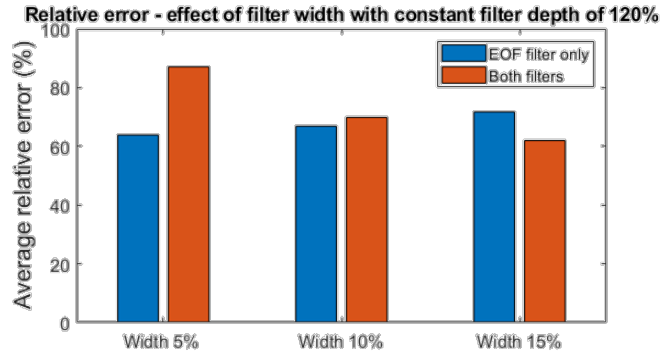
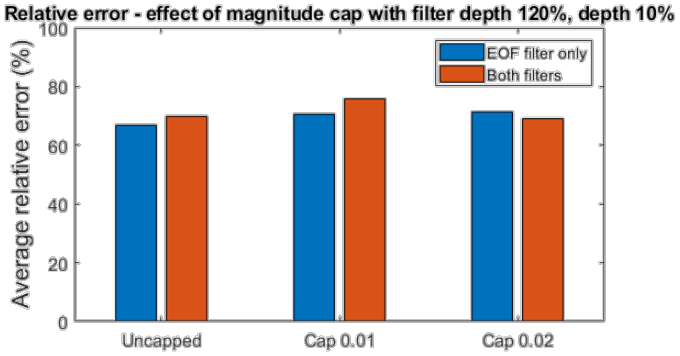
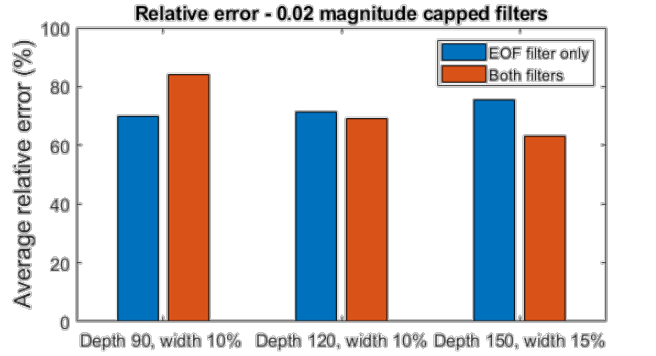
How well does the filter perform?

- As well as qualitative assessment, if we have independent wave data we can quantify the improvement in estimates of wave pseudo-*k*
- More aggressive spectral filters (covering a wider frequency range and removing more power) show better improvements
- Improvement in *k* cannot be directly quantified, because independent estimates of *k* are not available









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What happens next?

- The code for the filter has been documented and made freely available:
  github.com\MTogn\WTIMTS
- Virtual velocity data could allow quantifying filter improvement in estimates of *k*
- Analyse data from other sites to see how method performs at more/less sheltered locations