

WTIMTS

Wave and Turbulence Interaction and Measurement at Tidal Sites

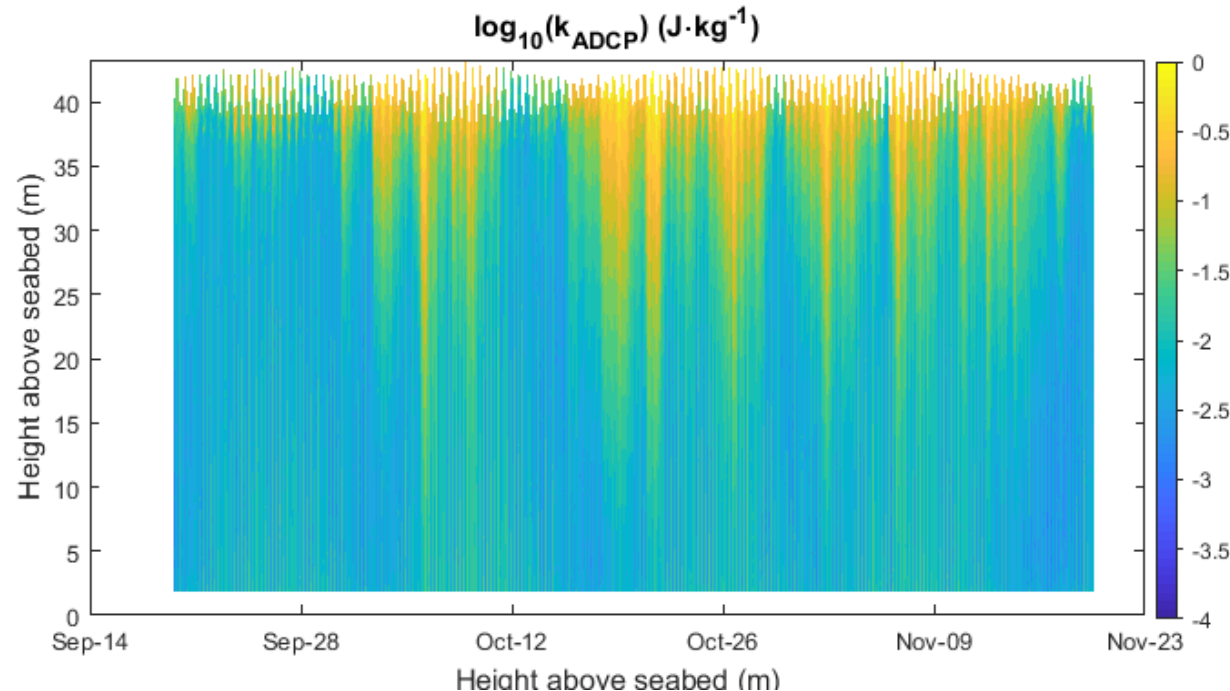
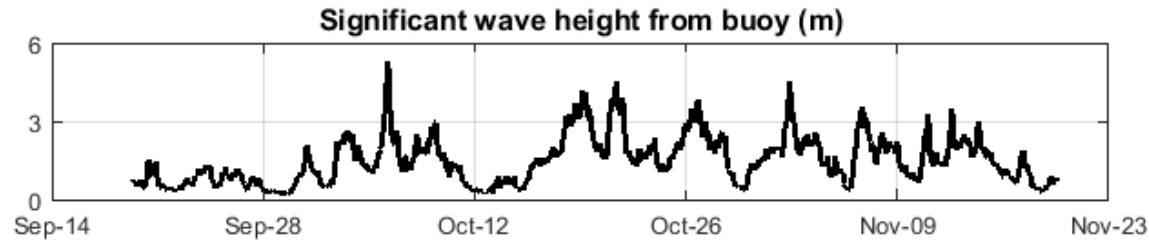
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Contents

- What is the problem with measuring turbulence?
 - Why is it waves?
- Separating turbulence and waves:
 - Spectral filter – wavelet synchrosqueezed transforms
 - Statistical filter – empirical orthogonal function analysis
 - Combined filter
- Assessing filter performance

Turbulent kinetic energy k

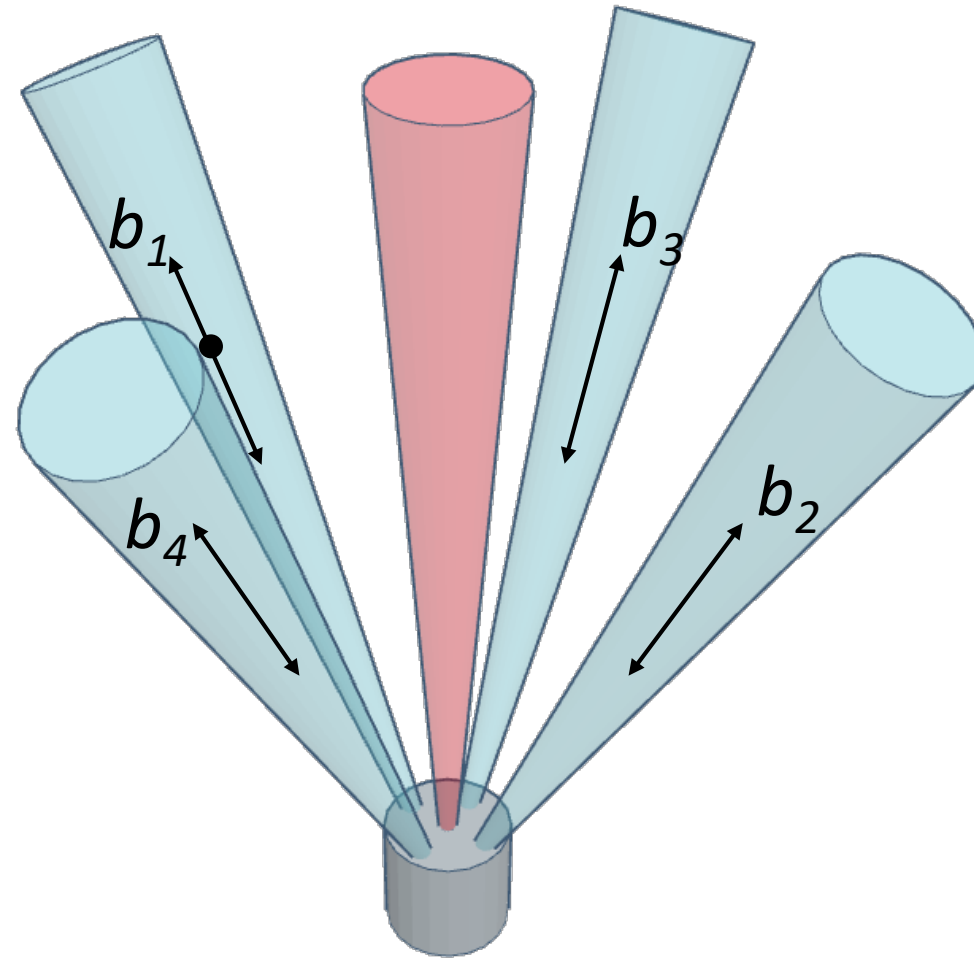


- Wave action is clearly driving near-surface k_{ADCP}
- We therefore observe that k_{ADCP} measures both turbulence and waves

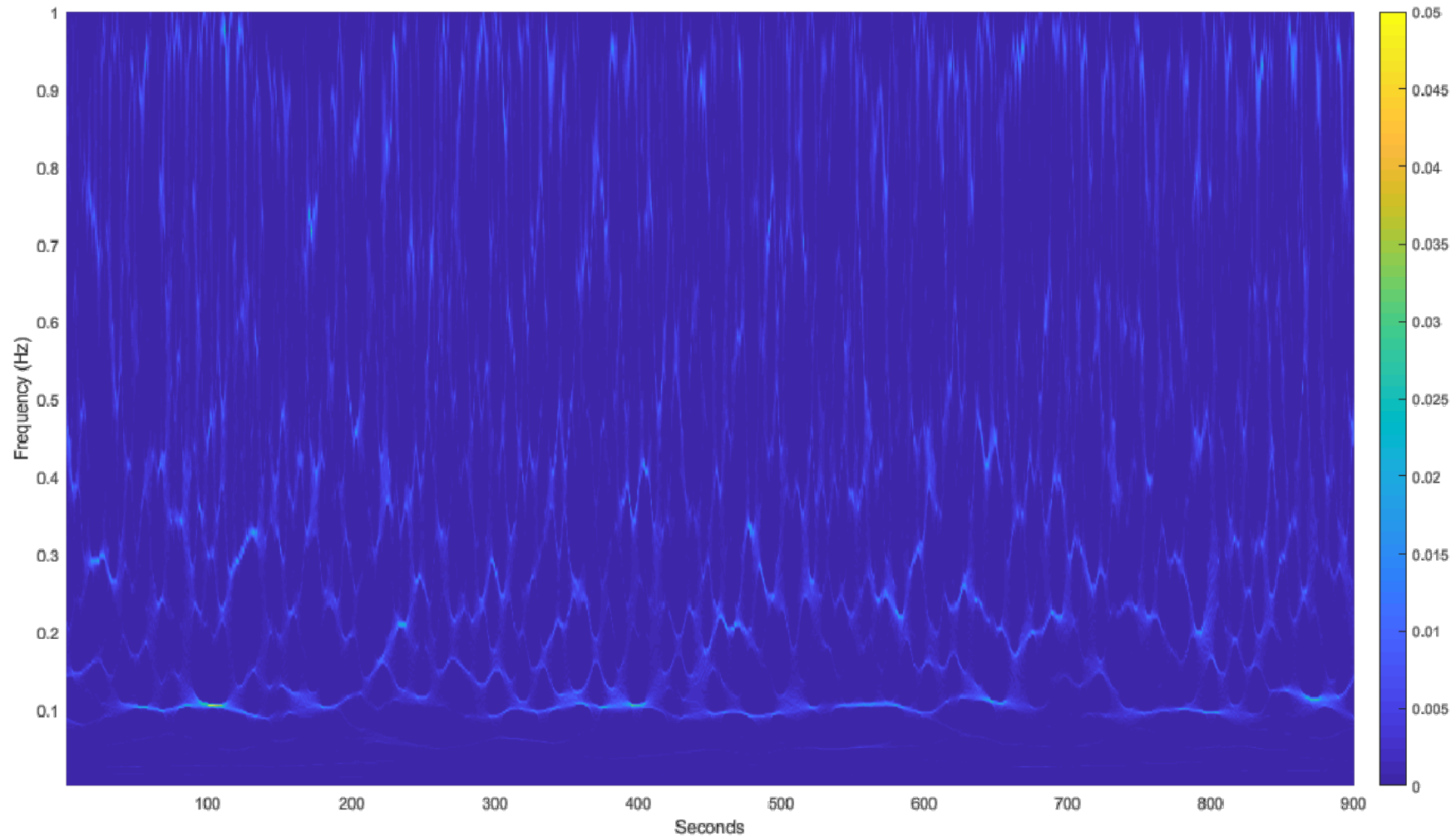
$$k_{ADCP} = k_t + k_w$$

- We want a filter to separate these phenomena

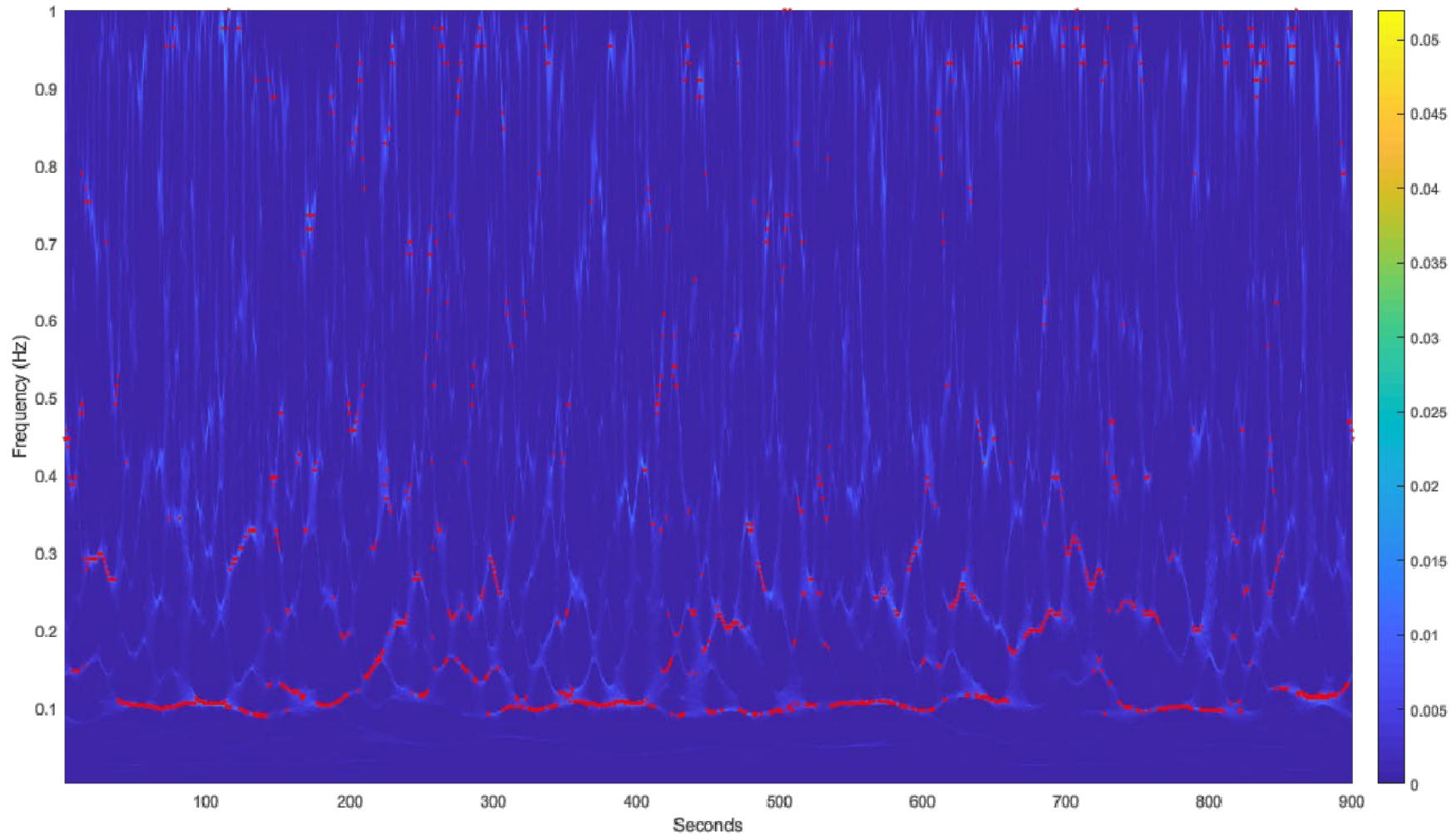
Spectral filter



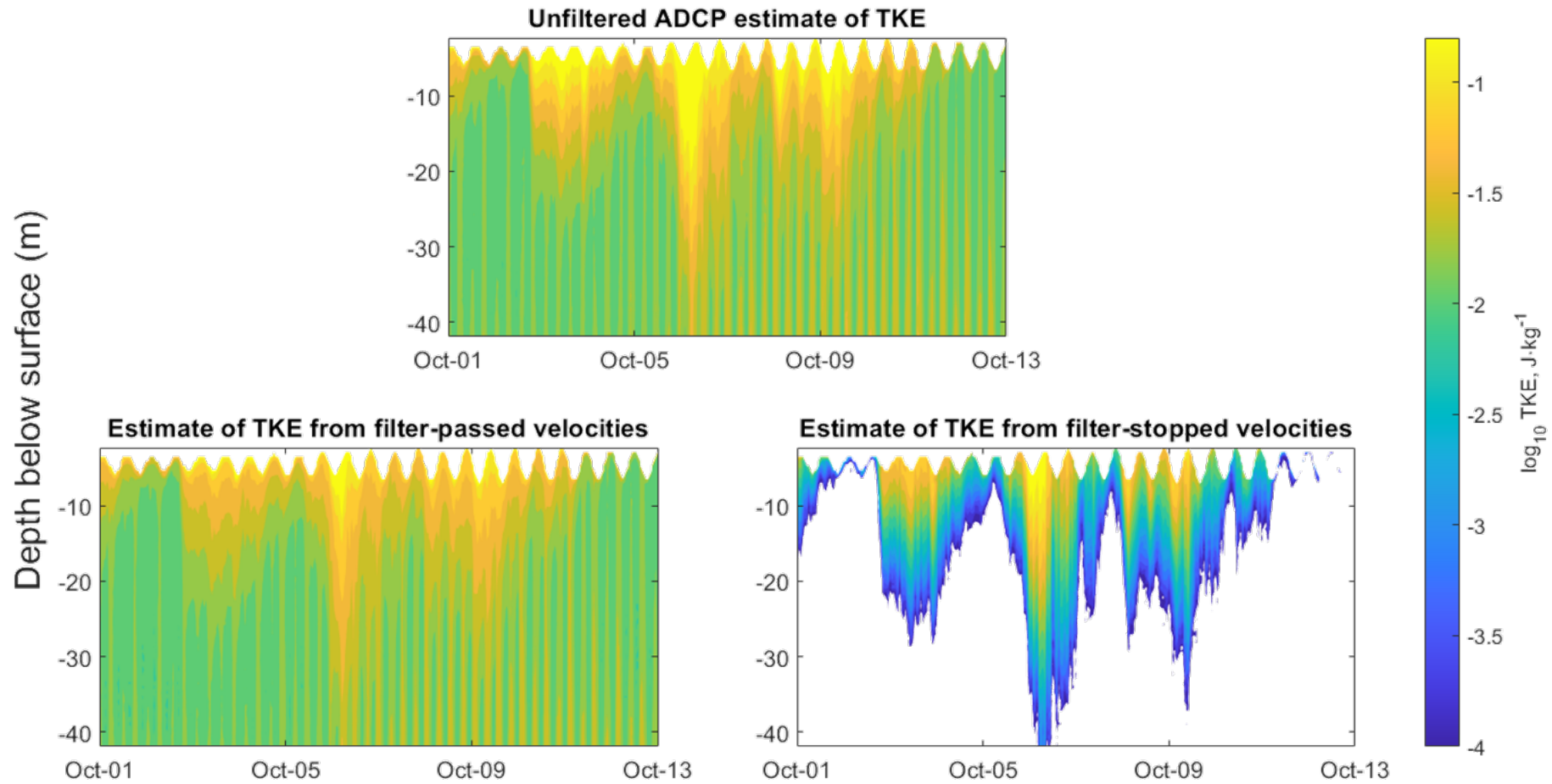
Wavelet synchro-squeeze



What to filter?



Spectral filter results



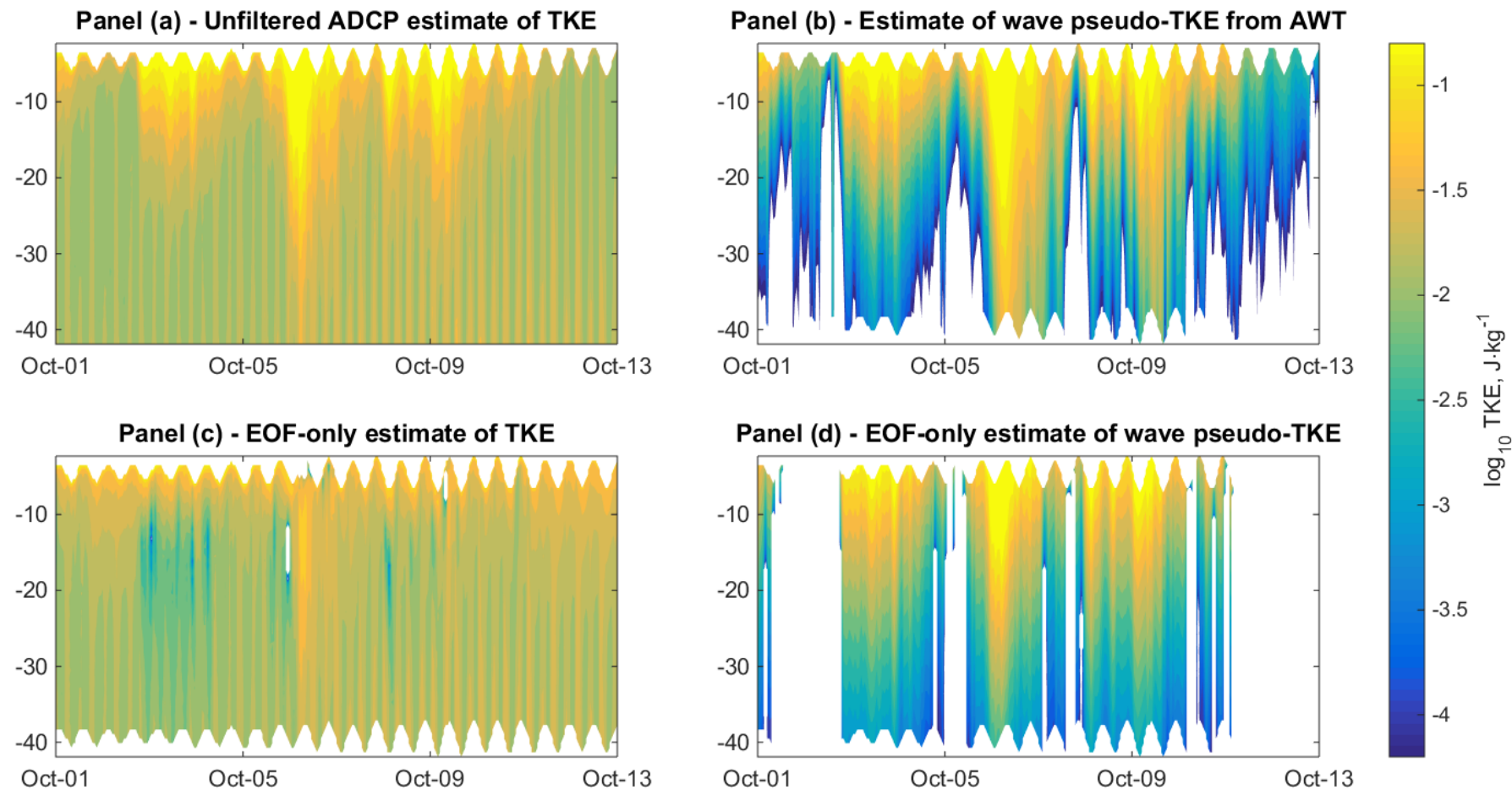
Statistical filter - EOFs

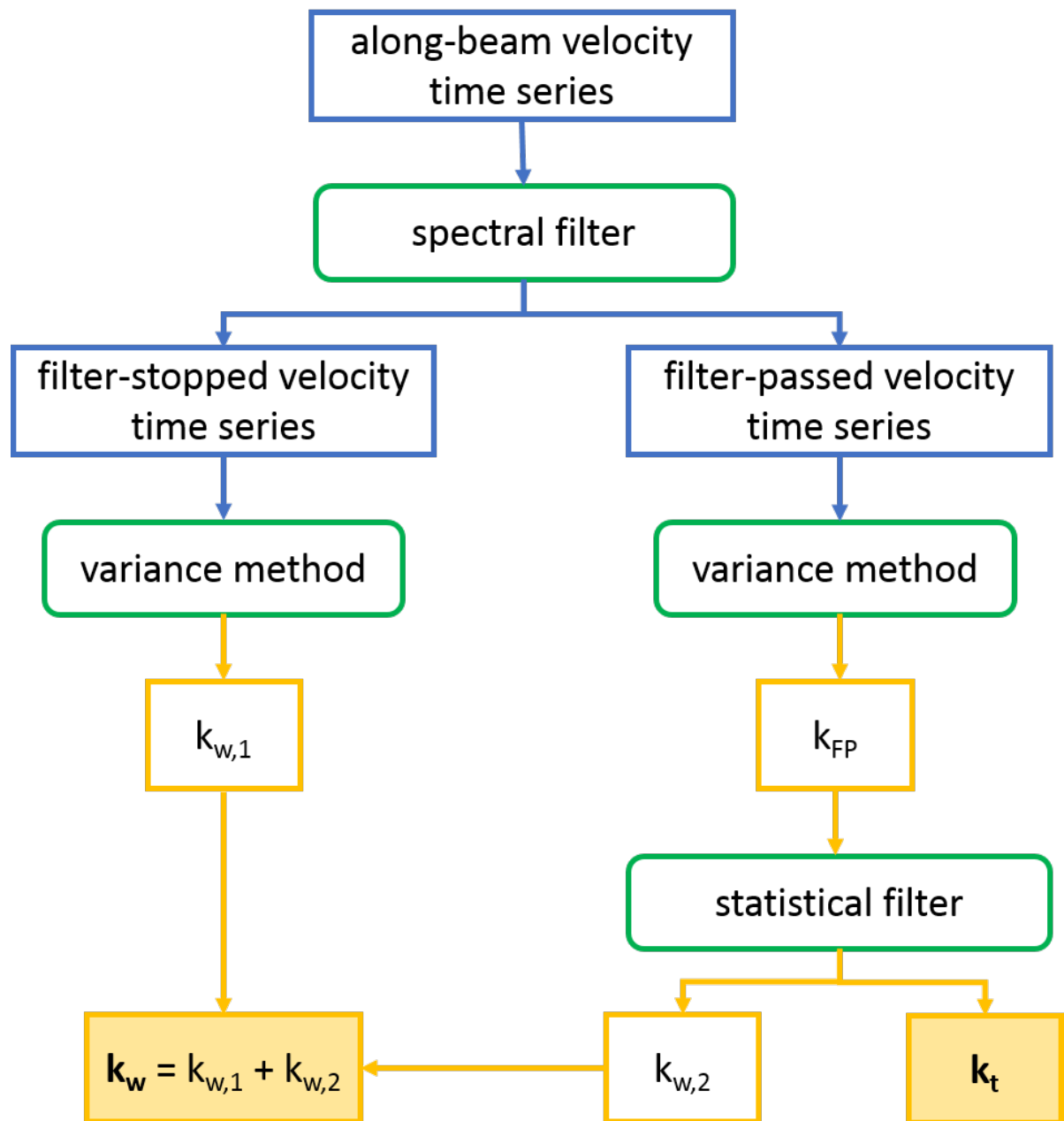
- Decompose space- & time-dependent variable (e.g., TKE) into separate time and space modes

$$\tilde{k}(\mathbf{x}, t) = \sum_{i=1}^N \text{EOF}_i(\mathbf{x}) \times \text{EC}_i(t)$$

- Modes are ordered by magnitude of autocorrelation explained
- Waves are expected to have a common shape ($\sinh^2(z)$)
 - Therefore they could be picked out as a common mode
- If they are dominant, the “wave” mode should be the 1st mode
- Method modified to deal with mean bias

Statistical filter results

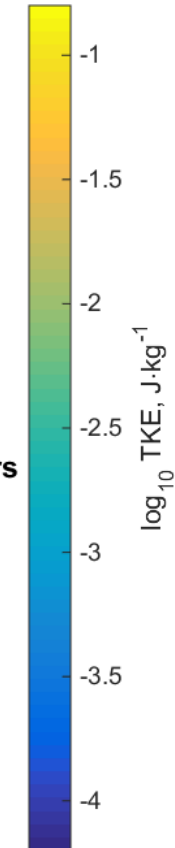
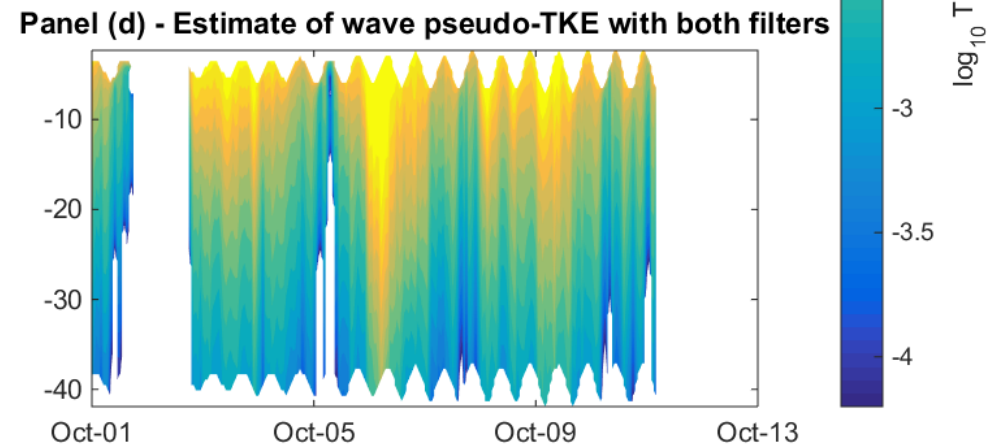
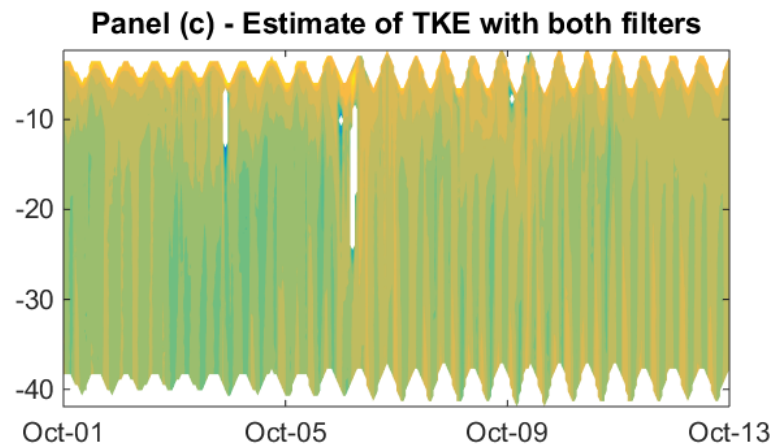
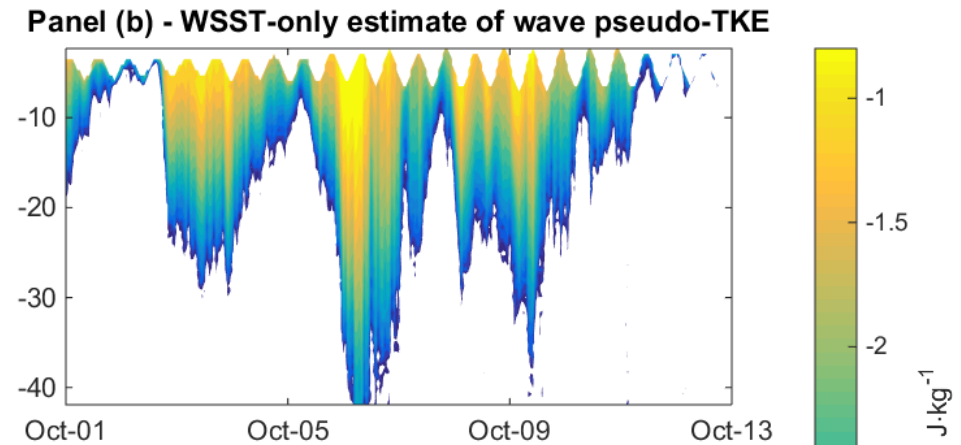
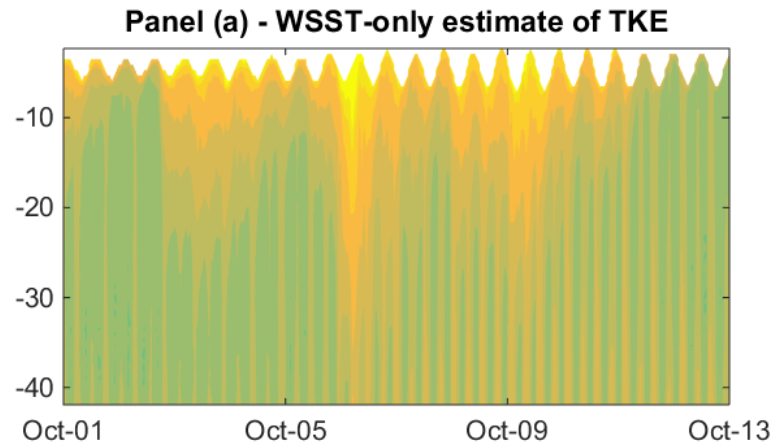




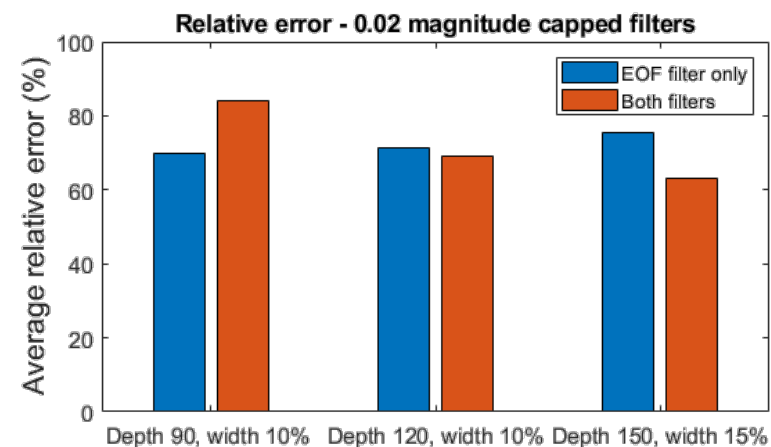
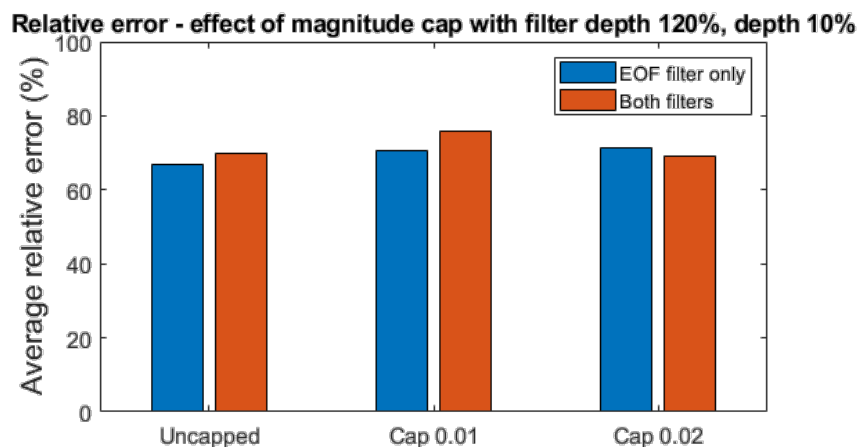
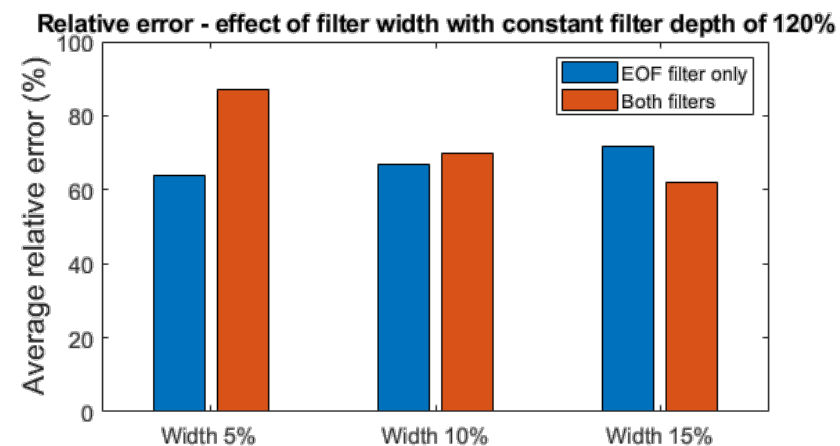
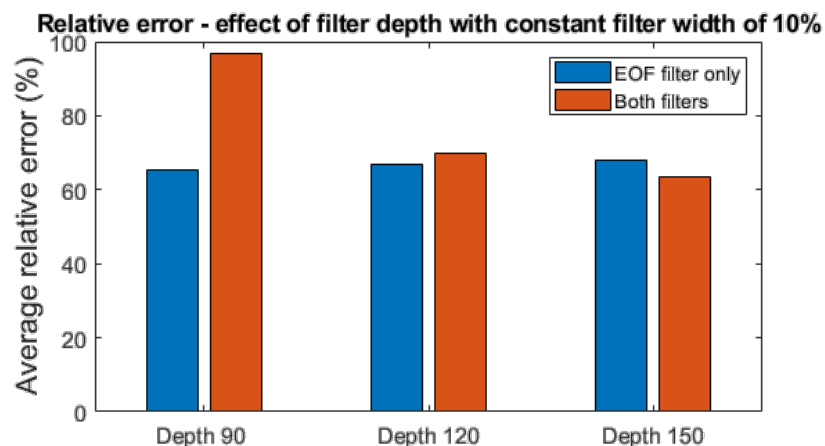
Combined filter

- Spectral/WSST filter and statistical/EOF filter apply on either side of the variance method
- Therefore combining the methods is straightforward

Combined filter



Combined filter



Conclusions

- A combined spectral-statistical filter for ADCP measurements of TKE has been developed:
 - Simple structure
 - Minimal computational cost
 - Improved error vs. waves
- Open source code available at github.com/MTogn/WTIMTS
 - User manual also available