

“Measurements of Surface Waves from SVP Drifter with ACM”

Peter Niiler and Luca Centurioni

The Scripps Institution of Oceanography

- Measure velocity and pressure relative to surface float with ACM
- Compute spectra of speed to identify swell and wind wave period
- Band pass data around spectral peaks and compute scatter diagram
- Identify direction of waves from pressure and velocity correlation
- Work on transfer function of pressure and velocity to wave height?

Wave Drifter with horizontal ACM attached at bottom of surface float



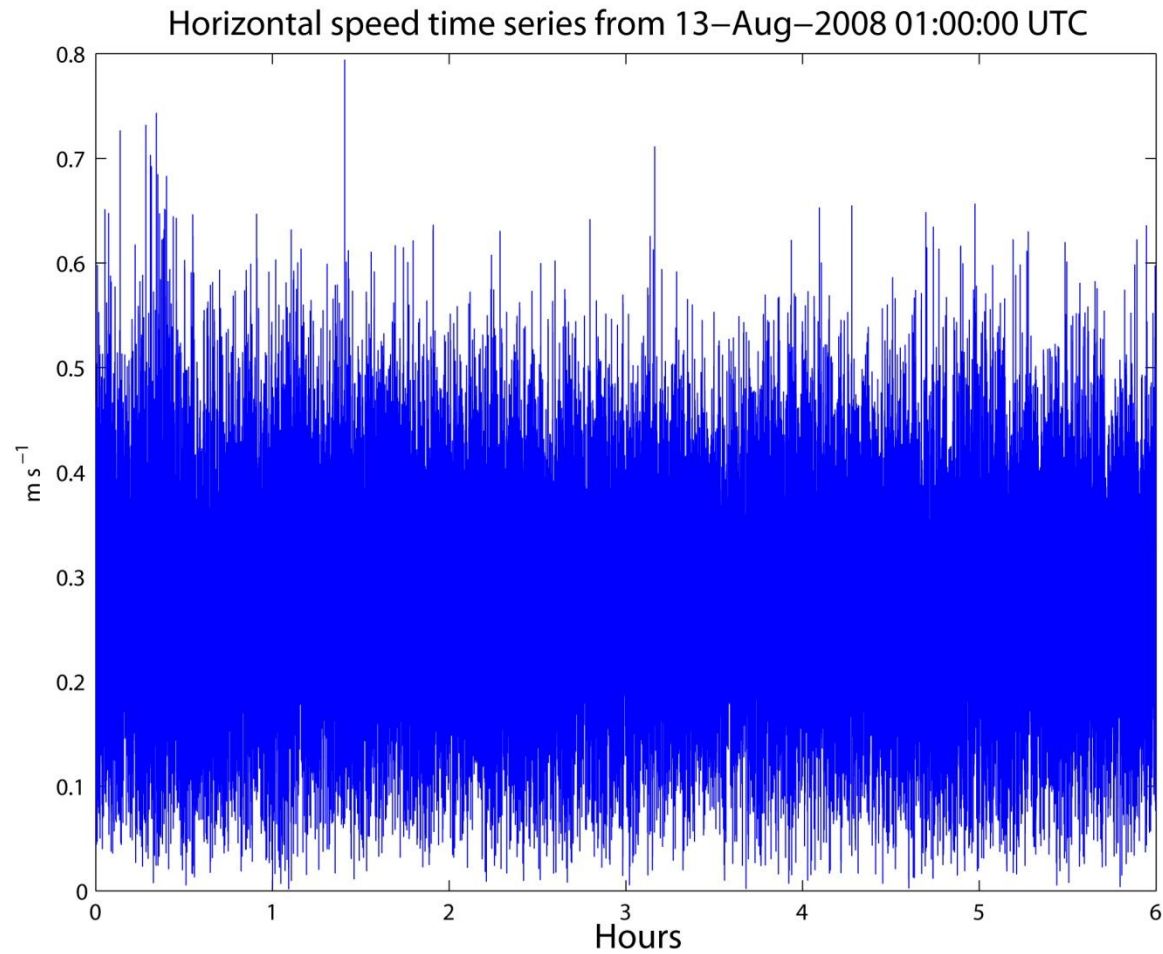
Location of SVP wave drifter on August 12-13, 2008, near NOAA buoy 46054



Sea state photo with drifter (red dot below horizon)



Raw time series of speed relative to drifter float



Summary of processing steps:

- 1) Compute cross-correlation between horizontal speed and pressure (from ADCP) and find a lag of 2 s. shift pressure backward by 2 seconds
- 2) Band-pass filter between 40 s and 2 s to remove the mean and lower frequencies
- 3) Compute power spectra to find swell and wind waves period
- 4) Use PUV method to find approximate direction of swell and wind waves. The method give only approximate results due to surface buoy going underwater as pulled by the drogue. Need to refine computation
- 5) Filter both swell and wind waves velocity signal with a band-pass filter centered at each frequency (~ 1 s bandwidth, 0db gain);
- 6) Compute direction from scatterplot (principal axis) and infer versus from PUV computation

The horizontal velocity of a deep water wave is:

$$u = a\omega e^{kx} \cos(kx - \omega t)$$

Therefo

$$\langle u^2 \rangle = \frac{(a\omega)^2}{2} \langle e^{2kx} \rangle$$

And, since these are deep water waves,

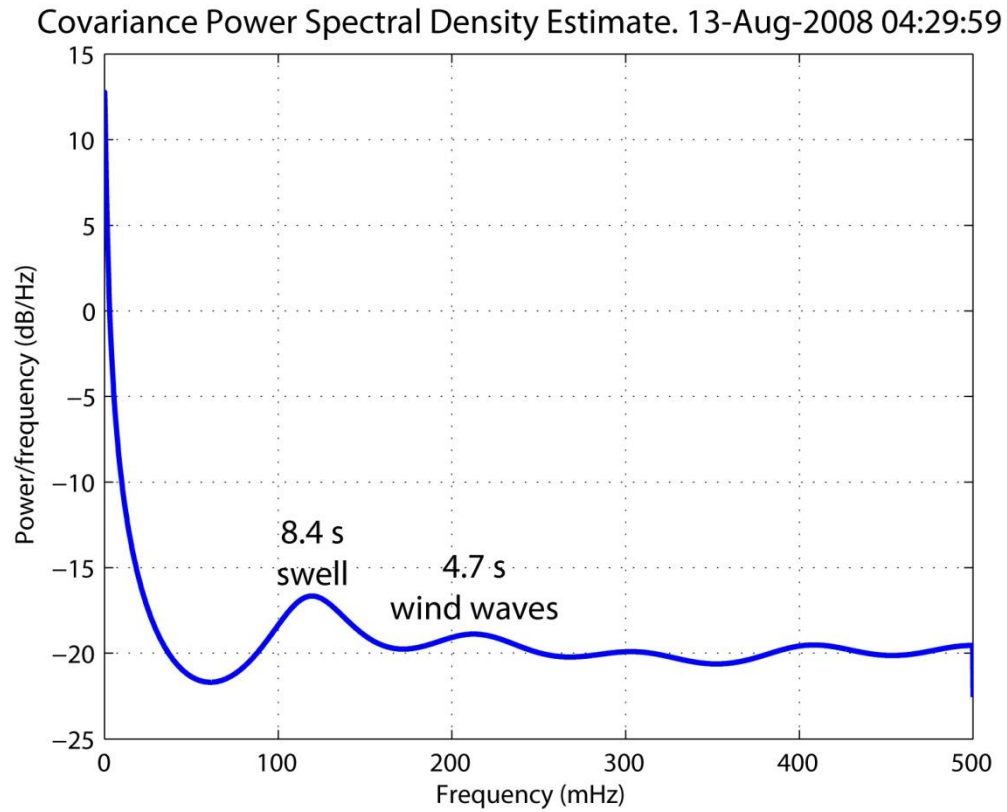
$$c = \frac{\lambda}{T} = \sqrt{\frac{g}{k}}$$

$$k = \frac{4\pi^2}{gT^2}$$

For a drifter fitted with and adcp we will have:

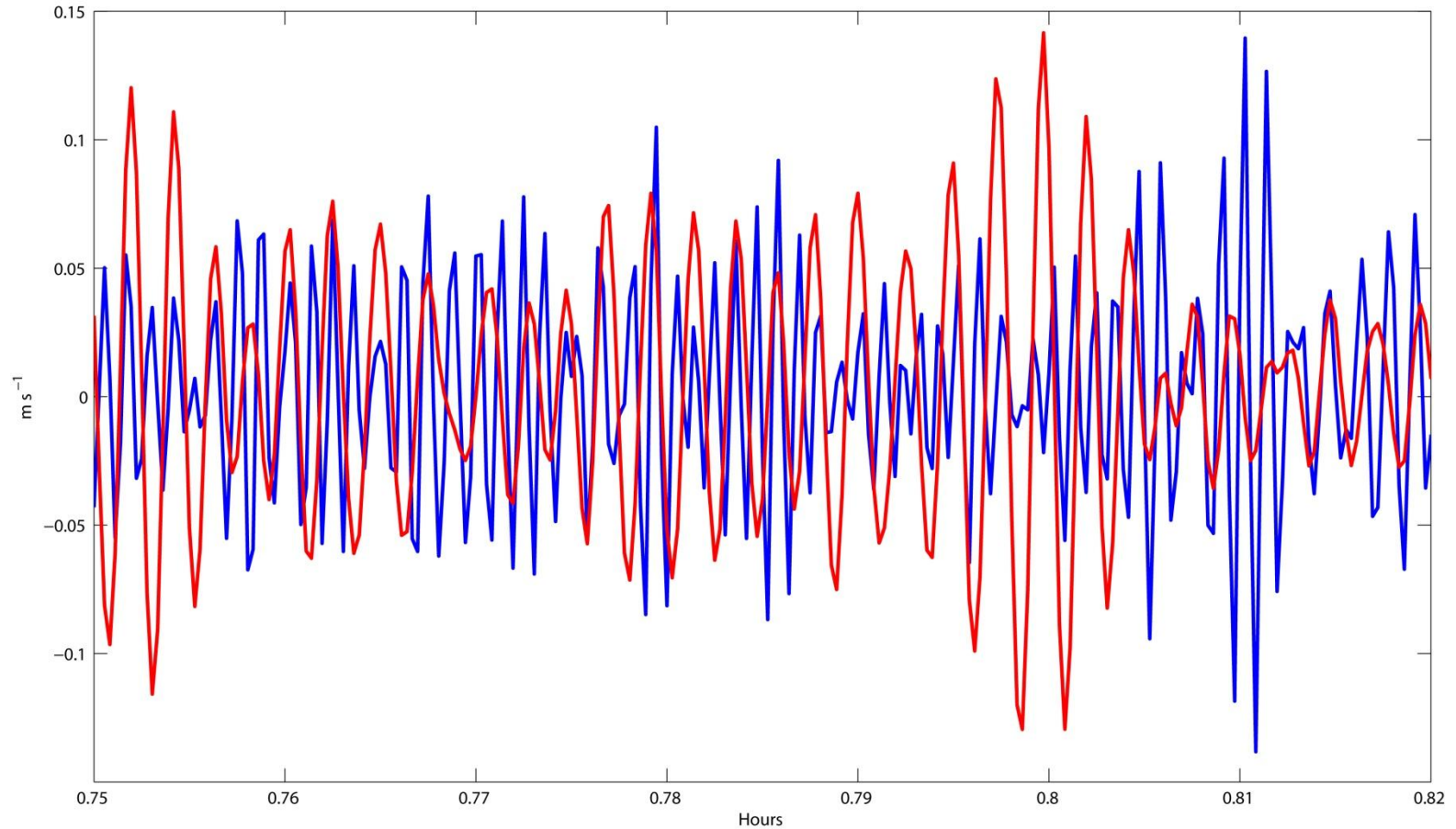
$$\langle u^2 \rangle = C(\omega) \frac{(a\omega)^2}{2} \langle e^{2kx} \rangle$$

Covariance power spectrum of speed

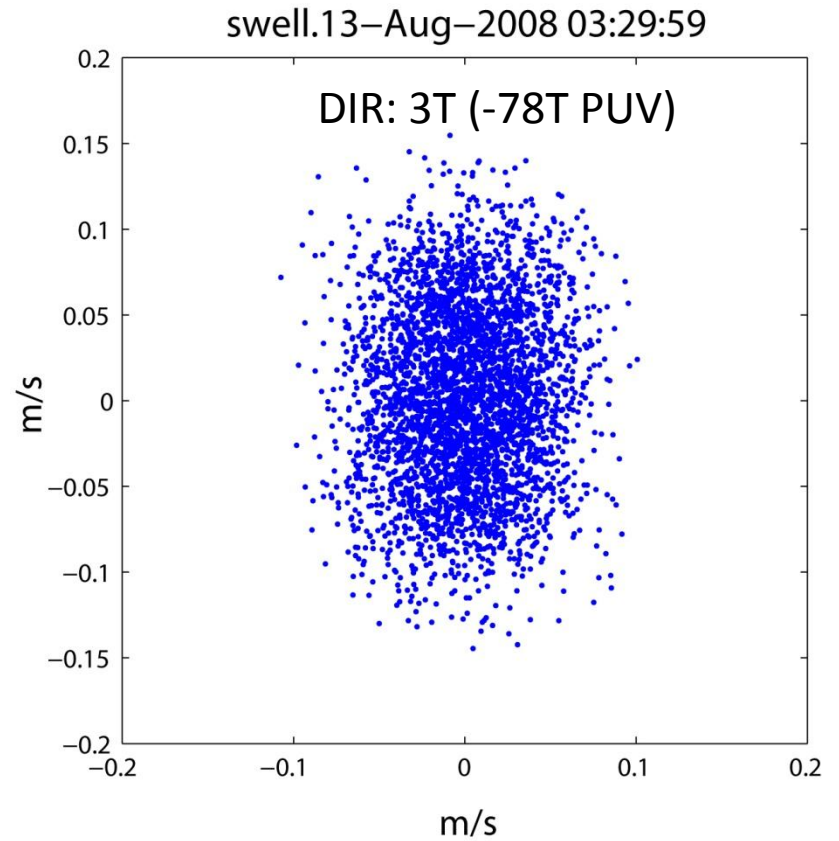
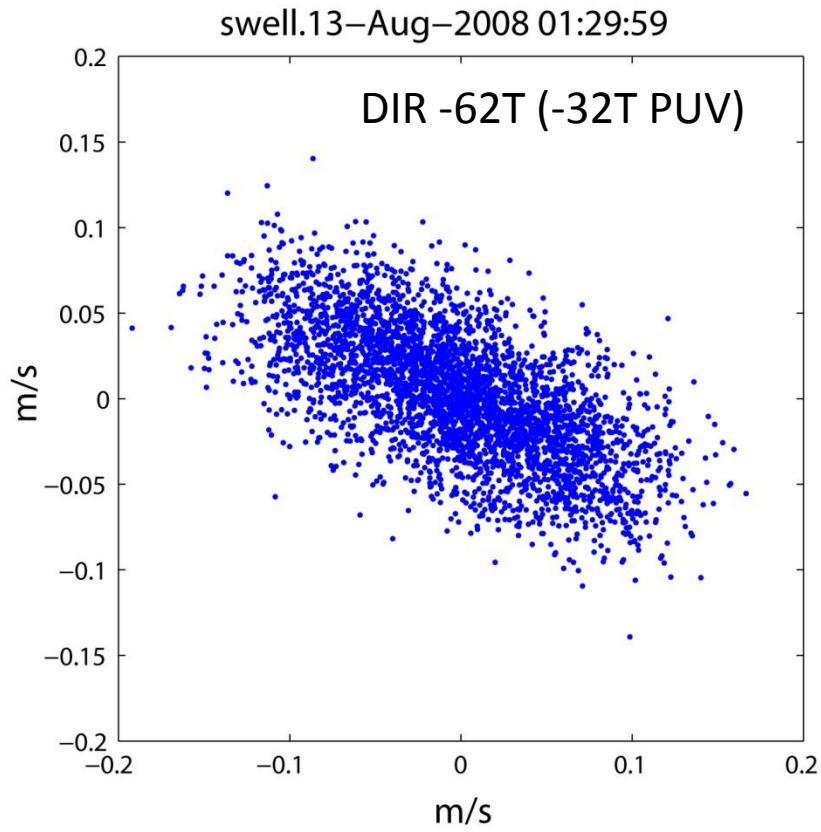


Time series of filtered zonal velocity component of swell (red) and wind waves (blue)

Filtered zonal velocity. Red: swell. Blue: wind waves. 13-Aug-2008 06:29:59



Scatter Diagram of band-pass (swell) filtered velocity



Example of comparison with NOAA buoy 46054

Time (UTC) of 8/12/08	Swell period (wave buoy)	Wind waves period (wave buoy)	Swell period (drifter)	Wind waves period (drifter)	Swell direction (drifter)	Wind waves direction to/from (drifter)	Wind direction (buoy)
5.30 am	8.3 (5 am)	4.5	9.1	5.0	129T	83T,263T	300 T
6:30 am	N/A	N/A	8.7	4.6	136T	98T,278T	N/A
7:30 am	9.1 (7am)	4.8	9.4	4.7	148T	94T,275T	310 T