

Introduction


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Data

Effects of
Forcing on
Grain Size

Temporal and
Spatial
Variability

Poking
Eyeball (Mark
I): Adriatic



Hourly Measurements of Grain-Size from the Inner Continental Shelf Seabed Using a Fully-Automated, Hydraulically-Controlled Underwater Video Microscope

Daniel Buscombe

School of Marine Science & Engineering
University of Plymouth, UK

David Rubin & Jessica Lacy

Naval Oceanic & Marine Systems, USA & UK

Revised in February 2008 for the 2nd Edition. Thanks to everyone 2010

The Need to Measure Seabed Grain Size

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- Previous research: bed grain size $\Delta 100\%$ in a single storm
- Small changes shown to change net direction of transport
- To date: rare; sporadic in location (and biased to shallow water); and short-lived (hours \rightarrow weeks)
- Pressing need for more data: research and operational modelling of sediment transport
- Lack of such measurements to date: technical shortfall rather than a perceived lack of requirement
- Manual sampling: logistically difficult & time-consuming (collection and analysis)

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Santa Cruz Seafloor Observatory

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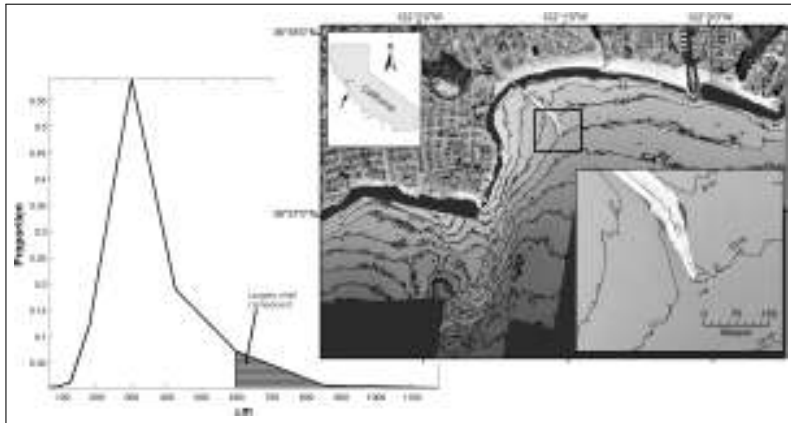
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New instrumentation: 'Poking Eyeball'

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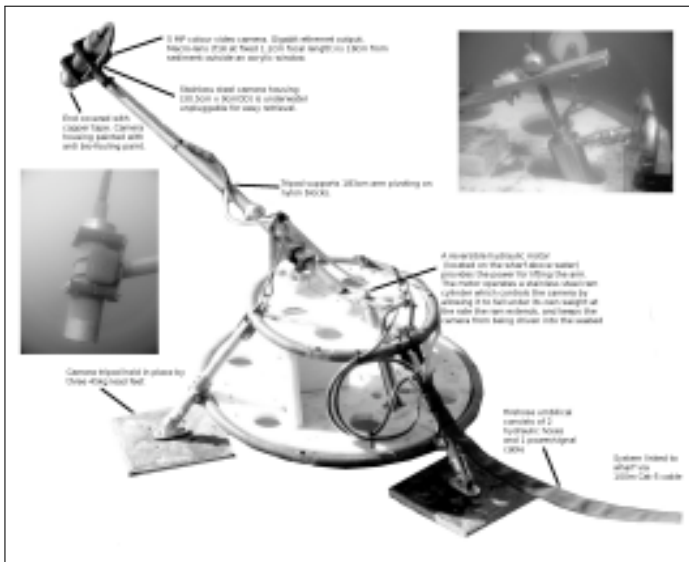
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Quality Control

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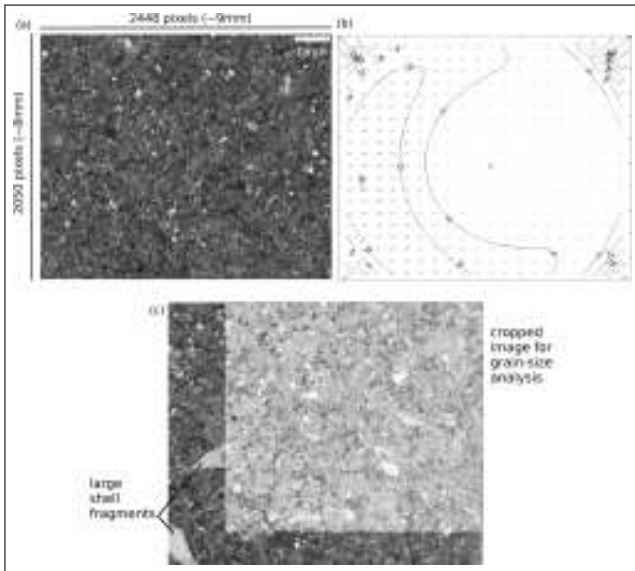
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Automated Grain Size Measurements I

Mean Grain Size (autocorrelation methods):



$$\mu = 2\pi k_R r$$

- Direct statistical estimate, grid-by-number style, of mean of all intermediate axes
- Requires neither calibration nor advanced image processing algorithms
- Reference:
Buscombe, D., Rubin, D.M., and Warrick, J.A. (2010) Universal Approximation of Grain Size from Images of Non-Cohesive Sediment. *Journal of Geophysical Research* 115, F02015
- <http://walrus.wr.usgs.gov/seds/grainsize/>

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Automated Grain Size Measurements II

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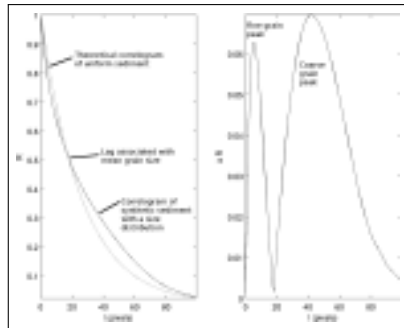
Arithmetic Sorting:

-

$$\sigma = \int_{L_0} [|R(l) - R(u)| dl] \pi r$$

$$R(u) = e^{-k_R l} \cos(k_R l)$$

- Buscombe, D., and Rubin, D.M. (submitted) *Journal of Geophysical Research - Earth Surface*



no calibration, and no sophisticated edge detection or machine vision

Method Validation

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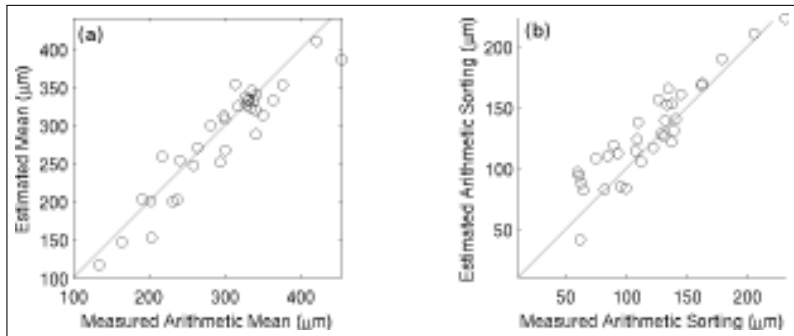
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Waves

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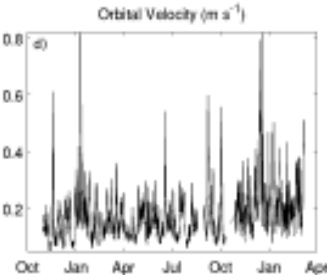
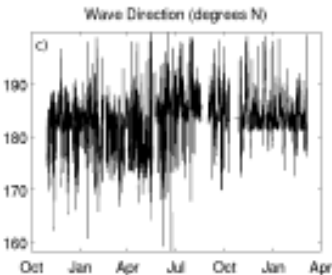
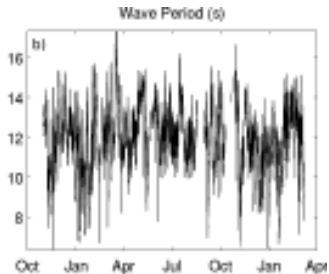
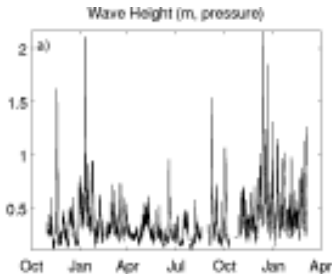
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Currents

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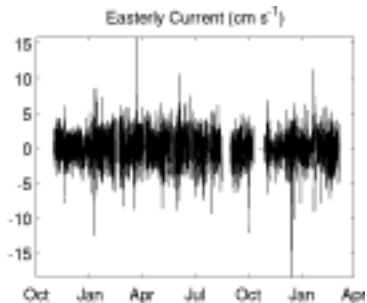
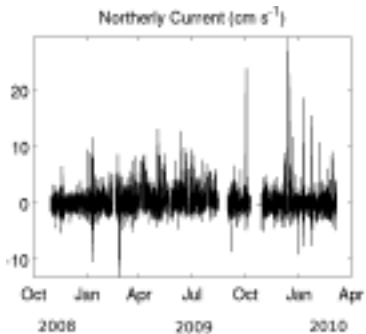
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Grain Size: A Unique Time-Series

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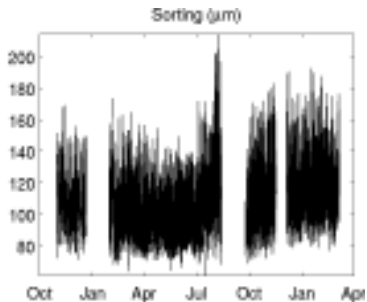
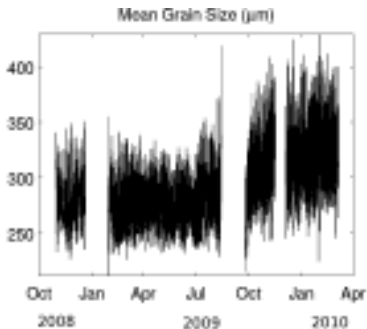
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Data Mining: Daily averages

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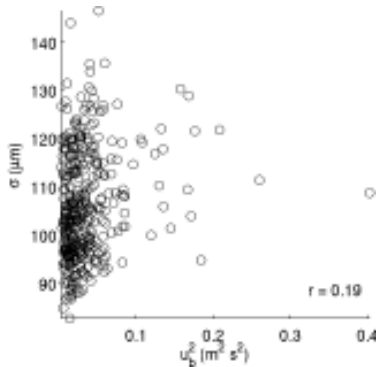
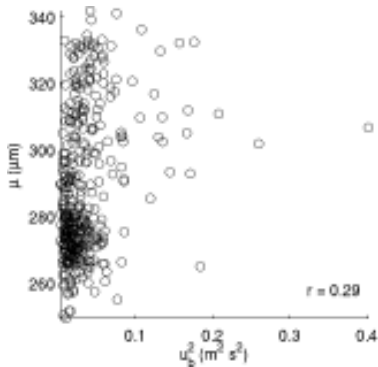
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Data Mining: Two-weekly averages

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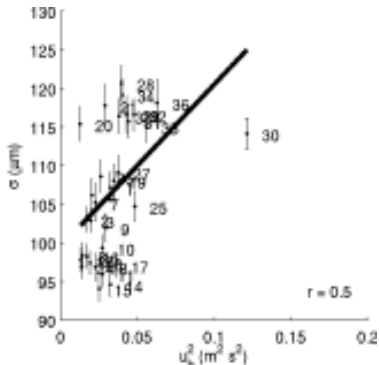
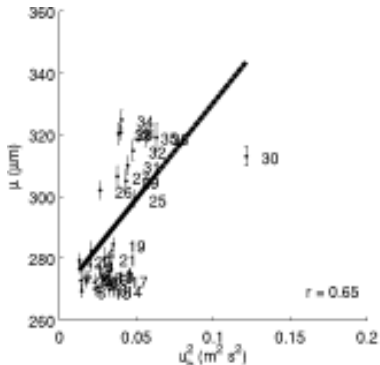
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Data Mining: Multiple Regression

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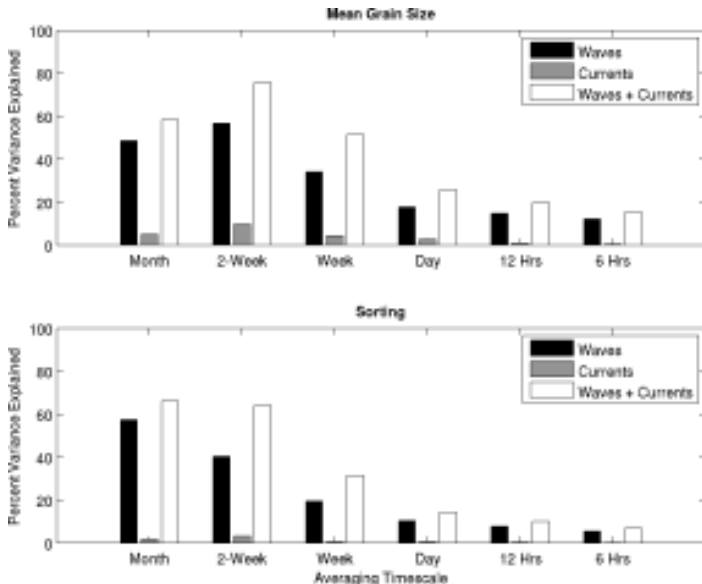
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Temporal: 10-minute sampling

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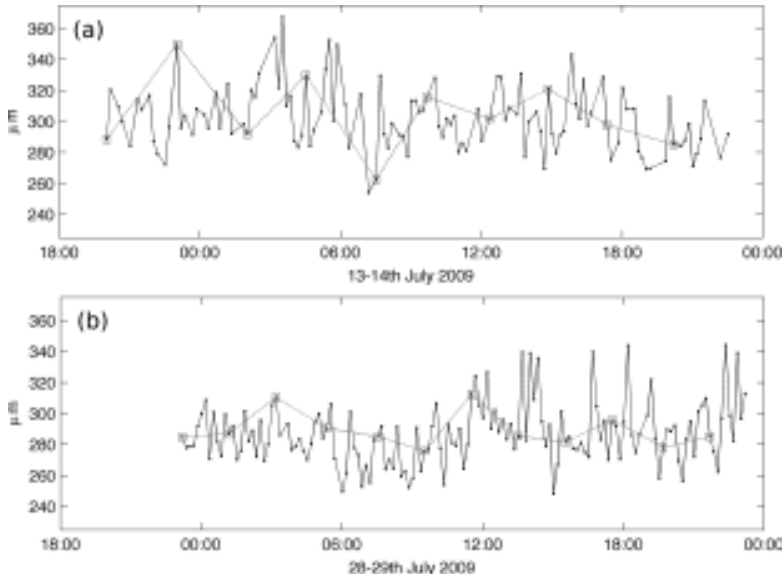
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Spatial: Diver surveys

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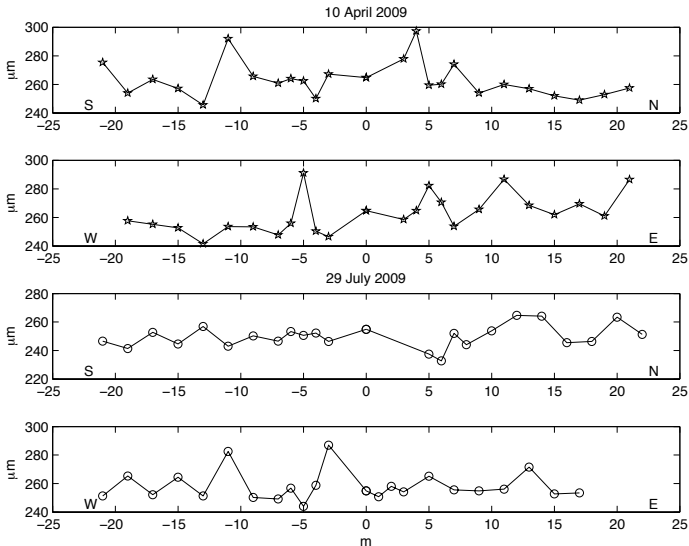
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Sediment Colour: Biofilms?

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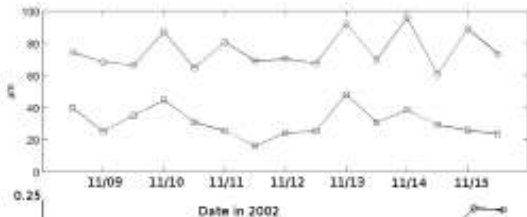
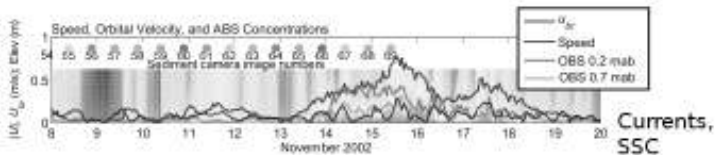
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Grain size
and sorting



Grain colour
(ratio of hue and
saturation)

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- Possible to measure (predominantly sandy) seabed properties $O(\mu)$; $O(\pm 20\%)$; $O(\text{minute})$; $O(\text{decades})$
- Longest known continuous record of seabed grain size
- Highly variable: what is significant?
- Statistical analyses suggest to use an average of 7 days
- Multi-variate stats suggest waves dominant over currents
- Ongoing research: relationships between bed grain size and suspension events and bedform dynamics

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- Curt Storlazzi, Josh Logan, Tom Reiss, Jamie Grover, and Pete Dal Farro for diving and boat handling.
- Parker Allwardt for manual point-counts on images for method validation.
- Gerry Hatcher, Hank Chezar, Rob Wyland, Kevin O'Toole and Tim Elfers for technical support.
- Chris Sherwood for Adriatic Sea data

Website (papers and code):

- <http://walrus.wr.usgs.gov/seds/grainsize/>
- Buscombe, D., Rubin, D.M., and Warrick, J.A. (2010) Universal Approximation of Grain Size from Images of Non-Cohesive Sediment. *Journal of Geophysical Research* 115, F02015
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