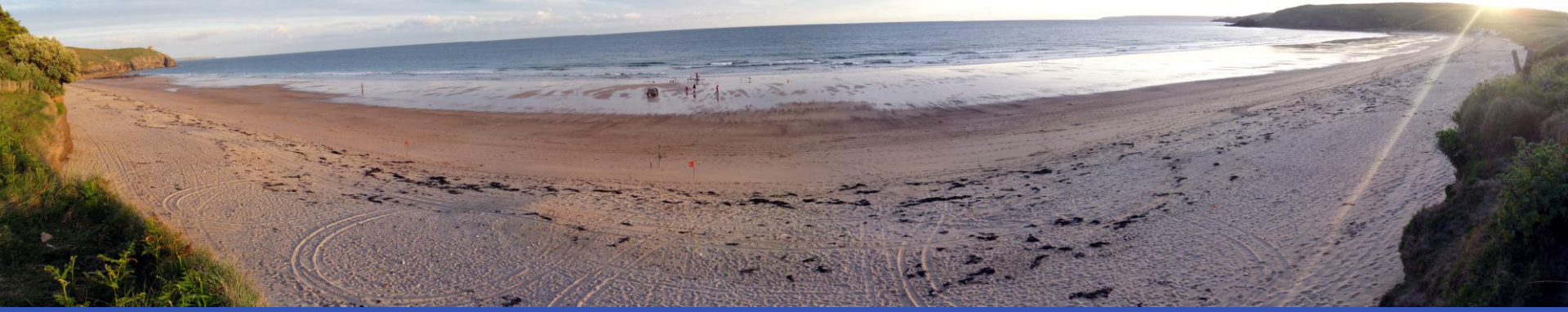


# Co-variation of intertidal morphology and grain size on a macrotidal sand beach: Praa Sands, UK.

Dan Buscombe, Daniel Conley,
Dave Rubin, & Alex Nimmo-Smith

daniel.buscombe@plymouth.ac.uk

MARINE SCIENCE & ENGINEERING WITH PLYMOUTH UNIVERSITY

USGS science for a changing world

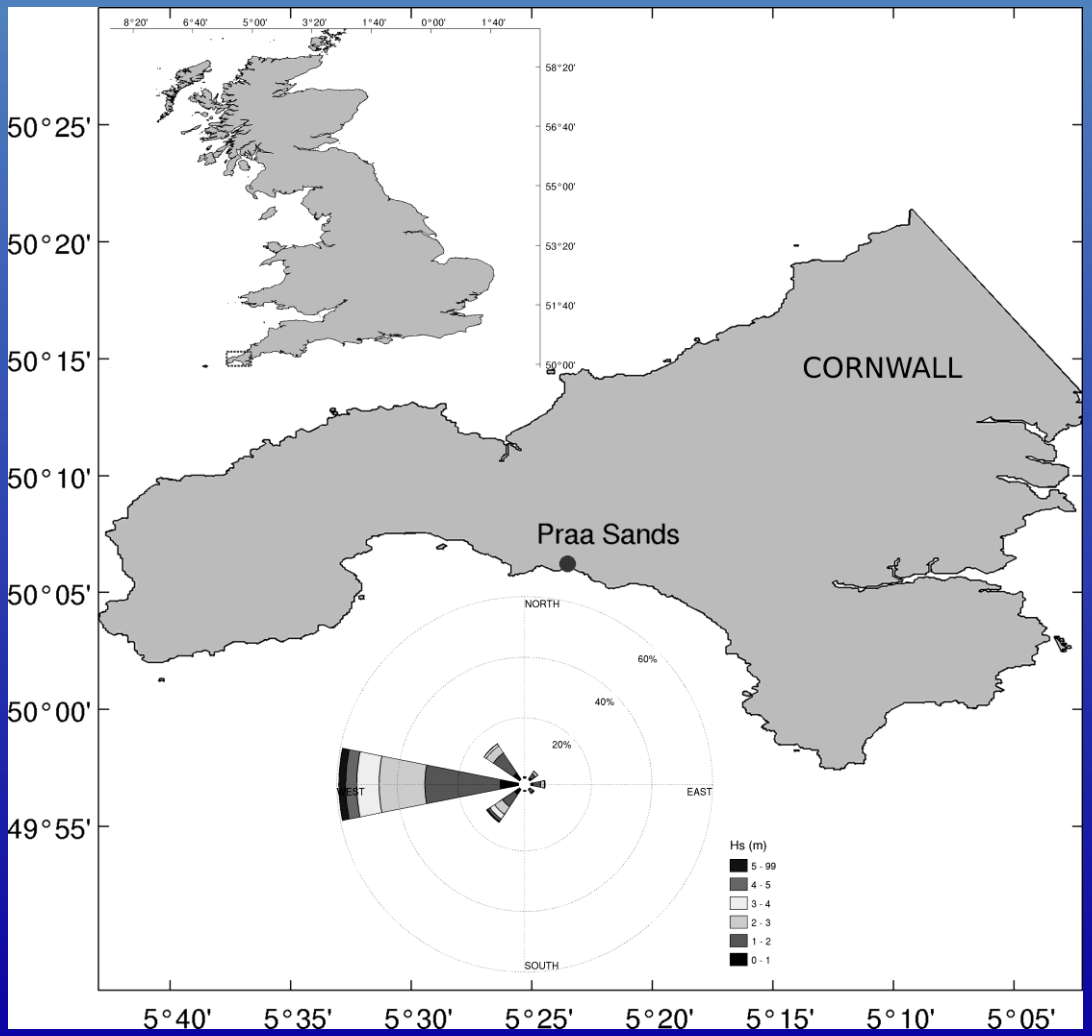
PARTICLE IMAGING WITH PLYMOUTH UNIVERSITY

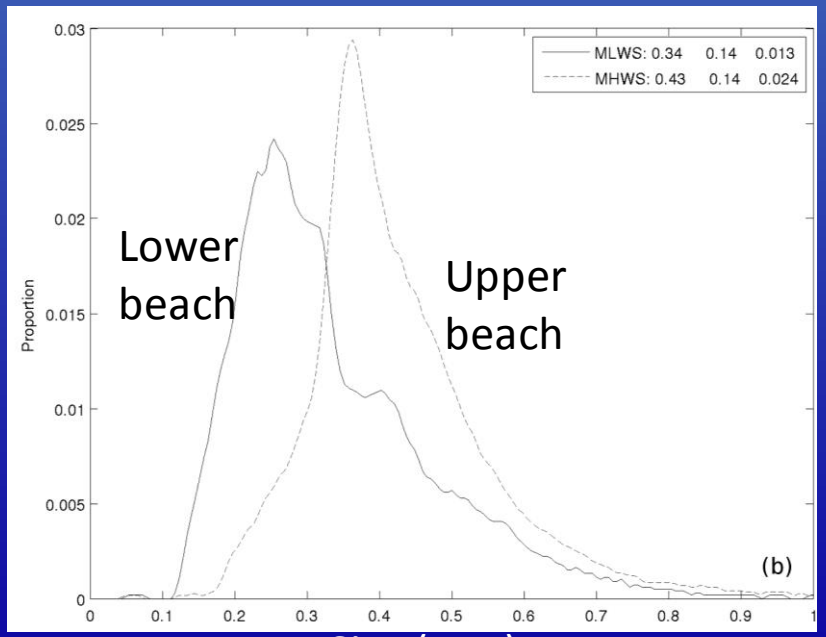
# Talk Outline

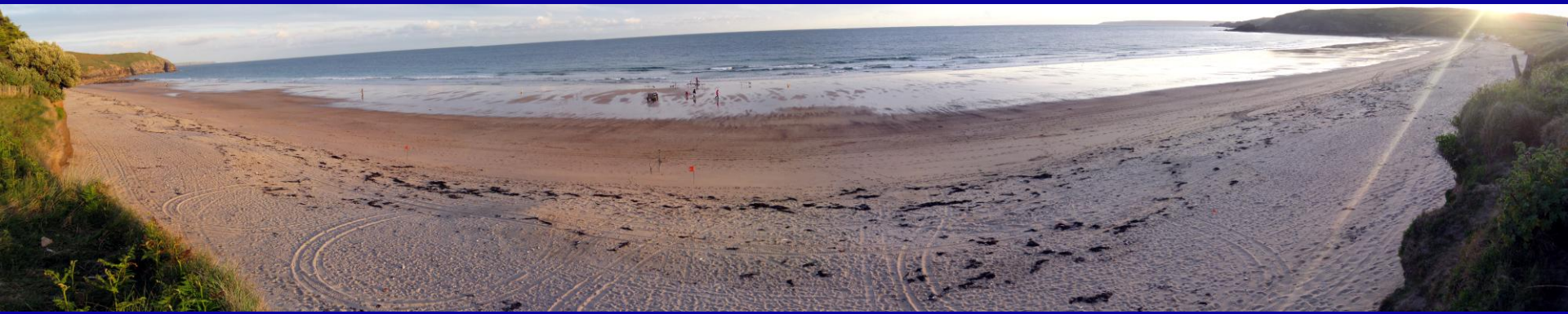
- Field observations from a high-energy macrotidal sand beach
- Morphological variability and spatial grain size trends
- Sorting processes by sediment suspension

- Bed sediment camera for bed sediment grain size
- Two holographic particle imaging systems for suspended sand size distribution

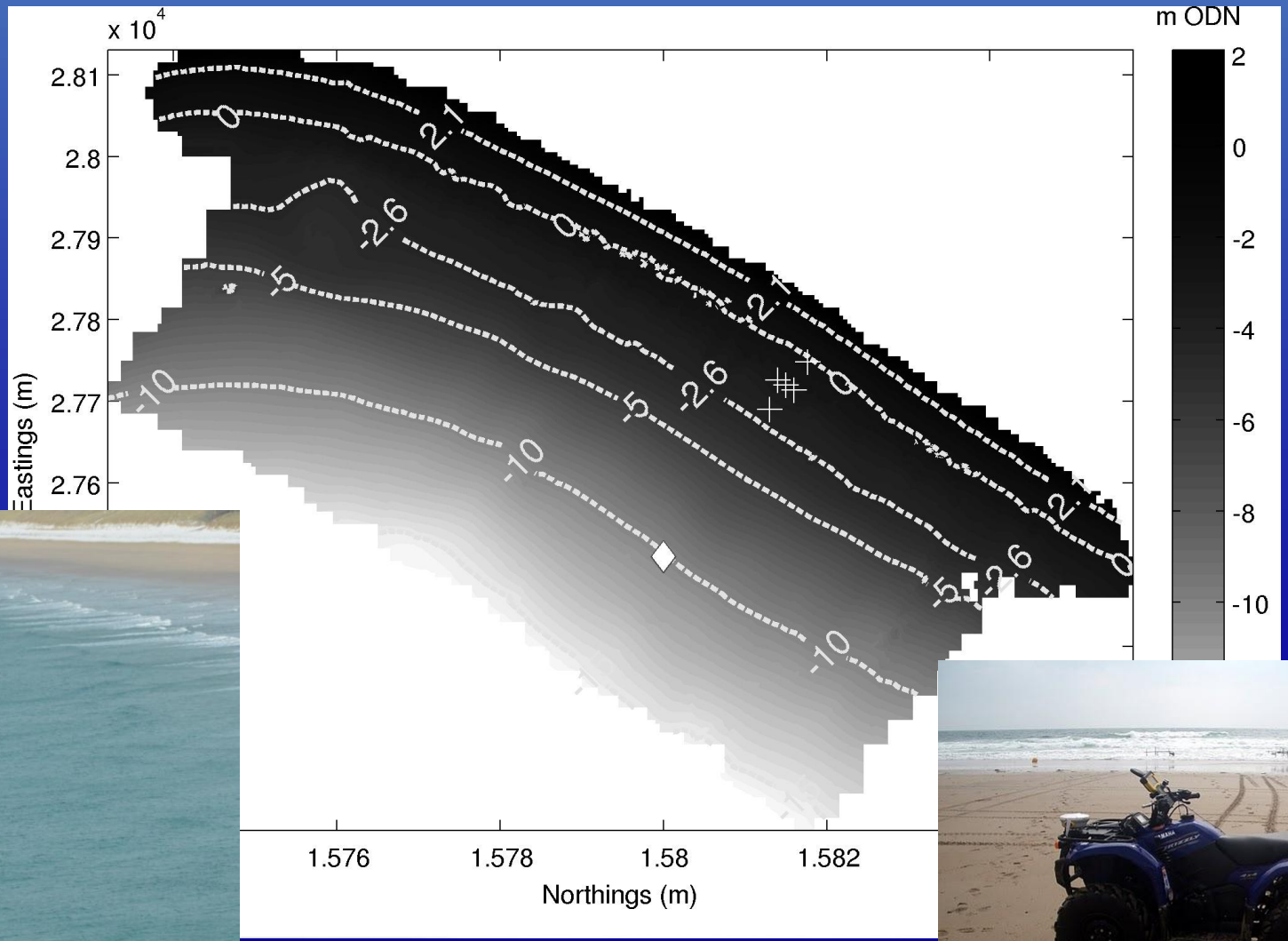
# Praa Sands, Cornwall, UK

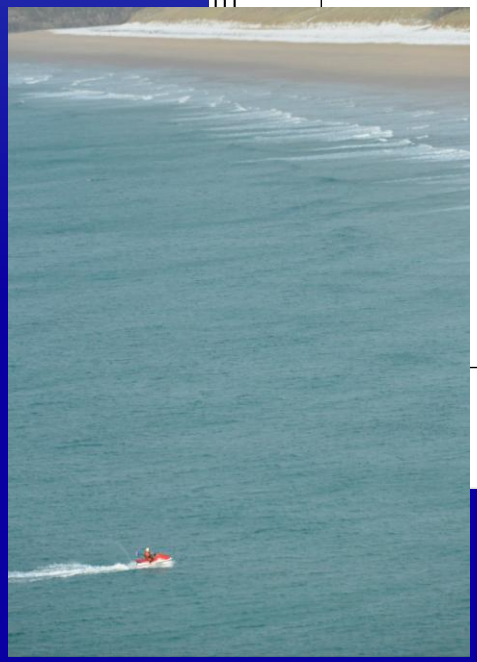


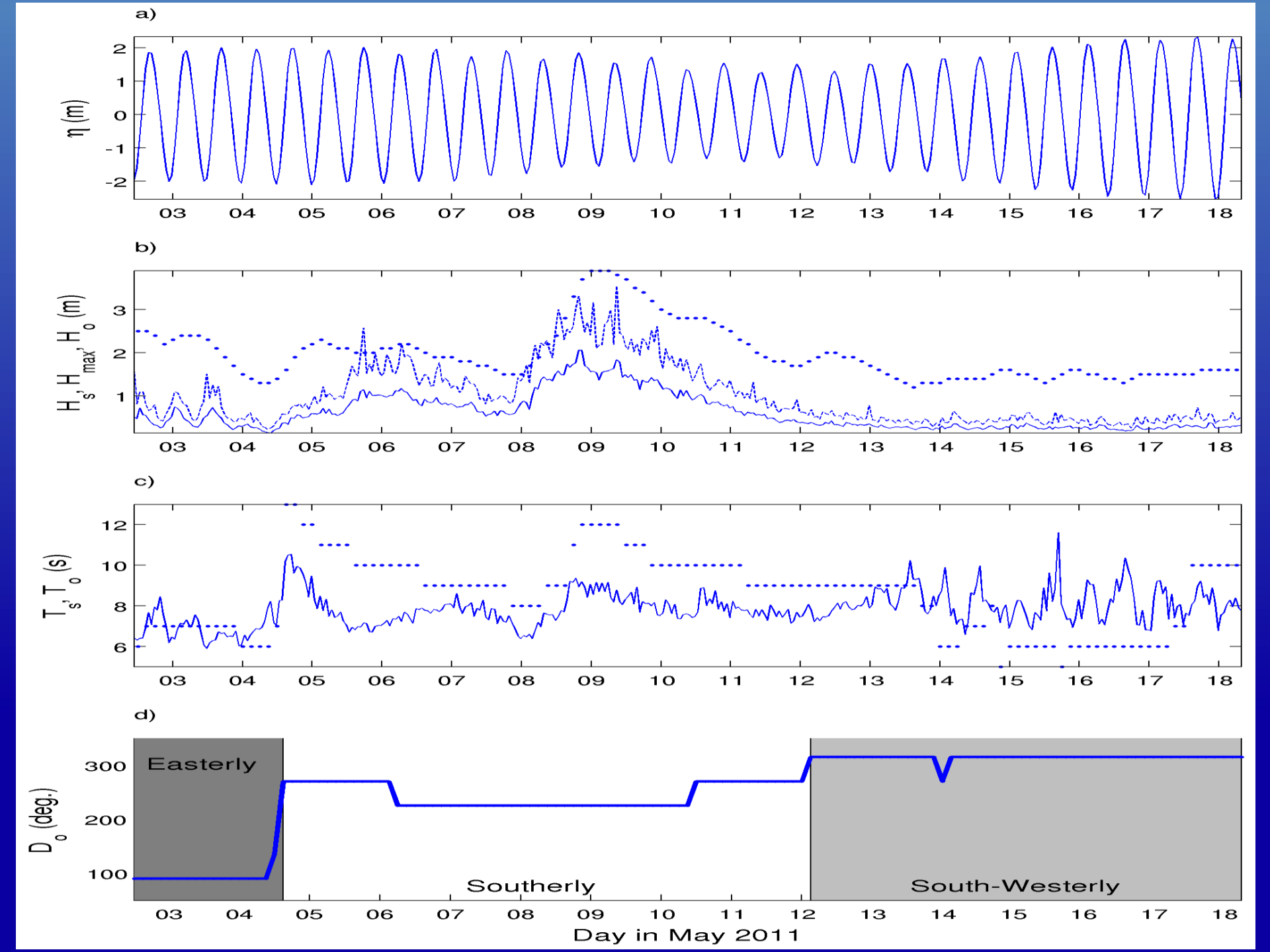



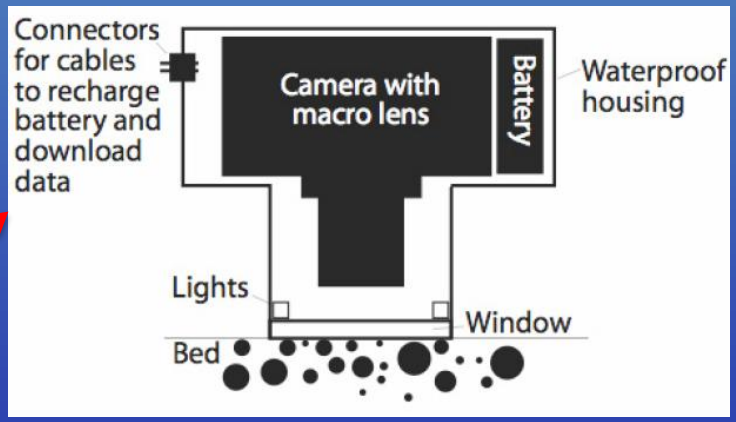
# Field Experiment, 1 – 21 May 2011



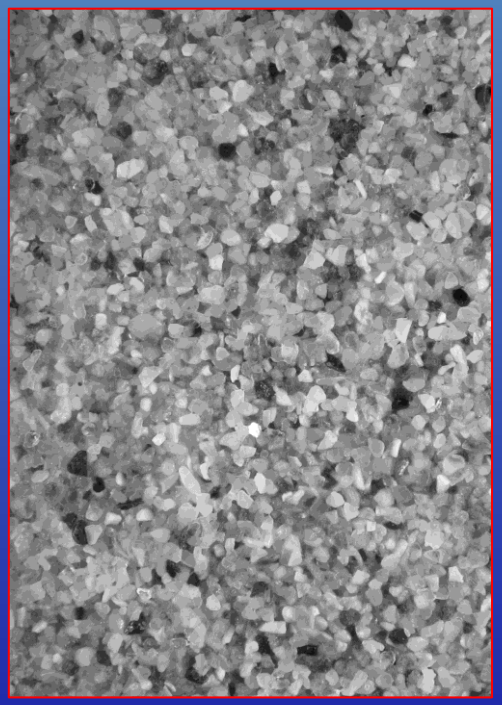




a)
η (m)
b)
H_s, H_max, H_o (m)
c)
T_s, T_o (s)
d)
D_o (deg.)
Easterly
Southerly
South-Westerly
Day in May 2011

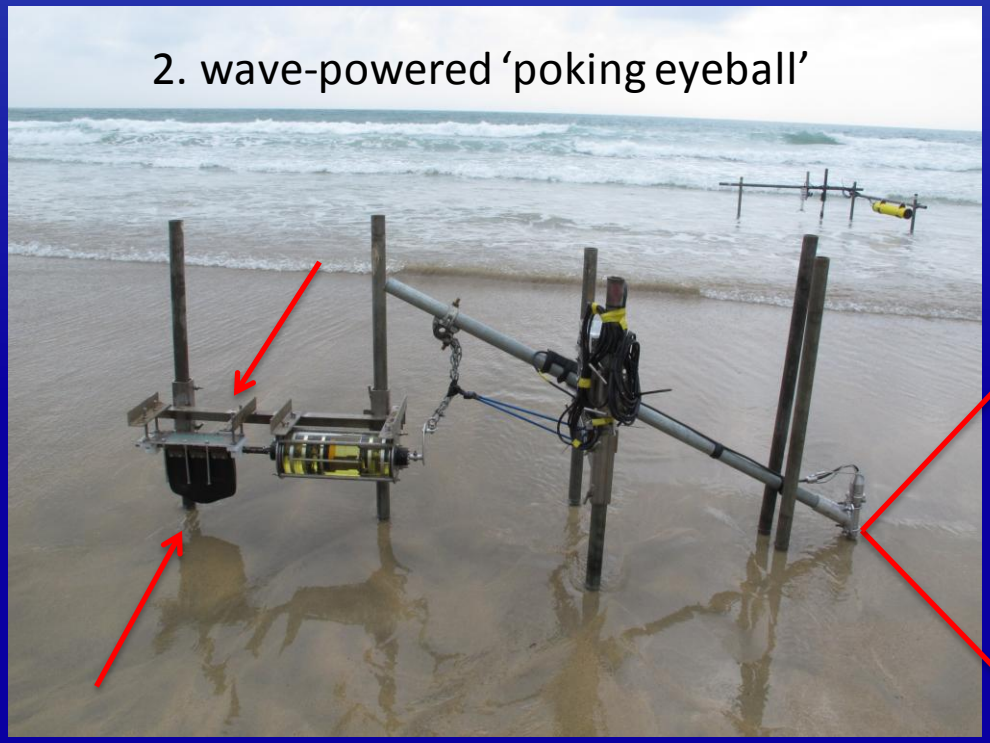
1. ‘beachball’



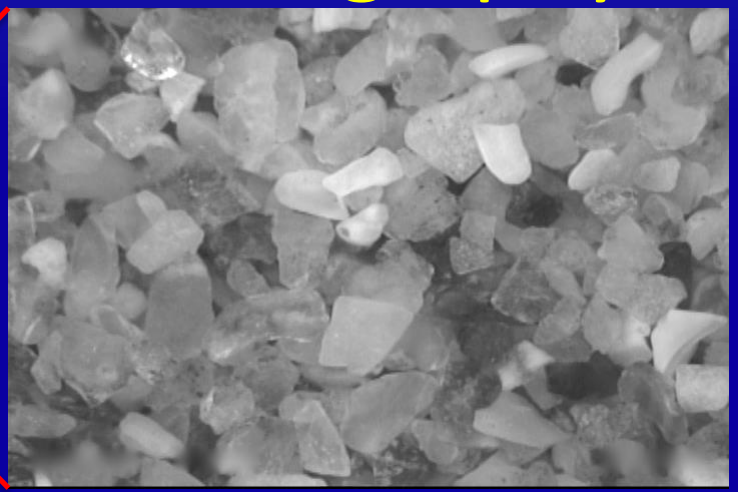

Buscombe et al (2010) J. Geophys. Res. 115, F02015
Buscombe & Rubin (2012) J. Geophys. Res, in press



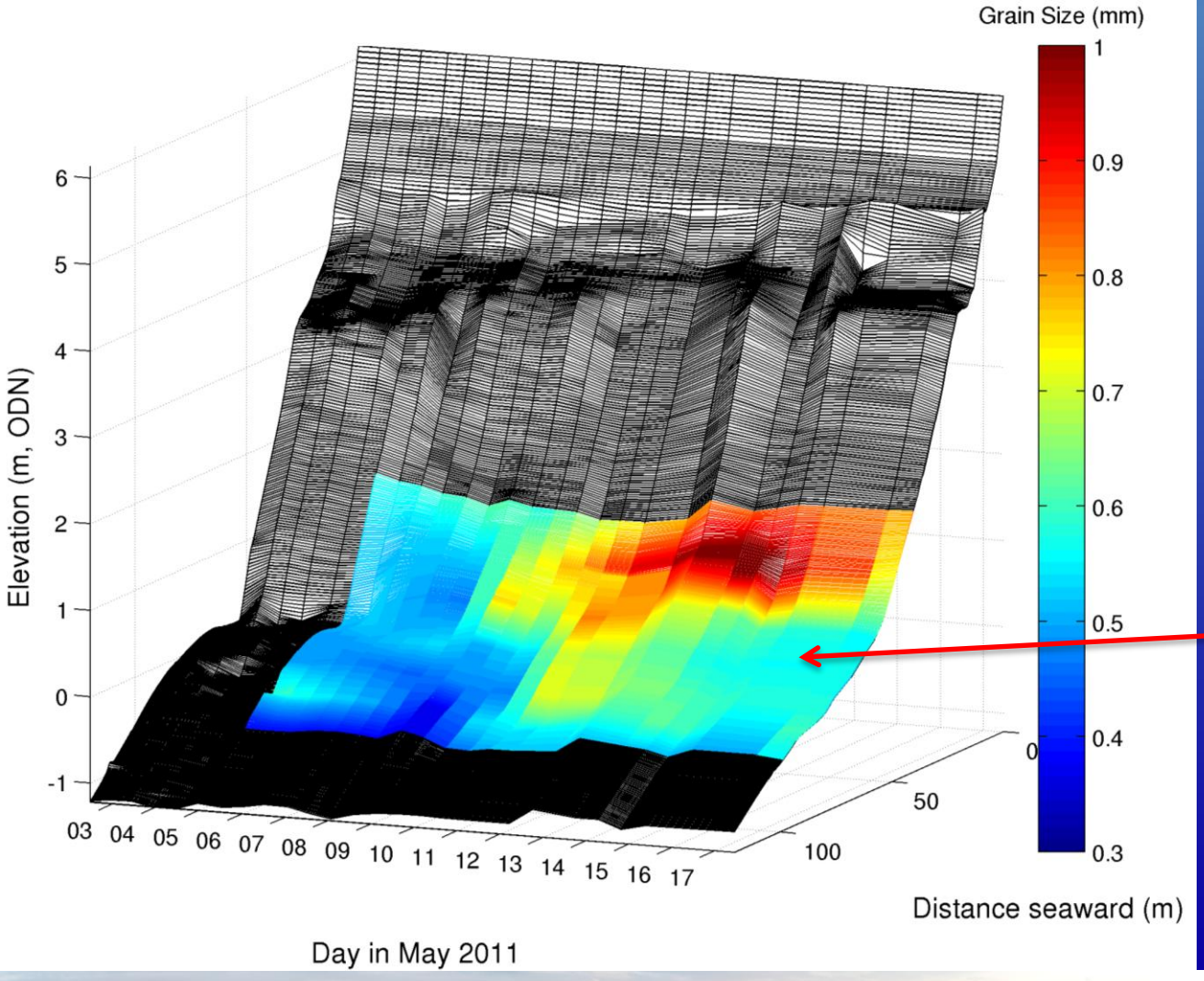
2. wave-powered ‘poking eyeball’

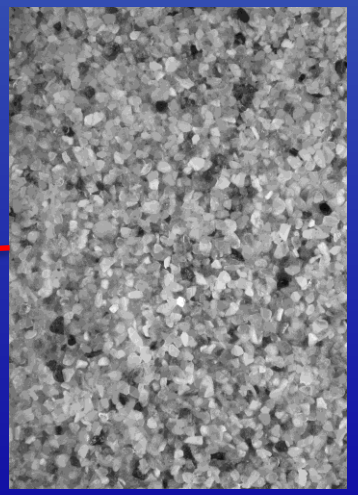


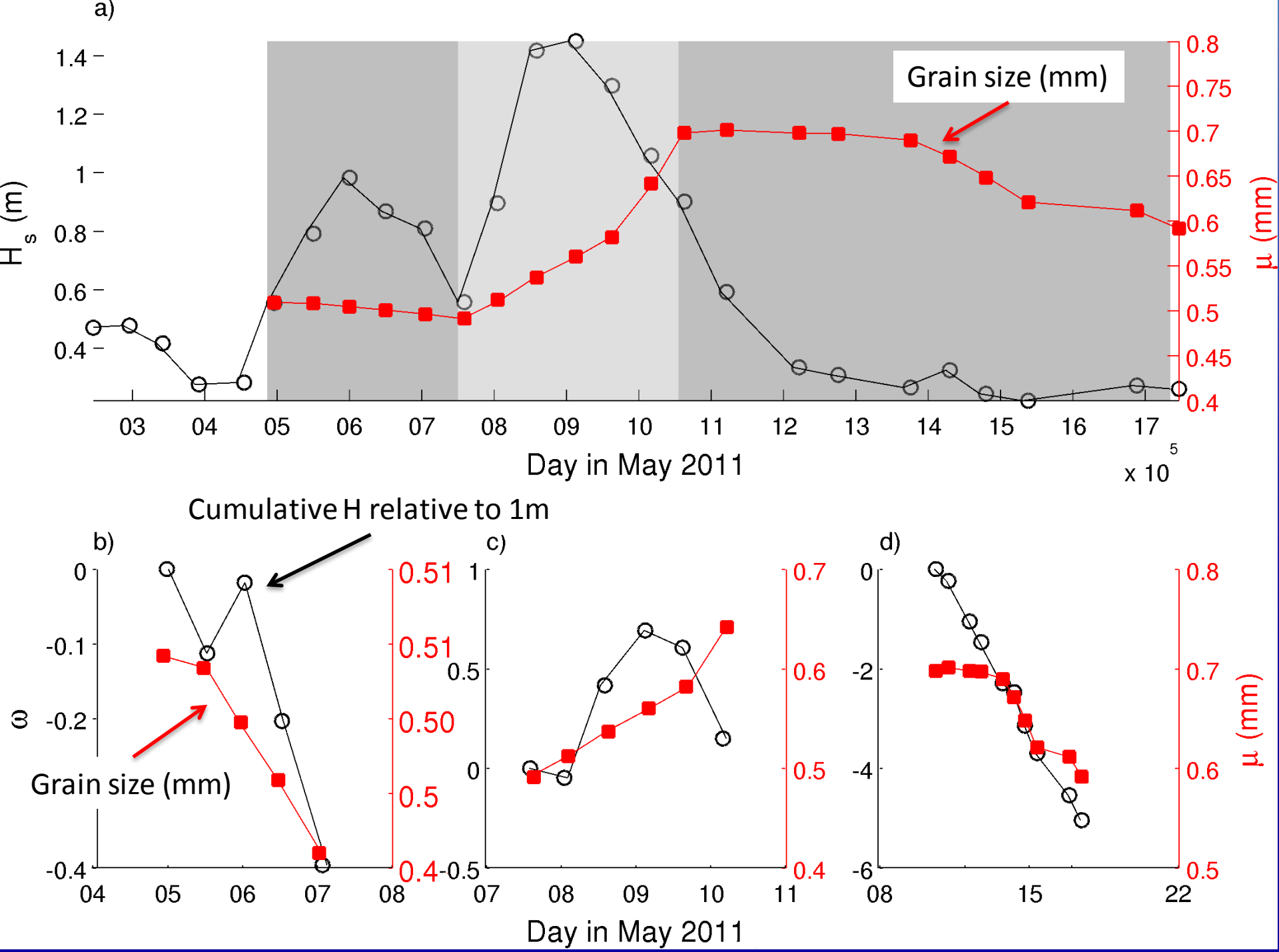
# Bed Sediment Photography

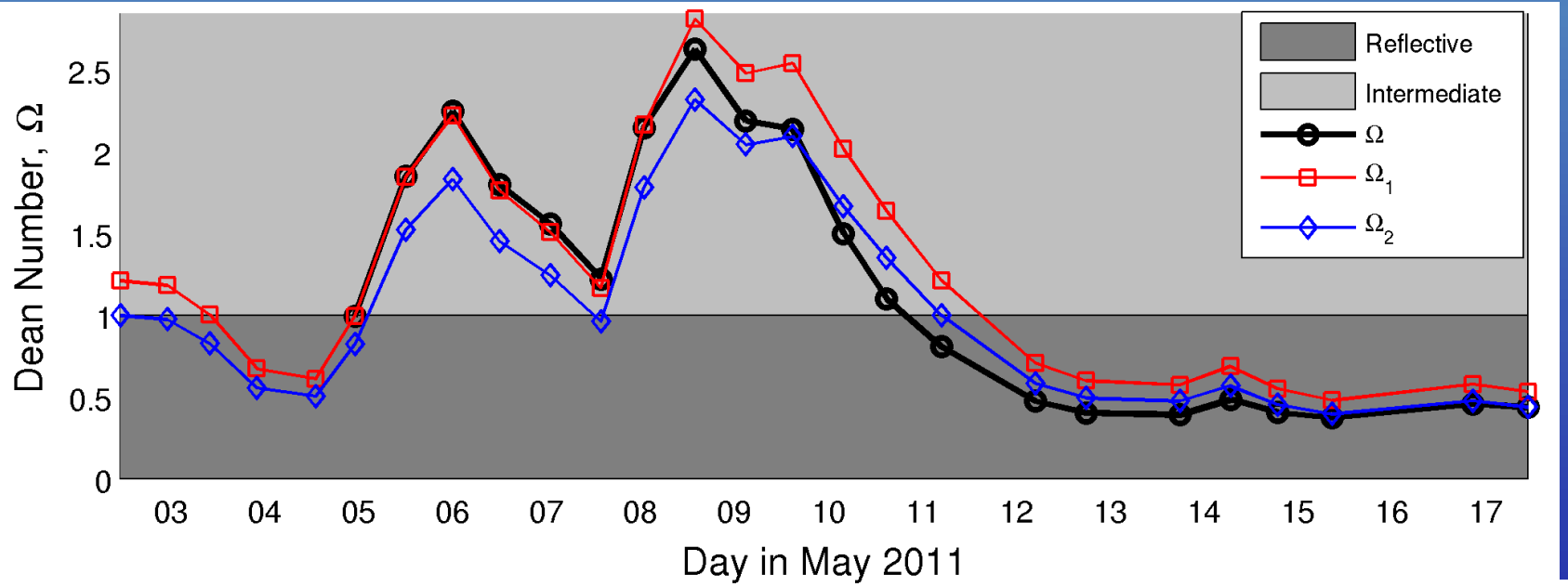


# Morpho-Sediment Trends

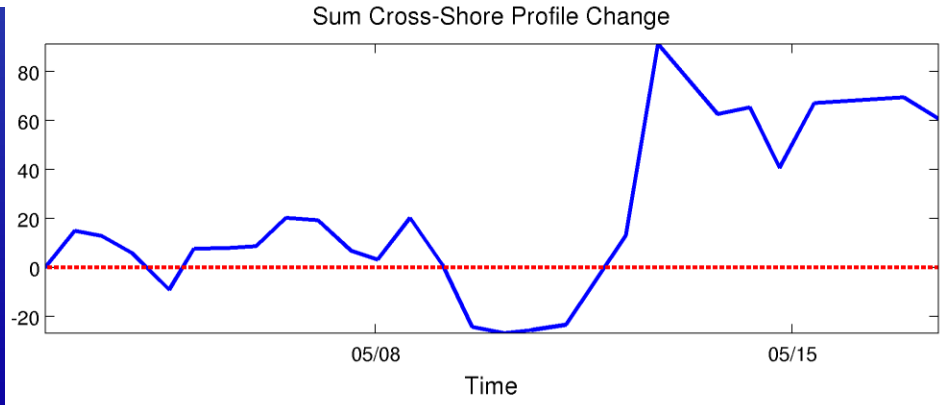


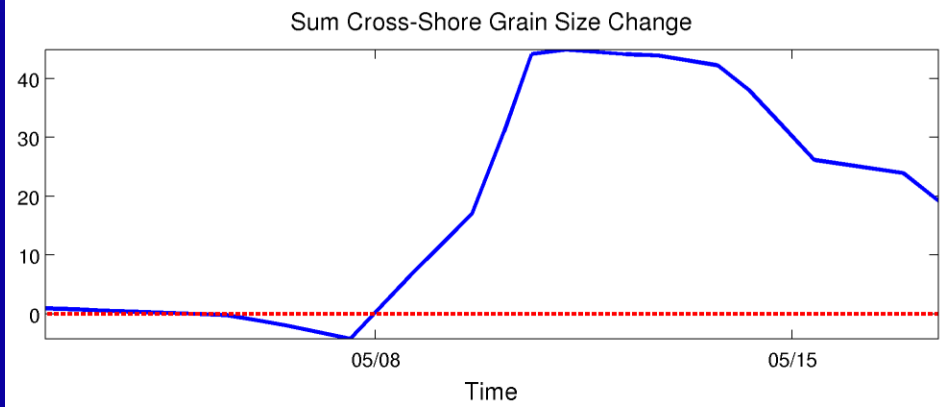




a)
Grain size (mm)
$H_s$ (m)
μ (mm)
Day in May 2011
x 10^5
Cumulative H relative to 1m
b)
c)
d)
ω
Grain size (mm)
Day in May 2011

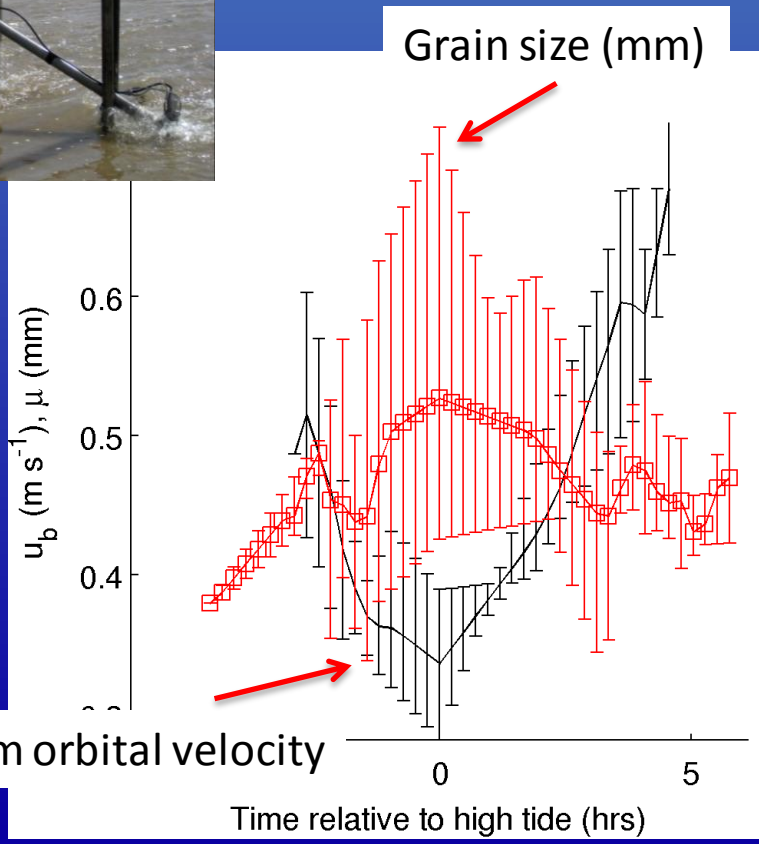


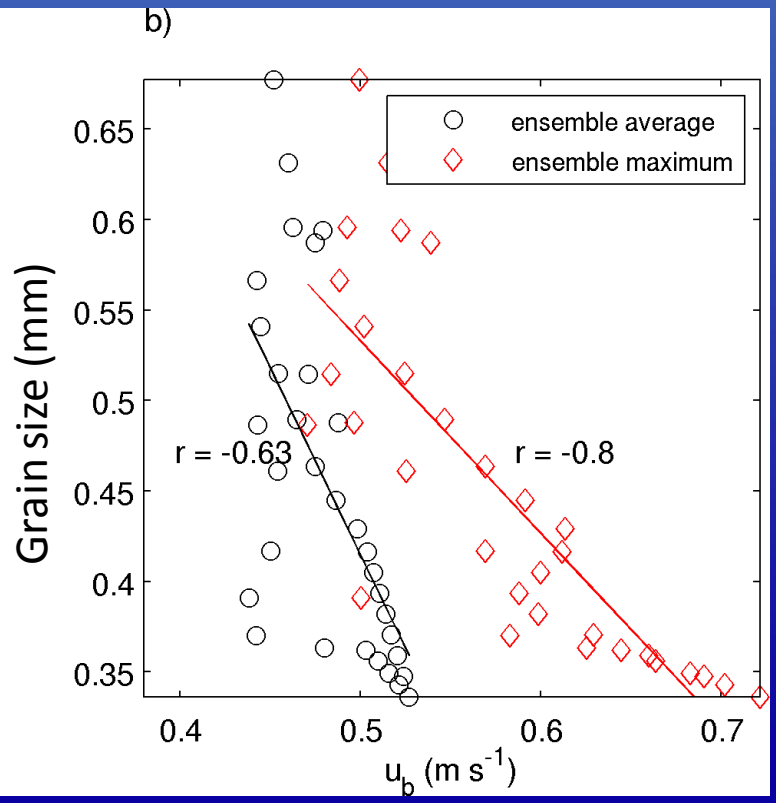

- Grain size does not affect morphodynamic classification
- No clear cut relationship between grain size and slope or morphological variability
- Net coarsening observed during both erosive and recovery conditions



# Ensemble Averages



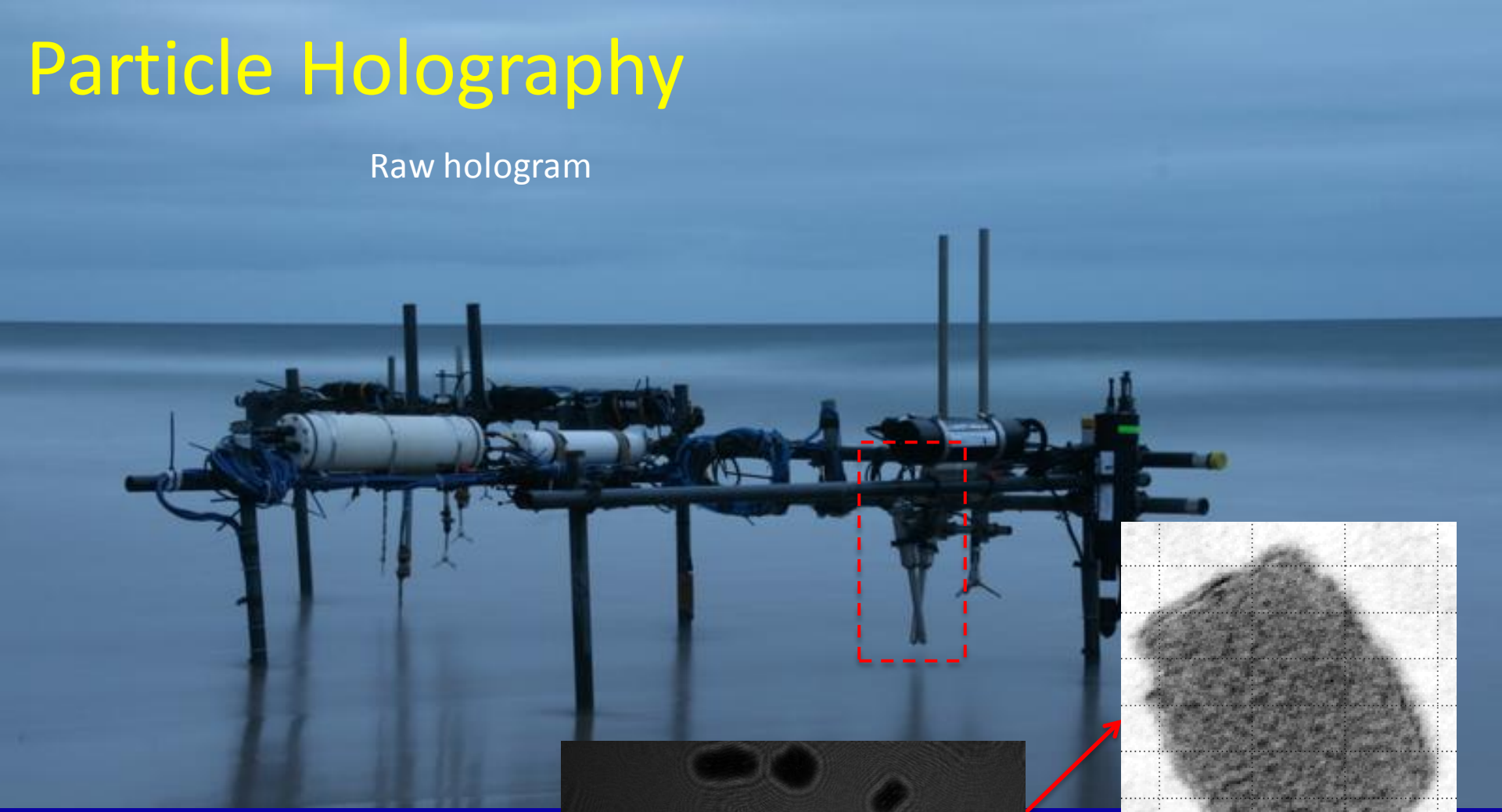



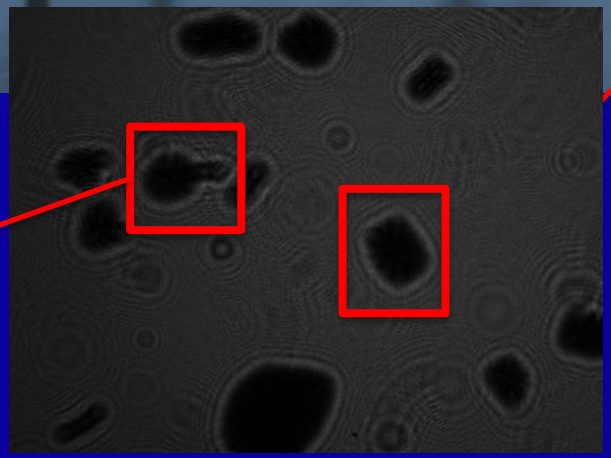

Inverse relationship between flow speed and bed grain size

- Weak flow, preferential selection of fines, leaving coarse lag
- Stronger flow, more equal mobilisation, lag appears finer

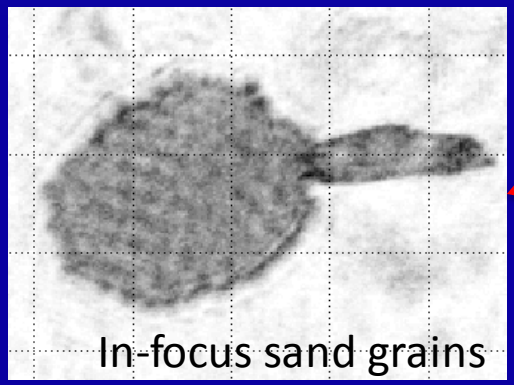
# Particle Holography

Raw hologram





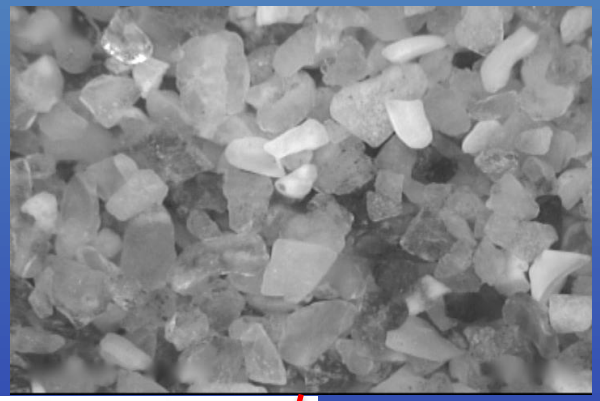




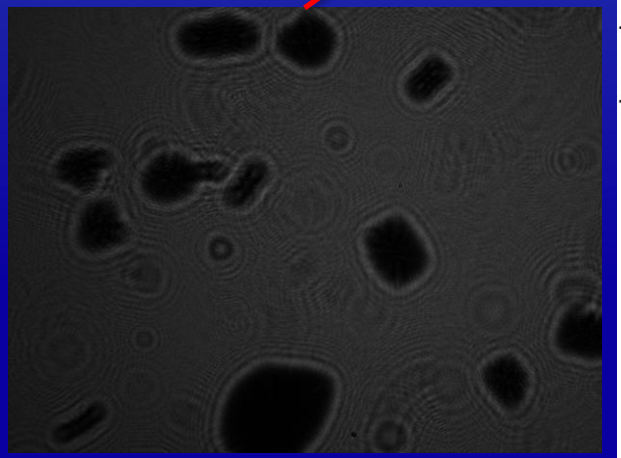
In-focus sand grains

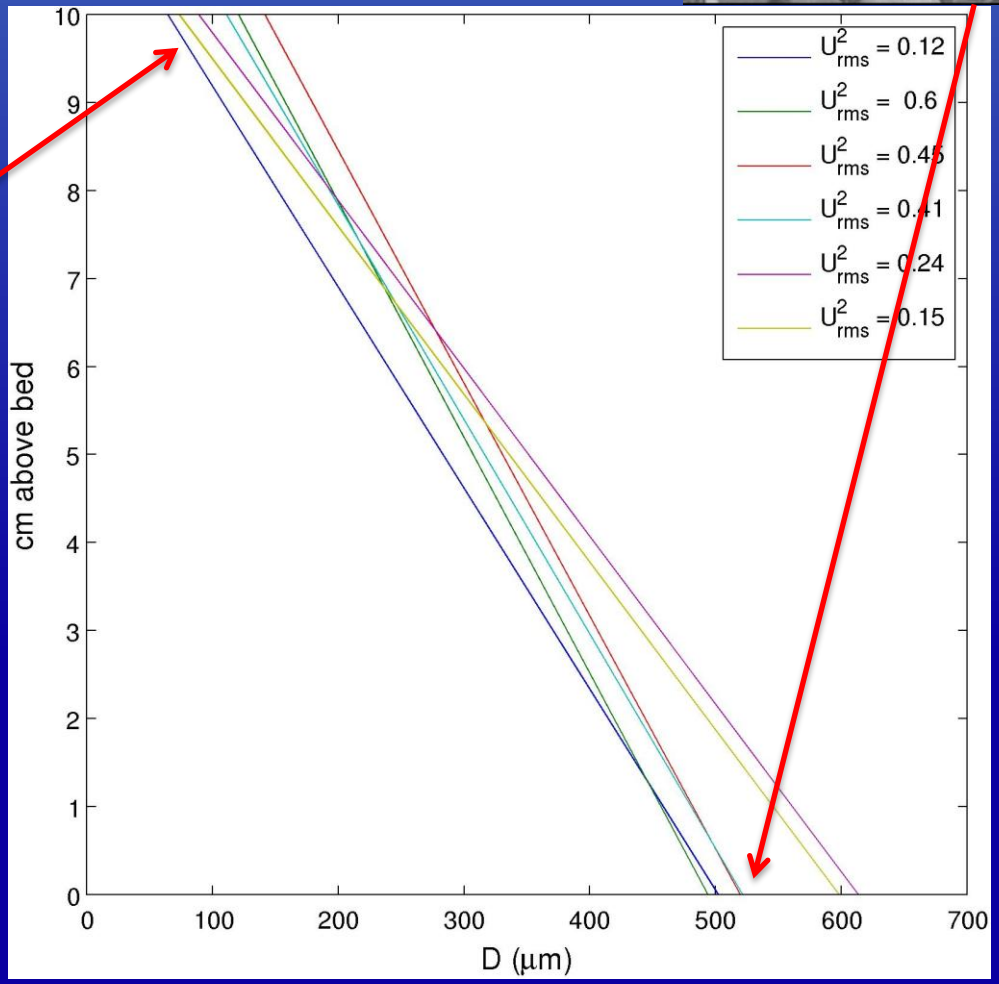
Graham & Nimmo-Smith (2010), Limnol. & Oceanog. Methods 8, 1-15

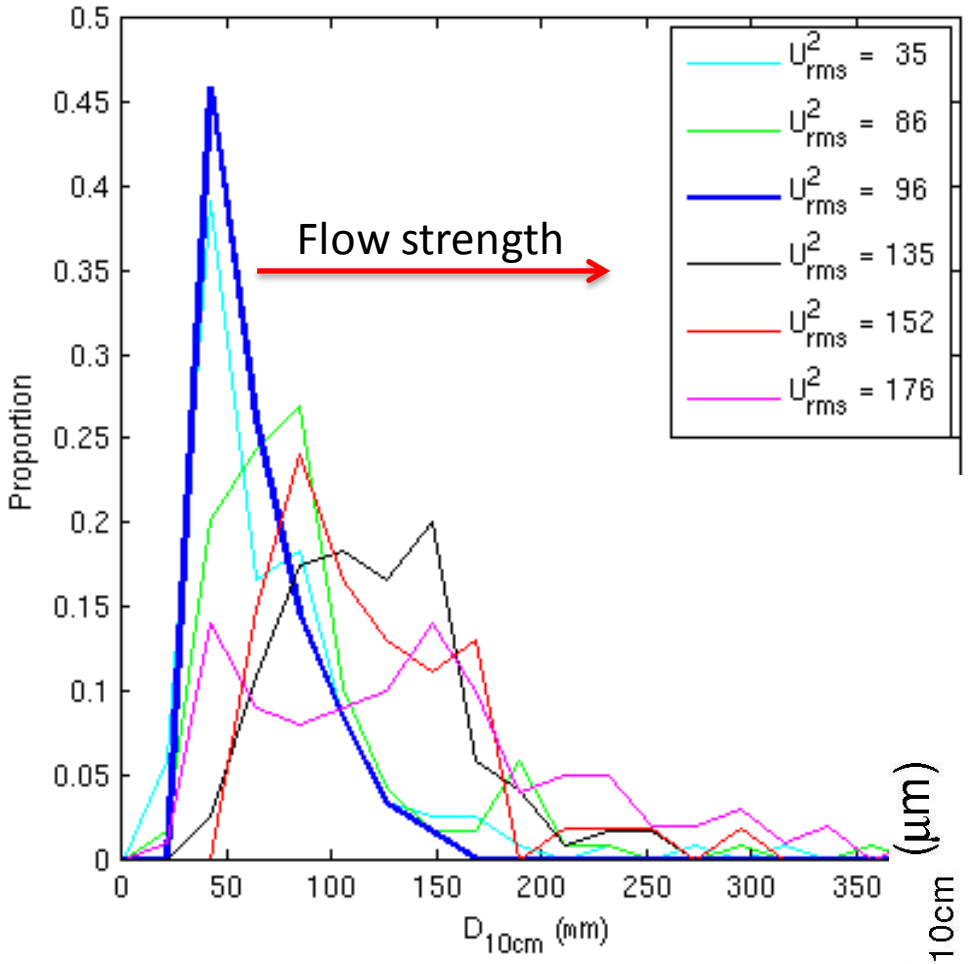
# Selective suspension



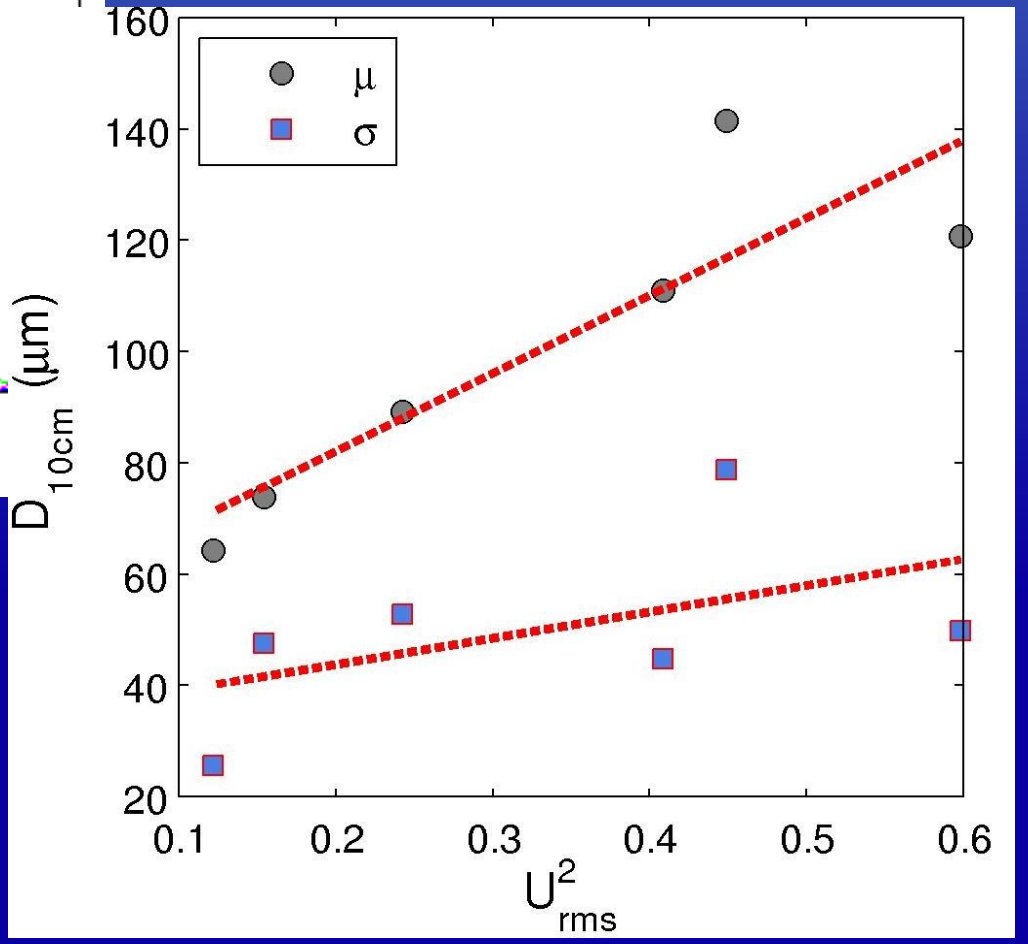
Decreasing vertical gradient with increasing shear








Size-distribution coarsens and broadens in stronger flows




Coarse sediment picked up without first depleting fines

# Summary

- Mean intertidal surface grain size varies significantly, and is not coincident with areas of relative depletion or accretion
- Grain size may be responding to cumulative wave energy over a period of a few tides
- Weak flow, preferential selection of fines, leaving coarse lag
- Stronger flow,  more equal mobilisation, lag appears finer
- Pickup of coarse material in stronger flows without first depleting fines

# Thanks for your attention.

- Project website:

http://www.research.plymouth.ac.uk/tssar_waves/

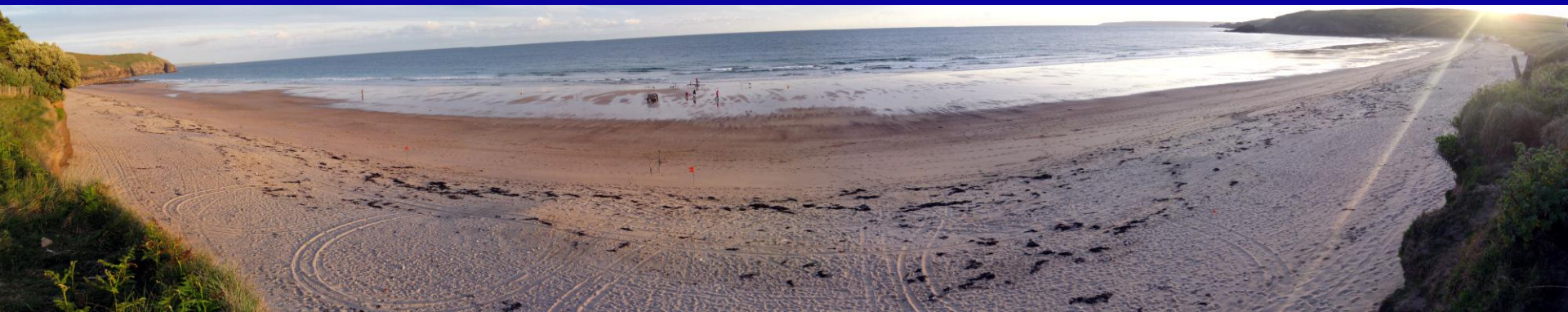
- In-line digital holography website & software:

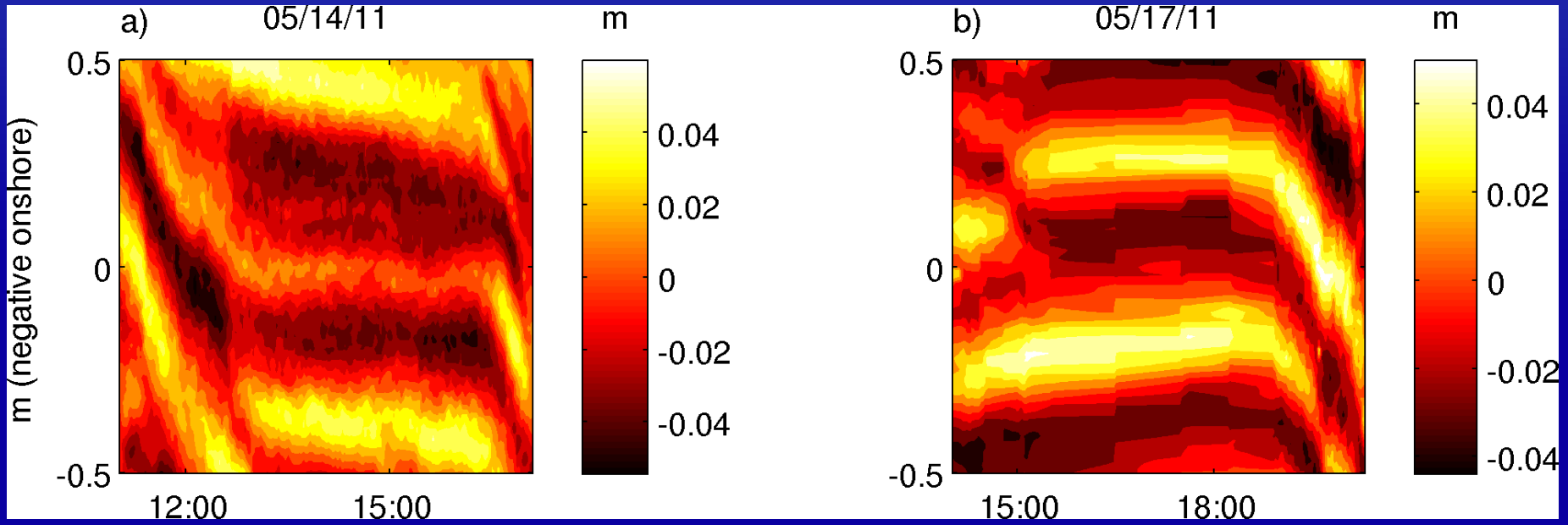
http://holoproc.marinephysics.org/

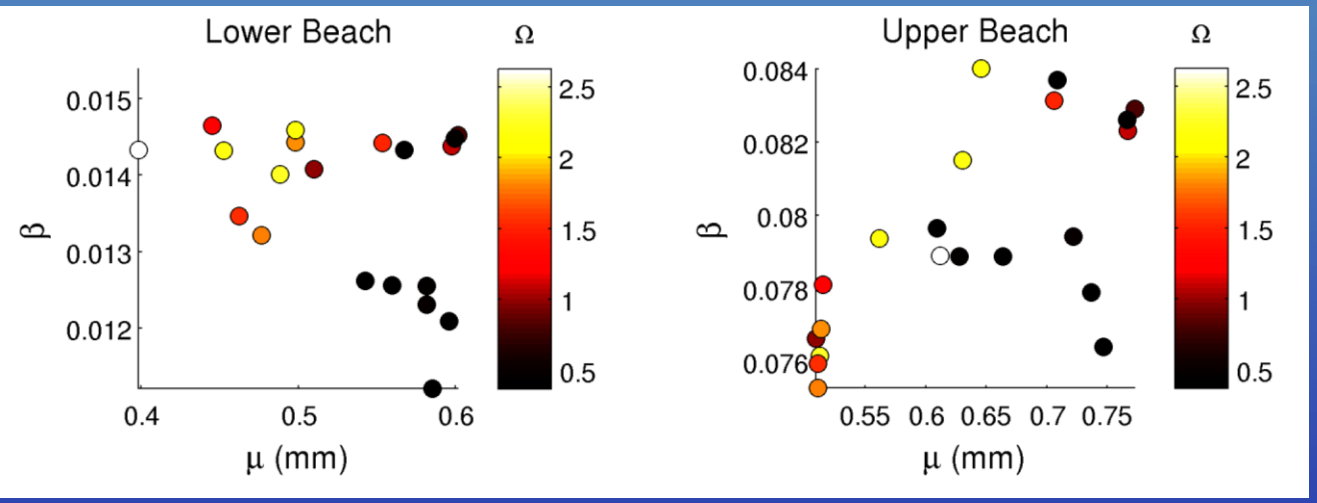
- Digital Grain Size website & software:

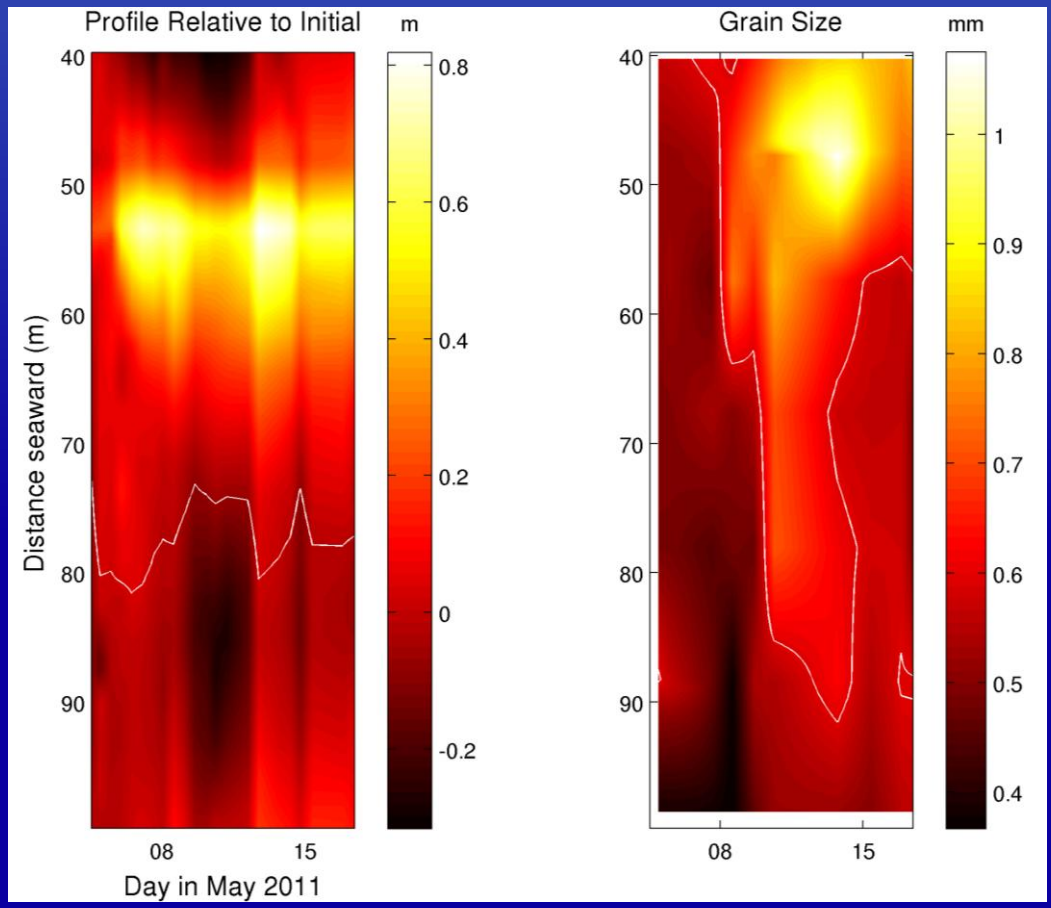
http://walrus.wr.usgs.gov/seds/grainsize/

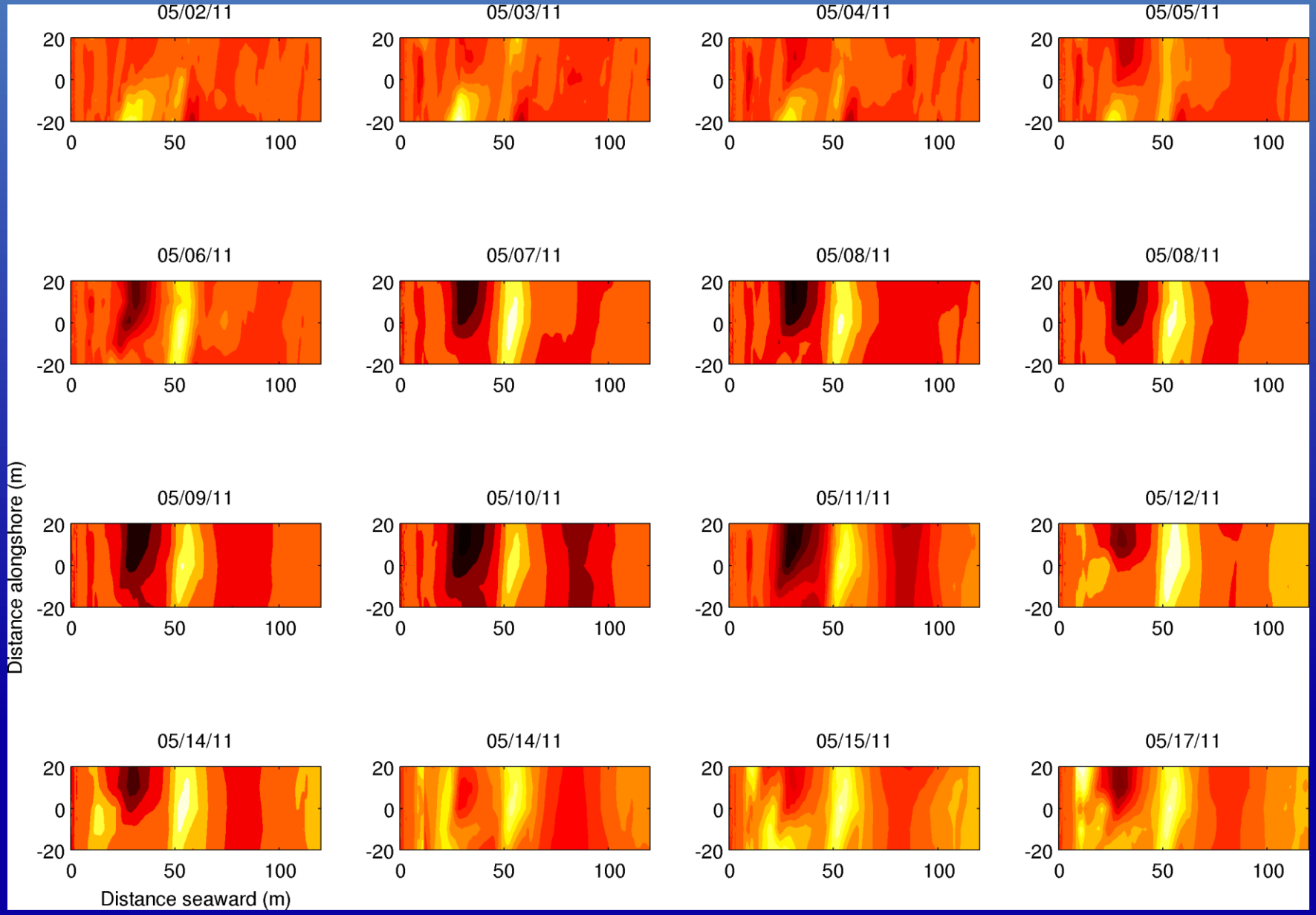
daniel.buscombe@plymouth.ac.uk




a)
05/14/11
m
0.5
0
-0.5
m (negative onshore)
12:00
15:00
0.04
0.02
0
-0.02
-0.04
b)
05/17/11
m
0.5
0
-0.5
15:00
18:00
0.04
0.02
0
-0.02
-0.04


Lower Beach
Ω
β
μ (mm)
Upper Beach
Ω
β
μ (mm)


Profile Relative to Initial
m
Distance seaward (m)
Day in May 2011
Grain Size
mm


05/02/11
05/03/11
05/04/11
05/05/11
05/06/11
05/07/11
05/08/11
05/08/11
05/09/11
05/10/11
05/11/11
05/12/11
05/14/11
05/14/11
05/15/11
05/17/11
20
0
-20
0
50
100
Distance alongshore (m)
Distance seaward (m)

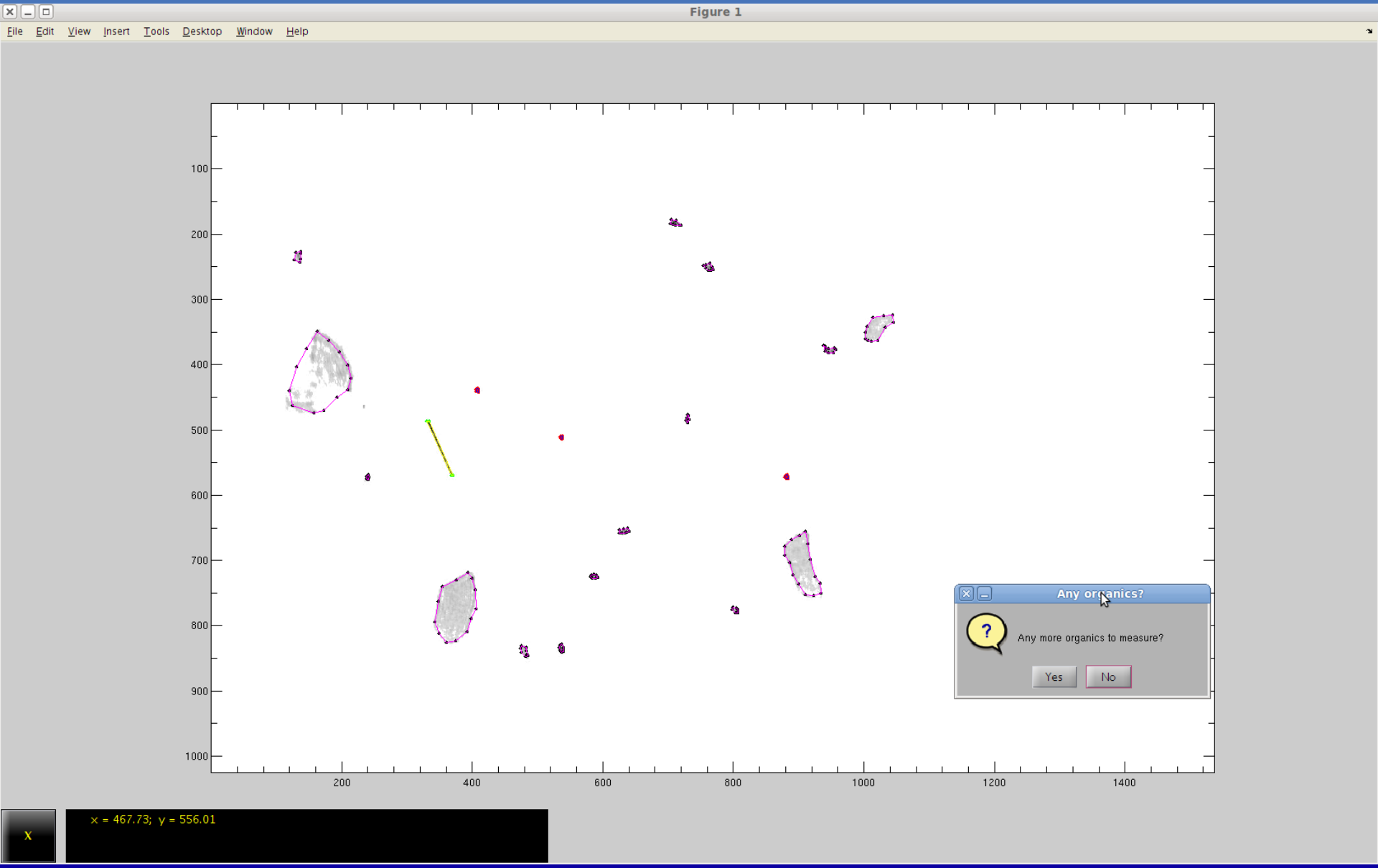


Figure 1
File Edit View Insert Tools Desktop Window Help
100
200
300
400
500
600
700
800
900
1000
200
400
600
800
1000
1200
1400
Any organics?
Any more organics to measure?
Yes
No
x = 467.73; y = 556.01