

Perspectives of ongoing acoustic developments for measuring sediment dynamics

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BASSI – Bedform And Suspended Sediment Imager

3D-ARP – 3 Dimensional Acoustic Ripple Profiler

HR-ACVP – High Resolution Acoustic Concentration and Velocity Profiler

Providing measurements to advance understanding of nearbed sediment transport dynamics

Invited presentation on Hydralab+ COMPLEX studies at the ASA/EAA conference in Boston, USA, 25-29 June 2017

**Thorne P. D. and Hurther D. 2017. Perspectives of ongoing developments for measuring sediment dynamics.
Journal Acoustical Society of America. Vol 141, No 5 Pt2 of 2, 3669-3670.**

The prediction of sediment transport is a world wide issue and is studied globally



economic



coastline

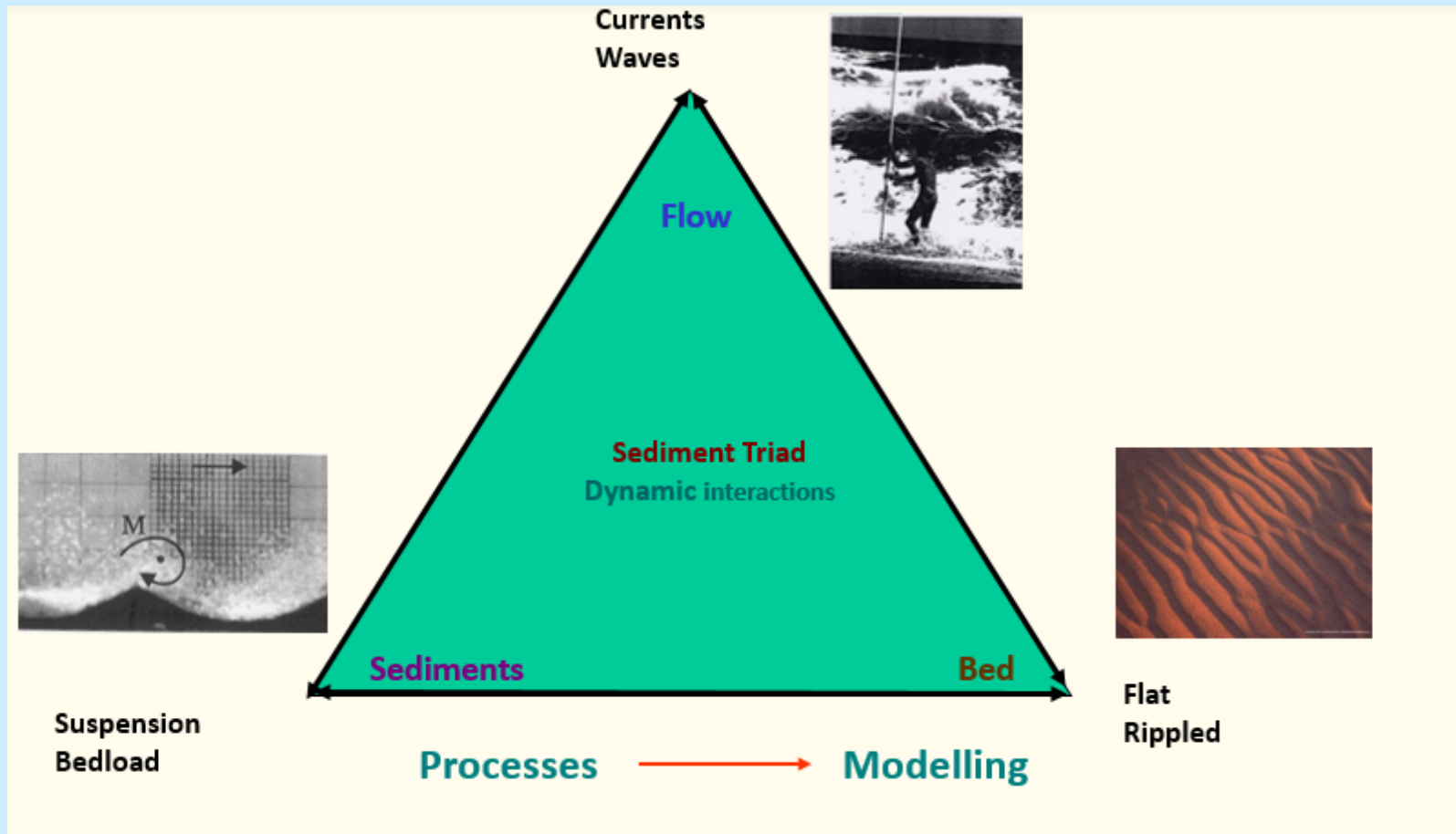


ecology

Sediments- Relevant to a broad spectrum of marine science
physical processes to complex biology

Developments have been carried out through EU funding as part of Hydralab programs
Provide access to large scale facilities, support staff and instrument development

Scientific aim Measure fundamental sediment processes



Simultaneous, co-located measurements of the dynamic interacting sediment triad

Typical experiment in the Barcelona Flume: 100 m long, 5 m deep, 3 m wide
Regular waves $H=0.3-0.5$ m $T=4.5$ s over bedforms



BASSI



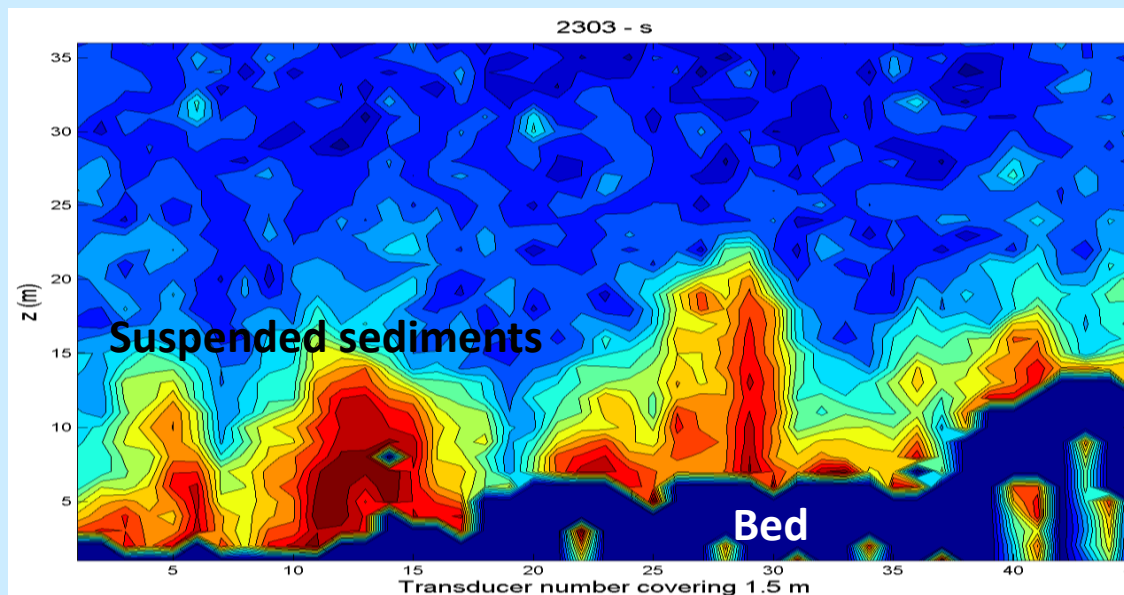
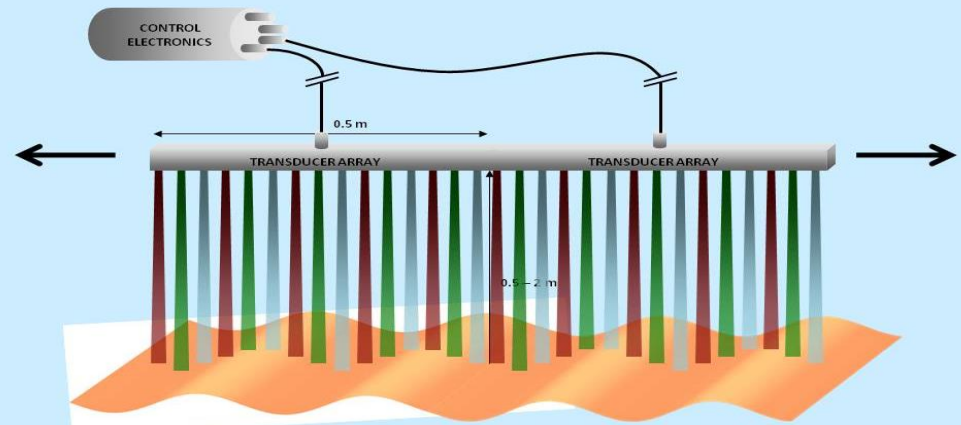
3D-ARP



HR-ACVP & ACVP

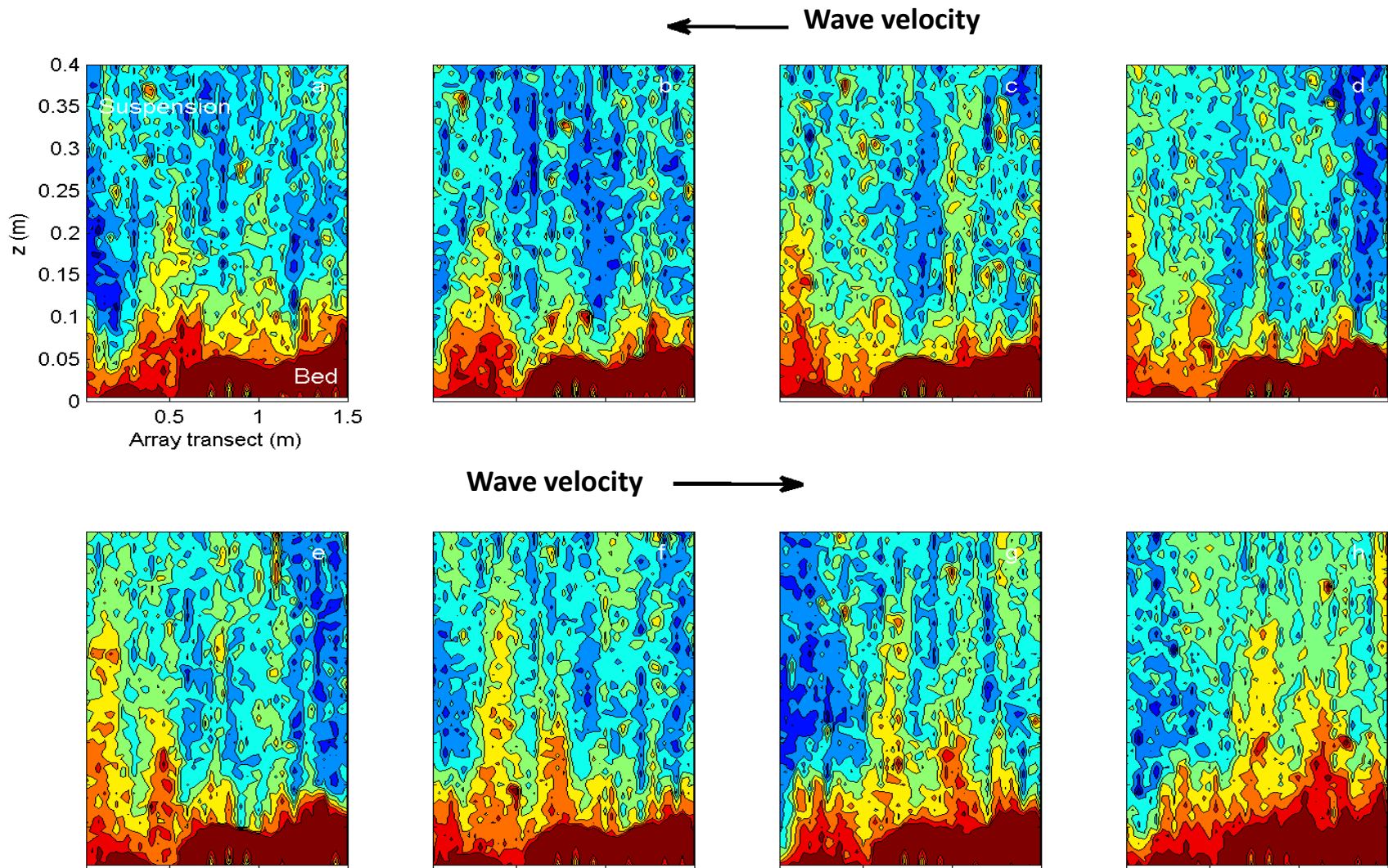
BASSI – Bedform And Suspended Sediment Imager

Operates at 0.75, 1.25, 2.5 MHz
Vertical profile 1m
Vertical resolution 5 mm
Horizontal resolution 3.3 cm
Image rate 10Hz
15 transducer/array
4 arrays variable configurations



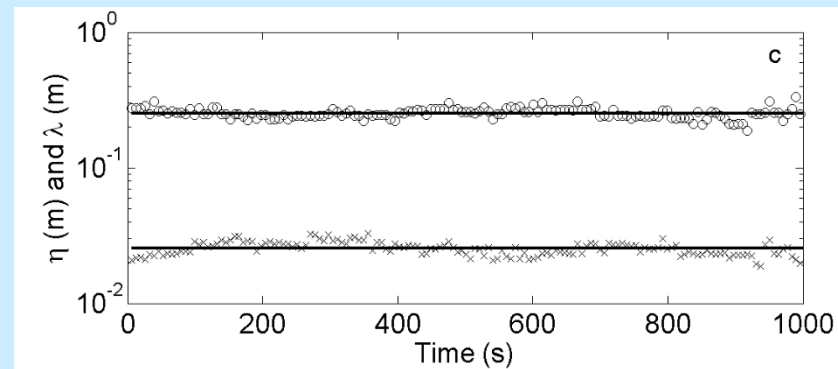
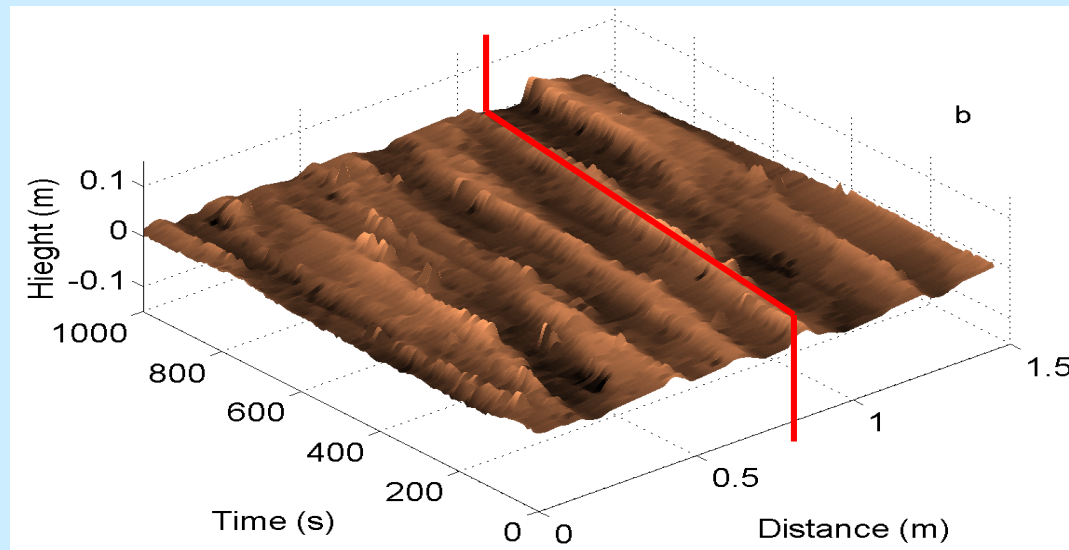
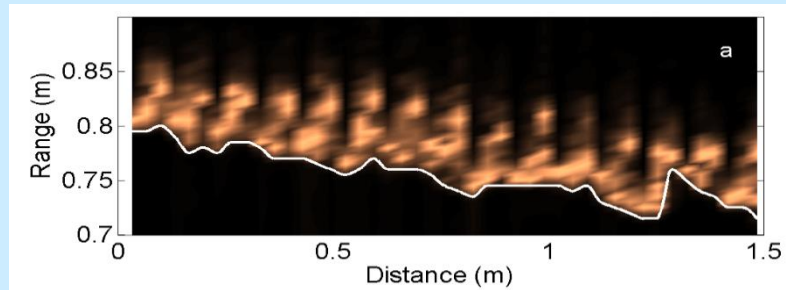
2DHV Suspension (concentration - particle size), 2D transects of the bed, ripple migration 5

Time varying intra-wave intra-ripple suspension processes



Images 0.5s apart

Bedforms, ripple migration and bedload



3D-ARP – 3 D imensional A coustic R ipple P rofiler

Operates at 1.1 MHz

90dB dynamic range

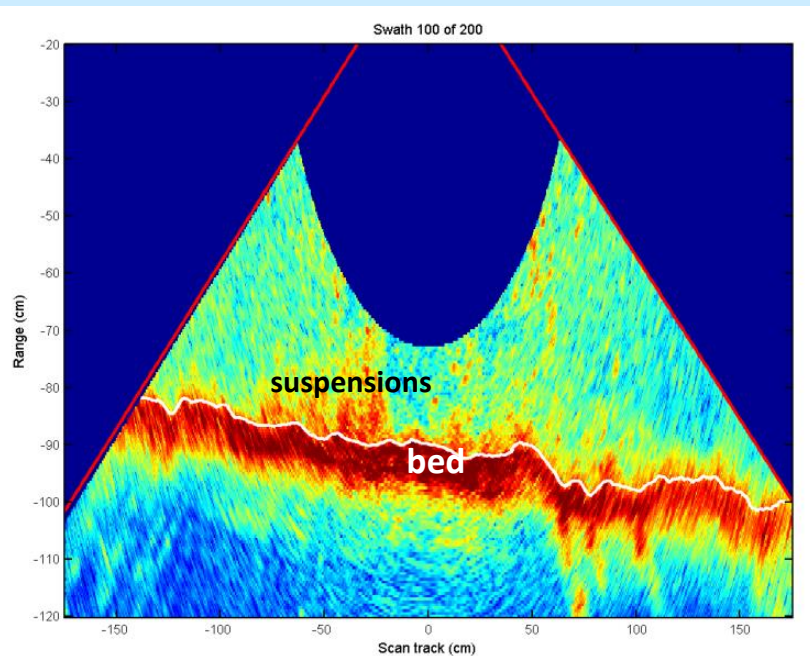
Variable sector and range

Variable azimuth rotation, 0.9° - 9°

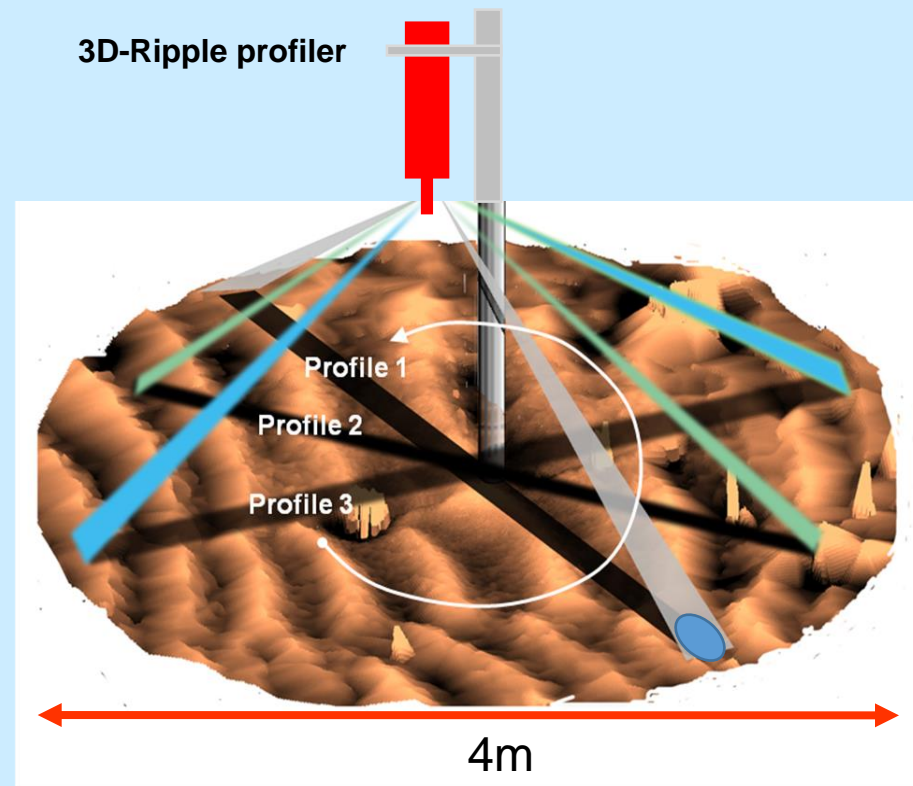
Variable swath 0.9° - 9°

Variable digitisation, 1-100 us

Pitch and roll sensors

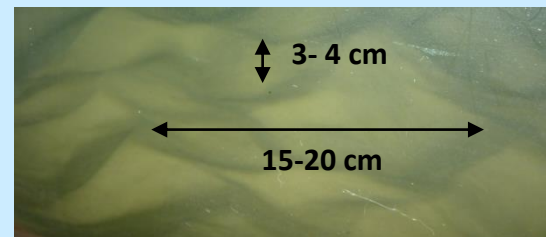
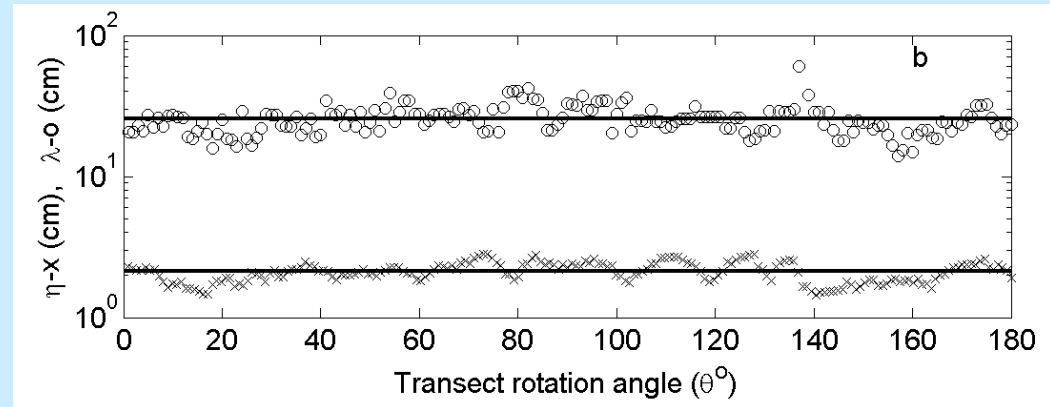
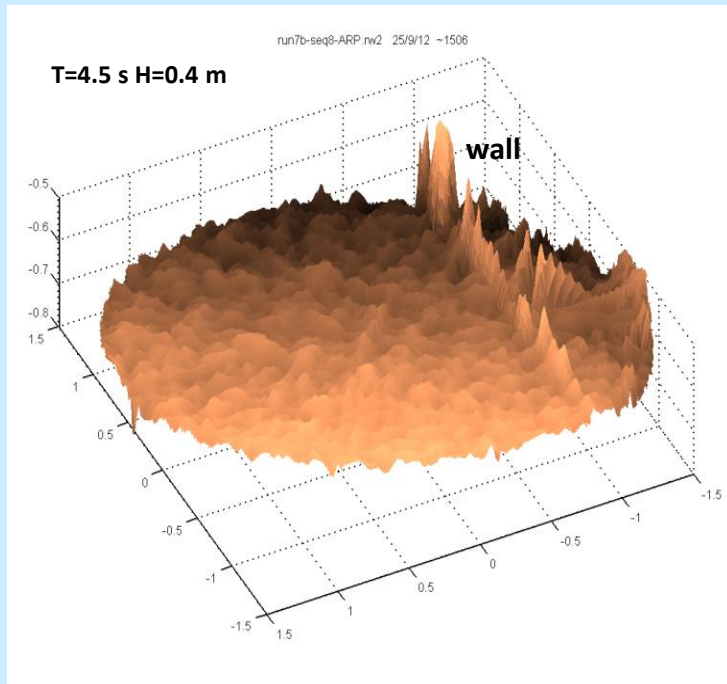


3D-Ripple profiler



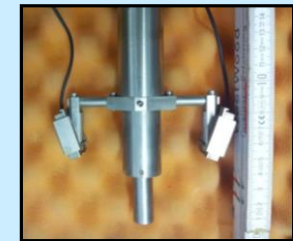
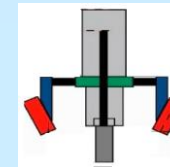
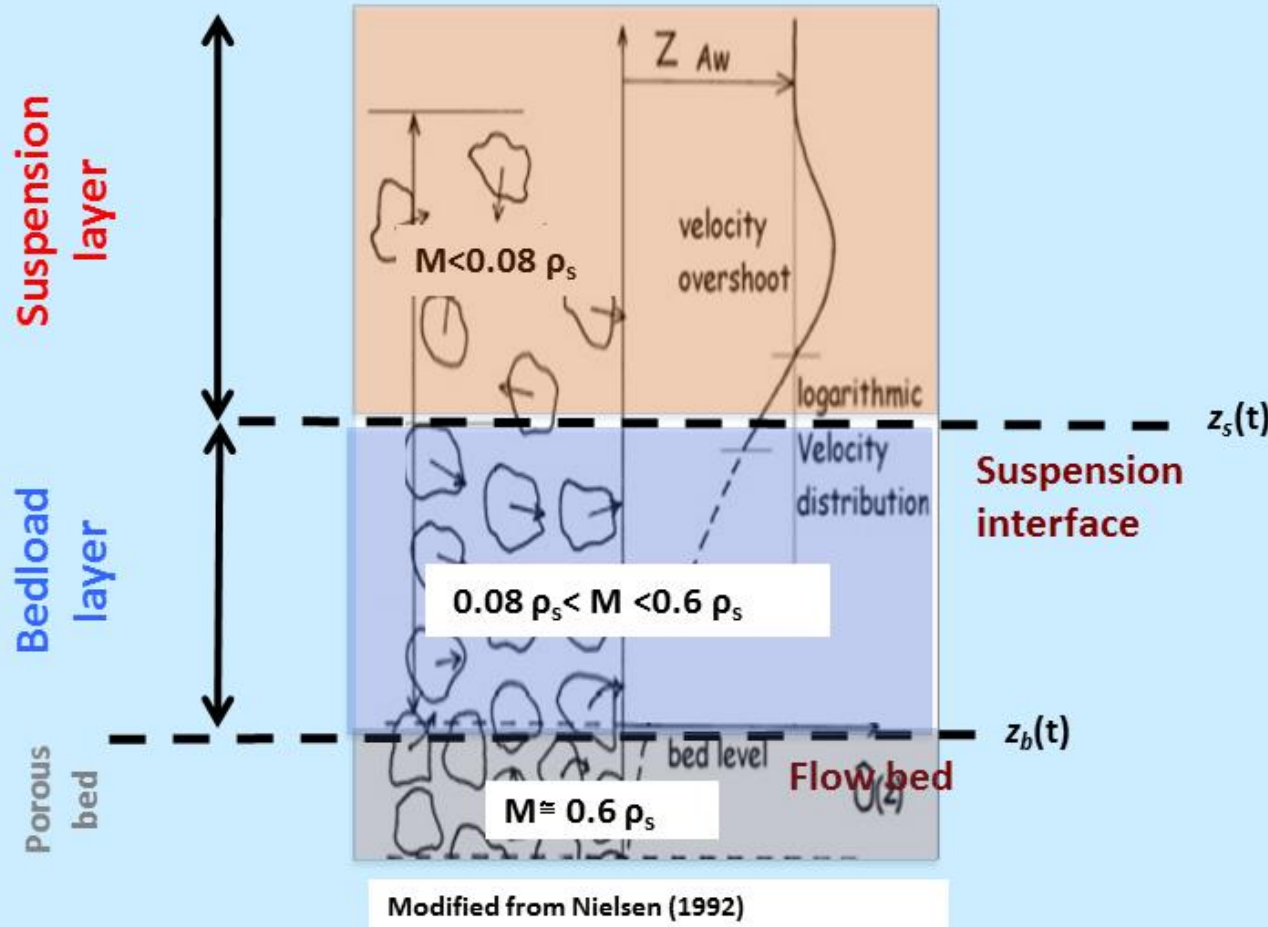
2DHV suspension, 3D- beforms, ripple migration

Bed topography from the 3D-ARP: **was expecting 2D vortex ripple**



3D-ripples

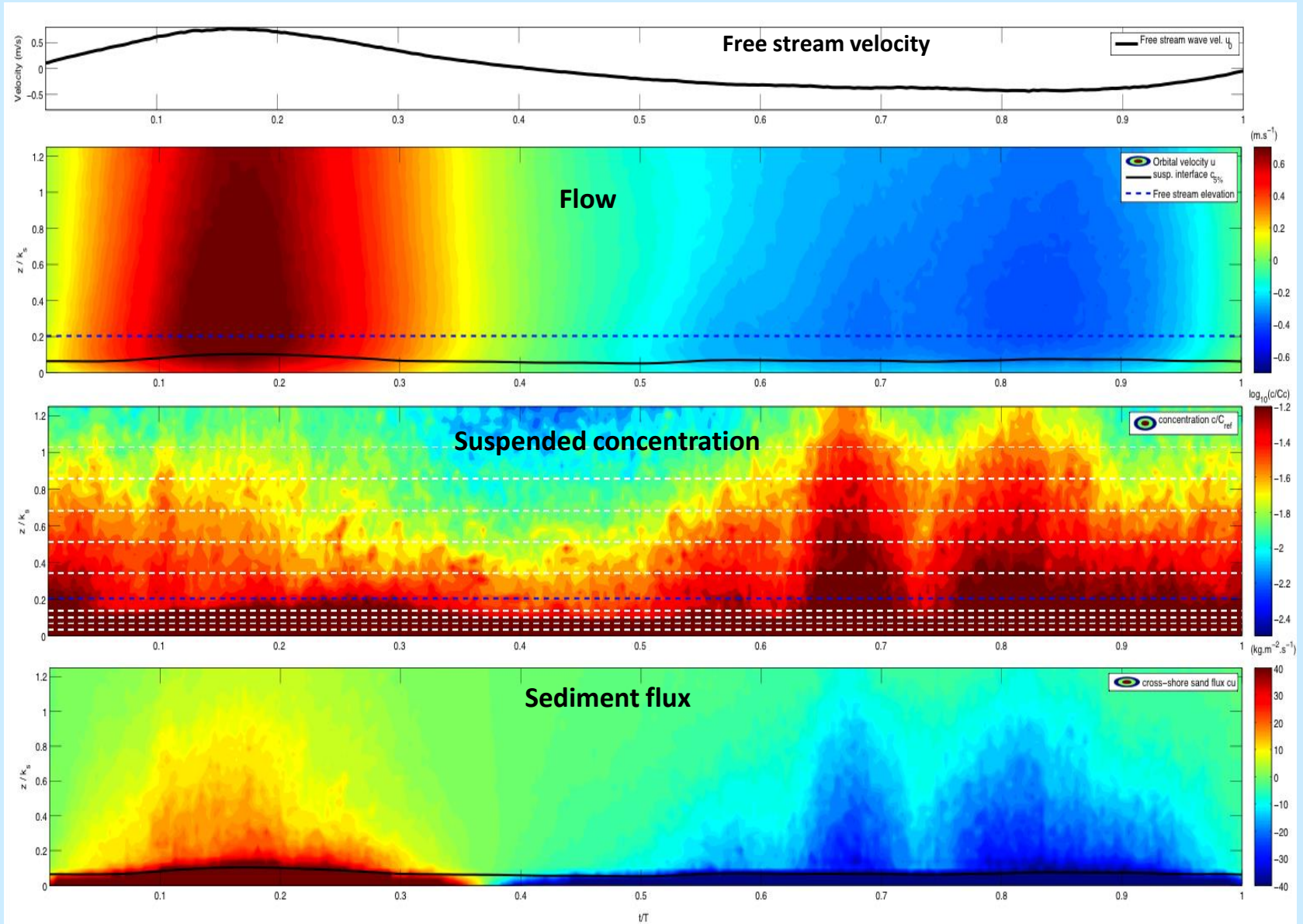
HR-ACVP - High Resolution Acoustic Concentration and Velocity Profiler



Dual freq
Resolution 1 mm
Vel 100 Hz - u,w
Conc 10 Hz

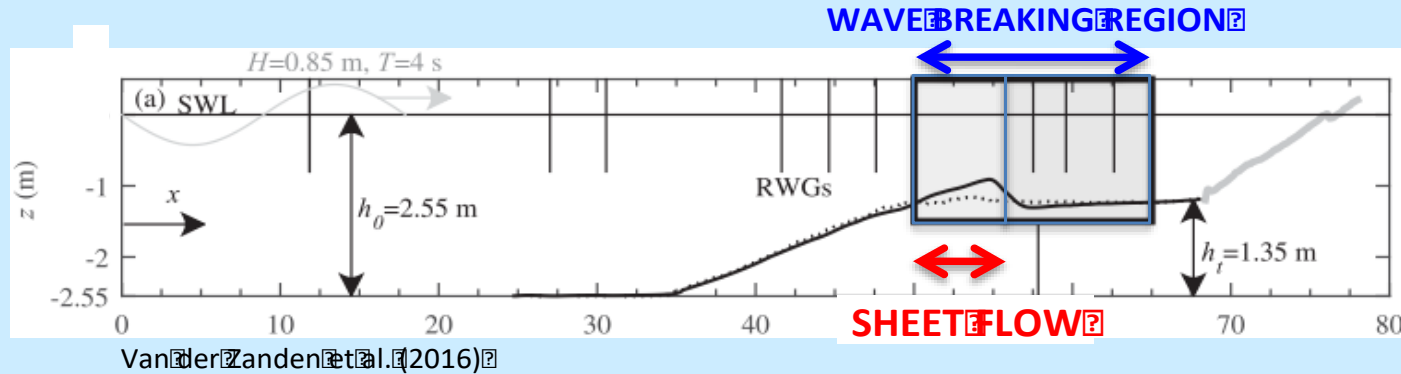
Suspension (concentration and particle size), 2 component velocity, bedload, bottom tracking

Measurements of flow, suspended concentration and sediment flux under waves over a ripple bed



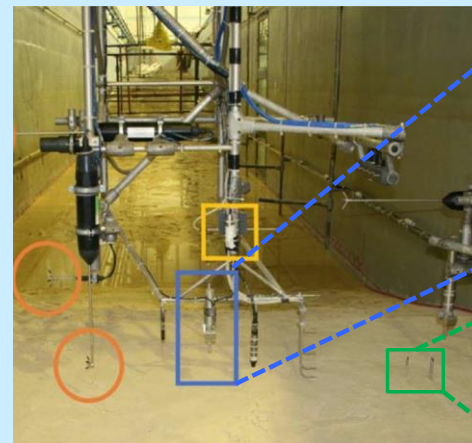
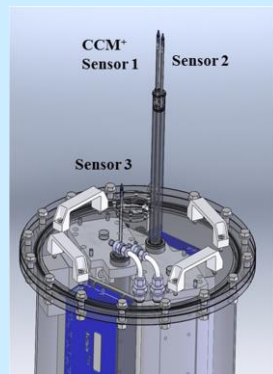
Wave-driven sheet flows in the wave breaking region

SINBAD experiment at UPC-CIEM (2014)

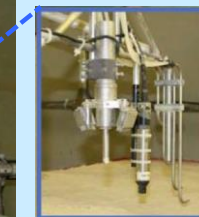


Sheet Flow Instrumentation

Conductivity
 Concentration
 Meter (CCM)



ACVP (CNRS-LEGI)



CCM+ (U. Twente)



Acoust. SF meas. validation

- concentration fields
- erosion depth
- sheet flow layer thickness
- net bedload transport rate

Hydrodynamic WBL properties

- intrawave velocity field
- WBL thickness
- velocity phase lead
- wave non-linearities

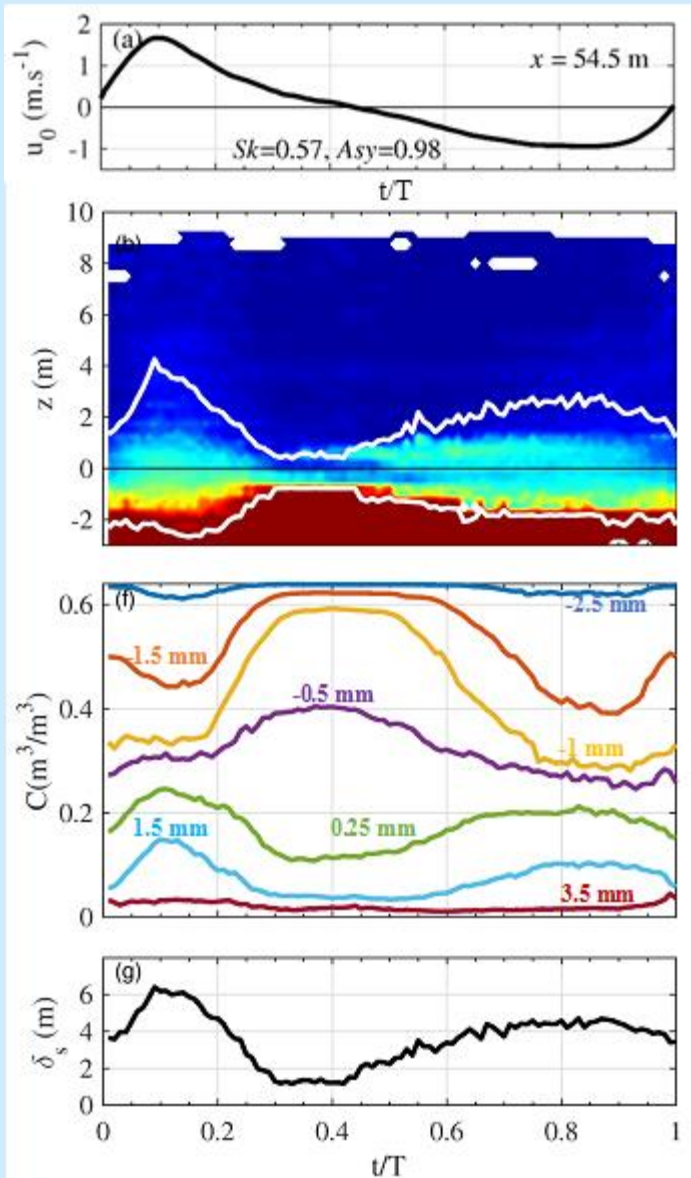
Sheet flow properties

- pick-up / upper SF layer dyn.
- Sheet flow layer thickness
- reference height / conc.
- bedload transport rates

Wave-driven sheet flows in the wave breaking region

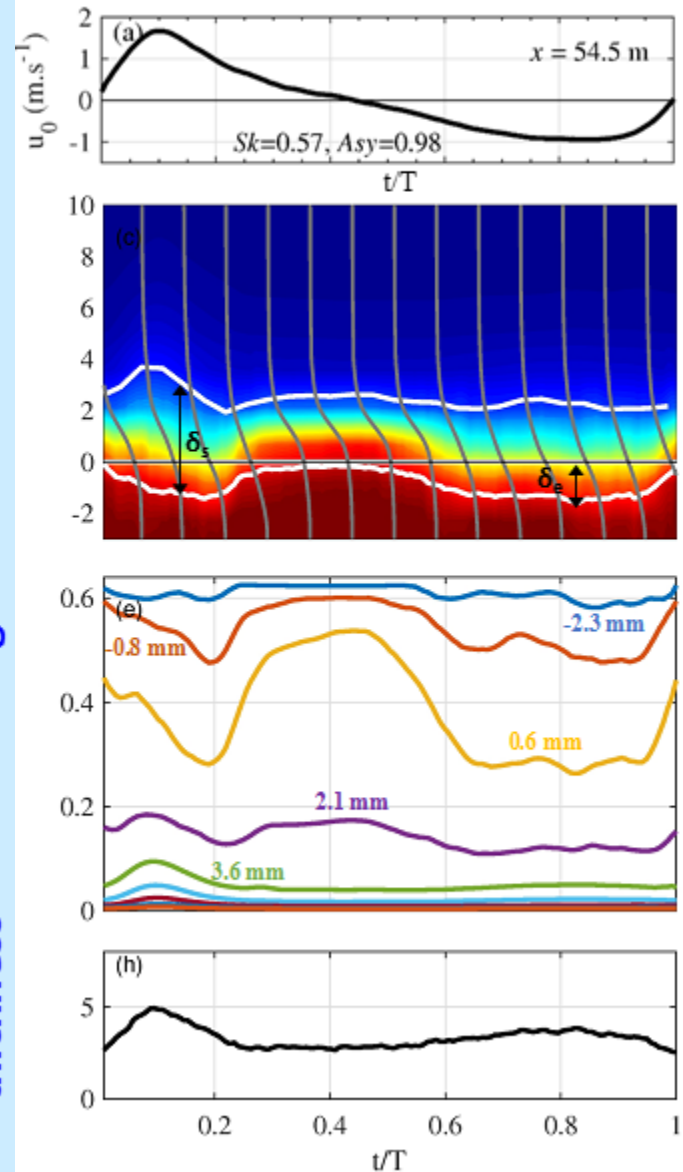
G. Fromant, J. van der Zanden

CCM-3p



u_0
 Concentration field
 Concentration at fixed heights
 Sheet Flow thickness

ACVP



δ_s sheet flow layer

δ_e erosion depth

Vol conc

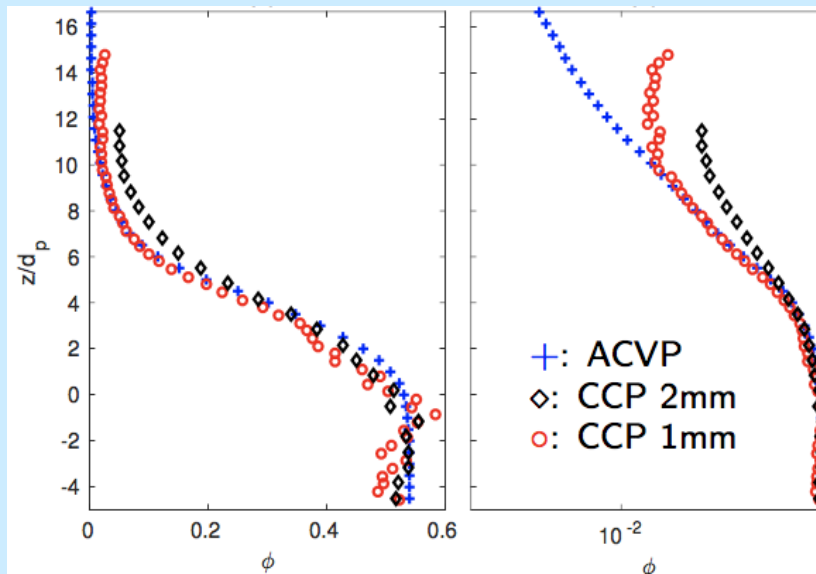
δ_s sheet flow layer

Current-driven Sheet Flows

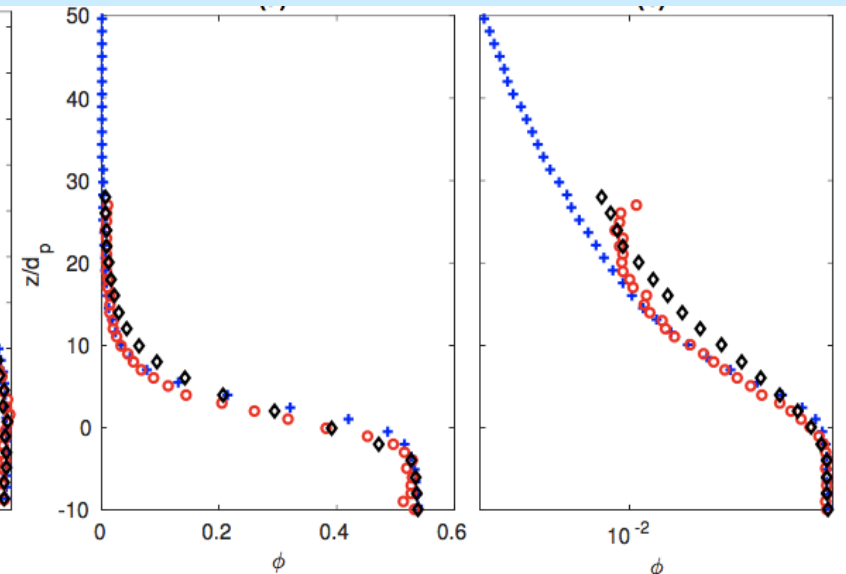
J. Chauchat, G. Fromant, T. Revil-Baudard, R. Myeras, J. Puleo

Bedload measurements: comparison of ACVP & CCProfiler measurements

Large particle (3mm)



Small particle (1mm)

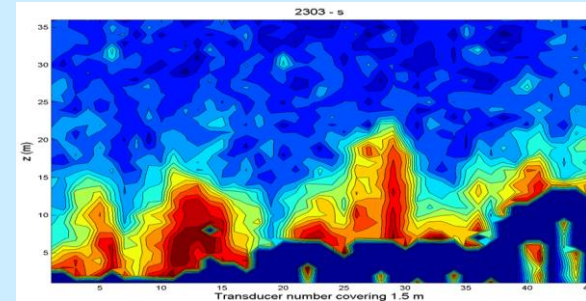


- Good agreement between CCP probes and ACVP
- CCP do not measure concentrations below $\Phi < 0.01$

Conclusions

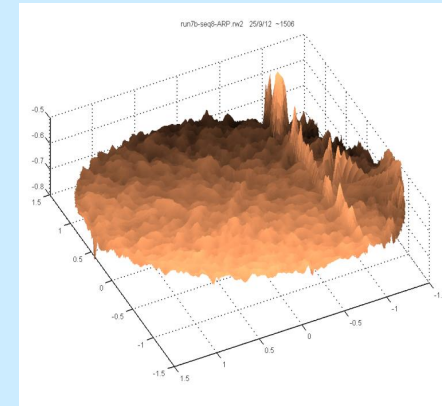
BASSI

2DHV images of suspended conc/size
Intra-wave intra-ripple suspended sediments
Transects of bedforms
Ripple dimensions
Ripple migration can be measured



3D-ARP

Individual transects of the bed
3D images of the bedforms
Ripple dimensions
Suspended sediment can be measured



HR-ACVP

particle size & concentration
velocity profiling & bed interface tracking
Suspended sediments & bedload fluxes
Bedform measurements on mobile beds

