## Turbulence measurements within fluid mud layers in a macrotidal estuary

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#### Fluid mud in estuaries



Le Hir et al, 1996

- High variability of concentration (0,1 to 100 kg/m3)
- Complex fluid-sediment interaction (turbulence damping)
- Big issue : measurements of velocities in the bottom layer

#### Aims

 to provide relevant instrumentation to study turbulence-sediment interaction in highly turbid waters

- $\rightarrow$  shear profile
- $\rightarrow$  flocculation
- $\rightarrow$  bottom shear stress
- $\rightarrow$  provide values of w'c'  $\rightarrow$  erosion fluxes

This work :

- to test an acoustic doppler velocimeter in natural conditions (initially lab oriented)

 $\rightarrow$  comparison of some mean values

### **ADVP : Acoustic Doppler Velocity Profiler**

- developed by LEGI Grenoble
- monostatic version (one emitor-receptor transducer)
- measures u' along the axis of the beam

- tested in laboratory conditions for SSC up to 150 kg/m3 (Gratiot et al., CSR, 2000)

## The experiment The Gironde estuary (SW France)



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#### Previous observations of fluid mud (Le Hir et al., 2000)



## The experiment Instrumental deployment



#### ADV Vector Nortek

#### **OBS** turbidimeters

#### **ADV Profiler**



Measurements by 5mn burts, every 20mn (OBS and ADV Vector) 3mn burts every 10mn (ADVP)

## The experiment Instrumental deployment







### Mean horizontal velocity (from Vector)



#### Mean horizontal velocity (from Vector)





#### **Mean SSC time evolution**



No fluid mud detected during the entire experiment, but high concentrations, near 40 kg/m3

#### **ADVP response during ebb phase : rejection rate**



election of 12 profiles (3 first hours of ebb tide)

configurations

	short profile	long profile
frequency	7800 Hz	3900 Hz
profil length	8,25 cm	18 cm
resolution	3 mm	6 mm
nb of points	16	24
vel res (cm/s)	130	65

good agreement between the 2 configurations

#### **ADVP response during ebb phase : rejection rate**



Rejection rate approaches 50% near the bottom  $\rightarrow$  acceptable value for high SSC

Profiles 13 and 14 : decrease of rejection rate

### ADVP response during ebb phase Velocity and turbulence profiles (vertical component)



# ADVP response during ebb phase Velocity and turbulence profiles



### **ADVP response during ebb phase**

#### **Turbulence profiles**



Weak rejection rates during high turbulence periods :

Turbulence level is the dominant factor in Doppler signal quality rather than concentration

#### **ADVP vs ADV Nortek**



### **ADVP turbulence response vs SSC**



#### **Further analysis and developments**

ADVP worked only during part of the ebb phase  $\rightarrow$  entire tidal cycle

SSC too weak

- $\rightarrow$  tests under higher concentratons
- $\rightarrow$  SSC along the ADVP profile ?

Poor information of the water column  $\rightarrow$  more intrumentation, continuous measurements  $\rightarrow$  SSC fully validation

→ Bi-static version (measurement of u' and w')





High-resolution vertical profiles of turbulence intensity and mean velocity have been obtained on a muddy bottom layer, under high SSC conditions

The ADVP response has been qualitatively correlated to events during the ebb tidal phase in the Gironde estuary

The ADV Profiler (originally lab oriented) is suitable for use in the field  $\rightarrow$  improvements on reliability, need of fully validation

The accurate profiling allows to *measure* erosion flux (w'c') and bottom shear stress

... Thanks for your attention