**SEDIMENT DYNAMICS AT THE MOUTH OF THE SEINE ESTUARY**

**TP ADCP 2021/2022**

**ENSTA Bretagne - 3A**

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***Main objective : Evaluating the Suspended Sediment concentration variability in the Seine Estuary mouth from ADCP backscattered signal***

*2 weeks after the last session : provide the matlab script and a report describing the methods used, assumptions made and results illustration and discussion : what is the sediment dynamics at the mouth, what happens ? why ?*

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1/ Calibrate the optical turbidity meter (wetlabs) in g/l (calibration.txt: 1 : NTU, 2 : MES\_all\_in\_mg/l). This step can be done either with excel or matlab

load the wetlabs files (surface and bottom) and plot the time series (use the function load). Be carefull, time is a matrix (YYYY MM DD hh mm ss). Construct a time array with *datenum*.

Each group works with a different subset of the data, i.e. over a 2-week period. You can create a subset (tata) of the variable toto using :

mask=(time>tmin & time<tmax);

toto=tata(mask) ;

tmin and tmax can be specified using datenum function, time being the time array.

Plot on a second figure the time series of the wetlabs turbidity subset. Discuss the variability in the turbidity signal.

**For questions 2 to 7 use the data subset.**

2/ load the ADCP file (awac.mat)

Plot the pressure sensor data (data.pressure, in m above bed) with time (data.time). Be carefull data.time is a matrix with 6 columns : YYYY MM DD hh mm ss.

Build the position array of ADCP cells (position of each cell in m from the bed to the surface), filter the ADCP data in air (i.e. data in air == -999 or NaN).

3/ Plot the current speed (EAST (ve) and NORTH (vn)) and the raw acoustic backscattered signal (a1, a2, a3) in (t,z). (data in air must be flagged (i.e. ==-999 or NaN) You can use the functions *imagesc*

4/ Compute the correction terms for the acoustic backscatter from the sonar equation.

5/ Compute BI for all cells in water, plot BI (in (t,z)).

6/ BI calibration : Plot the log10(SSC) obtained from wetlabs turbidity and your calibration function (question 1) as a function of BI, find the linear relationship between these two parameters, which is finally the empirical calibration of the acoustic backscatter (you can use the function *interp1*)

use first the bottom turbidity, next the surface turbidity

Discuss about the surface/bottom calibration. Investigate what might help for improving surface calibration. How would you estimate the uncertainty of the SSC calculated from the ADCP ?

7/ Apply this calibration to the BI dataset (give a method for the inversion over the whole water column), and discuss the observed dynamics.

8/ if you still have time…Repeat questions 2 to 7 with another 2-week period (i.e. 2 months later or earlier)

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**Files that you can use :**

Calibration.txt : wetlabs data (in NTU, first column) and SSC (from filters, in mg/l, second column)

Alpha\_w.txt : water attenuation coefficient table. Col 1 : depth, Col 2 : temperature, Col 3 : salinity, Col 4 : alpha\_w

awac.mat : awac data

wave.mat : wave data

wetlabs.mat : bottom wetlabs data (30cm above the bed)

wetlabs\_surface.mat : surface wetlabs data (1m below surface)

hydrocat\_data.mat : surface salinity data (1m below surface)

LC\_Tidal\_cycle.png : example of the tidal dynamics

salinity\_vertical.png : information about the development of the vertical stratification

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**Correction of the acoustic backscattered signal (sonar equation)**

**RL=SL-2\*TL+PGeo+BI**

* RL : received level, SL emitted signal, TL transmission loss, PGeo geometric loss, BI backscatter index (related to SSC such as 10\*log10(SSC)=a\*BI+b (a can be 1 (theory) or different from 1)
* TL = 10log10(ψ\*R^2)+sumR(r\*(w(r))) (s neglected as SSC assumed to be <100mg/l). Be careful, transmission loss (water attenuation) must be summed cells by cell until the target cell. w may change with depth, salinity and temperature...
* PGeo=10log10(V)
* RL=Kc\*(EC-EC0)+B
* EC : a1, a2 ou a3

**Informations :**

Salinity : 30 PSU (fixed) /Temperature obtained from the ADCP (but measured close to the bed, considered homogeneous along the water column)

You could also use the figure salinity\_vertical.png and propose a different method.

To calculate sound speed : celeriteChen.m

To calculate water attenuation w : equ\_att\_son\_garrison.m or alpha\_w.txt

To calculate geometric constant (V):

* phi=ouv\*pi/180 (in radians, ouv=0.99°)
* PSI=pi\*(phi/2)^2 (solid angle)
* V=PSI\*R^2\*0.5\*WS (WS : ADCP cell size, R distance from the transducer)

et z=R/R0 avec R0=1.08

*Acoustic data:*

Transducer frequency : 1MHz

Beam angle / vertical : 25°

ADCP cell size : 50cm

First cell position (from the transducer) : 90cm

Distance transducer/bed : 30cm

White noise B: 70

Raw level EC0 : 45

Emitted level SL: 196

Kc : 0.42

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**TIPS for matlab**

Functions you can use in matlab (do not hesitate to use the help to know how functions work)

load (load matlab .mat files or txt files)

plot : 1D plot

scatter : scatter plot to display 3 or 4 variables (the thid and fourth correspond to marker size and color)

imagesc (2D plot)

datetickzoom : automatic adaptation of the x axis in corresponding to time

xlabel (or ylabel) : to set label for axis. Options exist to set the fontsize for example

legend : legend of plots

xlim, ylim : set lower and upper boundaries of axis (you can also use the *axis* function)

set(gca,’FontSize’,18, LineWidth’,2) : set the fontsize to 18pt, and line width to 2pt

interp1 : 1D interpolation

pngprint(‘toto’) : print figures in png format with name toto.png

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**BE CAREFUL WITH UNITS, ALSO IN FUNCTIONS !**

**MAKE CLEAR GRAPHS, WITH READABLE EXPLICIT LEGENDS !**

**INCLUDE PHYSICAL INTERPRETATIONS OF YOUR RESULTS**