SEDIMENT DYNAMICS
Using CRCOCO sediment modules
#MUSTANG and #SEDIMENT

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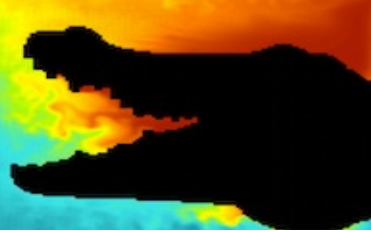
Outline

- **Sediment idealized test cases**
  - List of cases
  - TIDAL_FLAT
- **Sediment coastal example**
  - VILAINE
- **How to introduce sediment in your own configuration ?**
  - BENGUELA_LR example

Sediment idealized test cases



Review of Some Sediment Test Cases

WHY? >> Isolate specific sediment processes … with low computational resources

Initiate comparisons between sediment models

Sediment codes in Croco ?

Sediment USGS (U.S. Geological Survey model): native one, from the UCLA/ROMS Communauty / USGS , Blaas et al. (2007), Warner et al. (2008) and Shafiei et al. (2021)
(Contact in Croco team → P.Marchesiello, R.Benshila, G.Morvan)

Mustang model (MUd and Sand TrAnsport modelliNG) from Ifremer / Dhysed
(Contact in croco team → F. Dumas, M.Caillaud, S.Le Gac)

Sediment idealized test cases

Sedim.Test cases	Cppkeys	Model used (to be tested)	Processes transport / scheme ?
Plannar Beach	SHOREFACE	Usgs	Wave current Interaction (WCI)
Sandbar	SANDBAR	Usgs	WCI / Bedload / Suspload / Morpho
Rip	RIP	Usgs	WCI
Dune	DUNE	Usgs/Mustang	Non cohesive sediments / Bedload / Morpho
Dune 3d	DUNE3D	Usgs/Mustang	Non cohesive sediments / Bedload / Morpho
Analytical Dune	ANA_DUNE	Usgs/Mustang	Non cohesive sediments / Bedload
Sed toy (Rouse)	SED_TOY_ROUSE	Usgs/Mustang	Cohesive sediments / Suspload
Sed toy (Double Resuspension)	SED_TOY_RESUSP	Usgs *(Mustang)*	Mixed bed / Double erosion and resuspension events / stratigraphy
Sed toy (consolidation)	SED_TOY_CONSOLID	Usgs *(Mustang)*	Mixed bed / Consolidation / Swelling
Sed toy (flocculation)	SED_TOY_FLOC	*Usgs / Mustang*	Mixed bed / Flocculation
Tidal Flat	TIDAL_FLAT	*(Usgs)*/Mustang	Mixed bed / effects from tidal cycles forcing
Estuary	ESTUARY	*(Usgs)*/Mustang	Tide and river flowrate effect on mixed sediment

Example of TIDAL_FLAT

Goal :

Characterize bottom sand and mud concentration evolution over several tidal cycles

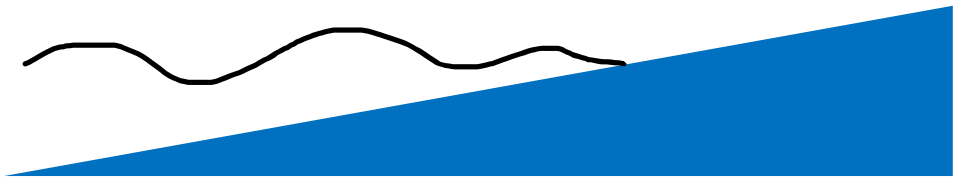
Model discretization :

200 x-horizontal grid point (LLm0) (100km) (resolution 500 m)
Seawater : 10 Layers / 16m depth at western boundary, -4m at eastern boundary
Sediments : 3 Layers / 15cm depth

Dynamics :

SSH pulses at western boundary:
*zetabry_west(j)=2.*sin(2.*pi***time***/(12.0*3600.0))*

Bottom roughness Length (Zob) : $1e^{-4}$ m



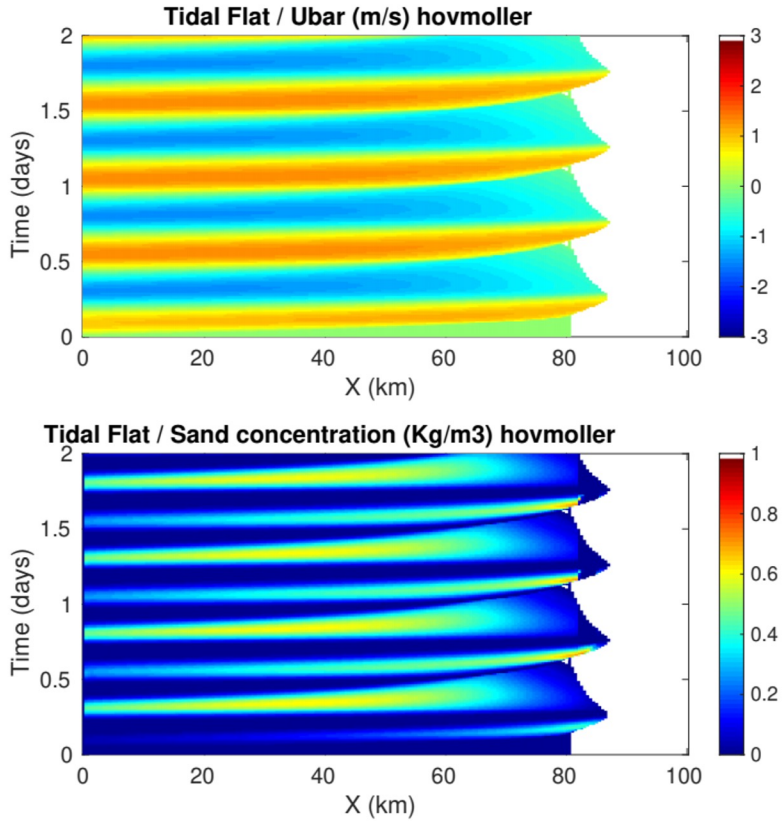
Example of TIDAL_FLAT

Sediments :

3 classes :

* 2 non cohesive sediment :
  200µm (40% in each layer) / 100µm (40%)
* 1 cohesive sediment (20%) / W_s : 0,5 mm/s
* E_0 : $2e^{-4}$

Western Tide pulses give sequences of higher and lower concentrations of material on the fluid (anti-correlated with barotropic flow)



Example of TIDAL_FLAT

To run this case :

1) Create the config directory

```
vi create_config.bash
./create_config.bash
```

In vi
MY_CONFIG_NAME=TIDAL_FLAT
options=(all-prod)

2) Edit cppdefs.h :

```
cd $HOME/ CONFIGS/TIDAL_FLAT/CROCO_IN
vi cppdefs.h
```

In vi
define TIDAL_FLAT
undef REGIONAL

3) Compile

```
./jobcomp > jobcomp.log
```

4) Run

```
./croco TEST_CASES/croco.in.Tidal_flat > croco.out
```

Results in tidal_flat_his.nc

5) Plot

```
cd ../PREPRO/CROCO
matlab -nodesktop
```

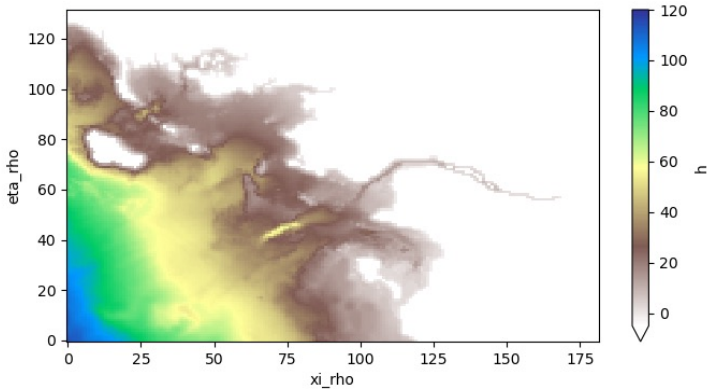
In matlab
>>start
>>cd $HOME/ CONFIGS/TIDAL_FLAT/CROCO_IN
>>addpath TEST_CASES
>>plot_tidal_flat

Sediment coastal example : VILAINE

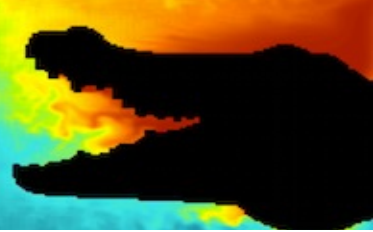
Config caracteristics : example of a realistic coastal configuration taking into account :

- Tidal circulation
- Wet/dry areas
- River outflows (Loire and Vilaine)
- Sediment dynamic with MUSTANG (including waves by using #WAVE_OFFLINE, no coupling)

Grid : 180 * 130
10 sigma layers



Sediment coastal example : VILAINE



To run this case :

1) Create the config directory

```
vi create_config.bash
./create_config.bash
```

In vi
MY_CONFIG_NAME=VILAINE
options=(all-prod)

2) Edit cppdefs.h :

```
cd $HOME/ CONFIGS/VILAINE/CROCO_IN
vi cppdefs.h
```

In vi
define COASTAL
undef REGIONAL

3) Compile

```
./jobcomp > jobcomp.log
```

4) Get input data and run (results in croco_out.nc)

```
cd $HOME/ CONFIGS/VILAINE/CROCO_FILES
ln -s /home/COMMONDATA/data_tutos/TP_SEDIM/VILAINE/* .
cd $HOME/ CONFIGS/VILAINE/CROCO_IN
ln –s ../CROCO_FILES CROCO_FILES
./croco TEST_CASES/croco.in.VILAINE > croco.out
```

And wait… cpu time much more longer than idealized testcase (could be improve by using MPI)

How to add sediment to your configuration ?

First of all : configuration must be **ready to use with only hydrodynamic**
(param.h, cppdefs.h, croco.in, all input files for hydrodynamic …)

WARNING !!! to use #MUSTANG , **#USE_CALENDAR is mandatory** !!!
To use #USE_CALENDAR you must add time attributes in your input netcdf file

Example of nco command to use : **origin date must be coherent with data in your file**
(see in /home/COMMONDATA/data_tutos/TP_SEDIM/cmd_ncatted_USE_CALENDAR.sh)

```
ncatted -O -a units,ocean_time,m,c,'seconds since 2000-01-01 00:00:00' croco_ini_SODA_Y2005M01.nc
ncatted -O -a units,scrum_time,m,c,'seconds since 2000-01-01 00:00:00' croco_ini_SODA_Y2005M01.nc
ncatted -O -a units,bulk_time,m,c,'days since 2000-01-01 00:00:00' croco_blk_ERA5_Y2005M01.nc
ncatted -O -a units,bry_time,m,c,'days since 2000-01-01 00:00:00' croco_bry_SODA_Y2005M01.nc
```

Now you can prepare your sediment case : with #MUSTANG or #SEDIMENT

How to add sediment to your configuration ?

#MUSTANG

1) Define the main option of the simulation >> cppdefs.h
2) Define the number of sediment class you want to use and the number of sediment layer in the sediment bed >> param.h
3) Change croco.in to add reading of sediment input files and change date of simulation if you did not used USE_CALENDAR before >> croco.in
4) Define the characteristics of each sediment class >> parasubstance.txt
5) Define the parameters of MUSTANG >> paraMUSTANG.txt (initialisation, érosion, layer size…)
6) Change input of river if needed (add sediment concentration in river) >> croco.in or runoff netcdf file

How to add sediment to your configuration ?

#MUSTANG, example with BENGUELA_LR
(all files available in /home/COMMONDATA/data_tutos/TP_SEDIM/BENGUELA_LR_MUSTANG)

1/10) Create a new CONFIG : vi create_config.bash
./create_config.bash

In vi
MY_CONFIG_NAME= BENGUELA_LR_MUSTANG
options=(all-prod)

2/10) Edit CROCO_IN/cppdefs.h :
- # define USE_CALENDAR
- # define MUSTANG
- # define PSOURCE
- # define BULK_FLUX

3/10) Edit CROCO_IN/param.h (lines 472 and 542) :
- parameter (ntrc_subs=2 , ntfix=0, ntrc_substot=ntrc_subs+ntfix)
- parameter (ksdmin=1,ksdmax=2)

4/10) Compile : ./jobcomp > jobcomp.log

How to add sediment to your configuration ?

#MUSTANG, example with BENGUELA_LR
(all files available in /home/COMMONDATA/data_tutos/TP_SEDIM/BENGUELA_LR_MUSTANG)

5/10) Check CROCO_FILES and use ncatted if time attributes are missing
(or : ln –s /home/COMMONDATA/data_tutos/TP_SEDIM/BENGUELA_LR_MUSTANG/CROCO_FILES)

6/10) Edit CROCO_IN/croco_inter.in (simulation date, PSOURCE, MUSTANG files)

7/10) Create your parasubstance.txt (see https://croco-ocean.gitlabpages.inria.fr/croco_doc/model/model.modules.sediment_mustang.html#input-file-substance-namelist)

8/10) Create your paraMUSTANG.txt (see https://croco-ocean.gitlabpages.inria.fr/croco_doc/model/model.modules.sediment_mustang.html#input-file-mustang-namelist)

How to add sediment to your configuration ?

#MUSTANG, example with BENGUELA_LR
(all files available in /home/COMMONDATA/data_tutos/TP_SEDIM/BENGUELA_LR_MUSTANG)

9/10) Change NM_END value to 1 in run_croco_inter.bash
Prepare run by copying files specific to MUSTANG not copied by script run_croco_inter.bash
And then run

```
cd $HOME/CONFIGS/BENGUELA_LR_MUSTANG/
mkdir SCRATCH
cp CROCO_IN/para*.txt SCRATCH/.
cp -R CROCO_IN/MUSTANG_NAMELIST/ SCRATCH/.
./run_croco_inter.bash
```

10/10) Explore results netcdf file in SCRATCH directory

How to add sediment to your configuration ?

#SEDIMENT

1) Define the main option of the simulation >> cppdefs.h
2) Define the number of sediment class you want to use and the number of sediment layer in the sediment bed >> param.h
3) Change croco.in to add reading of sediment input files >> croco.in
4) Define the characteristics of each sediment class and simulation param >> sediment.in
5) Change input of river if needed (add sediment concentration in river)

How to add sediment to your configuration ?

#SEDIMENT, example with BENGUELA_LR
(all files available in /home/COMMONDATA/data_tutos/TP_SEDIM/BENGUELA_LR_SEDIMENT)

1/9) Create a new CONFIG : vi create_config.bash
./create_config.bash

In vi
MY_CONFIG_NAME= BENGUELA_LR_SEDIMENT
options=(all-prod)

2/9) Edit CROCO_IN/cppdefs.h :
- # define USE_CALENDAR
- # define SEDIMENT
- # define PSOURCE
- # define BULK_FLUX

3/9) Edit CROCO_IN/param.h (lines 509 and 510) :
- parameter (NSAND=1, NMUD=1, NGRAV=0)
- parameter (NLAY=2)

4/9) Compile : ./jobcomp > jobcomp.log

How to add sediment to your configuration ?

#SEDIMENT, example with BENGUELA_LR
(all files available in /home/COMMONDATA/data_tutos/TP_SEDIM/BENGUELA_LR_SEDIMENT)

5/9) Check CROCO_FILES and use ncatted if time attributes are missing
(or : ln –s /home/COMMONDATA/data_tutos/TP_SEDIM/BENGUELA_LR_SEDIMENT/CROCO_FILES)

6/9) Edit CROCO_IN/croco_inter.in (simulation date, PSOURCE, SEDIMENT files)

7/9) Create your sediment.in

8/9) Change NM_END value to 1 in run_croco_inter.bash . Prepare run by copying files specific to SEDIMENT not copied by script run_croco_inter.bash . And then run

```
cd $HOME/CONFIGS/BENGUELA_LR_MUSTANG/
mkdir SCRATCH
cp CROCO_IN/sediment.in SCRATCH/.
./run_croco_inter.bash
```

9/9) Explore results netcdf file in SCRATCH directory