OBSTRUCTION module from MARS to CROCO

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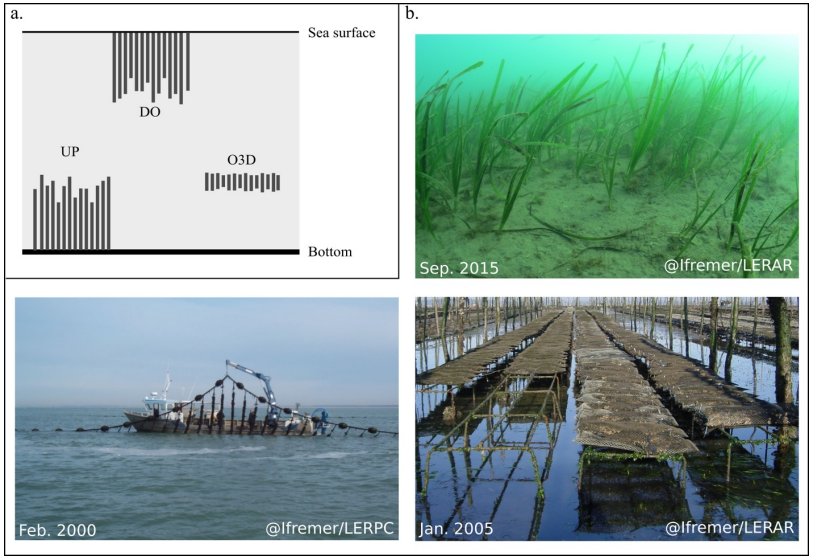
Summary

- What is OBSTRUCTION ?
- Why OBSTRUCTION in CROCO ?
- Implementation from MARS to CROCO
- Testing implementation : 2DV test case
- On going work

Work done with F.Ganthy and F.Dumas

What is OBSTRUCTION ?

- Purpose and principle



Source F.Ganthy

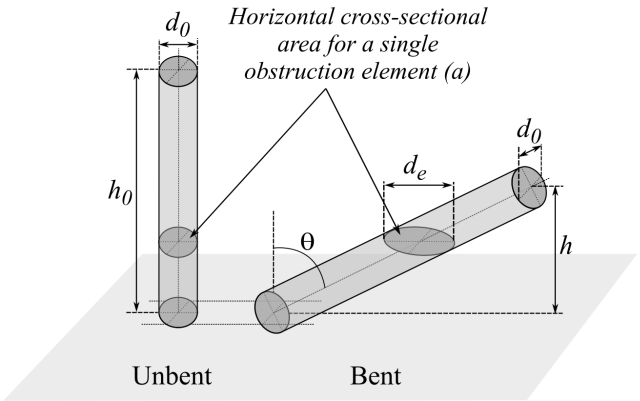
The drag induced by all obstruction elements is taken into account as a momentum loss term (friction force) in *x* and *y* directions

The influence of obstructions on turbulence leads to additional source terms in the equations of the *k-e* turbulence closure scheme

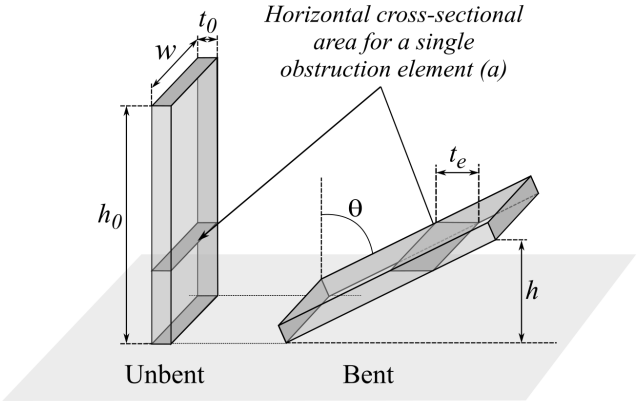
What is OBSTRUCTION ?

Obstruction type. + density and occupation rate

a. Cylinder-like obstruction



b. Parallelepiped-like obstruction



What is OBSTRUCTION ?

Main equations (cylinder case)

$$F_u(z) = -\cdot\frac{1}{2}\cdot C_D\cdot\rho\cdot d_0(z)\cdot n(z)\cdot u(z)\cdot\sqrt{u(z)^2+v(z)^2}\cdot f_z(z)\cdot f_{xy}(z)$$

$$F_v(z) = -\cdot\frac{1}{2}\cdot C_D\cdot\rho\cdot d_0(z)\cdot n(z)\cdot v(z)\cdot\sqrt{u(z)^2+v(z)^2}\cdot f_z(z)\cdot f_{xy}(z)$$

drag coefficient

leave diameter

obstruction density

fraction of layer // grid cell effectively occupied by obstructions

Drag part

$$\left(\frac{\partial k}{\partial t}\right)_{obstruction} = \frac{1}{1-A(z)}\cdot\frac{\partial}{\partial z}\left\{(1-A(z))\cdot\frac{\nu+\nu_t}{\sigma_k}\cdot\frac{\partial k}{\partial z}\right\}+T(z)$$

$$\left(\frac{\partial \varepsilon}{\partial t}\right)_{obstruction} = \frac{1}{1-A(z)}\cdot\frac{\partial}{\partial z}\left\{(1-A(z))\cdot\frac{\nu+\nu_t}{\sigma_\varepsilon}\cdot\frac{\partial \varepsilon}{\partial z}\right\}+T(z)\cdot\tau_\varepsilon^{-1}$$

horizontal cross-sectional obstruction area per unit area

function(Fu(z) ,u(z), Fv(z), v(z), rho)

function(A(z), n(z), k, eps, T(z))

Turbulence part

Why OBSTRUCTION in CROCO ?

- Needs of DHYSED :
  - F.Ganthy configuration of Arcachon bay from MARS to CROCO
  - Upcoming project
- Community model contribution
  - Configuration with submarine vegetation
  - Configuration with under mesh-size obstructions

Implementation from MARS to CROCO

- In MARS : separation implicit part /explicit part

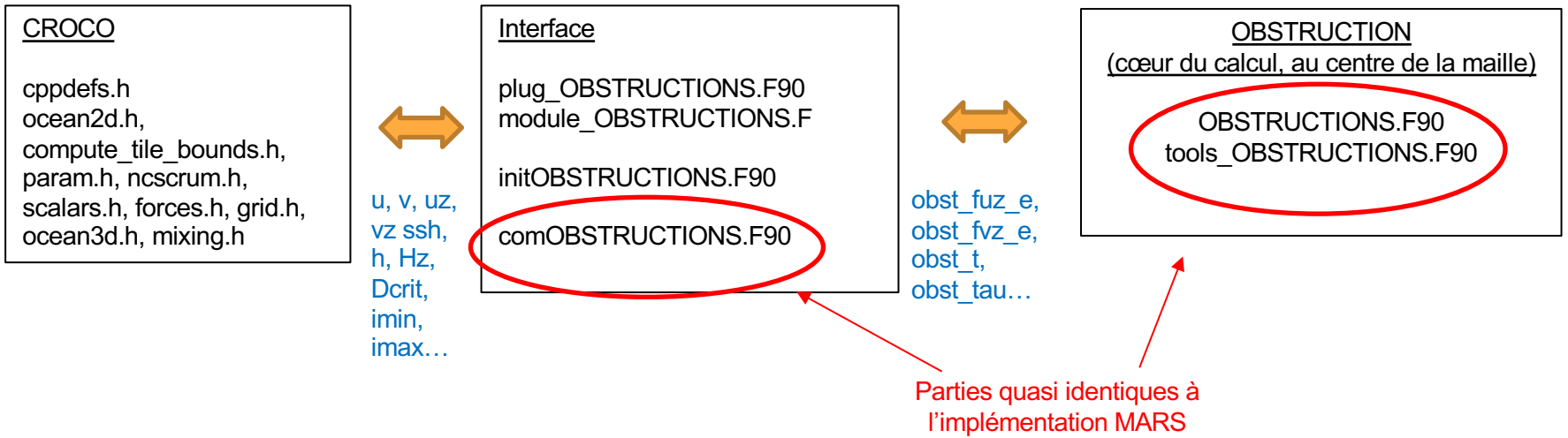
file	module	description	include	use
comOBSTRUCTIONS.F90	comOBSTRUCTIONS	déclaration des variables et allocation	toolcpp.h	parameters ; comvars2d
iniOBSTRUCTIONS.F90	initOBSTRUCTIONS	initialisation, lecture input (forte dépendance netcdf, ionc...)	toolcpp.h	comOBSTRUCTIONS; parameters; comvars2d; comvars3d; USE_MPI; comionc4; typeSizes; netcdf; ionc4; comsiggen; tidesaveobcrotated
OBSTRUCTIONS.F90	OBSTRUCTIONS	calcul principal	toolcpp.h	comOBSTRUCTIONS; initOBSTRUCTIONS; parameters; comvars2d; comvars3d; comvarp2d; comvarp3d; comturb, (toolgeom; comsiggen, wave >> comp_botstress)
tools_OBSTRUCTIONS.F90	/	tools functions		comOBSTRUCTIONS; parameters; comvars2d; comvarp2d
OBSTRUCTIONS_outputs.F90	/	output functions	toolcpp.h mpif.h	comOBSTRUCTIONS; parameters; comvars2d; comvars3d; USE_MPI; ionc4; outtools, outnetcdf, output

Implementation from MARS to CROCO

- In CROCO : all explicit

file	module	description	include	use
comOBSTRUCTIONS.F90	comOBSTRUCTIONS	déclaration des variables	cppdefs.h	
iniOBSTRUCTIONS.F90	initOBSTRUCTIONS	initialisation, allocation ,lecture input (forte dépendance netcdf, ionc...)	cppdefs.h	comOBSTRUCTIONS
OBSTRUCTIONS.F90	OBSTRUCTIONS	calcul principal	cppdefs.h	comOBSTRUCTIONS; initOBSTRUCTIONS
tools_OBSTRUCTIONS.F90	/	tools functions	cppdefs.h	comOBSTRUCTIONS
plug_OBSTRUCTIONS.F90	plug_OBSTRUCTIONS	interface OBSTRUCTIONS <> CROCO	cppdefs.h ocean2d.h, compute_tile_bounds.h	OBSTRUCTIONS; initOBSTRUCTIONS, module_OBSTRUCTIONS
module_OBSTRUCTIONS.F	module_OBSTRUCTIONS	passage fixed/free form to have access to CROCO vars	cppdefs.h param.h, ncscrum.h, scalars.h, forces.h, grid.h, ocean3d.h, mixing.h	

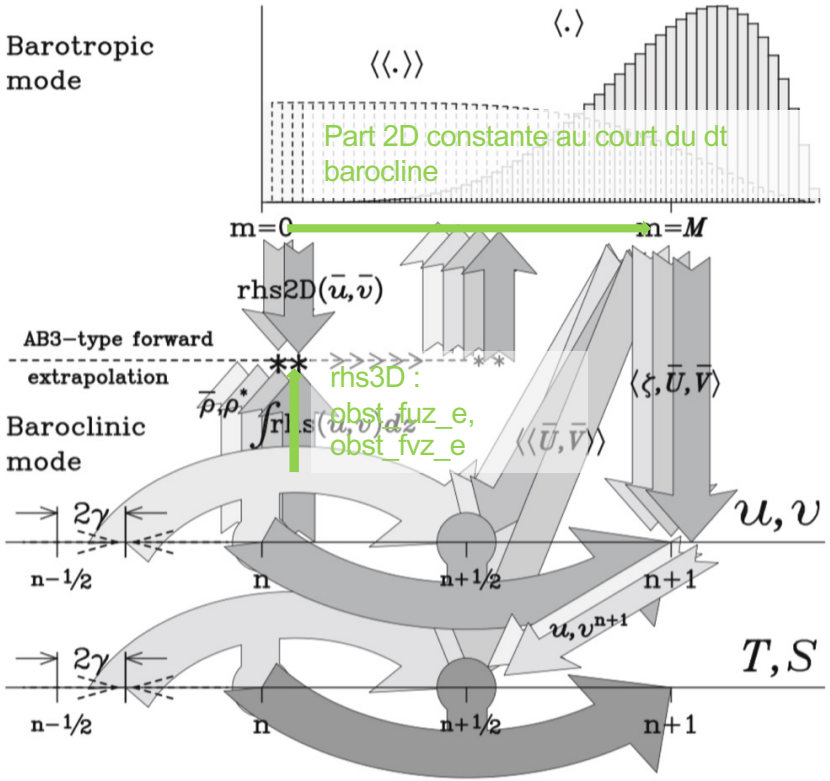
Implementation from MARS to CROCO



Move allocation in initialisation
Remove all include and USE in initOBSTRUCTION, OBSTRUCTIONS and tools_OBSTRUCTIONS
Pass variables through plug_OBSTRUCTIONS using module_OBSTRUCTIONS to retrieve arrays from CROCO
Remove OBSTRUCTIONS_outputs.F90 rewrite in CROCO (wrt_his)

Implementation from MARS to CROCO

In CROCO :
full explicit



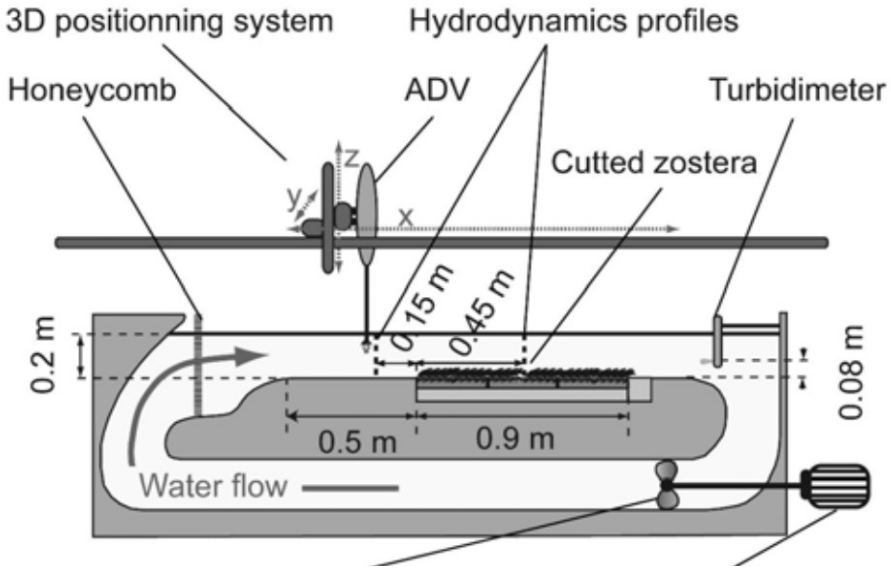
Insertion of obst_fuz_e, obst_fvz_e, obst_t et obst_tau ?
>> **rhs3D.F**
>> **gls_mixing.F**

Insertion of OBSTRUCTION_update call
>> **step.F** before rhs3D, with nstp index for u & v ; Zt_avg1 for zeta

Testing implementation

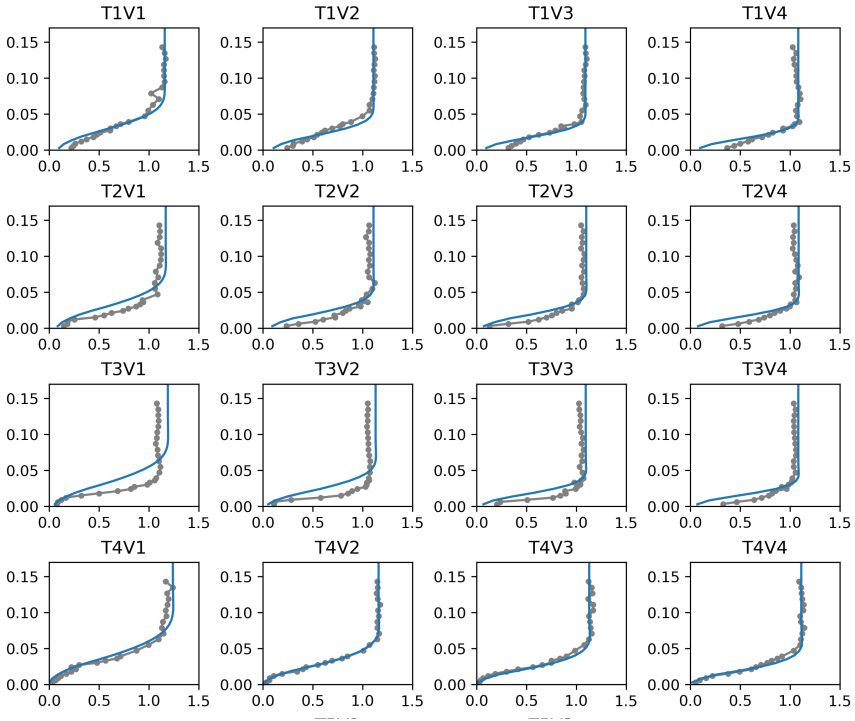
Compare experimental results from F.Ganthy (Phd p141)

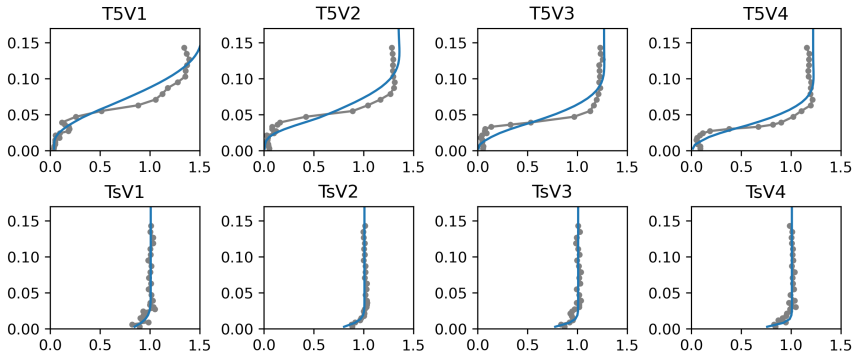
- 6 TESTS of different zosteras
- 4 current speeds : 0.1 to 0.4m/s
- 4 measured points :
  - P1 : 0.15m before zostera
  - P2 : 0.15m in zostera
  - P3 : 0.45m in zostera
  - P4 : 0.75m in zostera



CROCO : from RIVER test case
H~20cm; 40 sigmas layers; domain : 36x5

Testing implementation

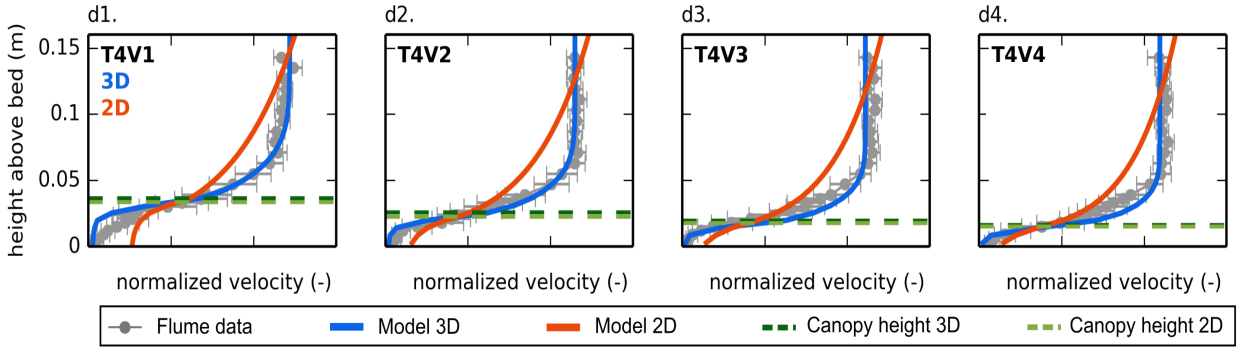




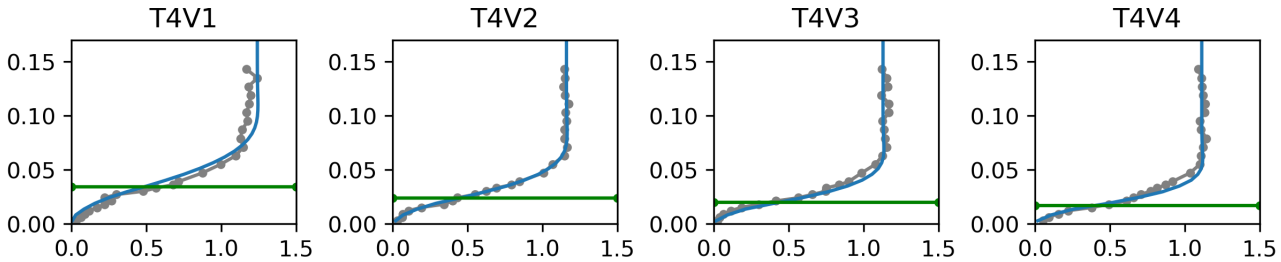
At P3
0.45m in
zostera

Testing implementation

MARS (from F.Ganthy)



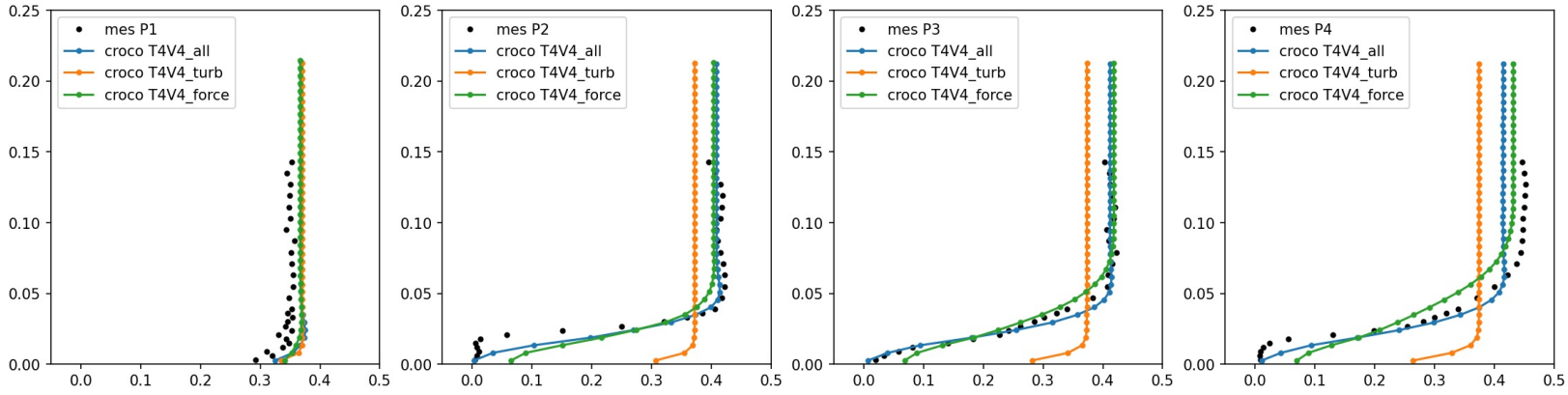
CROCO



At P3 0.45m in zostera

Testing implementation

Influence of each term : force & turbulence



P1 0.15m before zostera

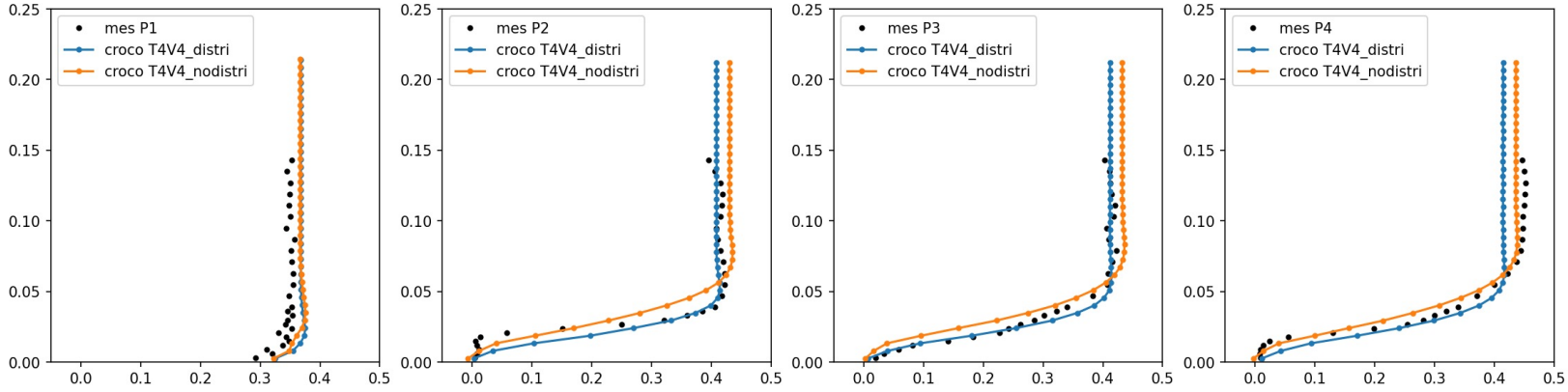
P2 0.15m in zostera

P3 0.45m in zostera

P4 0.75m in zostera

Testing implementation

Influence of vertical distribution of zostera



P1 0.15m before zostera

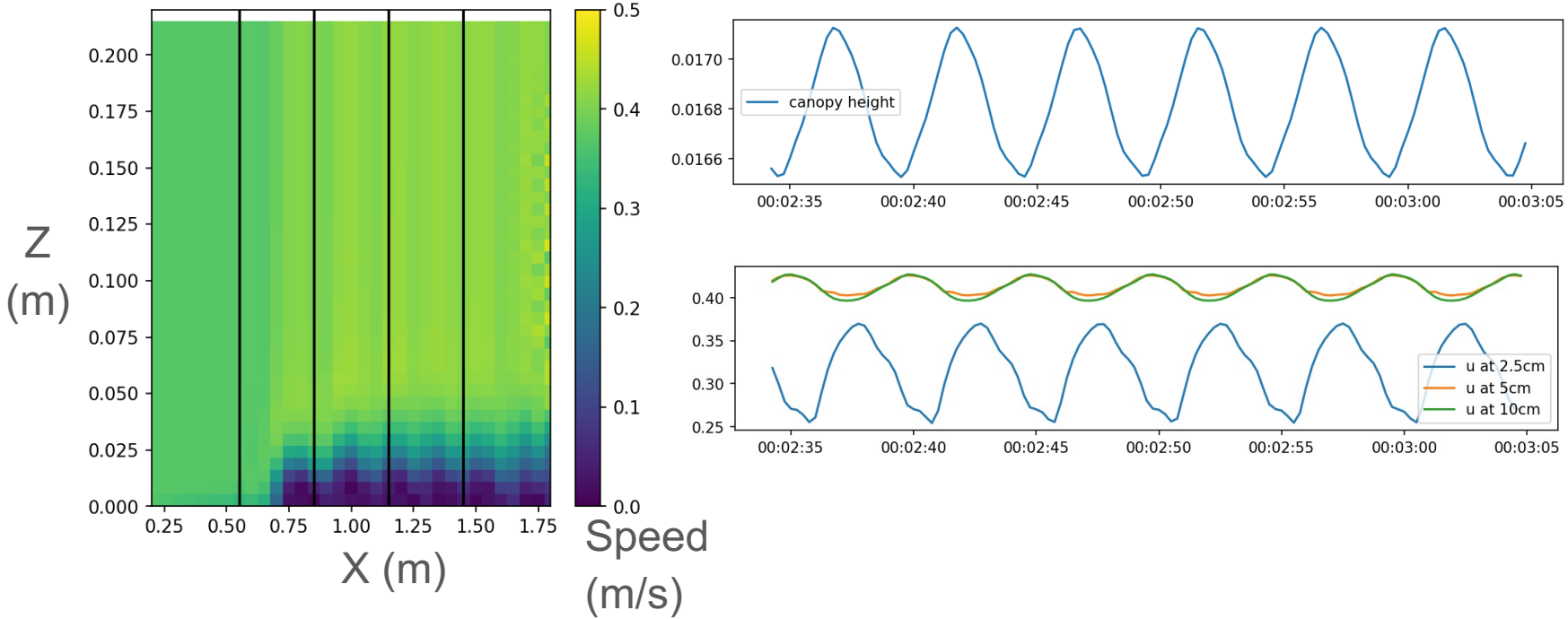
P2 0.15m in zostera

P3 0.45m in zostera

P4 0.75m in zostera

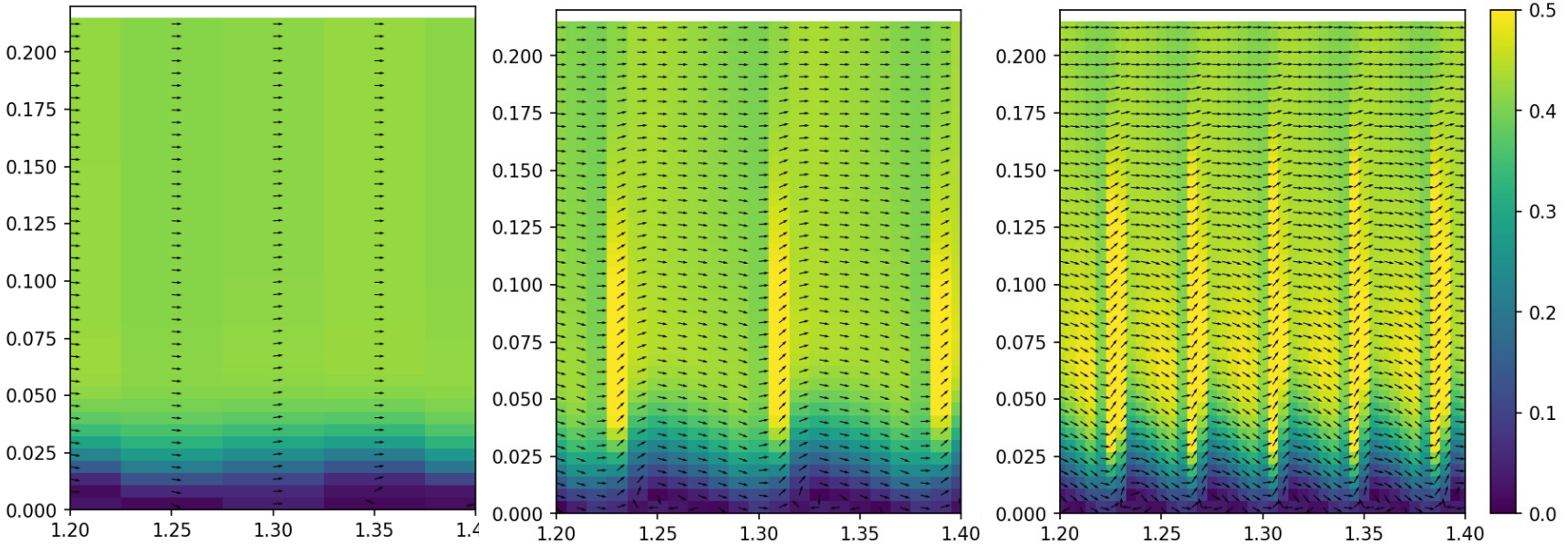
Testing implementation

Kelvin-Helmhotz instabilities and « monamis » (cf Phd F.Ganthy p198)



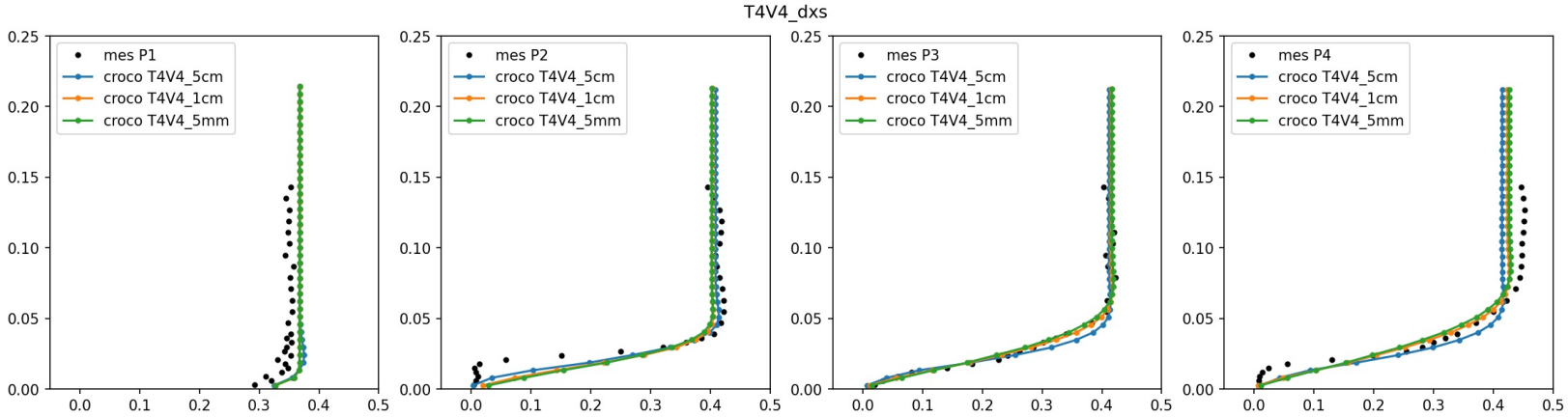
Testing implementation

- Influence of resolution : dx = 5cm / 1cm / 5mm



Testing implementation

- Influence of resolution



On-going work

- Code input file reading (spatial and temporal variation)
- Tests on 2DV (GPROF, other type (DO & O3D))
- Tests on TIDAL_FLAT and ESTUARY (check MPI, WET DRY // Dcrit)
- Tests on realistic case (MPI)
- Documentation
- Code links to MUSTANG > presence of sediment

Planning, finalized for autumn … and HYBIOSED after