


Delft3D

Software de modelação de processos costeiros

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sumário

- ▶ introdução
 - ▶ aplicações
 - ▶ formulação matemática
 - ▶ *software*
 - ▶ síntese resultados ano letivo 2012/2013
- 

introdução



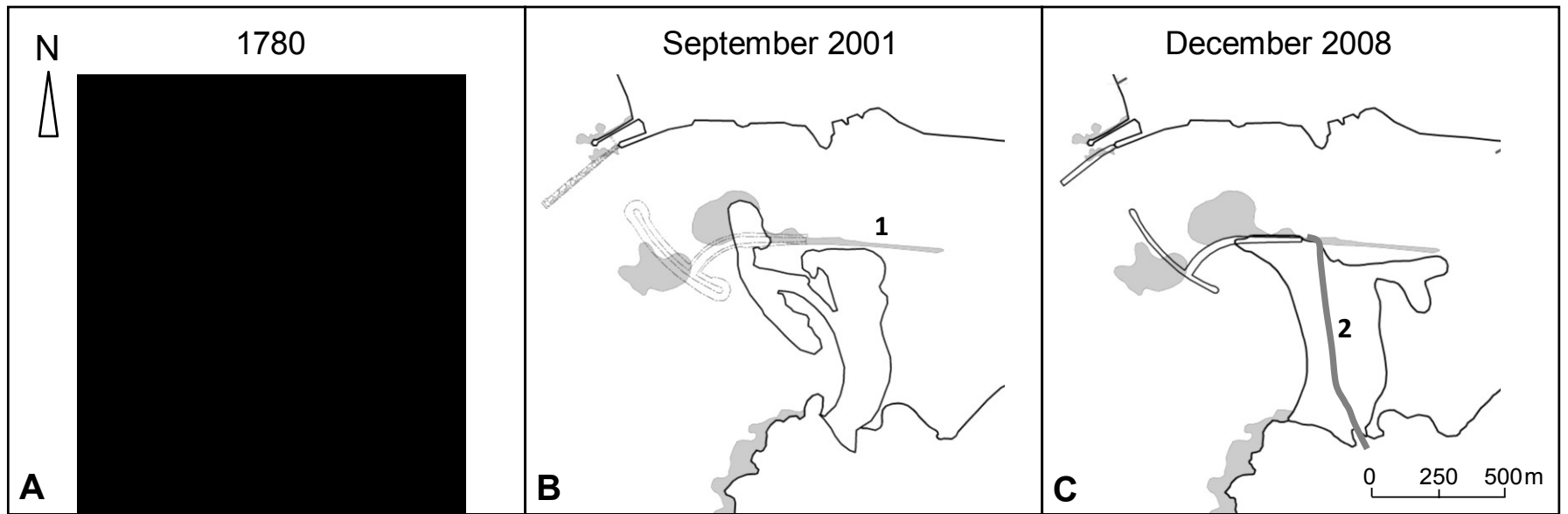
introdução



introdução



introdução



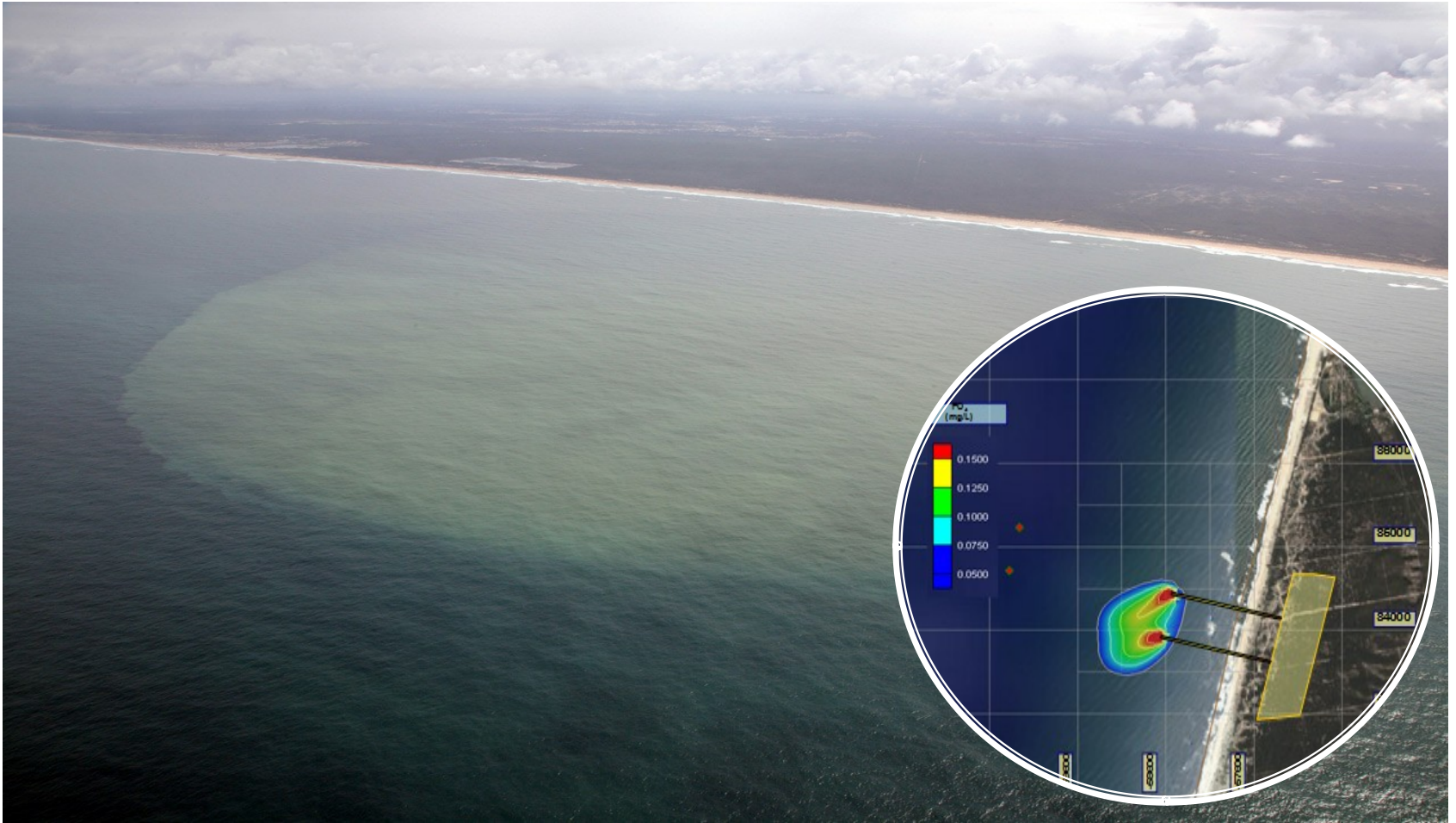
introdução



introdução




introdução



introdução



sumário

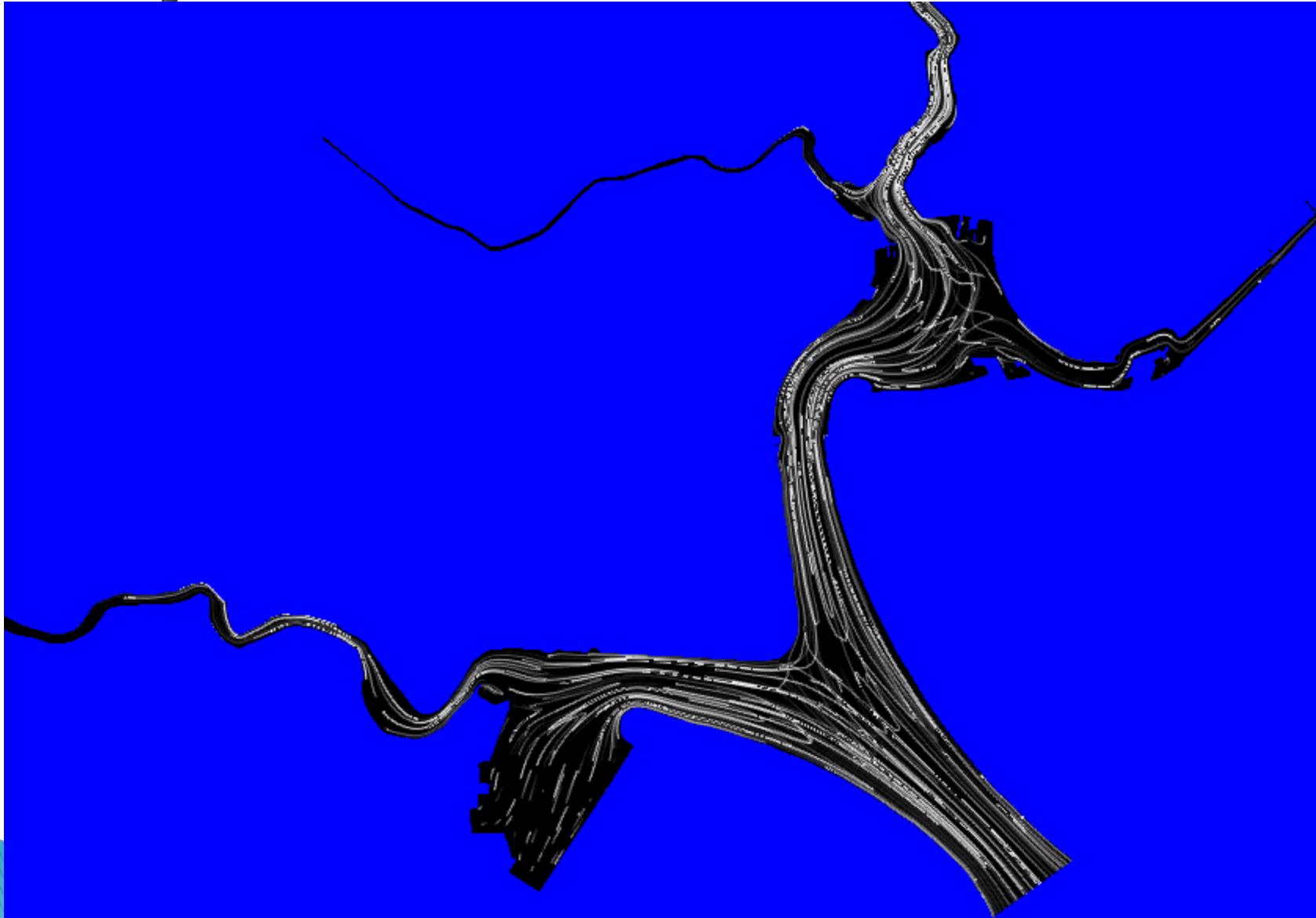
- ▶ introdução
 - ▶ **aplicações**
 - ▶ formulação matemática
 - ▶ *software*
 - ▶ síntese resultados ano letivo 2012/2013
- 

aplicações



Marina Bay
Singapura

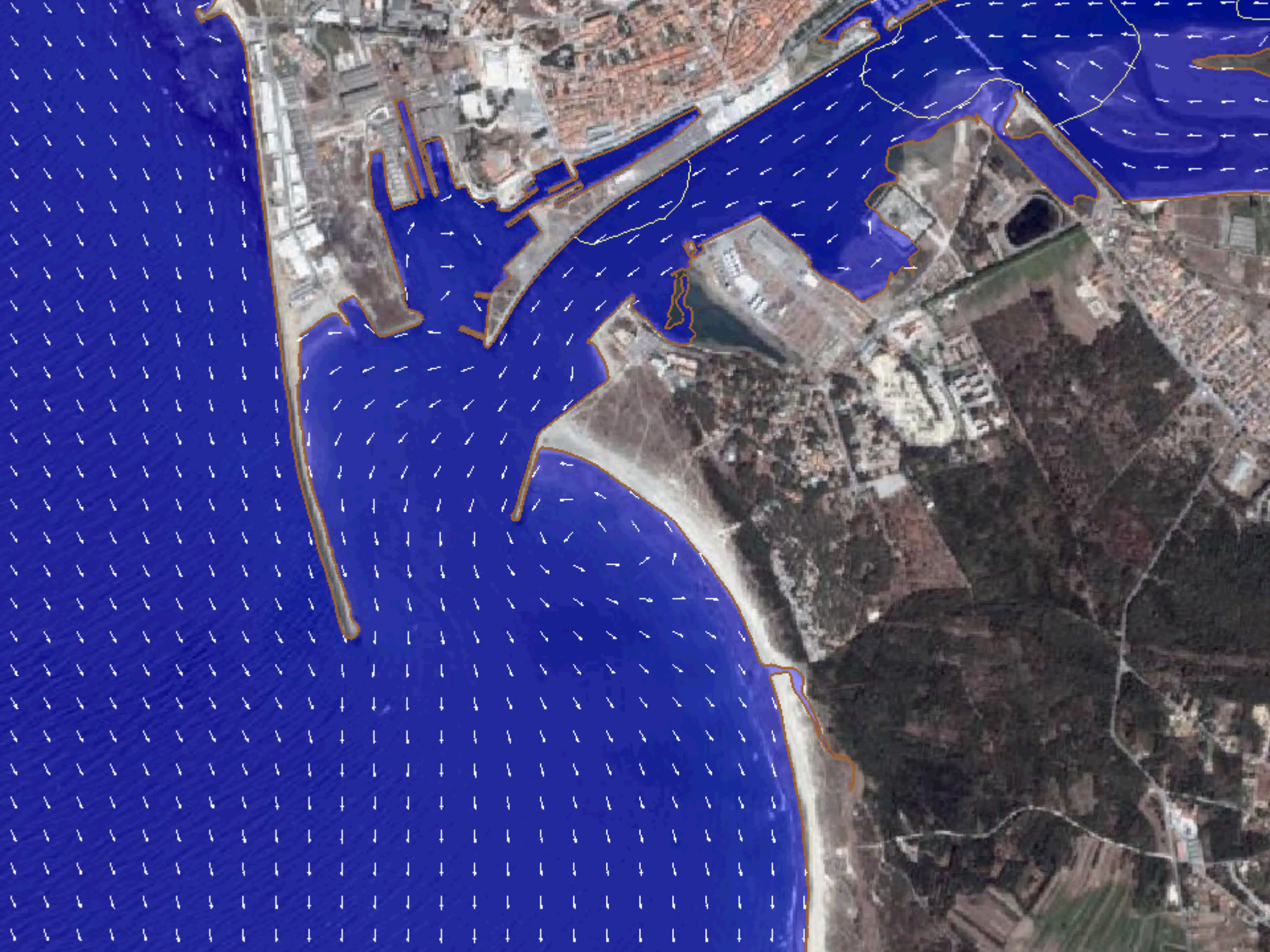
aplicações



aplicações



Estuário do rio Lima

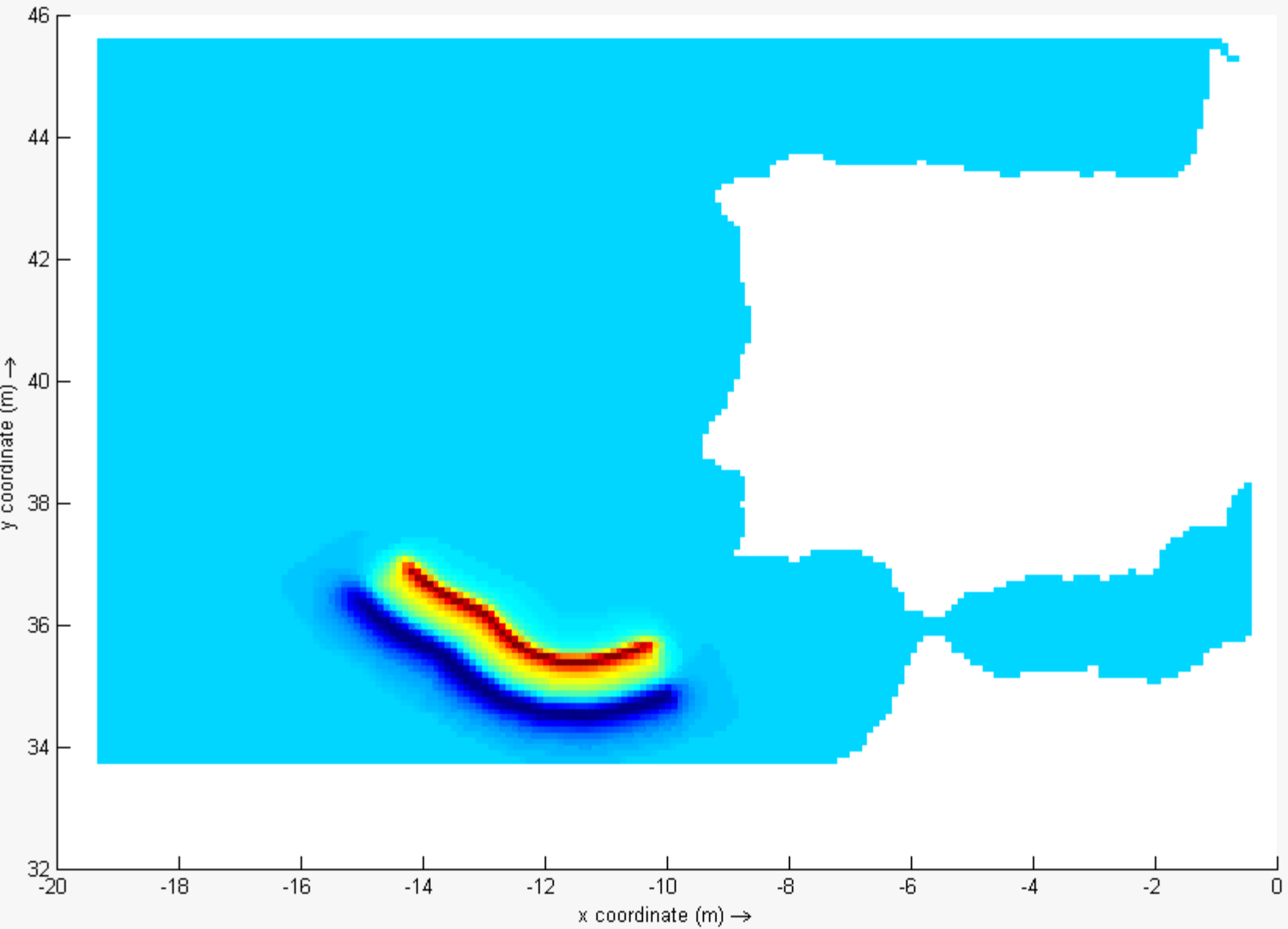


aplicações



Terramoto seguido de tsunami
Lisboa, 1755

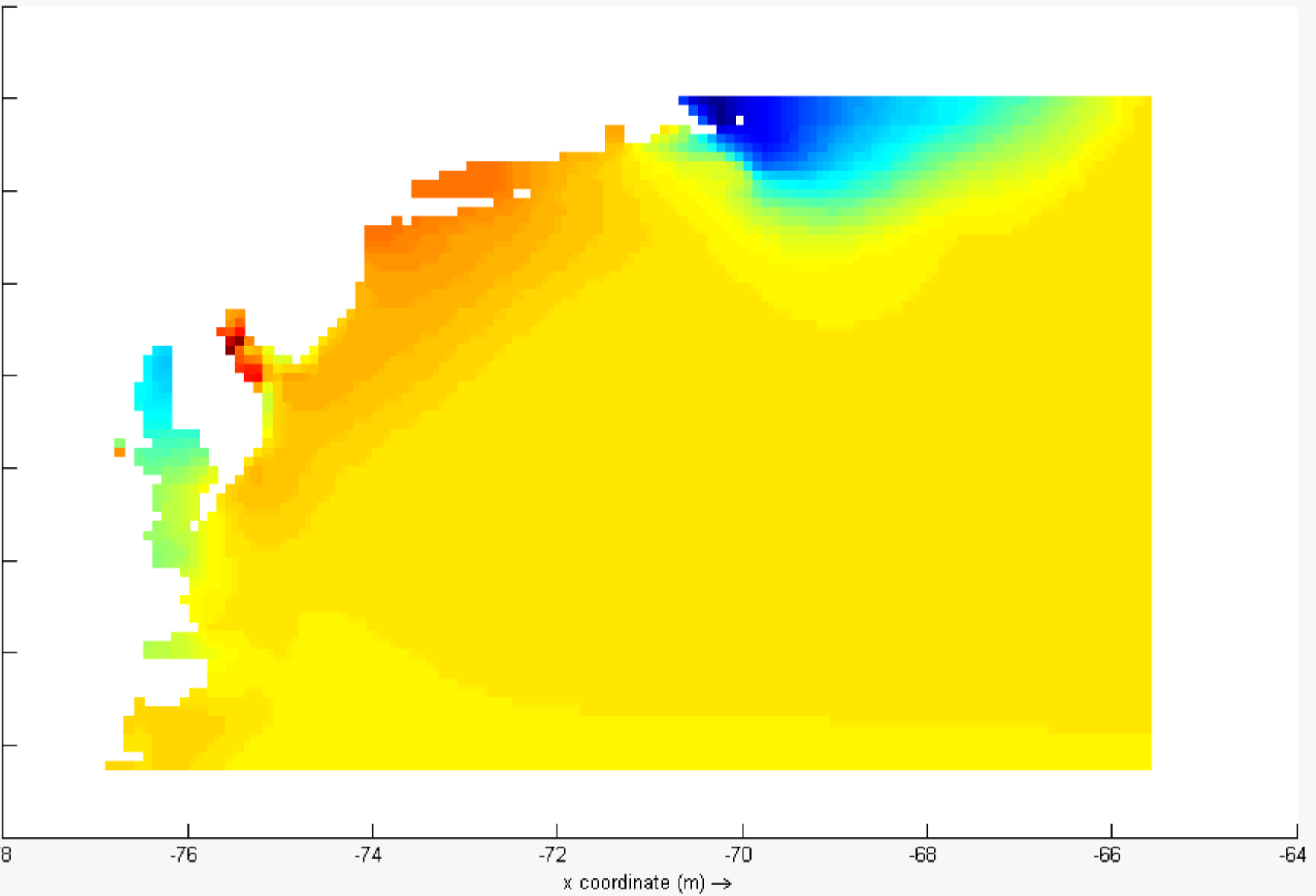
water level (m)
28-Oct-2012 00:00:00



aplicações



water level (m)
30-Oct-2012 00:00:00

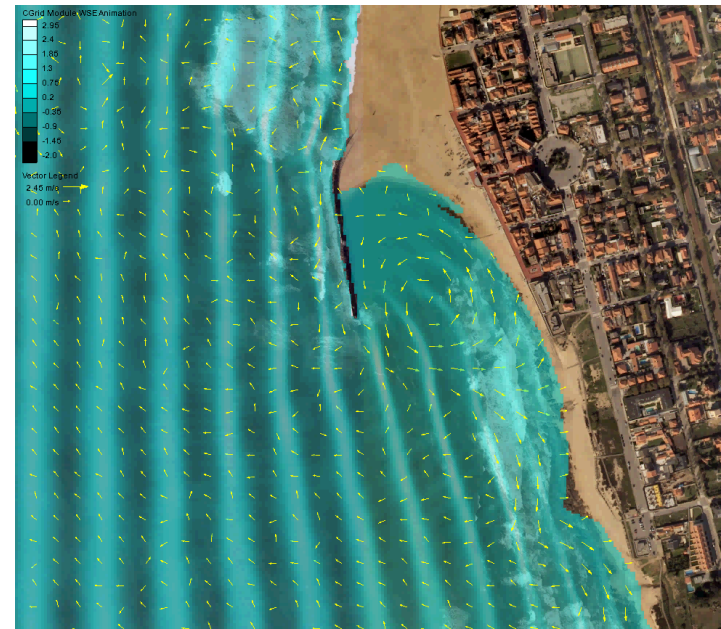
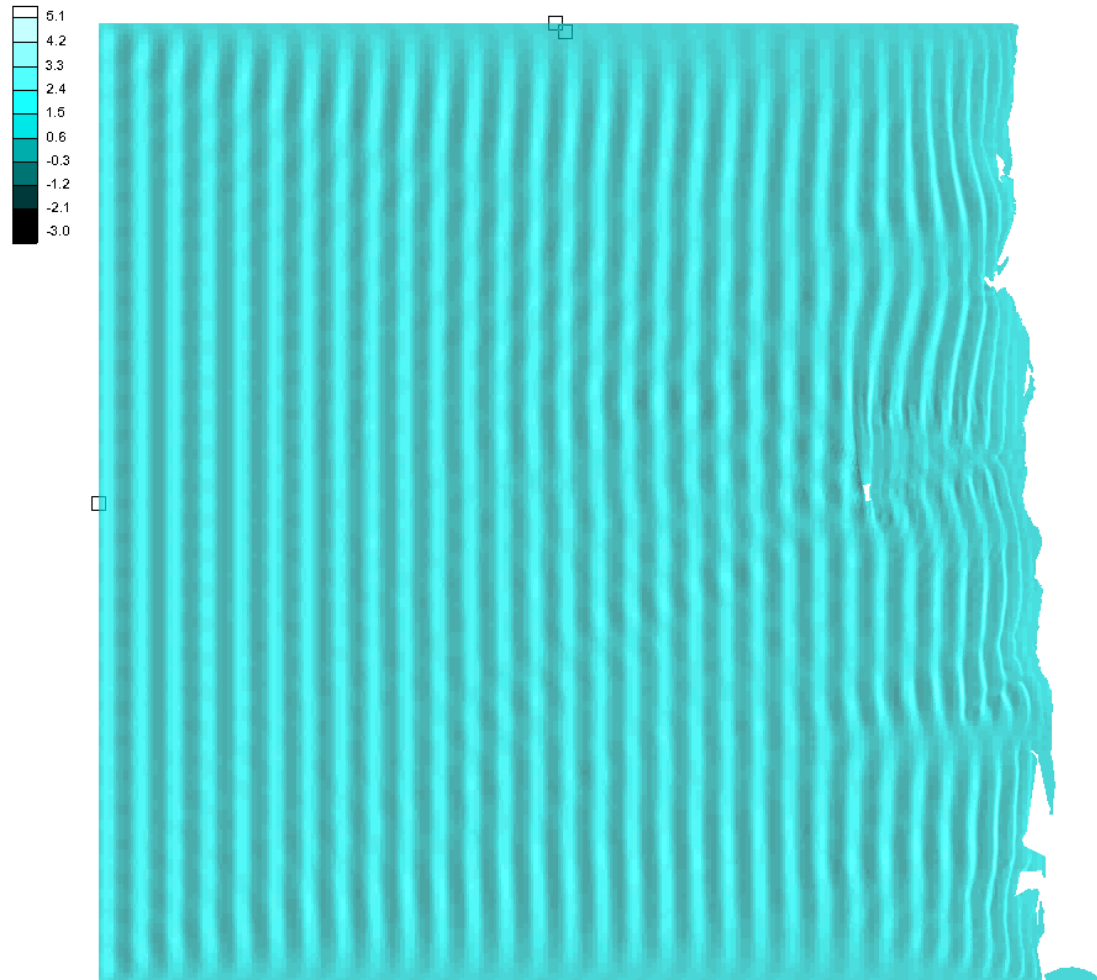


aplicações

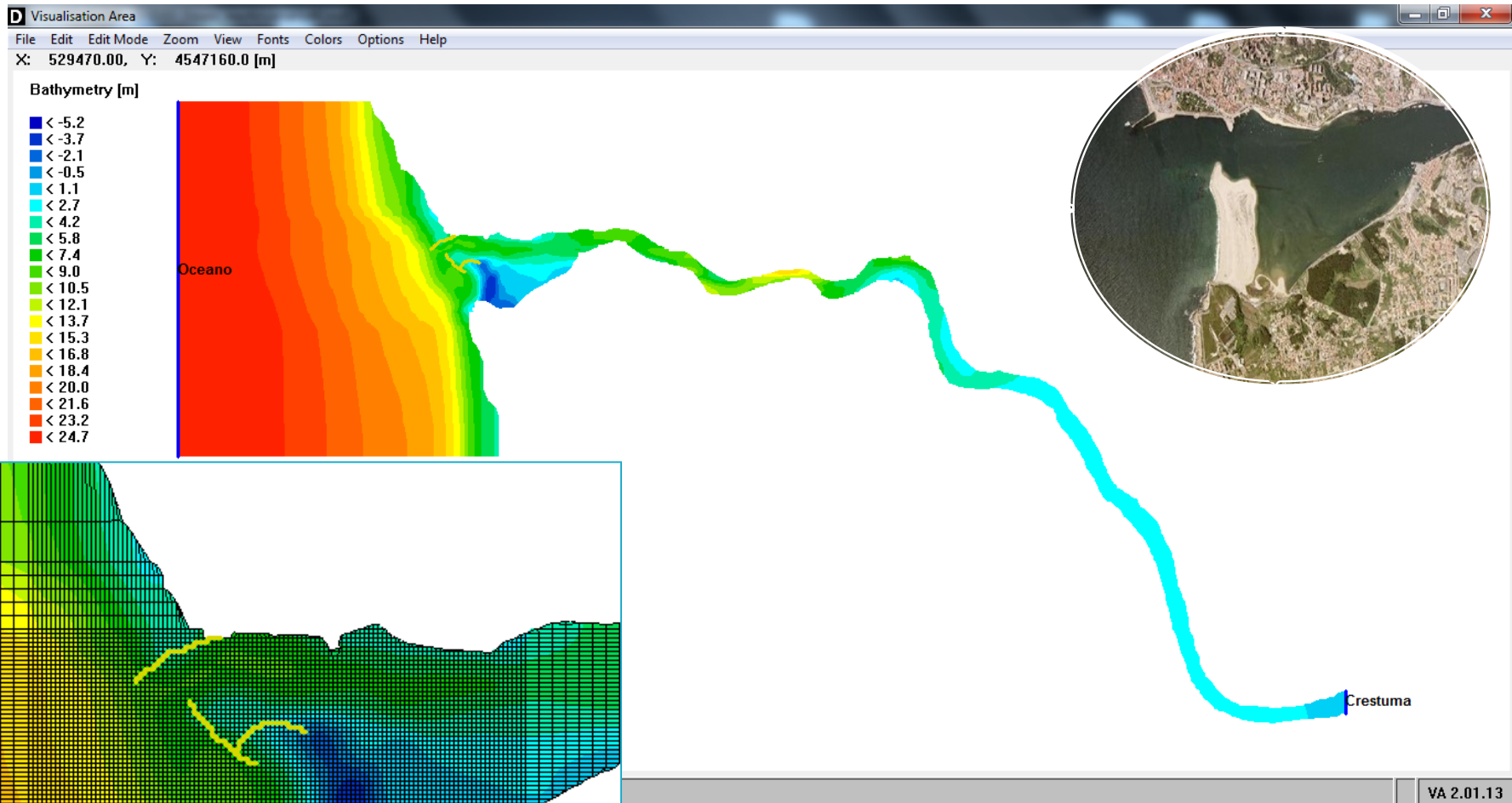


aplicações

CGrid Module WSEAnimation

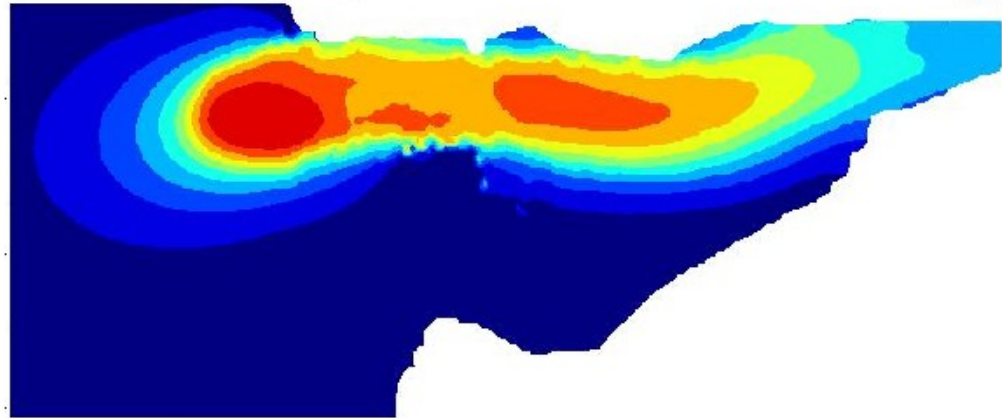


aplicações

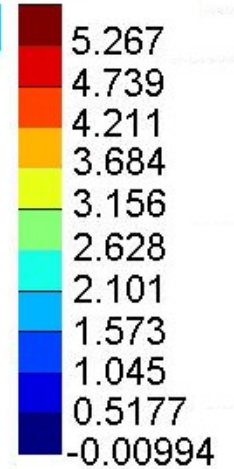


Hidrodinâmica e dinâmica sedimentar
Estuário do rio Douro

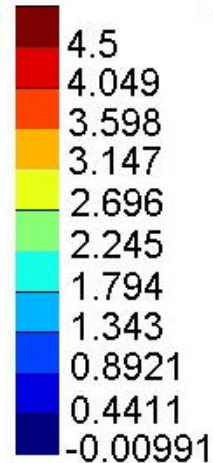
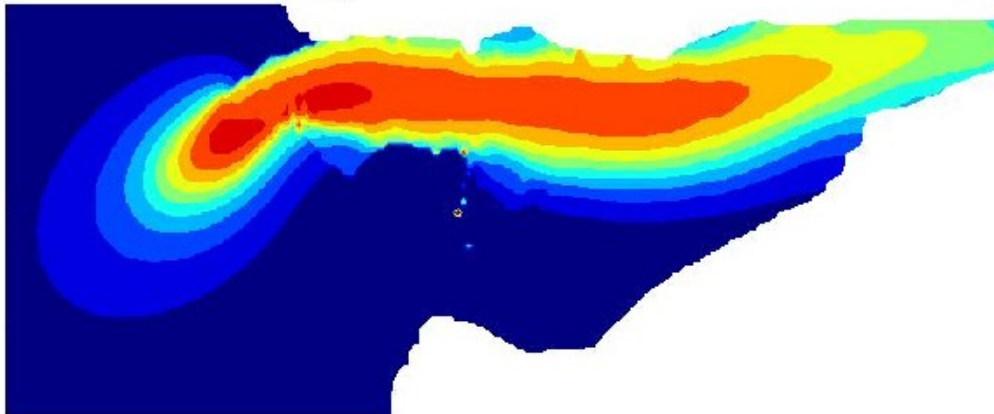
aplicações




Concentração de sedimentos (kg/m^3)



Concentração de sedimentos (kg/m^3)

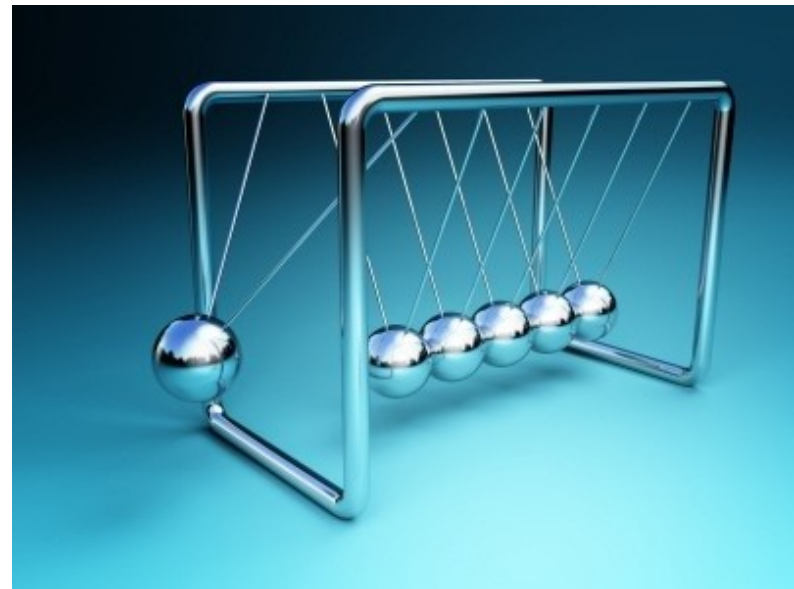


sumário

- ▶ introdução
 - ▶ aplicações
 - ▶ **formulação matemática**
 - ▶ *software*
 - ▶ síntese resultados ano letivo 2012/2013
- 

formulação matemática

- 1 – conservação de massa
- 2 – conservação de quantidade de movimento
- 3 – transporte de calor
- 4 – transporte de sal
- 5 – transporte de escalares turbulência
- 6 – transporte de escalares qualidade da água
- 7 – transporte de sedimentos



formulação matemática

CM

$$\frac{\partial \eta}{\partial t} + \frac{\partial}{\partial x}(uD) + \frac{\partial}{\partial y}(vD) + \frac{\partial w}{\partial \sigma} = 0$$

CQM-XX

$$\frac{\partial}{\partial t}(uD) + \frac{\partial(uuD)}{\partial x} + \frac{\partial(vuD)}{\partial y} + \frac{\partial}{\partial \sigma}(wu) - fvD = -DP_1 + \frac{\partial}{\partial \sigma} \left(\frac{K_M}{D} \frac{\partial u}{\partial \sigma} \right) + DF_1$$

CQM-YY

$$\frac{\partial}{\partial t}(vD) + \frac{\partial(uvD)}{\partial x} + \frac{\partial(vvD)}{\partial y} + \frac{\partial}{\partial \sigma}(wv) + fuD = -DP_2 + \frac{\partial}{\partial \sigma} \left(\frac{K_M}{D} \frac{\partial v}{\partial \sigma} \right) + DF_2$$

T Calor

$$\frac{\partial}{\partial t}(\Theta D) + \frac{\partial(u\Theta D)}{\partial x} + \frac{\partial(v\Theta D)}{\partial y} + \frac{\partial}{\partial \sigma}(w\Theta) = \frac{\partial}{\partial \sigma} \left(\frac{K_H}{D} \frac{\partial \Theta}{\partial \sigma} \right) + DF_\Theta$$

T Sal

$$\frac{\partial}{\partial t}(SD) + \frac{\partial(uSD)}{\partial x} + \frac{\partial(vSD)}{\partial y} + \frac{\partial}{\partial \sigma}(wS) = \frac{\partial}{\partial \sigma} \left(\frac{K_H}{D} \frac{\partial S}{\partial \sigma} \right) + DF_S$$

Modelo

Turbulência – q^2


$$\begin{aligned} \frac{\partial}{\partial t}(q^2 D) + \frac{\partial(uq^2 D)}{\partial x} + \frac{\partial(vq^2 D)}{\partial y} + \frac{\partial}{\partial \sigma}(wq^2) &= \frac{\partial}{\partial \sigma} \left(\frac{K_q}{D} \frac{\partial q^2}{\partial \sigma} \right) + \frac{2K_M}{D} \left[\left(\frac{\partial u}{\partial \sigma} \right)^2 + \left(\frac{\partial v}{\partial \sigma} \right)^2 \right] + \\ &+ 2K_H \frac{g}{\rho} \frac{\partial \rho}{\partial \sigma} - 2 \frac{q^3 D}{B_1 l} + DF_q \end{aligned}$$

Modelo

Turbulência – $q^2 l$

$$\begin{aligned} \frac{\partial}{\partial t}(q^2 l D) + \frac{\partial(uq^2 l D)}{\partial x} + \frac{\partial(vq^2 l D)}{\partial y} + \frac{\partial}{\partial \sigma}(wq^2 l) &= \frac{\partial}{\partial \sigma} \left(\frac{K_q}{D} \frac{\partial(q^2 l)}{\partial \sigma} \right) + \\ K_M E_1 \frac{l}{D} \left[\left(\frac{\partial u}{\partial \sigma} \right)^2 + \left(\frac{\partial v}{\partial \sigma} \right)^2 \right] &+ K_H E_3 l \frac{g}{\rho} \frac{\partial \rho}{\partial \sigma} - \frac{q^3 D}{B_1} \left[1 + E_2 \left(\frac{l}{\kappa L} \right)^2 \right] + DF_l \end{aligned}$$

sumário

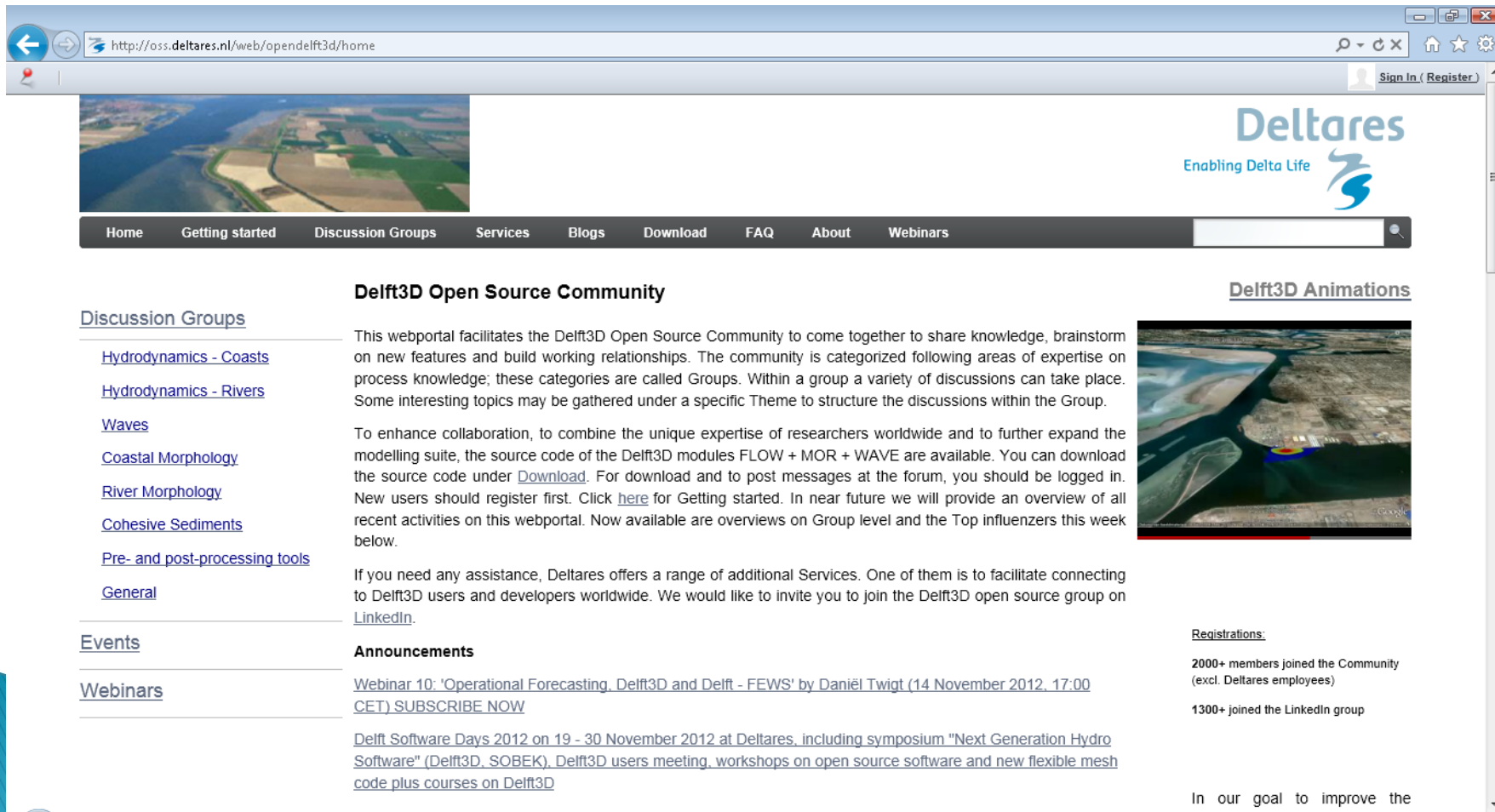
- ▶ introdução
 - ▶ aplicações
 - ▶ formulação matemática
 - ▶ *software*
 - ▶ síntese resultados ano letivo 2012/2013
- 

software

- ▶ Delft3d
 - ▶ Autores: Deltares (Holanda)
 - ▶ Idade: 30 anos
 - ▶ Linguagem: Fortran 90
 - ▶ SO: Linux, Windows
- 

software

► Delft3d



[Home](#) [Getting started](#) [Discussion Groups](#) [Services](#) [Blogs](#) [Download](#) [FAQ](#) [About](#) [Webinars](#)

Discussion Groups

- [Hydrodynamics - Coasts](#)
- [Hydrodynamics - Rivers](#)
- [Waves](#)
- [Coastal Morphology](#)
- [River Morphology](#)
- [Cohesive Sediments](#)
- [Pre- and post-processing tools](#)
- [General](#)

Events

Webinars

Delft3D Open Source Community

This webportal facilitates the Delft3D Open Source Community to come together to share knowledge, brainstorm on new features and build working relationships. The community is categorized following areas of expertise on process knowledge; these categories are called Groups. Within a group a variety of discussions can take place. Some interesting topics may be gathered under a specific Theme to structure the discussions within the Group.

To enhance collaboration, to combine the unique expertise of researchers worldwide and to further expand the modelling suite, the source code of the Delft3D modules FLOW + MOR + WAVE are available. You can download the source code under [Download](#). For download and to post messages at the forum, you should be logged in. New users should register first. Click [here](#) for Getting started. In near future we will provide an overview of all recent activities on this webportal. Now available are overviews on Group level and the Top influencers this week below.

If you need any assistance, Deltares offers a range of additional Services. One of them is to facilitate connecting to Delft3D users and developers worldwide. We would like to invite you to join the Delft3D open source group on [LinkedIn](#).

Announcements

[Webinar 10: 'Operational Forecasting, Delft3D and Delft - FEWS' by Daniël Twigt \(14 November 2012, 17:00 CET\) SUBSCRIBE NOW](#)

[Delft Software Days 2012 on 19 - 30 November 2012 at Deltares, including symposium "Next Generation Hydro Software" \(Delft3D, SOBEK\), Delft3D users meeting, workshops on open source software and new flexible mesh code plus courses on Delft3D](#)

Delft3D Animations

[Registrations:](#)

- 2000+ members joined the Community (excl. Deltares employees)
- 1300+ joined the LinkedIn group

In our goal to improve the

software

▶ Delft3d

Statistics of the Delft3D sourcecode (sloccount)

Totals grouped by language (dominant language first):

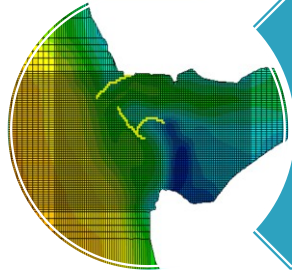
fgo:	187893	(56.87%)
ansic:	87491	(26.48%)
cpp:	24480	(7.41%)
sh:	12983	(3.93%)
fortran:	12973	(3.93%)
tcl:	1953	(0.59%)

...

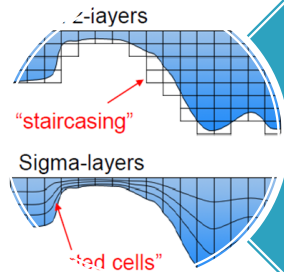
Total Physical Source Lines of Code (SLOC) = 330,382
(46968 in third party)

software

▶ Delft3d



Discretização espacial
horizontal – grelhas



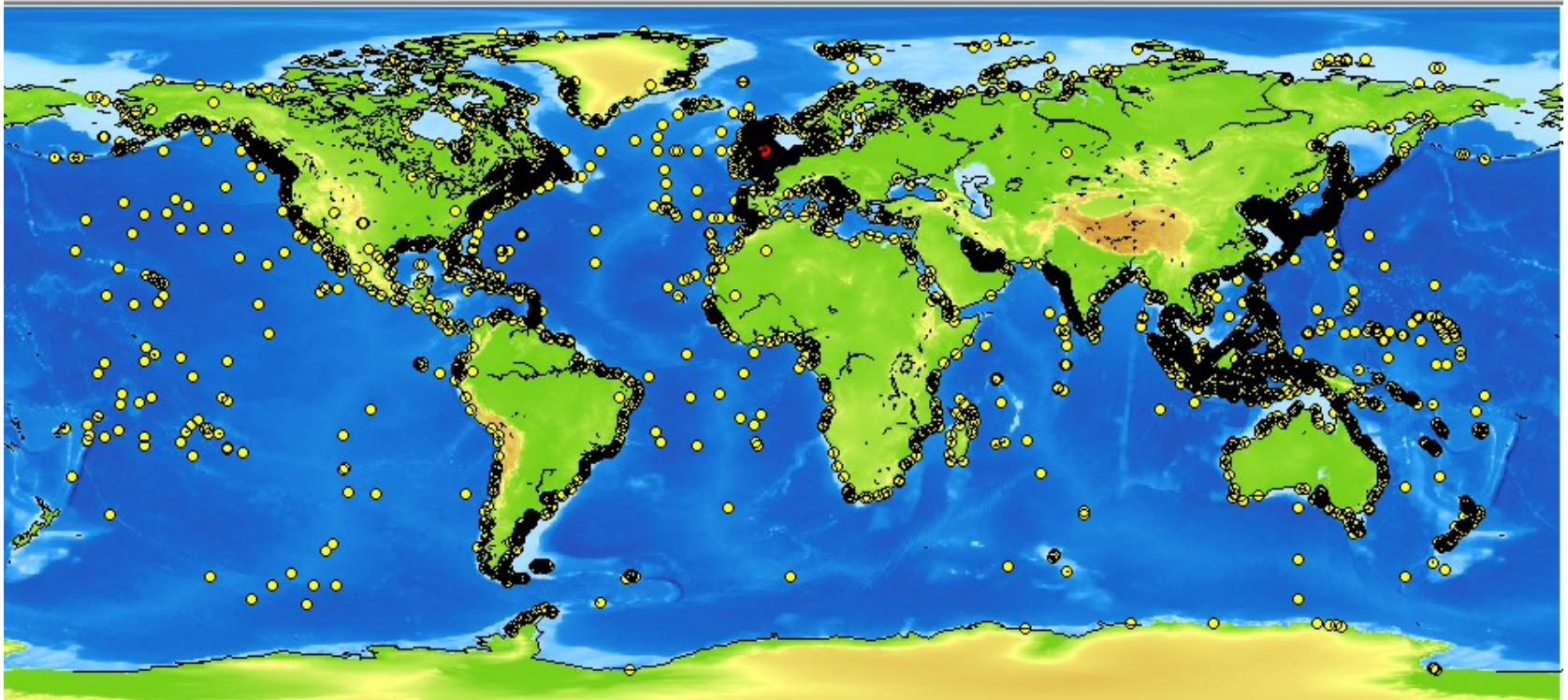
Discretização vertical –
coordenadas sigma ou z

$$\frac{u_j^{n+1/2} - u_j^n}{\Delta t/2} = \left(\delta_x^2 u_j^{n+1/2} + \delta_y^2 u_j^n \right)$$
$$\frac{u_j^{n+1/2} - u_j^n}{\Delta t/2} = \left(\delta_x^2 u_j^{n+1/2} + \delta_y^2 u_j^n \right)$$

Método diferenças finitas
– Implícito – ADI

software

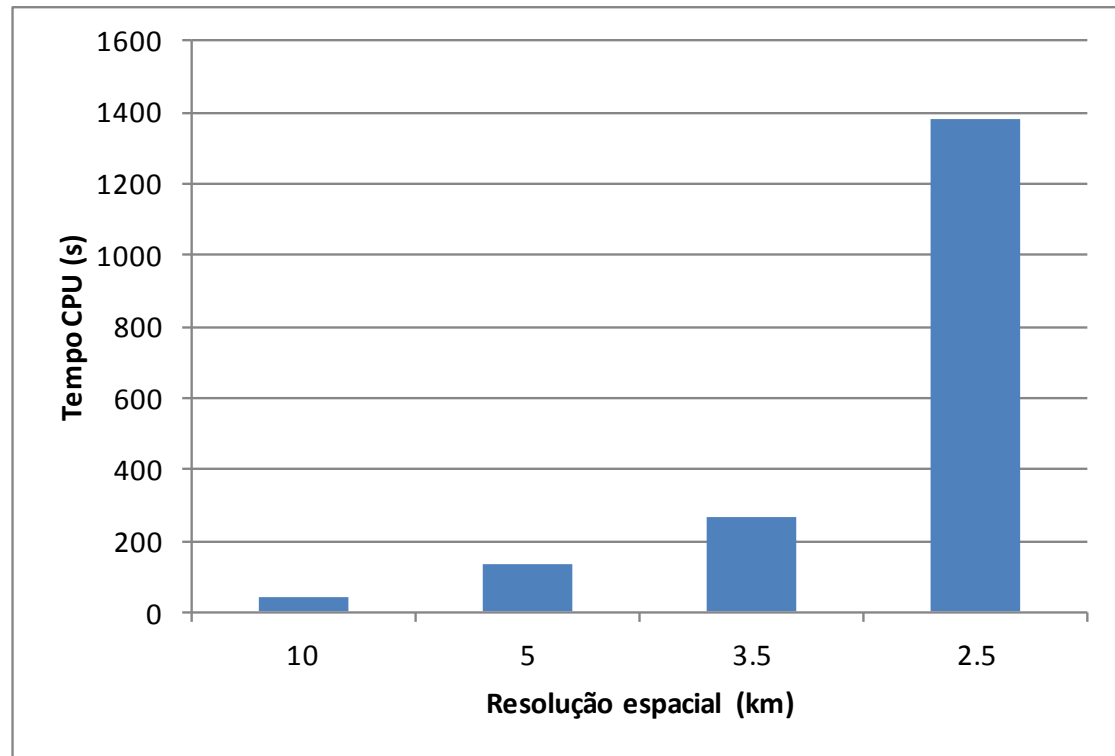
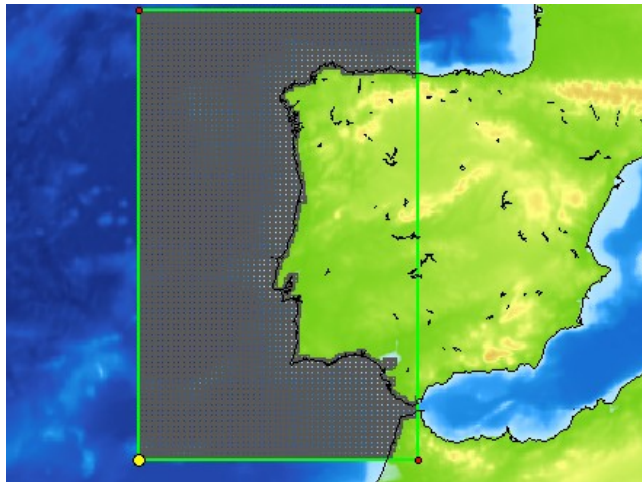
- ▶ Implementação de modelos



software

▶ processamento

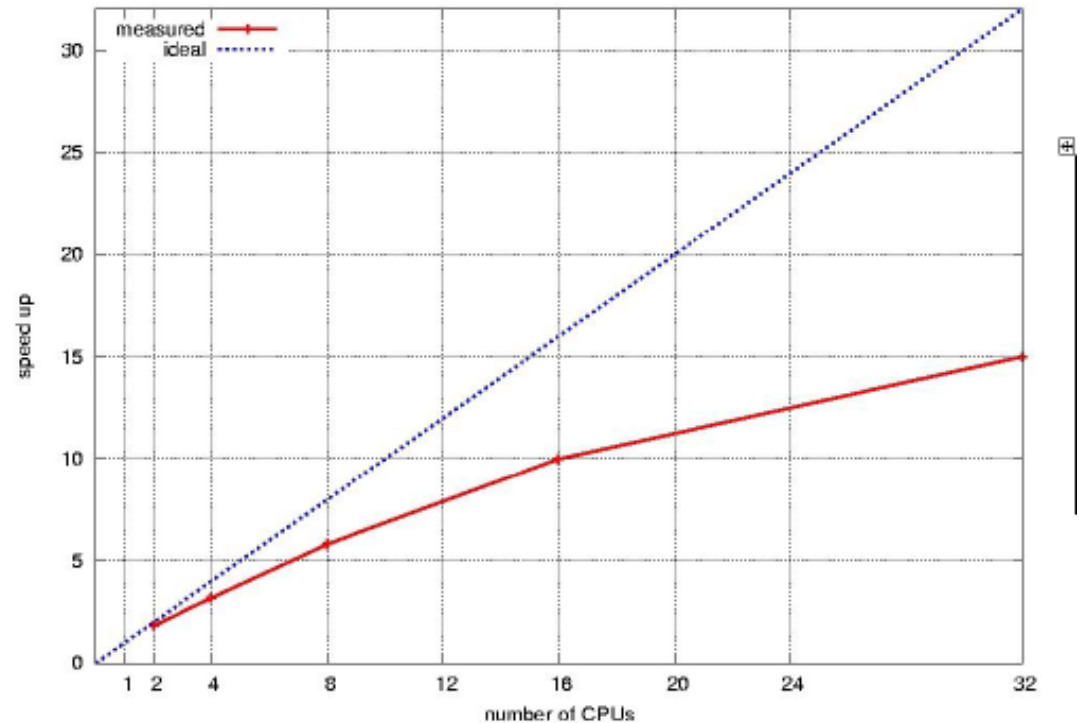
Delft3d



software


▶ processamento paralelo

Delft3d

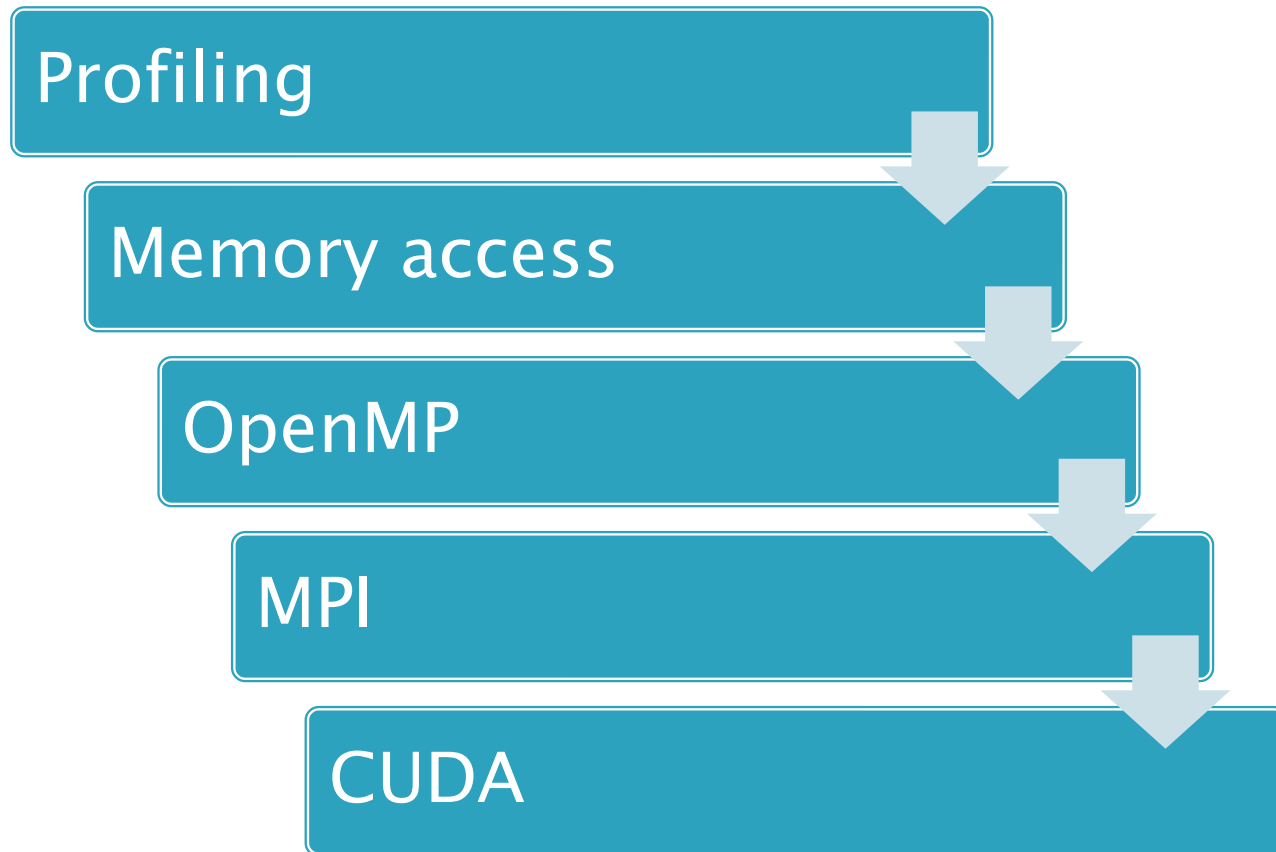


Jagers, B. / 4th PRACE International Seminar “HPC driving innovation in Europe” Bologna, 16–17 april 2012

sumário

- ▶ introdução
 - ▶ aplicações
 - ▶ formulação matemática
 - ▶ *Software*
 - ▶ resultados anteriores
- 

resultados anteriores



resultados anteriores

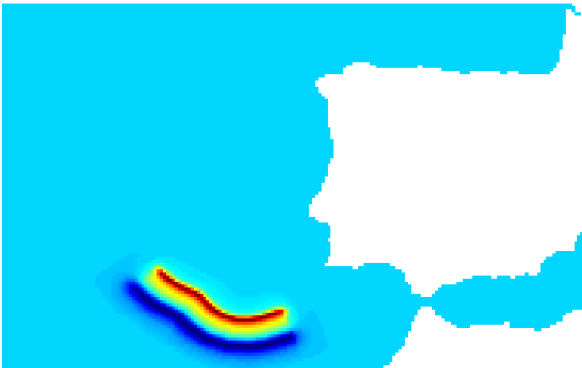


Figure 3: Tsunami's call graph.

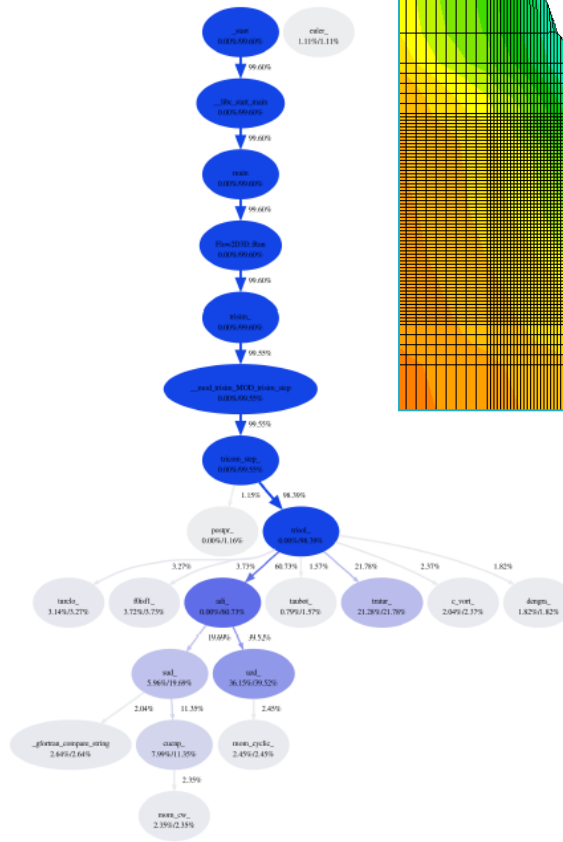
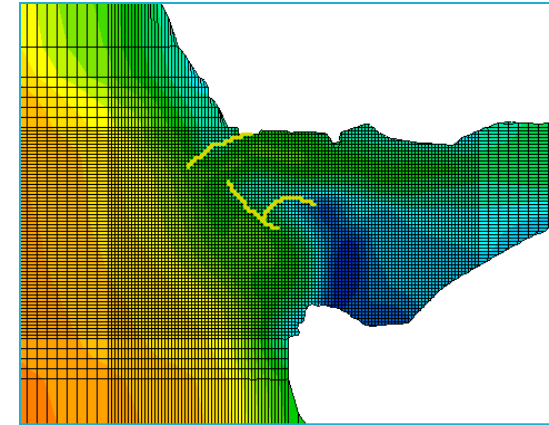


Figure 4: Douro's estuary call graph.



resultados anteriores

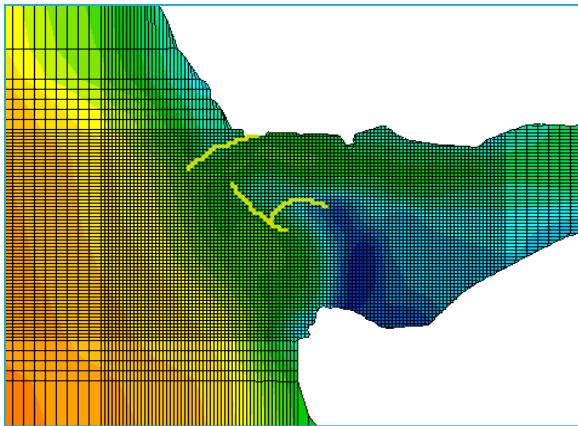
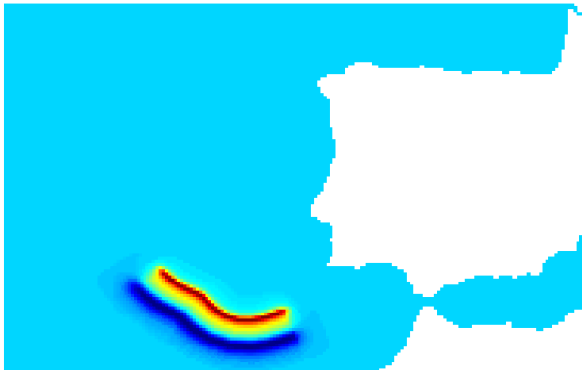


Figure 5: Tsunami's heaver subroutines.

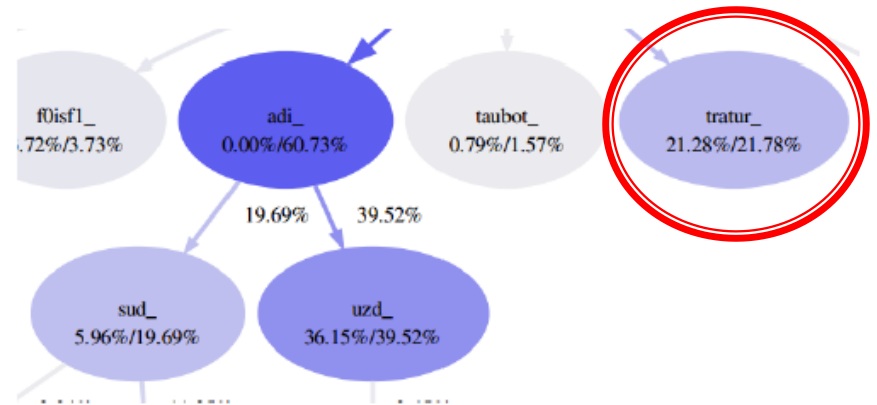


Figure 6: Douro's heaver subroutines.

resultados anteriores

- Just by improving the memory accesses relevant performance was achieved
- Increasing #cores often results in a performance increase . Sometimes such increases were higher than the expected ones accordingly to Amdahl's law
- Douro estuary tests for 8 and 12 cores failed. Possibly because of data races conflicts
- CUDA version for tsunami (4h) has a slight performance loss. Overhead from copying data to *GPU for small data sets*
- CUDA version for Douro's estuary has some issues. Works but gives wrong results

Questões?

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Profiling



```
graph TD; A[Profiling] --> B[Memory access]; B --> C[OpenMP]; C --> D[CUDA]
```

Memory access

OpenMP

CUDA