MARETEC
MARINE ENVIRONMENT & TECHNOLOGY CENTER

Bidirectional method for MOHID modelling system

An introduction on the first algorithm

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Motivation

- Current nested modelling system – one way downscalling – assumes the affected of local features of its child domains do not compromise the solution near the boundary of the two domains.

- This means, for the case of an estuarine discharge, two options should be considered:
  - Implementing the fresh water discharge from the estuary in both domains – less accurate.
  - Having a bigger local domain to avoid strong divergence near its open boundary condition with the parent (regional) domain.

Motivation

- Improving computational power promotes higher resolution regional domains, but still cannot accomodate the esturaries.
  - Nested domains for estuaries, islands, etc are still needed.
  - Online solutions could be done using MPI, but with the extra risk of having one or many estuarine applications that can fail – for a variety of reasons.

- The purpose of this development is to improve the nested solutions using one or several local scale domains.
  - A better solution for the parent regional domains which will be fed with small scale forcings such as fresh water plumes.
  - As an extra (?) the size of the local child domains could be reduced without compromising the regional parent domain.

Concept

- Relaxation of the parent domain towards the child domain using:

$$P = P^{Cg} + (P^{Fg} - P^{Cg}).\frac{\Delta t}{T_d}$$

- Where superscripts *Cg* and *Fg* reffer to the courser grid and finer grid, and the T_d is the decay time in seconds.

- This relaxation is made for all the main hydrodynamic variables:
  - Water level
  - Velocities
  - Temperature
  - Salinity
  - Vertical grid(configured but being used at this stage)

Algorithm

- The relaxation procedure occurs when a child domain reaches the same instant as its parent domain and is explicit.

- Initial procedure simply averaged the child results inside each parent cell, but this would not be usable on variable grids.

- Currently, it makes a volume weithed average and considers a radious of search dependent on the courser grid space in order to account for variable grids.

- In the near future it will also be able to use the inverse weithed distance method (almost finished, using functions already made in mohid code).

Applications

- Forecasting systems using one regional parent domain and several child domains with local-only forcings
  - Example : Portuguese estuaries and PCOMS running offline

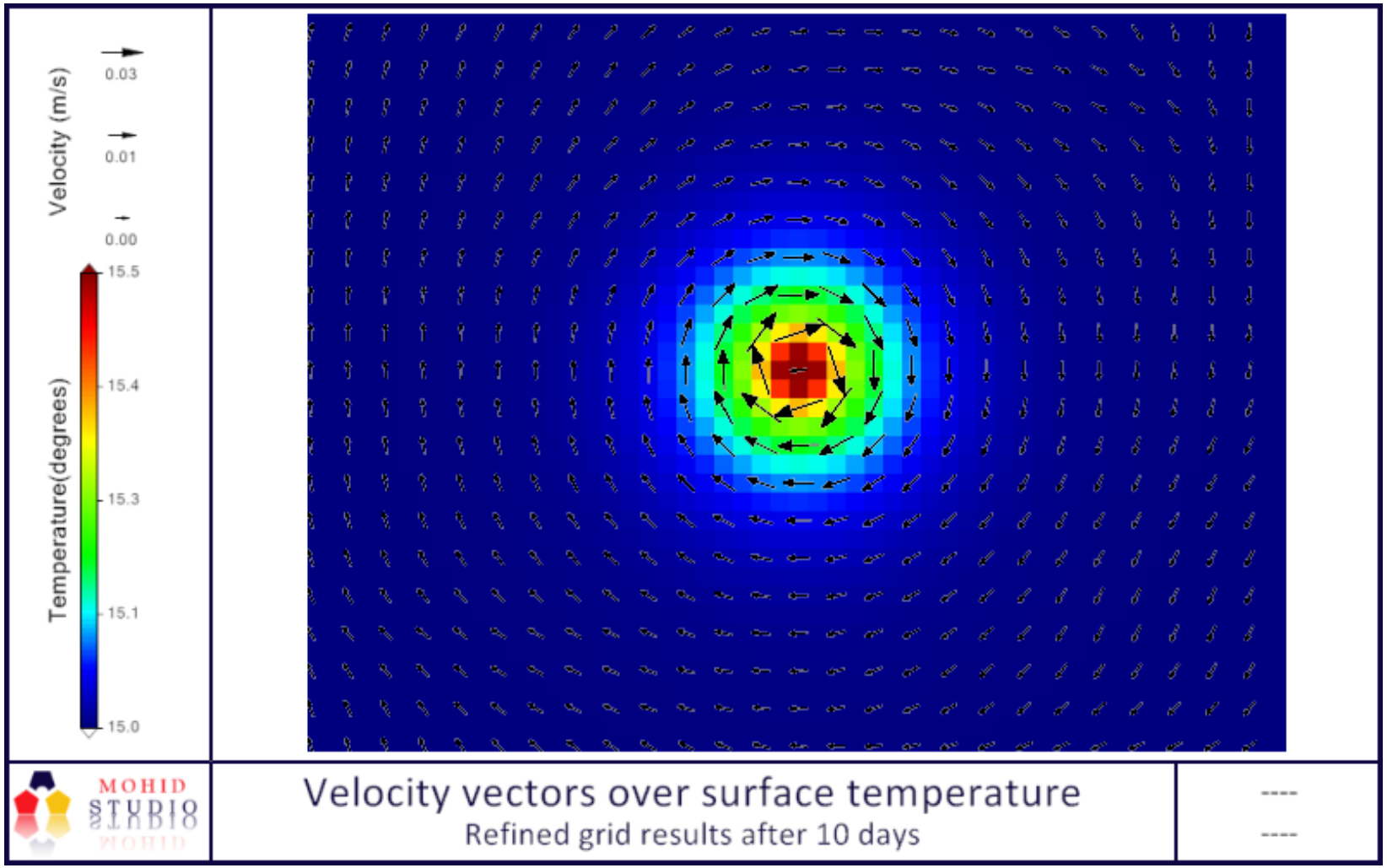
- Improvement of solutions with narrow areas such as the golf of gibraltar, by adding a nested child domain with higher resolution focused on the narrow strait.

- Influence of turbines on regional scale model applications.

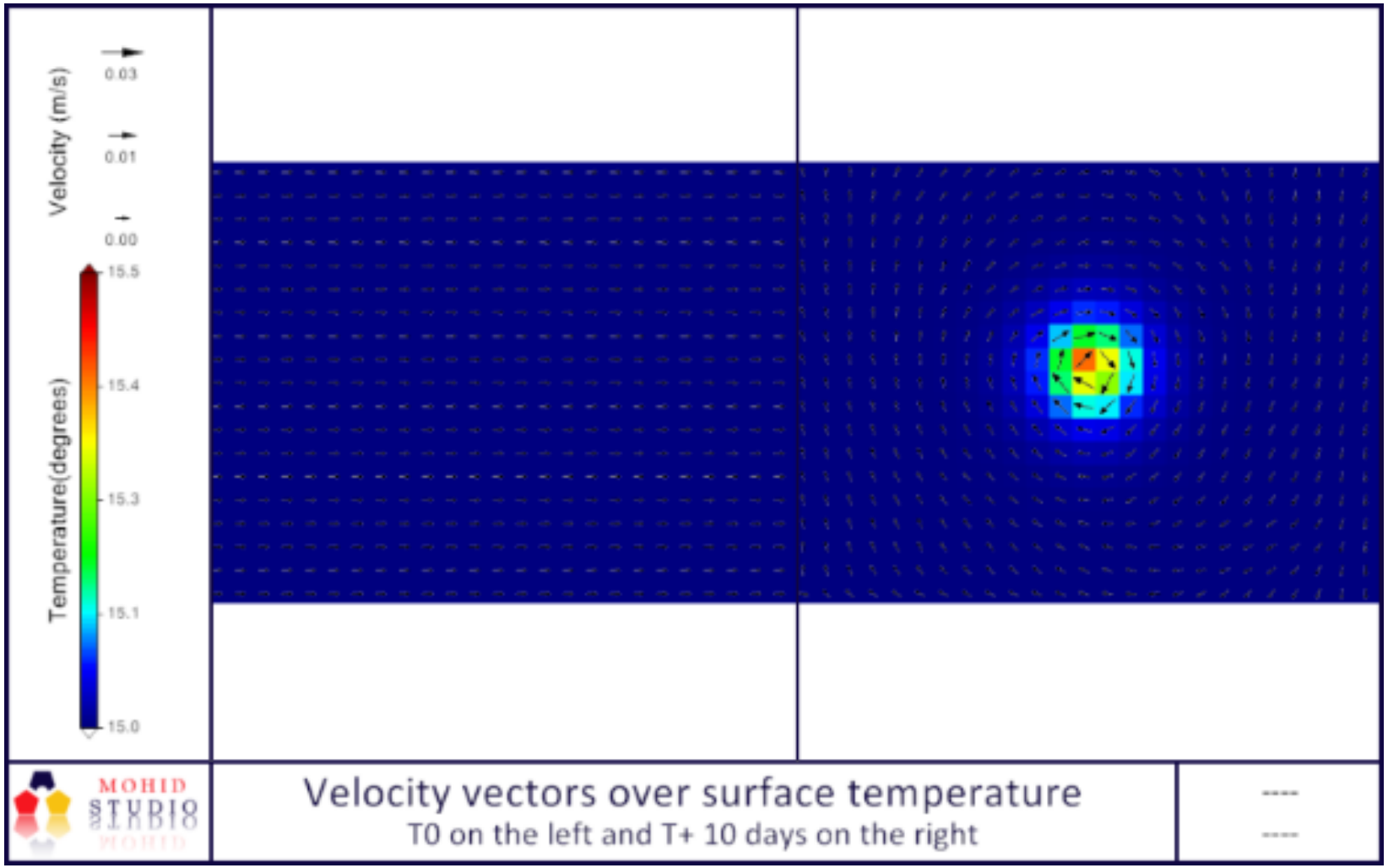
Early validation

- This first validation was made with the older version of the algorithm as the new one has caught a bug!
- Application:
  - 2 nested grids. The parent with 3km and the child with 1km. Constant depth of 1000m in both
  - 4 openboundaries and 11 vertical cartesian layers.
  - Initial temperature of 15°C in both domains
  - 500m^3/s dicharge with a temperature of 18°C only in the child domain
  - Coriolis, barotropic and baroclinic forces
  - Advection and difusion
  - Constant salinity of 36.
  - Decay time of 3600s

Early validation



Early validation



Near future work

- Validation of the new version of the relaxation algorithm for the test case shown before.
- Validation of the algorithm on a real case (location yet to be determined). Options:
  - Tagus+sado estuary yet to be created for the MyCoast project
  - Current tagus nesting system
  - PCOMS + Tagus
  - Açores

- Definition of the best option for relaxation:
  - Should the relaxation include the boundary cells between child and parent domains as well as the entire domain? Or should it be only in the interior?

Near future work

- Profiling of the hydrodynamic module and improvement of code performance both in cpu and memory usage.

- OpenMP and MPI capability of the algorithm, and improvement of part of the hydrodynamic module in regards to these parallization methods