

# Bidirectional method for MOHID modelling system

An introduction on the first algorithm

# Motivation

- Current nested modelling system – one way downscaling – 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 accommodate the estuaries.
  - 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:

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

- Where superscripts *Cg* and *Fg* refer to the coarser 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 weighted average and considers a radius of search dependent on the coarser grid space in order to account for variable grids.
- In the near future it will also be able to use the inverse weighted distance method (almost finished, using functions already made in mohid code).

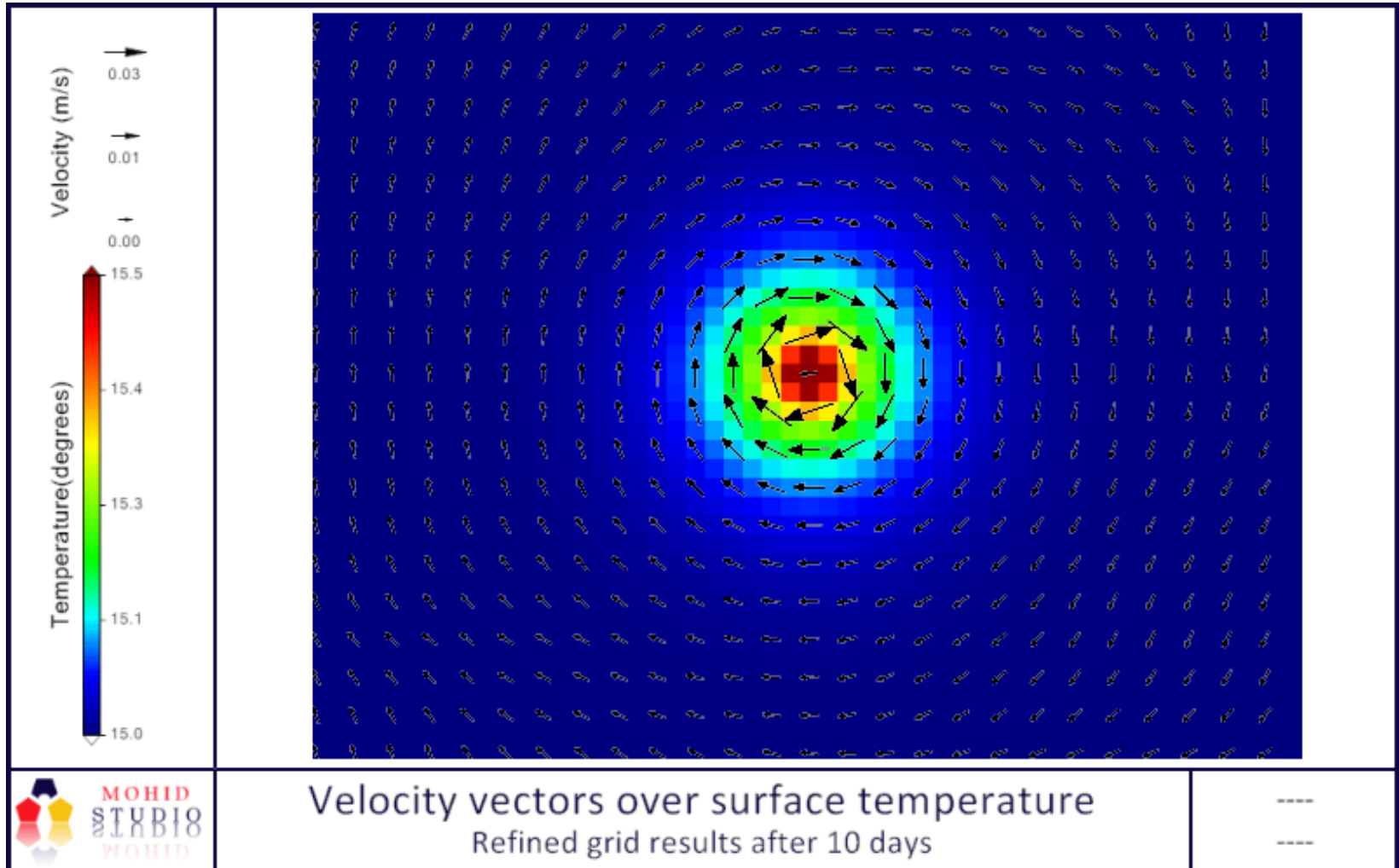
# Applications

- 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 gulf 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

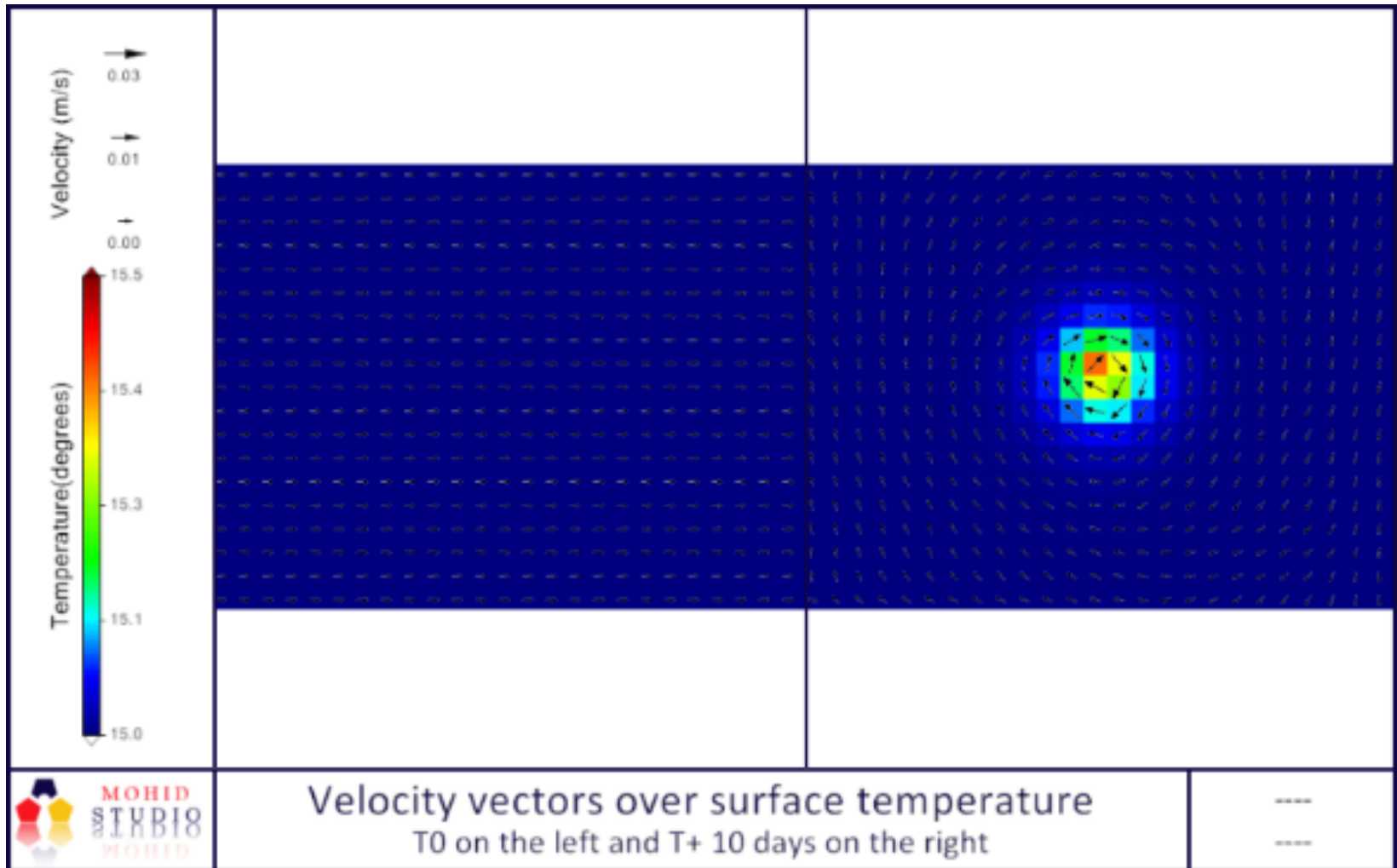
- This first validation was made with the older version of the algorithm as the new one has caught a bug!
- Application:
  - 2 nested grids. The parent with 3km and the child with 1km. Constant depth of 1000m in both
  - 4 openboundaries and 11 vertical cartesian layers.
  - Initial temperature of 15°C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