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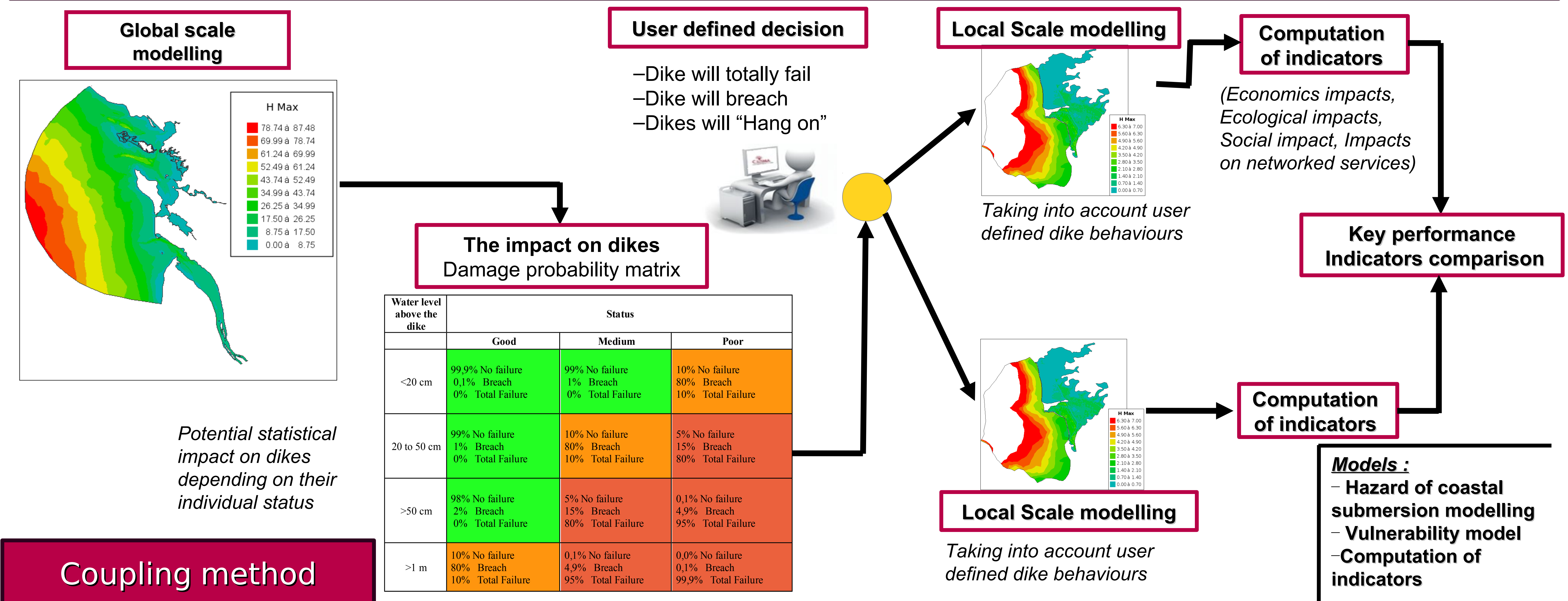
Modelling submersion on the Charente-Maritime coast

Mehdi Pierre DAOU • Agnès CABAL • Christophe COULET • Olivier BERTRAND • Eric BLAYO • Antoine ROUSSEAU • Arnaud DEGROOF

Abstract: CRISMA is a Research and Development project financed by the European Community. Its objective is to develop a simulation-based decision support system, in different domains of the natural or industrial risk (flood, snowstorm, seism, forest fires, accidental pollution, urban accidents). The application in France, coordinated by ARTELIA Eau & Environnement, is devoted to the submersion risk on the Charente-Maritime coast and based on the experience feedback of the storm Xynthia in February, 2010.

In this framework, a specific work is in progress through a thesis realized in collaboration between ARTELIA and INRIA. Its objective is to elaborate a methodology of multi-model coupling which should be effective and applicable for the CRISMA project. These models may differ in several ways, related either to the physics and/or to the numeric concepts. The developed methodology may allow to taking into account more specific areas (urban zone, bridge in charge, ...), but also should be able to simplify the simulation by dimension changes of model parts (for example, a 1D model for rivers, and a 2D one for sea). The present work addresses more specifically the problem of coupling models with different spatial dimensions.

Implementation of a user defined dike behaviour with the help of Damage Probability matrix



Models :

- The Coupling method :
 - Navier Stokes 3D equations (Telemac3d module)
 - Shallow water 1D equations (Mascare module)
- Managed communication : Open-Palm
- Coupling Method : Schwarz
 - iterative method, few intrusive

Conditions :

- No bottom friction $K_s \rightarrow +\infty$ and $\nu = 10^{-6} \text{ m}^2 \cdot \text{s}^{-1}$
- Initial Condition :**
 - $U = 0 \text{ m} \cdot \text{s}^{-1}$ and constant height $Z_s = 0.114 \text{ m}$

Boundary conditions :

$$U \cdot \vec{n} = 0 \text{ no flow through solid boundaries (bottom and lateral)}$$

$$U = U_d(Q_d) \text{ at the input}$$

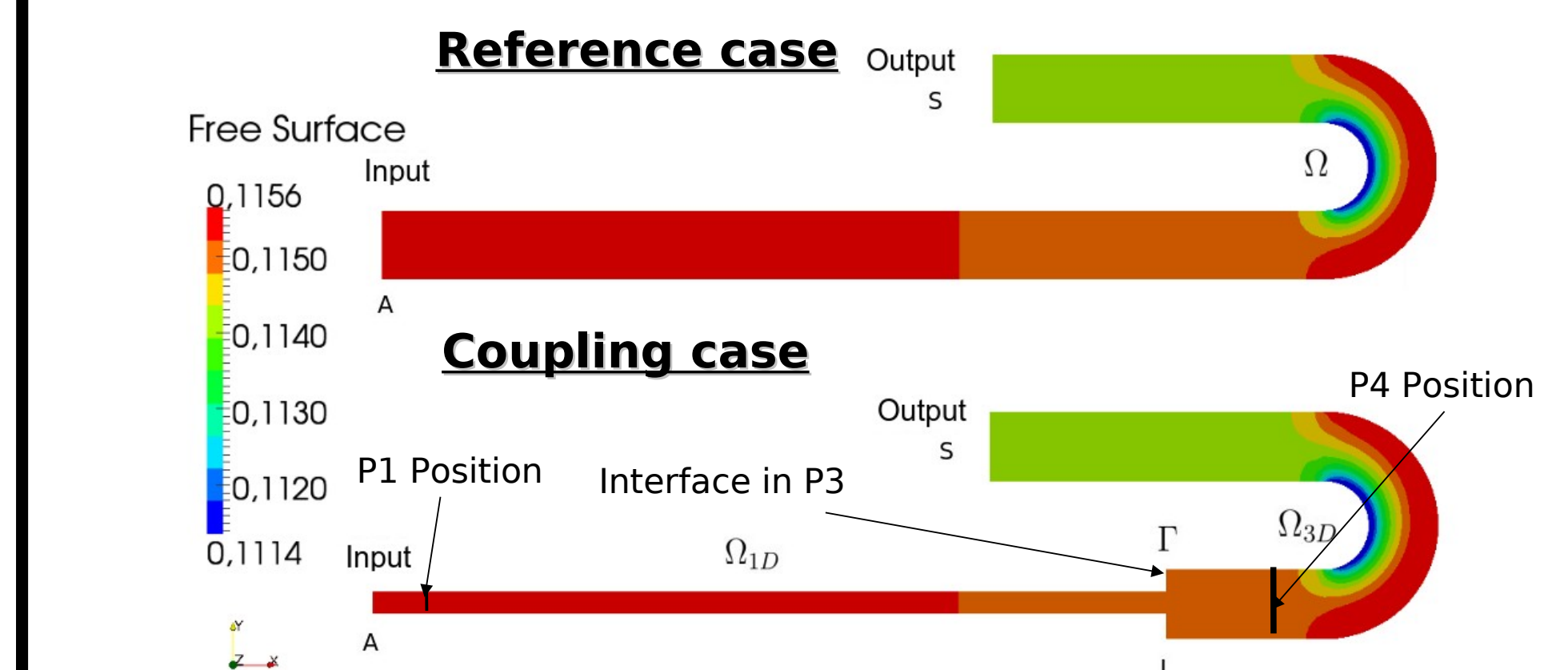
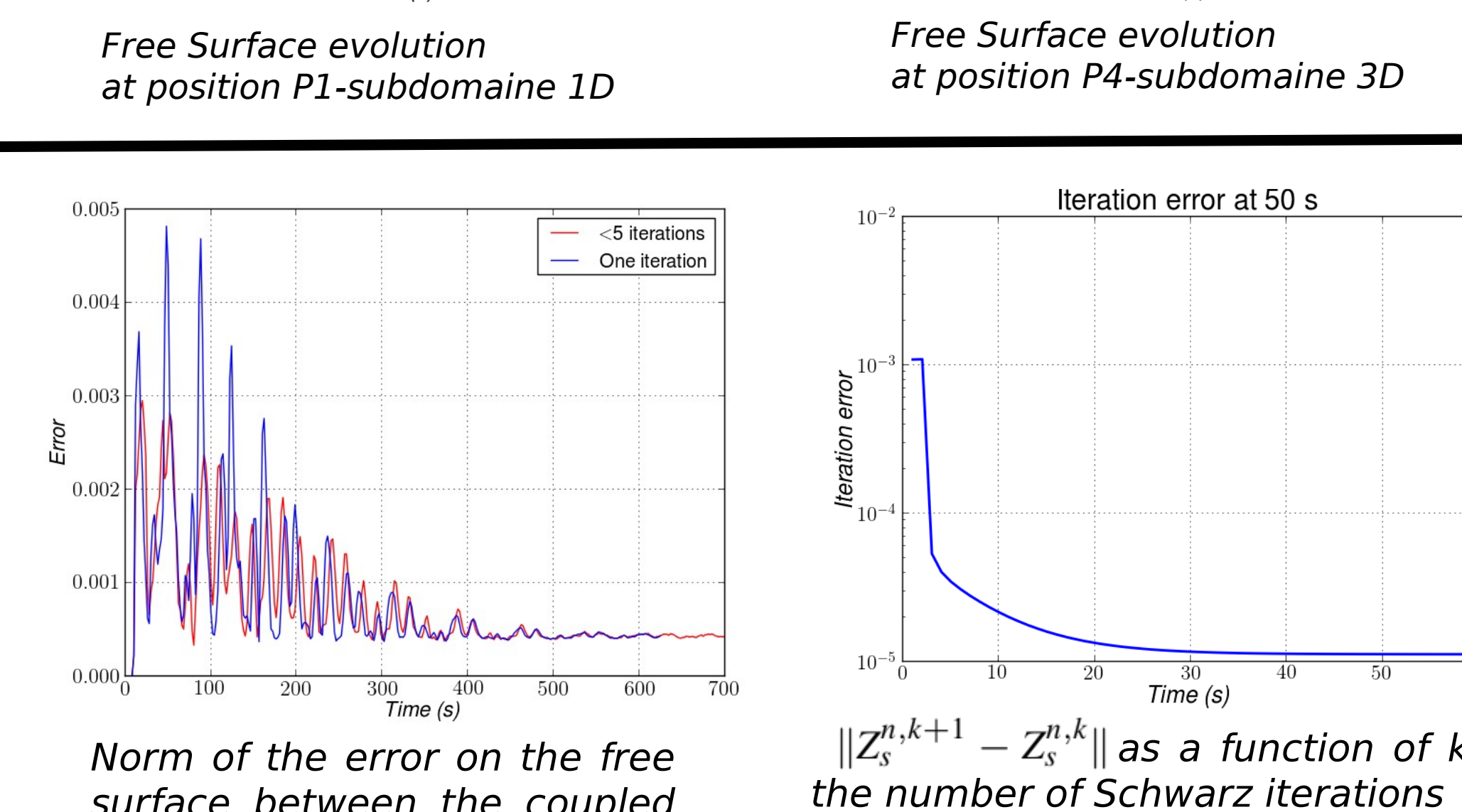
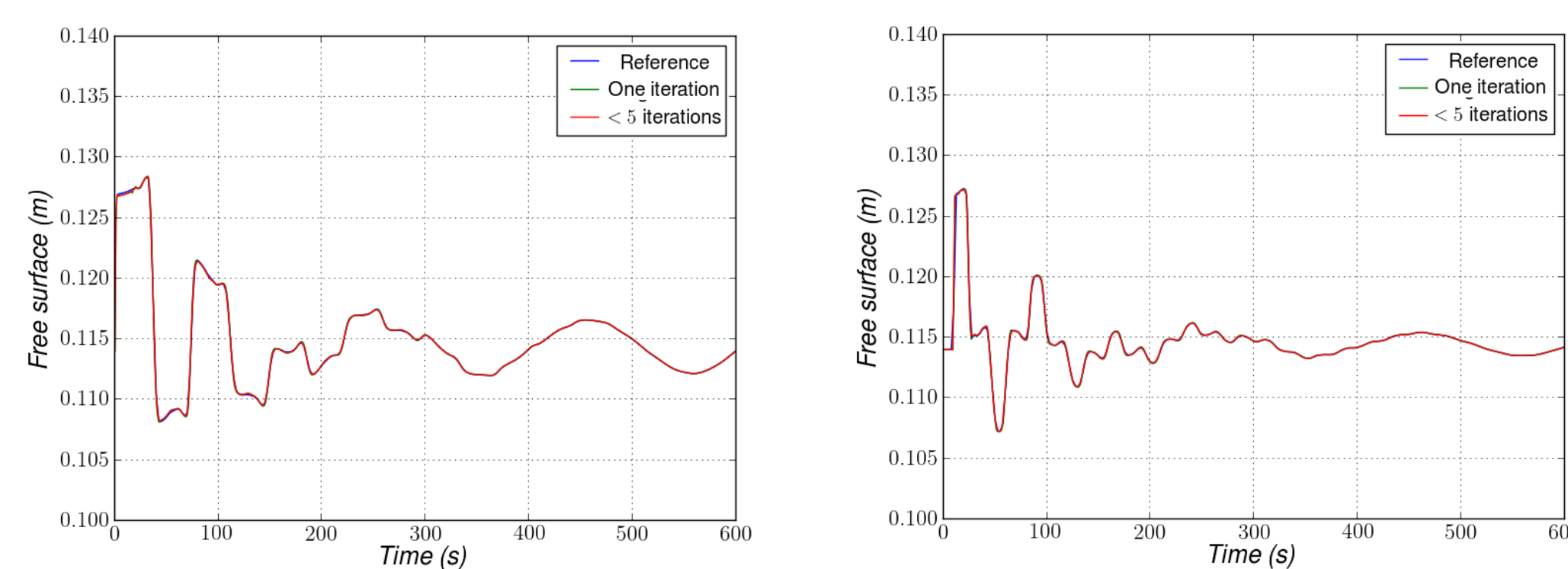
$$Z_s = Z_{sd} \text{ at the output}$$

$$\frac{\partial Z_s}{\partial t} + U_h \cdot \nabla_h Z_s - w = 0 \text{ at the free surface } z = Z_s(x, y, t)$$

$$Q_d = 0.01372 [1 - 0.2 \cos(0.01 \pi t)] \quad Z_{sd} = 0.114 \text{ m}$$

Physical interface conditions :

$$Q_{1D}(L, t) = Q_{3D}(L, t) \text{ and } Z_{s1D}(L, t) = \overline{Z_{s3D}}(L, t)$$



Conclusion

- The coupling method is valid :
 - If the flow must be almost one-dimensional in the 1D domain
 - If the interface 1-D/3-D must be located in this area.
- The simple coupling algorithm gives almost the same results than the reference full 3-D simulation in our simplified case.
- For complex cases, it's possible to use Schwarz based coupling algorithm to improve accuracy

Perspective

- Definition of a test-case more complex (La Rochelle)
 - Validation this iterative algorithm
 - Using more complex interface conditions, in order to ensure a fast convergence



CRISMA Consortium

The CRISMA project (www.crismaproject.eu) is co-ordinated by VTT Technical Research Centre of Finland. The consortium counts 17 partners from 9 countries, representing end-users, research and industry. The project ends in August 2015.

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