europass Curriculum vitae

PERSONAL INFORMATION

Luca Arpaia

Santa Croce 1498A, Venice 30135 Italy

+33 6 51657002 (Fr) +39 338 9994175 (It)

luca.arpaia@ve.ismar.cnr.it

https://github.com/lucarpaia

https://gitlab.inria.fr/larpaia

ORCID 0000-0002-5518-1377

Google Scholar https://scholar.google.com/citations?user=ICVHEjoAAAAJ&hl=en

Citations 109, h-index 6, i10-index 5, Date: 09 June 2023

Date of birth 8 July 1987 | Nationality Italy

WORK EXPERIENCE

Oct 2021 – Present — Research fellow

CNR ISMAR (National Research Council - Institute of Marine Sciences)
Venice, Italy

I am currently working on the development and analysis of the vertical coordinates in the SHYFEM finite element coastal ocean model. I have developed a $z-$coordinate algorithm for ocean models which, thanks to the insertion and removal of surface layers, can deal with an arbitrarily large tidal oscillation independently of the vertical resolution. I am studying the impact of the vertical discretization on typical coastal processes such as wetting/drying, river plumes and salt water intrusion in river.

Keywords vertical coordinates, finite element, coastal ocean models

Reference #1 Title: "Attestazione di partecipazione alle attività a carattere tecnico-scientifico inerenti i progetti di ricerca svolti dalla Dott. Luca Arpaia". Signature: Dott.ssa Michol Ghezzo and Dott. Christian Ferrarin. Date: 27/01/2023.

Oct 2017 – Present (sabbatical since Sep 2017) — Research-engineer

BRGM (French Geological Survey), R3C Coastal Risk and Climate Change Unit
Orléans, France

I have mainly co-developed an unstructured discontinuous finite element model for nearshore wave modelling and coastal flooding, called UHAINA. My research activity was focused on the design of a well-balanced scheme for the spherical shallow water equations. A novel mixed 3d/2d form of the shallow water equations was used with the advantage of maintaining flux and source terms in Cartesian form, thus independent of the parametrization of the sphere. I have looked to high order well-balanced corrections that allow to mimic at a discrete level relevant geophysical steady states on the sphere.

Related to tsunami simulations, I developed a random fault rupture tool which can generate random initial waveforms for stochastic tsunami simulations.

Currently I am still working with the BRGM on the development of a novel high order finite element model for global storm surge simulations.

Keywords discontinuous galerkin, well-balanced methods, spherical shallow water equations, tsunami and storm surge modelling, flooding, heterogeneous stochastic fault slip modelling

Reference #1 Title: "Certificate of the activities carried out by Luca Arpaia as research engineer at the BRGM from October 2017 to September 2021". Signature: Dr. Rodrigo Pedreros and Dr. Eric David. Date: 12/06/2023.
Reference #2 Title: "Certificate of participation to the ANR-Lagoon project (2022-2026)". Signature: Dr. Vincent Perrier. Date: 03/05/2023.

EDUCATION AND TRAINING

Mar 2014–Sep 2017

PhD in applied mathematics and scientific computing

Thesis title: “Adaptive and robust tools for the numerical simulation of free surface waves”

Supervisors: Mario Ricchiuto, Philippe Bonneton

INRIA Bordeaux Sud-Ouest (National Institute for Research in Digital Science and Technology)
Bordeaux, France

Mention: très honorable

We have improved multi-scale tsunami simulations, from basin scale wave propagation up to localized runup with moving adaptive meshes, in order to enhance the resolution of important flow features such as bore development and small scale flooding. We have used a dynamic mesh adaptation based on a redistribution of mesh nodes, also called $r-$adaptation. We have analyzed the relationship between mass/volume conservation and well-balancing (or the ability of a scheme to mantain the lake-at-rest solution) on moving meshes both in Cartesian and spherical coordinates. We have shown the preservation of all these constraints for two families of second order accurate numerical schemes: the Residual Distribution and the Finite Volume method.

In a side project we have investigated the large scale mechanism of tidal bore formation in convergent alluvial estuaries. We have numerically investigated the estuarine parameter space and proposed a new scaling for the shallow water equations that ensures a clear separation of the effect of non-linearity and friction dissipation. As a consequence, we ended up with a set of dimensionless parameters defining a space in which real alluvial estuaries developing bores are clearly divided from those where bores are not observed.

Keywords moving adaptive meshes, arbitrary lagriangian eulerian coordinates, residual distribution method, well-balanced methods, tsunami simulations, tidal bores in estuaries

Reference Title: "Lettera di presentazione di Luca Arpaia". Signature: Dr. Mario Ricchiuto. Date: 10/12/2022.

May 2016

Visiting PhD student

LHSV (Laboratoire d’Hydraulic Saint-Venant) – ParisTech
Paris, France

During this visiting period I have worked on the integration of the adaptive moving mesh algorithm for free-surface flows, that I developed during the PhD, within the TELEMAC flow solver. TELEMAC is one of the major standard unstructured code in the field of free-surface hydrodynamics.

Sep 2009 – Jul 2013

MSc in Aeronautical Engineering

Dissertation title: “Residual Distribution method in Arbitary Lagrangian Eulerian formulation for the study of compressible flows with moving meshes“

Supervisor: Alberto Guardone

Politecnico di Milano
Milan, Italy

GPA: 102/110

Mar 2012 – Oct 2012

Internship

INRIA Bordeaux Sud-Ouest (National Institute for Research in Digital Science and Technology)
Bordeaux, France

Supervisor: Remi Abgrall
The internship was conducted as part of my MSc thesis. I have worked on a particular class of low dissipative schemes based on multidimensional upwinding on unstructured meshes and known as Residual Distribution. Specifically, I focused on the extension of an existing Residual Distribution scheme to accommodate moving meshes.

Feb 2011 – Jul 2011

Student Exchange

Technion – Israel Institute of Technology
Haifa, Israel

Sep 2006 – Sep 2009

BSc in Aerospace Engineering

Dissertation title: “Hydrodynamical and structural study of the centerboard for a racing sailing skiff“

Politecnico di Milano
Milan, Italy

GPA: 98/110

Jul 2006

High School Diploma

Liceo Scientifico Statale E. Fermi
Bari, Italy

GPA: 100/100

PERSONAL SKILLS

Mother tongue: Italian

Other languages

	UNDERSTANDING		SPEAKING		WRITING
	Listening	Reading	Spoken interaction	Spoken production	
English	B2	B2	B2	B1	B2
	First Certificate in English B2 (2004), TOEFL Certificate (2008)				
French	C1	C1	C1	C1	B1

Levels: A1 and A2: Basic user – B1 and B2: Independent user – C1 and C2: Proficient user
Common European Framework of Reference for Languages

Computer skills

– OS: Windows, Linux.
– Programming Languages: Fortran, C, C++, Matlab, Python, Latex, Bash

PUBLICATIONS

[under review] **L. Arpaia**, C. Ferrarin, M. Bajo and G. Umgiesser. A flexible $z-$coordinate approach for the accurate representation of free surface flows in a coastal ocean model (SHYFEM v. 7_5_71). Submitted to *Geoscientific Model Development*, preprint available at:
https://gmd.copernicus.org/preprints/gmd-2023-13

[1] G. Umgiesser, C. Ferrarin, M. Bajo, D. Bellafiore, A. Cucco, F. De Pascalis, M. Ghezzo, W. McKiver and **L. Arpaia**. Hydrodynamic modelling in marginal and coastal seas - the case of the Adriatic Sea as a permanent laboratory for numerical approach. *Ocean Modelling*, 179 102123 (2022)
https://doi.org/10.1016/j.ocemod.2022.102123

[2] **L. Arpaia**, M. Ricchiuto, A.G. Filippini and R. Pedreros. An efficient covariant frame for the spherical shallow water equations: well balanced Discontinuous Galerkin approximation and application to tsunami and storm surge. *Ocean Modelling*, 169 101915 (2022).
https://doi.org/10.1016/j.ocemod.2021.101915

[3] **L. Arpaia**, H. Beaugendre, L. Cirrottola, A. Froehly, M. Lorini, L. Nouveau and M. Ricchiuto. $h-$and $r-$adaptation on simplicial meshes using MMG tools. Chapter in *Mesh Adaptation and Generation, SEMA-SIMAI Springer Series* (2021)
https://link.springer.com/chapter/10.1007/978-3-030-92540-6_9

[4] **L. Arpaia** and M. Ricchiuto. Well-balanced Residual Distribution for the ALE spherical shallow water equations on moving adaptive meshes. *Journal of Computational Physics* 405 109173 (2020).
https://doi.org/10.1016/j.jcp.2019.109173

[5] A.G. Filippini, **L. Arpaia**, P. Bonneton and M. Ricchiuto. Modeling analysis of tidal bore formation in convergent estuaries. *Eur. J. Mech. B Fluids*, 73 55-68 (2018).
https://doi.org/10.1016/j.euromechflu.2018.01.001

[6] **L. Arpaia** and M. Ricchiuto. $r-$adaptation for shallow water flows: conservation, well-balancedness, efficiency. *Computers and Fluids* 160 175-203 (2017).
https://doi.org/10.1016/j.compfluid.2017.10.026

[7] P. Bonneton, A.G. Filippini, **L. Arpaia**, N. Bonneton and M. Ricchiuto. Conditions for tidal bore formation in convergent alluvial estuaries. *Estuarine, Coastal and Shelf Science*. 172, 121-127 (2016).
https://doi.org/10.1016/j.ecss.2016.01.019

[8] **L. Arpaia**, M. Ricchiuto and R. Abgrall. An ALE formulation for explicit Runge-Kutta Residual Distribution. *Journal of Scientific Computing*, 190(34):1467–1482 (2014).
https://doi.org/10.1007/s10915-014-9910-5

CONFERENCES AND WORKSHOPS

[1] **L. Arpaia**, C. Ferrarin, M. Bajo and G. Umgiesser. $z-$coordinates with surface layer insertion/removal for accurate representation of free-surface flows in ocean models. *EGU General Assembly 2023*, April 2023 Wien, Austria.
https://doi.org/10.5194/egusphere-egu23-9551

[2] **L. Arpaia**, C. Ferrarin, M. Bajo and G. Umgiesser. $z-$coordinates for accurate representation of free-surface flows in coastal ocean models. *HPC-TRES Workshop: High Performance Computing Training and Research for Earth Sciences*, January 2023 Trieste, Italy.

[3] **L. Arpaia**, J. Rohmer, A. Lemoine, R. Pedreros, and P. Sochala. Influence of the fault slip spatial heterogeneity on tsunami-induced sea surface height. *Scientific Workshop for 10th anniversary of CENALT*, September 2022 CEA Paris, France.

[4] **L. Arpaia**, M. Ricchiuto, A.G. Filippini and R. Pedreros. Well-Balanced Discontinuous Galerkin scheme for the Shallow Water Equations on the sphere for tsunami and storm surge applications. *SIAM Geoscience*, July 2021 Virtual meeting.

[5] **L. Arpaia**, M. Ricchiuto, A.G. Filippini and R. Pedreros. Well-Balanced Discontinuous Galerkin scheme for the shallow water equations in spherical geometry for storm-surge applications. *American Meterological Society, 34th Conference on Hurricanes and Tropical Meteorology*, May 2021 Virtual meeting.
https://ams.confex.com/ams/34HURR/meetingapp.cgi/Paper/386662

[6] **L. Arpaia**, M. Ricchiuto and R. Pedreros. Well-Balanced Discontinuous galerkin scheme for the shallow water equations in spherical geometry. *World Congress on Computational Mechanics (WCCM-ECCOMAS)*, January 2021 Virtual meeting.

[7] **L. Arpaia** and M. Ricchiuto. A Residual Distribution method for the shallow water equations in ALE framework on the sphere. *European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS)*, June 2018 Glasgow, Scotland.
https://hal.science/hal-01736137/

[8] **L. Arpaia** and M. Ricchiuto. ALE moving mesh tsunami simulations. Application to the case study of the Tohoku tsunami. *SIAM Geoscience*, September 2017 Erlangen, Germany.
https://hal.science/hal-01625302/

[9] **L. Arpaia** and M. Ricchiuto. An ALE moving mesh method on the sphere for tsunami wave propagation and inundation. *PDEs on the sphere 2017*, April 2017 Paris, France.
https://hal.univ-smb.fr/INRIA-BORDEAUX/hal-01625335v1

[10] **L. Arpaia** and M. Ricchiuto, r-adaptation strategies for wave runup on complex bathymetries. *European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS)*, June 2016 Crete Island, Greece.
https://www.eccomas2016.org/proceedings/pdf/8097.pdf

[11] **L. Arpaia**, A.G. Filippini, P. Bonneton and M.Ricchiuto, Modelling analysis of tidal bore formation in convergent estuaries. *36th International Association for Hydro-Environment Engineering and Research (IAHR) World Conference*, June 2015 The Hague, Netherlands. 2015.
https://inria.hal.science/hal-01169254/

[12] **L. Arpaia** and M. Ricchiuto, Well-Balanced ALE: on time dependent mesh adaptation for shallow water flows. *GAMM 86th Annual Scientific Conference*, March 2015 Lecce, Italy.
https://team.inria.fr/cardamom/files/2015/03/Arpaia.pdf

[13] M. Ricchiuto and **L. Arpaia**, Well-balanced ALE: a framework for time dependent mesh adaptation for the shallow water equations. *SIAM Conference on Nonlinear Waves and Coherent Structures,* August 2014 Cambridge, UK.
https://hal.science/hal-01087971/

[14] R. Abgrall, **L. Arpaia** and M. Ricchiuto, ALE formulation for explicit Runge-Kutta Residual Distribution. Procs of *Finite Volumes for Complex Applications VII*, June 2014, Berlin; Fuhrmann, Ohlberger and Rohde Eds., Springer Proceedings in Mathematics and Statistics 77, 2014.
https://link.springer.com/chapter/10.1007/978-3-319-05684-5_4

TEACHING AND SHORT COURSES

Jun 2021 *"Fundamental of hydrodynamic modeling for coastal hazards"*. Short Course on coastal modelling given to Maldivian students, scientists and engineers. Virtual class due to Covid pandemic restriction. Class duration: 24 hours.
Reference Title: "Confirmation of Attendance". Signature: Dr. Gonéri Le Cozannet. Date: 09/02/2023.

Jan 2021 – Apr 2021 Teacher-assistant at École supérieure des techniques aéronautiques et de construction automobile (ESTACA Engineering School). Saint Quentin en Yvelines, France. Lecture title: *"Numerical tools for scientific modelling"*. Class duration: 48 hours.
Reference Title: "Employer Certificate". Signature: Mr. Philippe Thauvin. Date: 15/02/2023.

REVIEWS

I have reviewed:

- 1 manuscript for the *Journal of Geophysical Research*
- 2 manuscripts for the *Journal of Computational Physics*
- 2 manuscripts for the *Journal of Scientific Computing*
- 1 manuscript for *ESAIM-M2AN (Mathematical Modelling and Numerical Analysis)*
- 1 manuscript for *Computer and Fluids*
- 1 manuscript for *Estuarine, Coastal and Shelf Sciences*

EVENT ORGANIZATION

I am a co-organizer of the *18^{th} International Workshop on Multi-scale Unstructured mesh numerical Modeling (IMUM) for coastal, shelf, and global ocean dynamic*. IMUM-2023 will take place in Venice at the CNR-ISMAR, later this year. Conference website:
`https://sites.google.com/view/imum2023/`

SUMMER SCHOOLS

Apr 2016 Title: *"TANDEM and DEFI LITTORAL: Tsunami School"*. Location: Institute de Mathématique de Bordeaux. Website with lecturers: `https://project.inria.fr/tsunamischool2016/`

Jan 2016 Title: *"The Immersed Boundary Method for Fluid/Structure/Thermal Coupling: Theory and Applications"*. Lecturer: Prof. G. Iaccarino (Stanford University). Location: INRIA Bordeaux Sud-Ouest. Website: `http://www.pietrocongedo.altervista.org/iaccarino_ib_bordeaux.pdf`

CODE OWNERSHIP

Oct 2021 – Present SHYFEM

Description A coastal ocean model developed by CNR-ISMAR researchers. It implements the multilayer shallow water equations on unstructured grids with B-type staggering. It uses a semi-implicit time integration.

Programming Language Fortran

Contribution Vertical coordinates

Website Here my forked SHYFEM repository
`https://github.com/lucarpaia/shyfem`

Oct 2018 – Oct 2021 RAGEN

Description A random fault rupture model used to generate initial tsunami waveforms. It is based on heterogeneous stochastic slip modelling.

Programming Language Python

Contribution The code was written by myself.

Website It is stored in the BRGM gitlab repository which I am the maintainer (private repo):
`https://gitlab.brgm.fr/brgm/ragen`

Oct 2018 – Oct 2021 UHAINA

Description An unstructured finite element shallow water model for long waves (e.g. storm surge, tsunami) and coastal flooding. It has been developed by a collaboration between several french research institutes (INRIA, BRGM, Université de Bordeaux). It includes a non-hydrostatic module for dispersive nearshore waves. It uses high order discontinuous finite elements with an explicit Runge-Kutta time scheme.

Programming Language C++

Contribution Spherical geometry, upgrade to storm surge model with meteorological forcing and semi-implicit bottom friction.

Website Here a link to the UHAINA platform with the main developers (included myself):
`https://gitlab.inria.fr/uhaina1/uhaina/-/wikis/Partners-and-financial-support`.

Mar 2014 – Oct 2017 **SLOWS**

Description A C-platform developed by my PhD supervisor that simulates near shore hydrodynamics, wave transformations processes, etc. It uses both static and time dependent unstructured mesh adaptation. Both hydrostatic and non hydrostatic flows can be simulated, based on a depth averaged approach. The kernel of the code allows triangle-based Residual Distribution or Finite Volume simulations.

Programming Language C

Contribution Moving adaptive meshes, second order Finite Volume, spherical geometry

Website Here a link to the code webpage:
`https://team.inria.fr/cardamom/slows-shallow-water-flows/`
Here a link to the manual with the developers (included myself):
`https://team.inria.fr/cardamom/files/2019/11/slows-doc-v0.pdf`

PROJECTS: ACTIVITIES AND DELIVERABLES

Feb 2023 – Present **EU Horizon Danube4all, `https://www.danube4allproject.eu`**

Role Project team member

Activities Studying the impact of vertical discretization on river-coastal modelling. Investigating the effects of lagoon-river-sea reconnection measures on the lagoon hydrodynamics, connectivity and mixing.

Jan 2023 – Present **ANR Lagoon, `https://vperrier.gitlabpages.inria.fr/lagoon`**

Role Project conception and project team member

Activities Mentoring/supervision of a PhD student working on implicit/explicit entropy-stable schemes to speed-up/improve global storm surge simulations.

Oct 2021 – Present **INTERREG Adriaclim, `https://www.italy-croatia.eu/web/adriaclim`**

Role Project team member

Activities Implementation of two vertical $z-$coordinates in the SHYFEM ocean model:

- an Eulerian z-coordinate with fixed geo-potential interfaces and insertion/removal of surface layers
- the popular $z-$star

Deliverables new developments committed in a branch of SHYFEM v.7_5_71 that can be accessed from Zenodo https://doi.org/10.5281/zenodo.7528681

Mar 2020 – Mar 2021 **LIFE Adapto**, https://www.lifeadapto.eu/

Role Project team member

Activities Development of small technical and numerical improvements in the in-house code UHAINA: e.g. river discharge boundary condition, stable semi-implicit bottom friction term, automatization of pre/post-processing operations. Realization of three high resolution flooding simulations based on different scenarios of water-level/wind speed/river discharge. Here a link with the visualization of a typical simulation and other details: https://gitlab.inria.fr/uhaina1/uhaina/-/wikis/Test%20cases#authie-bay

Deliverables
- new features committed in gitlab repo of the code https://gitlab.inria.fr/uhaina1/uhaina
- technical report: ongoing

Sep 2019 – Sep 2021 **INTERREG Carib-coast**, https://www.carib-coast.com/

Role Project team member

Activities Development of a spherical coordinate algorithm for shallow water solvers in the in-house finite element code UHAINA. Application to hurricane Irma.

Deliverables
- new spherical version committed in gitlab repo of the code https://gitlab.inria.fr/uhaina1/uhaina

Oct 2018 – Sep 2021 **H2020 Narsis**, http://www.narsis.eu/

Role Project team member

Activities Development of a random fault rupture numerical tool for stochastic tsunami simulations. Application to the 1755 Lisbon event.

Deliverables
- code accessible from the BRGM gitlab repository (private) https://gitlab.brgm.fr/brgm/ragen
- technical report: "A. Gailler ... **L. Arpaia**, ... et al., WP1: Characterization of potential physical threats due to different external hazards and scenarios. Del 1.2: Improved methodologies for tsunami hazard assessment" (2020) available here: http://www.narsis.eu/sites/default/files/upload/documents/narsis_del1.2_final_0.pdf

Oct 2017 – Jul 2018 **Hydrosedmar**, https://hydrosedmar.brgm.fr/

Role Project team member

Activities Annual simulation of the ocean circulation in the Fort-de-France bay (Martinique) with the structured ocean model CROCO.

Deliverables
- Online database with the numerical results (currents, water level, salinity and temperature) available at: https://hydrosedmar.brgm.fr/cartographie-et-visualisation-de-donnees
- technical report (in French): "S. Lecacheux, **L. Arpaia**, R. Pedreros, D. Idier and J. Lousior, Numerical modelling of waves and 3D circulations in the Fort-de-France bay. Final Report BRGM/RP-69025-FR" (2019) available here: https://hydrosedmar.brgm.fr/sites/default/files/documents/Rapport_BRGM-69025_modelisation.pdf

"Le informazioni contenute nel presente curriculum vitae sono rese sotto la personale responsabilità del sottoscritto ai sensi degli artt.

46 e 47 del DPR 28.12.2000, n. 445, consapevole della responsabilità penale prevista all'art. 76 del medesimo DPR 28.12.2000, n. 445, per le ipotesi di falsità in atti e dichiarazioni mendaci"

"Autorizzo il trattamento dei miei dati personali presenti nel curriculum vitae ai sensi del Decreto Legislativo 30 giugno 2003, n. 196 "Codice in materia di protezione dei dati personali" e dell'art. 13 del GDPR (Regolamento UE 2016/679)"