

Curriculum Vitae

Ludovic Métivier

February 5, 2019

1 General information

Ludovic Métivier
Researcher at CNRS LJK, Univ. Grenoble Alpes
Born on 22/08/1982 at Céret France

Professional address:
Ludovic Métivier
Bâtiment IMAG
Université Grenoble Alpes
700 Avenue Centrale, 38401 Saint Martin d'Hères

Phone: + 33 4 57 42 17 67
e-mail: ludovic.metivier@univ-grenoble-alpes.fr

Websites:
<https://www-ljk.imag.fr/membres/Ludovic.Metivier/>
<https://seiscope2.osug.fr/>

2 Scientific production

- 45 articles in peer-reviewed international journals
- 42 extended abstracts in peer-reviewed international conferences
- 1 patent
- 1163 citations, h-factor : **17** / i10 factor : **25** (Google Scholar https://scholar.google.fr/citations?user=S2-_b7oAAAAJ&hl=fr)

3 Honors and Awards

- **2018.** *MT180*
Philippe Le Bouteiller, student co-supervised with Jean Virieux (ISTerre, Univ. Grenoble Alpes) wins the first prize + public prize at national final of MT180 (Ma Thèse en 180 secondes) <http://mt180.fr/>, and second prize + public prize at international final at Lausanne <https://www.mt180.ch/finale-internationale-2018/>
- **2017.** *SIAM*
Publication of the paper “Full-waveform inversion and the truncated Newton method” in the section SIAM SIGEST of SIAM REVIEW 2017
- **2015.** *Geophysical Journal International*
Citation as “excellent reviewer” for Geophysical Journal International
- **2015.** *Geophysics*
Award for the paper: “Computationally efficient three-dimensional acoustic finite-difference frequency-domain seismic modeling in vertical transversely isotropic media with sparse direct

solver”, S. Operto, R. Brossier, L. Combe, L. Métivier, A. Ribodetti, J. Virieux, *Geophysics*, 2014, 79(5), T257–T275

- **2013.** *IWAGPR 2013*

Best paper prize at international conference IWAGPR 2013 “2D full waveform inversion of GPR surface data: permittivity and conductivity imaging”, F. Lavoué, R. Brossier, L. Métivier, S. Garambois, J. Virieux (présentation par F. Lavoué)

- **2010.** *Prix Yves Chauvin*

PhD award prize “Yves Chauvin” from IFPEN for : “Une méthode d’inversion non linéaire pour l’imagerie sismique haute résolution”

- **2010.** *Diplôme d’honneur Université Paris XIII*

Honor degree from Univ. Paris XIII for PhD: “Une méthode d’inversion non linéaire pour l’imagerie sismique haute résolution”

- **2010.** *Certificat de compétence en calcul intensif C3I*

HPC award from GENCI (Grand Equipement National pour le Calcul Intensif) for PhD: “Une méthode d’inversion non linéaire pour l’imagerie sismique haute résolution”

- **2008.** *CANUM 2008*

Best poster award at national conference CANUM 2008: “2D Inversion of well-seismic data”, L. Métivier, F. Delprat-Jannaud, P. Lailly, L. Halpern

4 Degrees and professional experience

Degrees

- **2017** *Habilitation à diriger des recherches (HDR), Univ. Grenoble Alpes, France*

Thèse d’habilitation à diriger des recherches, at Univ. Grenoble Alpes, doctoral school MSTII (Mathematics, Information science and technology, Informatics)

- **2006-2009.** *PhD in applied mathematics, Univ. Paris XIII, France*

PhD in applied mathematics, supervised by L. Halpern (Univ. Paris XIII), P. Lailly (IFPEN, Rueil-Malmaison) and F. Delprat-Jannaud (IFPEN, Rueil-Malmaison).

- **2005-2006.** *Master 2 degree, Univ. Paul Sabatier Toulouse, France*

Master 2 degree in applied mathematics.

- **2003-2006.** *Engineer degree, ENSEEIHT, Toulouse, France*

Applied mathematics and informatics engineer degree from ENSEEIHT, Toulouse, France.

Professional experience

- **2012-présent.** *Researcher at CNRS, LJK, Univ. Grenoble Alpes, France*

Mathematics and interactions. Research project based on methodological developments for seismic imaging. Modeling of seismic wave: accounting for anisotropy, elasticity, development of robust absorbing boundary conditions. Seismic imaging using the full waveform. Approximation strategies for the local curvature of the misfit function. Application to multi-parameter inversion, uncertainty estimation. Development of a large scale numerical optimization strategy for smooth nonlinear function problems. Development of misfit functions based on optimal transport distances: application to full waveform inversion.

- **2011-2012.** *Post-doctoral position, Institut des Sciences de la Terre (ISTerre), Univ. Grenoble Alpes, France*

Study, analysis, and implementation of new numerical strategies for seismic imaging using the full waveform. In particular, analysis and implementation of the truncated Newton strategy. Application to multi-parameter inversion.

- **2010-2011.** *Post-doctoral position, CEA Saclay, France*

Modeling and numerical solution of a transport/chemical problem for liquid/liquid extraction. Implementation of a prototype within a software platform dedicated to the modeling of the back end of the nuclear fuel cycle.

5 Editorial activities

- **Associate editor** for Geophysical Journal International since January 2016
- **Reviewer** for the journals
 - SIAM Journal on Scientific Computing
 - Inverse Problems
 - Journal on Scientific computing
 - Geophysics
 - Geophysical Journal International
 - Geophysical Prospecting
 - Computers and geosciences
 - Journal of Applied Geophysics
 - Engineering Analysis with Boundary Elements

6 Research projects/fundings

- **2016-***. *SEISCOPE project*

co-PI with R. Brossier (ISTerre-UGA) of the research project SEISCOPE. The project is built as a consortium of industrial partners which fund PhD projects, post-doc and engineer positions at the University. The project is organized following 3 years periods renewable once (6 years in total). A 3 years period starts in 2019 with 11 industrial partners: AkerBP, CGG, Chevron, Equinor, ExxonMobil, JGI, PETROBRAS, Schlumberger, Shell, Sinopec, Total, for a budget of approximately 1.5 ME for three years. Website: <https://seiscope2.osug.fr/>

- **2016-2021.** *ANR project “Défi des Autres savoirs” HIWAI*

Local coordinator of the ANR project HIWAI “Homogenized seismic full Waveform Inversion and downscaling”. The PI of this project is Y. Capdeville (Univ. Nantes, France, LPG)

- **2015-2016** *INSU-INSMI project*

PI of the INSU-INSMI project “Implicit parallel in time integration strategy through Spectral Deferred Correction method for magneto-hydro-dynamic equations” (8kE)

- **2015-2016.** *Projet local AGIR*

PI of the local Univ. Grenoble Alpes project “Asymptotic approach for preconditioning a multi-parameter inverse problem in seismic imaging” (10 kE)

- **2013-2014.** *Projet local AGIR*

PI of the local Univ. Grenoble Alpes project “Wasserstein Distance for Full Waveform Inversion” (10 kE)

7 Research supervision

Unofficial PhD supervision

1. Clara Castellanos

- **Funding:** SEISCOPE
- **Period:** November 2010 - November 2013
- **Advisors:** Stéphane Operto, Géoazur (75 %), Stéphane Gaffet, CNRS, Géoazur (25 %)
- **Summary:** Source encoding techniques and non-smooth regularization strategies for full waveform inversion.
- **Post PhD:** Researcher at Schlumberger Cambridge

2. Francois Lavoué

- **Funding:** École normale supérieure de Lyon.
- **Period :** December 2010 - December 2013
- **Advisors** Stéphane Garambois, ISTerre (50 %), Jean Virieux, ISTerre (50 %)
- **Summary:** Full waveform inversion applied to ground penetrating radar surface data.
- **Post PhD:** Post-doc, Dublin Institute for Advanced Studies

Defended PhD

1. Yang Li

- **Funding:** exchange PhD student for 2 years from Harbin Institute (China), funded by the Chinese national program
- **Period:** September 2012- September 2014
- **Advisors** Ludovic Métivier, LJK (75 %), Jean Virieux, ISTerre (25 %)
- **Summary:** Implementation of the iterative solver CARP-CG. Application to 2D and 3D visco-elastic frequency-domain wave propagation modeling.
- **Post-PhD:** Post-doc, ISTerre, Univ. Grenoble Alpes

2. Okba Hamitou

- **Funding:** SEISCOPE
- **Period:** November 2013 - November 2016
- **Advisors:** Ludovic Métivier, LJK (50 %), Stéphane Labbé, LJK (25 %), Jean Virieux, ISTerre (25 %)
- **Summary:** Development of preconditioning techniques for the iterative solver CARP-CG. Application to 2D and 3D visco-elastic frequency-domain wave propagation modeling.
- **Post-PhD:** Research engineer, BULL ATOS

3. Hugo Pinard

- **Funding:** SEISCOPE
- **Start:** November 2013
- **Advisors:** Stéphane Garambois, ISTerre (33 %), Ludovic Métivier, LJK (33 %), Michel Dietrich, ISTerre (33 %)
- **Summary:** Multi-parameter full waveform inversion for near surface imaging using Ground Penetrating Radar data. Application to cross-hole data from the LSBB site (Rustrell).
- **Post-PhD:** Engineer at Etudis <https://etudis.fr/>

4. Phong-Thu Trinh

- **Funding:** SEISCOPE
- **Start:** November 2015
- **Advisors:** Romain Brossier, ISTerre (33 %), Ludovic Métivier, LJK (33 %), Jean Virieux, ISTerre (33 %)
- **Summary:** 3D visco-elastic time-domain full waveform inversion using a spectral element modeling engine. Application to land data with complex topography
- **Post-PhD:** Research engineer at TOTAL

5. Philippe Le Bouteiller

- **Funding:** SEISCOPE
- **Start:** December 2015
- **Advisors:** Jean Virieux, ISTerre (50 %), Ludovic Métivier, LJK (50 %)
- **Summary:** Travel-time computation in complex media in the asymptotic approximation through Hamilton-Jacobi equations and a discontinuous Galerkin solver.
- **Post-PhD:** Co-direction startup HYMAG'IN <https://www.hymagin.com/>

Ongoing PhD

1. Arnaud Pladys

- **Funding:** SEISCOPE
- **Start:** January 2017
- **Advisors:** Romain Brossier, ISTerre (50 %), Ludovic Métivier, LJK (50 %)
- **Summary:** Comparison and characterization of misfit functions for full waveform inversion.

2. Julien Thurin

- **Funding:** National grant
- **Start:** December 2016
- **Advisors:** Romain Brossier, ISTerre (50 %), Ludovic Métivier, LJK (50 %)
- **Summary:** Uncertainty quantification through extended Kalman filter in seismic imaging.

3. Hugo Sanchez

- **Funding:** CNRS handicap grant
- **Start:** November 2015
- **Advisors:** Jean Virieux, ISTerre (33 %), Ludovic Métivier, LJK (33 %), Josué Tago, UNAM (Mexico) (33 %)
- **Summary:** Kinematic inversion of seismic source through full waveform inversion. Application to real earthquake data.

4. Marwan Irnaka

- **Funding:** SEISCOPE
- **Start:** January 2017
- **Advisors:** Romain Brossier, ISTerre (50 %), Ludovic Métivier, LJK (50 %)
- **Summary:** 3D visco-elastic full waveform inversion of a 3x3C near surface field data.

Others

1. Aude Allain

- **Funding:** National grant
- **Start:** December 2016 - quit for personal reasons in October 2018
- **Advisors:** Ludovic Métivier, LJK (50 %), Edouard Oudet, LJK (50 %)
- **Summary:** Optimal transport distances for the comparison of signed measures. Application to seismic imaging.

8 Scientific animation and teaching

- **2019.** *Mini-symposium at SIAM Conference on Geosciences “Optimal transport for imaging in geosciences” (Houston)*
Mini-symposium dedicate to applications of optimal transport to seismic imaging in geosciences at SIAM Geosciences conference. Co-organization with Yunan Yang, instructor at Courant Institute, NY.
- **2017.** *EAGE E-Lecture: “A misfit function based on an optimal transport distance for FWI”*
Recording of a 20 minutes video lectures on the use of optimal transport for seismic imaging using full waveform inversion, in the frame of EAGE e-lectures <https://www.youtube.com/watch?v=QzAQXxi3mjU>
- **2016.** *Master 2 module “Frontiers in Geophysics” in Earth Sciences Master (Univ. Grenoble Alpes)*
Three days module on full waveform inversion for the master 2 degree in Earth Sciences, together with R. Brossier (ISTerre, Univ. Grenoble Alpes).
- **2016.** *EAGE workshop on seismic wave modeling (Vienna)*
Organization of a one day workshop on seismic wave modeling together with R. Brossier (ISTerre, Univ. Grenoble Alpes) and M. Huiskes (Shell Global Solutions International) within the international applied geophysics conference EAGE in Vienna.
- **2016.** *Doctoral school training on full waveform inversion (Univ. Grenoble Alpes)*
Three days training on full waveform inversion for PhD students in Earth Sciences and Applied Mathematics, together with R. Brossier (ISTerre, Univ. Grenoble Alpes).
- **2015.** *Mini-symposium at SIAM Conference on Geosciences (Stanford)*
Organization of a mini-symposium on elastic imaging together with S. Chaillat (ENSTA, POEMS, CNRS) at the SIAM Conference on Geosciences in Stanford.
- **2015.** *Full Waveform Inversion training at CGG and TOTAL*
Three days training at TOTAL (Pau) and CGG (Massy) on full waveform inversion, together with R. Brossier (ISTerre, Univ. Grenoble Alpes) and J. Virieux (ISTerre, Univ. Grenoble Alpes).
- **2014-***. *SEISCOPE annual meeting (Grenoble)*
Organization of the SEISCOPE annual meeting together with R. Brossier (ISTerre, Univ. Grenoble Alpes) and J. Virieux (ISTerre, Univ. Grenoble Alpes). Two days of scientific presentations on the SEISCOPE consortium research activities and one day training on our computation code. The meeting is organized for the sponsors of SEISCOPE but is opened to colleagues from other laboratories of the university.
- **2012-***. *EDP team seminar at LJK (Grenoble)*
Organization of the EDP team seminar EDP at LJK together with C. Jourdana (LJK, Univ. Grenoble Alpes).

9 Invitations

- **2019.** *ICIAM 2019, Valencia*
A graph space optimal transport approach as a generalization of L^p distances: application to seismic imaging.
- **2019.** *Applied Inverse Problems 2019, Grenoble*
From L^p to p -Wasserstein distance: how optimal transport can be used to enhance the subsurface mechanical properties recovery from seismic data
- **2018.** *Séminaire Basel Mathematisches Institut (Basel)*
Optimal transport for full waveform inversion.
- **2018.** *Séminaire laboratoire Dieudonné (Nice)*
Optimal transport for seismic imaging: application to full waveform inversion
- **2018.** *Séminaire laboratoire mathématiques d'Orsay (Univ. Paris-Sud)*
On the use of optimal transport to measure the distance between datasets: application to seismic imaging
- **2017.** *ANR MAGA meeting (Grenoble)*
Optimal Transport for full waveform inversion: dealing with oscillatory signals
- **2017.** *Séminaire IPGP*
Optimal transport for signed measures: application to seismic imaging.
- **2017.** *OILWS2 workshop: Full Waveform Inversion and Velocity Analysis, IPAM, UCLA (Los Angeles)*
On the use of Wasserstein distances for full waveform inversion.
- **2016.** *ANR Optiform/Geometrya meeting, Ecole Normal Supérieure (Paris)*
Optimal transport distance for seismic imaging.
- **2016.** *Séminaire Maison de la Modélisation (Saclay)*
An implementation of an optimal transport distance for full waveform inversion.
- **2015.** *4ièmes Journées Scientifiques Equip Meso : Sciences de l'Univers (Toulouse)*
Full waveform inversion for high resolution seismic imaging: HPC issues on recent applications and ongoing research.
- **2015.** *Séminaire MATHIAS TOTAL (Paris)*
High resolution seismic imaging through full waveform inversion: successful attempts and challenges for the next years.
- **2015.** *Platform for Advanced Science Computing (PASC) conference 2015, ETH (Zurich)*
Multi-parameter Full Waveform Inversion: tentative simultaneous reconstruction of v_P, ρ, Q_p in the 2D acoustic approximation.
- **2015.** *Joint Inversion Summer School (Barcelonnette)*
Numerical optimization and adjoint state methods for large-scale nonlinear least-squares problems.
- **2014.** *Journées Ondes Sud-Ouest, ONERA (Toulouse)*
A robust absorbing layer for seismic wave propagation in anisotropic media.
- **2013.** *Colloquium Julich Forschungszentrum (Julich)*
Second-order derivatives approximation for multi-parameter Full Waveform Inversion.

- **2013.** *Séminaire Basel Mathematisches Institut (Bâle)*
Full Waveform Inversion using the truncated Newton method.
- **2013.** *ENSTA-POEMS seminar (Saclay)*
Utilisation d'une méthode de Newton tronqué préconditionnée pour l'imagerie de structures complexes par inversion de formes d'ondes complètes.
- **2012.** *DYSCO seminar (Alleverd)*
Full Waveform Inversion using the truncated Newton method : imaging complex subsurface structures.
- **2012.** *EDP Rhône-Alpes meeting (Chambéry)*
Numerical methods for Full Waveform Inversion.
- **2012.** *LJK Team EDP seminar, Univ. Joseph Fourier (Grenoble)*
Numerical challenges for full waveform inversion.
- **2011.** *Sergio Stecco department seminar at Florence University (Florence)*
Stiff Differential Algebraic Equations solver for a reactive transport problem.
- **2011.** *LGIT seminar, Univ. Joseph Fourier (Grenoble)*
A nonlinear inversion for high resolution seismic imaging.
- **2011.** *INRIA team ESTIME seminar, Rocquencourt (Paris)*
A nonlinear inversion for high resolution seismic imaging.
- **2011.** *IHP seminar (Paris)*
A nonlinear inversion for high resolution seismic imaging.
- **2010.** *LJK Team EDP seminar, Univ. Joseph Fourier (Grenoble)*
A nonlinear inversion for high resolution seismic imaging.