

NATAF Henri-Claude

ISTerre, CNRS,

Univ Grenoble Alpes, France

Henri-Claude.Nataf@univ-grenoble-alpes.fr

69 years, married, 2 children

Emeritus Senior Scientist in Geosciences



Education

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| 1986 | Thèse d'Etat , <u>University Paris-South</u> , "Elements of anatomy and physiology of the Earth's mantle: seismic tomography and experimental convection" |
| 1980 | Thèse de 3^{ème} cycle , <u>University Paris-South</u> , "Convection in the Earth's mantle: experimental study of the effect of the lateral cooling produced by the subducting oceanic lithosphere on sub-continental convection", Dissertation advisor: C. Froidevaux |
| 1978 | Master in Physics (Geophysics specialty), <u>University Paris-South</u> |

Research Positions

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| 2021- | <u>Institut des Sciences de la Terre, University Grenoble Alpes, France</u>
CNRS Emeritus Senior Scientist | |
| 2011-2021 | <u>Institut des Sciences de la Terre, University Grenoble Alpes, France</u>
CNRS Research Director
Collaborations with: N. Schaeffer, D. Schmitt, D. Jault, T. Alboussière, P. Cardin, D. Cébron | |
| | <table border="1"><tr><td>02/2011-05/2011</td><td><u>IREAP, University of Maryland, USA</u>
CNRS Researcher in residence
Collaborations with: D.P. Lathrop, D. Zimmerman, S. Triana</td></tr></table> | 02/2011-05/2011 |
| 02/2011-05/2011 | <u>IREAP, University of Maryland, USA</u>
CNRS Researcher in residence
Collaborations with: D.P. Lathrop, D. Zimmerman, S. Triana | |
| 1996-2010 | <u>Laboratoire de Géophysique Interne et Tectonophysique, University of Grenoble, France</u>
CNRS Research Director
Collaborations with: P. Cardin, D. Brito, D. Jault, T. Alboussière, D. Schmitt | |
| 1989-1995 | <u>Laboratoire de Géologie de l'Ecole Normale Supérieure, Paris, France</u>
CNRS Research Director (1991-)
Collaborations with: Y. Ricard, P. Olson, V. Maupin | |
| | <table border="1"><tr><td>1991-1992</td><td><u>Institute of Earth Sciences, Utrecht University, the Netherlands</u>
CNRS Researcher in residence
Collaborations with: J. VanDecar</td></tr></table> | 1991-1992 |
| 1991-1992 | <u>Institute of Earth Sciences, Utrecht University, the Netherlands</u>
CNRS Researcher in residence
Collaborations with: J. VanDecar | |
| 1982-1988 | <u>Laboratoire de Géophysique et Géodynamique Interne, University Paris-South, Orsay, France</u>
CNRS Research Associate
Collaborations with: J-P. Montagner | |
| 1981-1982 | <u>Seismological Laboratory, California Institute of Technology, Pasadena, USA</u>
Research Assistant
Collaborations with: Don L. Anderson, I. Nakanishi, T. Lay, B. Hager, R.F. Scott, E.A. Okal | |
| 1980 | <u>Department of Geophysical Sciences, The University of Chicago, USA</u>
Research Associate
Collaborations with: F.M. Richter, S.F. Daly | |

Main Administrative Positions

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| 2012-2018 | President of the Council of the Observatory Midi-Pyrénées |
| 2006-2010 | Director of the Observatory of Sciences of the Universe of Grenoble |
| 2004-2006 | President of the Commission of Specialists in Earth and Environment Science, University of Grenoble |
| 2000-2004 | President of the French National Evaluation Committee "Earth: physics and chemistry" |
| 1999-2002 | Director of the Graduate School "Earth, Universe, Environment" of the University of Grenoble |

Other Service

Journals

Editor of **eEarth** EGU Journal (2005-2008), Member of the Editorial Boards of "Earth & Planetary Science Letters" (1987-2007), and "Physics of the Earth & Planetary Interiors" (1992-2015)

International

Member of the Scientific Advisory Board of "Helmholtz Zentrum Dresden Rossendorf" (2018-2022)
Vice-President of the International Group "Study of the Earth Deep Interior" (1999-2003)

Awards

2021

Ampère Prize of the French Academy of Science (as a member of the Geodynamo team)

2011

Paul Doistau-Émile Blutet Prize of the French Academy of Science

1997

Barrabé Prize of the French Geological Society

1985

CNRS Bronze medal

1981

Guinier Prize of the French Physical Society

Doctoral Research Direction

2021-	Thomas FRASSON	"How does the mantle influence magnetic reversals?", <i>University Grenoble Alpes</i> (S. Labrosse co-advisor)
2014	Simon CABANES	"Contributions of turbulent fluctuations to the induced magnetic field in a liquid sodium experiment", <i>University Grenoble Alpes Thesis</i> . (N. Schaeffer co-advisor)
2009	Nadège GAGNIÈRE	"Experimental study of the magnetostrophic regime with DTS (Derviche Tourneur Sodium)", <i>University Joseph Fourier Grenoble Thesis</i> .
2004	Nathanaël SCHAEFFER	"Instabilities, turbulence and dynamo in a sheared fluid layer in rapid rotation", <i>University Joseph Fourier Grenoble Thesis</i> . (P. Cardin advisor)
2001	Julien AUBERT	"Experimental and numerical models of convection on the Earth's core", <i>University Joseph Fourier Grenoble Thesis</i> . (P. Cardin advisor)
1998	Daniel BRITO	"Experimental and theoretical approaches of the dynamics of the Earth's core", <i>Ecole Normale Supérieure Thesis & Johns Hopkins University PhD</i> . (P. Olson co-advisor)
1997	Valérie EMERY	"Diffracted S waves at the base of the mantle: modeling diffusion by the heterogeneous D" layer", <i>Ecole Normale Supérieure Thesis</i> . (V. Maupin co-advisor)
1996	Ji Ying	"Diffraction tomography and detection of plumes in the lower mantle", <i>Ecole Normale Supérieure Thesis</i> .
1995	Bruno LAFAURIE	"Modeling convection by a lattice-gas method and interface tracking technique", <i>Ecole Normale Supérieure Thesis</i> . (S. Zaleski advisor)
1993	Sylvain HOUARD	"Structure of the D" layer, study of the caustic of the PKP waves", <i>University Paris 6 Thesis</i> .
1992	Philippe CARDIN	"Aspects of convection in the Earth: coupling of the upper and lower mantles, thermal convection in the liquid core", <i>University Paris 6 Thesis</i> . (P. Olson co-advisor)
1989	Valérie ANSEL	"Mantle anisotropy deduced from shear wave splitting", <i>University Paris-South Thesis</i> .

Main Research Achievements

Core dynamics, MHD and dynamo

- * first experimental observation of geostrophic Alfvén waves
- * introduction of $\tau - \ell$ diagrams for turbulence in planetary cores
- * experimental discovery of negative turbulent magnetic diffusivity
- * first experiment exploring the magnetostrophic regime
- * experimental evidence of zonal motions in rotating convection

Experimental Fluid Dynamics

- * co-invention of Modal Acoustic Velocimetry
- * adaptation of Ultrasound Doppler Velocimetry to liquid metals

Seismology

- * diffraction tomography and detection of mantle plumes
- * construction and diffusion of the 3SMAC model
- * characteristics of the D" discontinuity
- * first tomographic anisotropic model of the upper mantle

Mantle dynamics

- * properties of convection with temperature-dependent viscosity

Main Courses Taught

<i>Geophysical fluid dynamics</i>	* From the Lab, up and down (Master class for graduate students and postdocs in Kyoto, Japan) (FDEPS program. On line course at: http://www.gfd-dennou.org/seminars/fdeps/2018-11-27/index.htm.en)
<i>Core dynamics, MHD and dynamo</i>	* core dynamics and dynamo (Master and PhD levels)
<i>Seismology</i>	* seismic waves and modes (Bachelor and Master levels) * properties of the D'' layer (post-doctoral Les Houches) * exploration geophysics (Bachelor level)
<i>Mantle dynamics</i>	* geochemistry and mantle convection (Master level and PhD levels)
<i>Geophysics</i>	* Earth dynamics, Physics of the Earth (Master level)

Books and Chapters

- 2015 **Nataf H-C.** and N. Schaeffer, Turbulence in the core, in *Treatise on Geophysics, second Edition*, Vol. 8 Core Dynamics, P. Olson and G. Schubert Eds, Elsevier B.V., p. 161-181, 2015.
- 2000 **Nataf H-C.** et J. Sommeria, coordinators, *La physique et la Terre*, Collection Croisée des Sciences, Belin-CNRS-Editions, 144 pp.
- 1998 Jolivet L. et **H-C. Nataf**, *Géodynamique*, Collection Geosciences, Dunod, 226 pp, Paris.

Articles in Refereed Journals

- Frasson T., N. Schaeffer, **H-C. Nataf** and S. Labrosse, Geomagnetic dipole stability and zonal flows controlled by mantle heat flux heterogeneities, *Geophys. J. Int.*, **240**, 1481-1504, [DOI](#), 2025.
- Nataf H-C.** and N. Schaeffer, Dynamic regimes in planetary cores: tau-ell diagrams, *CR Geosciences*, **356**, 1-30, 2024.
- Tomasetto L., P. Boué, L. Stehly, F. Ardhuin and **H-C. Nataf**, On the stability of mantle-sensitive P-wave interference during a secondary microseismic event, *Geophys. Res. Lett.*, **51**, e2023GL108018, 2024.
- Frasson T., S. Labrosse, **H-C. Nataf**, N. Coltice and N. Flament, On the impact of true polar wander on heat flux patterns at the core–mantle boundary, *Solid Earth*, **15**, 617–637, [DOI](#), 2024.
- Nataf H-C.**, Tidally synchronized solar dynamo: a rebuttal, *Solar Physics*, **297**, 107, 2022 + Response to Comment on “Tidally Synchronized Solar Dynamo: a Rebuttal”, *Solar Physics*, **298**, 33, 2023.
- Landeau M., A. Fournier, **H-C. Nataf**, D. Cébron and N. Schaeffer, Sustaining Earth’s magnetic dynamo, *Nature Reviews Earth & Environment*, 2022.
- Su S., D. Cébron, **H-C. Nataf**, P. Cardin, J. Vidal, M. Solazzo and Y. Do, Acoustic spectra of a gas-filled rotating spheroid, *European J. Mech. B/Fluids*, **84**, 302-310, 2020.
- Tigrine Z., **H-C. Nataf**, N. Schaeffer, P. Cardin and F. Plunian, Torsional Alfvén waves in a dipolar magnetic field: experiments and simulations, *Geophys. J. Int.*, **219**, S83-S100, 2019.
- Kaplan E.J., **H-C. Nataf** and N. Schaeffer, Dynamic domains of DTS: simulations of a spherical magnetized Couette flow, *Phys. Rev. Fluids*, **3**, 034608, 2018.
- Schaeffer N., D. Jault, **H-C. Nataf** and A. Fournier, Turbulent geodynamo simulations: a leap towards Earth’s core, *Geophys. J. Int.*, **211**, 1–29, 2017.
- Cabanes S., N. Schaeffer and **H-C. Nataf**, Turbulence reduces magnetic diffusivity in a liquid sodium experiment, *Physical Review Letters*, **113**, 184501, 2014 + *Erratum*, *Phys. Rev. Lett.*, **115**, 189901, 2015.
- Cabanes S., N. Schaeffer and **H-C. Nataf**, Magnetic induction and diffusion mechanisms in a liquid sodium spherical Couette experiment, *Phys. Rev. E*, **90**, 043018, 2014.
- Triana S.A., D.S. Zimmerman, **H-C. Nataf**, A. Thorette, V. Lekic and D.P. Lathrop, Helioseismology in a bottle: Modal acoustic velocimetry, *New Journal of Physics*, **16**, 113005, 2014.
- Zimmerman D.S., S.A. Triana, **H-C. Nataf** and D.P. Lathrop, A turbulent, high magnetic Reynolds number experimental model of Earth’s core, *J. Geophys. Res. Solid Earth*, **119**, doi:10.1002/2013JB010733, 2014.
- Nataf H-C.**, Magnetic induction maps in a magnetized spherical Couette flow experiment, *Comptes Rendus Physique*, **14**, 248-267, 2013.
- Figueroa A., N. Schaeffer, **H-C. Nataf** and D. Schmitt, Modes and instabilities in magnetized spherical Couette flow, *J. Fluid Mech.*, **716**, 445-469, 2013.
- Schmitt D., P. Cardin, P. La Rizza and **H-C. Nataf**, Magneto-Coriolis Waves in a spherical Couette flow experiment, *European J. Mech., B/Fluids*, **37**, 10-22, 2013.
- Brito D., T. Alboussière, P. Cardin, N. Gagnière, D. Jault, P. La Rizza, J-P. Masson, **H-C. Nataf** and D. Schmitt, Zonal shear and super-rotation in a magnetized spherical Couette flow experiment, *Phys. Rev. E*, **83**, 066310, 2011.
- Nataf H-C.** and N. Gagnière, On the peculiar nature of turbulence in planetary dynamos, *Compte Rendus Physique*, **9**, 702-710, 2008.
- Schmitt D., T. Alboussière, D. Brito, P. Cardin, N. Gagnière, D. Jault, and **H-C. Nataf**, Rotating spherical Couette flow in a dipolar magnetic field: experimental study of magneto-inertial waves, *J. Fluid Mech.*, **604**, 175-197, 2008.
- Nataf H-C.**, T. Alboussière, D. Brito, P. Cardin, N. Gagnière, D. Jault, and D. Schmitt, Rapidly rotating spherical Couette flow in a dipolar magnetic field: an experimental study of the mean axisymmetric flow, *Phys. Earth Planet. Inter.*, **170**, 60-72, 2008.
- Gillet N., D. Brito, D. Jault and **H-C. Nataf**, Experimental and numerical studies of convection in a rapidly rotating spherical shell, *Journal of Fluid Mechanics*, **580**, 83-123, 2007.
- Gillet N., D. Brito, D. Jault and **H-C. Nataf**, Experimental and numerical studies of magnetoconvection in a rapidly rotating spherical shell, *Journal of Fluid Mechanics*, **580**, 123-143, 2007.
- Nataf H-C.**, T. Alboussière, D. Brito, P. Cardin, N. Gagnière, D. Jault, J-P. Masson and D. Schmitt, Experimental study of super-rotation in a magnetostrophic spherical Couette flow, *Geophysical and Astrophysical Fluid Dynamics*, **100**, 281-298, 2006.

- Nataf H-C.**, Dynamo and convection experiments, in *Earth's core and lower mantle* (Eds. C.A. Jones, A.M. Soward and K. Zhang), Taylor and Francis, pp 153-179, 2003.
- Cardin P., D. Brito, D. Jault, **H-C. Nataf** and J.-P. Masson, Towards a rapidly rotating liquid sodium dynamo experiment, *Magnetohydrodynamics*, **38**, 177-189, 2002.
- Brito D., **H-C. Nataf**, Ph. Cardin, J. Aubert and J-P Masson, Ultrasonic Doppler velocimetry in liquid gallium, *Experiments in Fluids*, **31**, 653-663, 2001.
- Aubert J., D. Brito, Ph. Cardin, **H-C. Nataf** and J-P. Masson, A systematic experimental study of rapidly rotating spherical convection in water and gallium, *Phys. Earth Planet. Inter.*, **128**, 51-74, 2001.
- Nataf H-C.**, Seismic imaging of mantle plumes, *Ann. Rev. Earth Planet. Sci.*, **28**, 391-417, 2000.
- Nataf H-C.**, Inner core takes another turn, (*news and views*), *Nature*, **405**, 411-412, 2000.
- Emery V., V. Maupin and **H-C. Nataf**, Scattering of S waves diffracted at the core-mantle boundary: forward modelling, *Geophys. J. Int.*, **139**, 325-344, 1999.
- Ji Ying and **H-C. Nataf**, Detection of mantle plumes in the lower mantle by diffraction tomography: Hawaii, *Earth Planet. Sci. Lett.*, **159**, 99-115, 1998.
- Ji Ying and **H-C. Nataf**, Detection of mantle plumes in the lower mantle by diffraction tomography: theory, *Earth Planet. Sci. Lett.*, **159**, 87-98, 1998.
- Nataf H-C.** and Y. Ricard, 3SMAC: an a priori tomographic model of the upper mantle based on geophysical modeling, *Phys. Earth Planet. Inter.*, **95**, 101-122, 1996.
- Ricard Y., **H-C. Nataf** and J-P. Montagner, The three-dimensional seismological model a priori constrained: confrontation with seismic data, *J. Geophys. Res.*, **101**, 8457-8472, 1996.
- Brito D., Ph. Cardin, **H-C. Nataf** and P. Olson, Experiments on Joule heating and the dissipation of energy in the Earth's core, *Geophys. J. Int.*, **127**, 339-347, 1996.
- Brito D., Ph. Cardin, **H-C. Nataf** and G. Marolleau, Experimental study of a geostrophic vortex of gallium in a transverse magnetic field, *Phys. Earth Planet. Inter.*, **91**, 77-98, 1995.
- Busse F., U. Christensen, R. Clever, L. Cserepes, C. Gable, E. Giannandrea, L. Guillou, G. Houseman, **H-C. Nataf**, M. Ogawa, M. Parmentier, C. Sotin and B. Travis, 3D convection at infinite Prandtl number in Cartesian geometry - a benchmark comparison, *Geophys. Astrophys. Fluid Dyn.*, **75**, 39-59, 1994.
- Nataf H-C.** and J. VanDecar, Seismological detection of a mantle plume?, *Nature*, **364**, 115-120, 1993.
- Houard S., **H-C. Nataf**, Laterally varying reflector at the top of D" beneath northern Siberia, *Geophys. J. Int.*, **115**, 168-182, 1993.
- Nataf H-C.**, S. Houard, Seismic discontinuity at the top of D": a world-wide feature?, *Geophys. Res. Lett.*, **20**, 2371-2374, 1993.
- Houard S., J-L. Plantet, J-P. Massot and **H-C. Nataf**, Amplitudes of core waves near the PKP caustic, from nuclear explosions in the South Pacific recorded at the L.D.G. network, in France, *Bull. Seis. Soc. Am.*, **83**, 1835-1854, 1993.
- Houard S. and **H-C. Nataf**, Further evidence for the 'Lay discontinuity' beneath northern Siberia and the North Atlantic from short-period P-waves recorded in France, *Phys. Earth Planet. Inter.*, **72**, 264-275, 1992.
- Nataf H-C.**, Mantle convection, plates, and hotspots, *Tectonophysics*, **187**, 361-371, 1991.
- Cardin Ph., **H-C. Nataf** and Ph. Dewost, Thermal coupling in layered convection: evidence for an interface viscosity control, from mechanical experiments and marginal stability analysis, *J. Phys. II*, **1**, 599-622, 1991.
- Cardin Ph. and **H-C. Nataf**, Non-linear dynamical coupling observed near the threshold of convection in a two-layer system, *Europhysics Lett.*, **14**, 655-660, 1991.
- Ansel V. and **H-C. Nataf**, Anisotropy beneath 9 stations of the Geoscope broadband network as deduced from shear-wave splitting, *Geophys. Res. Lett.*, **16**, 409-412, 1989.
- Montagner J.-P. and **H-C. Nataf**, Vectorial tomography - I. Theory, *Geophys. J.*, **94**, 295-307, 1988.
- Nataf H-C.**, S. Moreno and Ph. Cardin, What is responsible for thermal coupling in layered convection?, *J. Phys. France*, **49**, 1707-1714, 1988.
- Montagner J.-P. and **H-C. Nataf**, A simple method for inverting the azimuthal anisotropy of surface waves, *J. Geophys. Res.*, **91**, 511-520, 1986.
- Nataf H-C.**, I. Nakanishi and Don L. Anderson, Measurements of mantle wave velocities and inversion for lateral heterogeneities and anisotropy. 3. Inversion, *J. Geophys. Res.*, **91**, 7261-7307, 1986.
- Nataf H-C.**, I. Nakanishi and Don L. Anderson, Anisotropy and shear-velocity heterogeneities in the upper mantle, *Geophys. Res. Lett.*, **11**, 109-112, 1984.
- Nataf H-C.**, B.H. Hager and R.F. Scott, Convection experiments in a centrifuge and the generation of plumes in a very viscous fluid, *Annales Geophysicae*, **2**, 303-310, 1984.
- Richter F.M., **H-C. Nataf** and S.F. Daly, Heat transfer and horizontally averaged temperature of convection with large viscosity variations, *J. Fluid Mech.*, **129**, 173-192, 1983.
- Nataf H-C.** and F.M. Richter, Convection experiments in fluids with highly temperature dependent viscosity and the thermal evolution of the planets, *Phys. Earth Planet. Inter.*, **29**, 320-329, 1982.
- Richter F.M., S.F. Daly and **H-C. Nataf**, A parameterized model for the evolution of isotopic heterogeneities in a convecting system, *Earth Planet. Sci. Lett.*, **60**, 178-194, 1982.

Froidevaux C. and **H-C. Nataf**, Continental drift: what driving mechanism?, *Geologische Rundschau*, **70**, 166-176, 1981.

Nataf H-C., C. Froidevaux, J.-L. Levrat and M. Rabinowicz, Laboratory convection experiments: the effect of lateral cooling and generation of instabilities in the horizontal boundary layers, *J. Geophys. Res.*, **86**, 6143-6154, 1981.

Nataf H-C., T. Lay, Don L. Anderson and E.A. Okal, Reassessment of a reported S-delay under Trinidad, *Geophys. Res. Lett.*, **8**, 1027-1030, 1981.

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