Long LI

PhD in Applied Mathematics

Stochastic Modeling and Scientific Computing

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Profile

I am an applied mathematician working at the interface of stochastic modeling and scientific computing, with a primary focus on geophysical fluid dynamics. My research develops mathematically grounded and computationally efficient methods for the modeling and simulation of high-dimensional nonlinear systems under uncertainty.

Expertise and Interests: Stochastic Modeling; Uncertainty Quantification; Data Assimilation; Scientific Computing; Numerical Methods; Geophysical Fluid Dynamics; Turbulence

Experience

10/2025 – Present **CNRS Postdoctoral Researcher**, *Institut de Physique de Nice*, France
- Investigating intermittency in scalar turbulence driven by random flows
- Developing high-fidelity simulations to validate theoretical predictions
- Extending the framework to multifractal flows via Gaussian multiplicative chaos

04/2021 – 07/2025 **Inria Starting Research Positions (Research Fellow)**, *Centre Inria de l'Université de Rennes*, France
- Contributed to the European Research Council (ERC) project STUOD
- Developed stochastic and data-driven models for unresolved subgrid-scale processes
- Built GPU-accelerated and auto-differentiable solvers with efficient stochastic integrators
- Studied air-sea interactions and boundary-layer turbulence through stochastic approaches

10/2017 – 03/2021 **Doctoral Researcher**, *Institut de recherche mathématique de Rennes*, France
- PhD Thesis: *Stochastic modeling and numerical simulation of ocean dynamics*, supervised by Etienne Mémin and Werner Bauer
- Developed a hierarchy of geophysical models governed by stochastic PDEs
- Investigated uncertainty quantification and ensemble forecasting in ocean dynamics

01/2017 – 06/2017 **Research Intern**, *Laboratoire Jean Kuntzmann*, Grenoble, France
- Master's Thesis: *Global sensitivity analysis for a parametrized diffusion process*, supervised by Clémentine Prieur and Pierre Étoré
- Developed a novel uncertainty quantification method for stochastic differential equations by combining the Feynman-Kac formula with polynomial chaos expansion.

03/2016 – 06/2016 **Research Intern**, *Laboratoire Jean Kuntzmann*, Grenoble, France
- Project: Numerical methods for stochastic differential equations

Education

2017 – 2020 **PhD in Applied Mathematics**, *Université de Rennes I*, France

2015 – 2017 **Master's Degree in Applied Mathematics**, *Université Grenoble Alpes*, France

2012 – 2015 **Bachelor's Degree in Mathematics**, *Université Jean Monnet Saint-Étienne*, France

Supervision and Teaching

10/2021 – 04/2024 **Co-supervisor of PhD thesis (50%)**, *Francesco Tucciarone*, Computer Science, University of Rennes 1, France
- Thesis: *Stochastic parametrization of ocean models through high-resolution observations*
- Outcome: one journal article and three book chapters

04/2024 – 06/2024 **Co-supervisor of Master's internship (50%)**, *Antoine Guines*, Applied Mathematics, INSA Rouen, France
- Subject: *Numerical study of a stochastic ocean model in the Mediterranean configuration*
- Performed a detailed comparison between deterministic and stochastic simulations

03/2015 – 05/2015 **Undergraduate Tutor (30 hours)**, *Faculty of Sciences and Techniques*, Université Jean Monnet, France
- Led exercise sessions in Analysis and Algebra (first-year level)

Peer Reviewing

Journals Journal of Advances in Modeling Earth Systems (JAMES), Geoscientific Model Development (GMD), Frontiers in Marine Science (Physical Oceanography)

Book Chapters in Mathematics of Planet Earth (MPE)

Languages

Chinese Native

English Fluent (C1)

French Fluent (C1)

Computer Skills

Programming Python, Fortran, C/C++, PyTorch, Julia, Matlab, R

HPC OpenMP, MPI, CUDA

Tools Vim, Jupyter Notebook, Markdown, LaTeX, ParaView, NetCDF, XIOS

Systems Linux, macOS, Git, SVN, Docker, OAR, SLURM, shell/batch scripting

Selected Software Development

QGSW A PyTorch-based solver unifying quasi-geostrophic and shallow-water equations. It is GPU-accelerated, auto-differentiable, and designed for high-resolution and large-ensemble simulations with realistic configurations.

pyns2d A PyTorch-based solver for two-dimensional geophysical fluid dynamics, including barotropic quasi-geostrophic and surface quasi-geostrophic models. It provides a flexible platform for turbulence and transport studies.

QGCM-LU A stochastic extension of the q-gcm model for representing unresolved subgrid-scale processes in coupled ocean–atmosphere simulations. It also includes tools for coarse-graining and statistical analysis.

NEMO-LU A stochastic extension of the NEMO ocean model for improving the representation of unresolved processes in realistic large-scale simulations. It can be used for regional and global ocean forecasting studies.

SGESM A stochastic generalized Ekman–Stokes solver for one-dimensional upper-ocean boundary-layer simulations, designed for ensemble simulations and statistical analysis.

SCESM An extension of SGESM to coupled ocean–wave–atmosphere dynamics. It is designed to study uncertainty propagation and turbulent transport in coupled boundary-layer processes.

Publications

Journal Articles

[doi] [pdf] [code] Li, L., Mémin, E., Chapron, B. (2025). A generalized stochastic formulation of the Ekman-Stokes model with statistical analyses. Journal of Physical Oceanography, 55, 1389–1407.

[doi] [pdf] [code] Tucciarone, F., Li, L., Mémin, E., Chandramouli, P. (2025). Derivation and numerical assessment of a stochastic large-scale hydrostatic primitive model. Journal of Advances in Modeling Earth Systems, 17, e2024MS004783.

[doi] [pdf] [code] Clement, S., Blayo, E., Debreu, L., Brankart, J.-M., Brasseur, P., Li, L., Mémin, E. (2025). Link between stochastic grid perturbation and location uncertainty framework. Journal of Advances in Modeling Earth Systems, 17, e2024MS004528.

[doi] [pdf] [code] Thiry, L., Li, L., Mémin, E., Roullet, G. (2024). A unified formulation of quasi-geostrophic and shallow water equations via projection. Journal of Advances in Modeling Earth Systems, 16, e2024MS004510.

[doi] [pdf] [code] Thiry, L., Li, L., Roullet, G., Mémin, E. (2024). MQGeometry-1.0: a multi-layer quasi-geostrophic solver on non-rectangular geometries. Geoscientific Model Development, 17, 1749–1764.

[doi] [pdf] [code] Li, L., Deremble, B., Lahaye, N., Mémin, E. (2023). Stochastic data-driven parameterization of unresolved eddy effects in a baroclinic quasi-geostrophic model. Journal of Advances in Modeling Earth Systems, 15, e2022MS003297.

[doi] [pdf] [code] Brecht, R., Li, L., Bauer, W., Mémin, E. (2021). Rotating shallow water flow under location uncertainty with a structure-preserving discretization. Journal of Advances in Modeling Earth Systems, 13 (12), e2021MS002492.

[doi] [pdf] Bauer, W., Chandramouli, P., Chapron, B., Li, L., Mémin, E. (2020). Deciphering the role of small-scale inhomogeneity on geophysical flow structuration: a stochastic approach. Journal of Physical Oceanography 50, 983-1003.

[doi] [pdf] Bauer, W., Chandramouli, P., Li, L., Mémin, E. (2020). Stochastic representation of mesoscale eddy effects in coarse-resolution barotropic models. Ocean Modelling 151, 101646.

[doi] [pdf] [code] Resseguier, V., Li, L., Jouan, G., Derian, P., Mémin, E., Chapron, B. (2020). New trends in ensemble forecast strategy: uncertainty quantification for coarse-grid computational fluid dynamics. Archives of Computational Methods in Engineering, 1886-1784.

[doi] [pdf] Étoré, P., Prieur, C., Pham, D., Li, L. (2020). Global sensitivity analysis for models described by stochastic differential equations. Methodology and Computing in Applied Probability 22, 803-831.

Book Chapters

[doi] [pdf] [code] Li, L., Mémin, E., Chapron, B. (2026). A stochastic Ekman-Stokes model for coupled ocean-atmosphere-wave dynamics. Stochastic Transport in Upper Ocean Dynamics IV, Mathematics of Planet Earth, vol 15. Springer, 105-131.

[doi] [pdf] Tucciarone, F., Li, L., Mémin, E., Thiry, L. (2025). Transport noise defined from wavelet transform for model-based stochastic ocean models. Stochastic Transport in Upper Ocean Dynamics III, Mathematics of Planet Earth, vol 13. Springer, 287-303.

[doi] [pdf] [code] Mémin, E., Li, L., Lahaye, N., Tissot, G., and Chapron, B. (2024). Linear wave solutions of a stochastic shallow water model. Stochastic Transport in Upper Ocean Dynamics II, Mathematics of Planet Earth, vol 11. Springer, 223–245.

[doi] [pdf] Tucciarone, F., Mémin, E., Li, L. (2024). Data driven stochastic primitive equations with dynamic modes decomposition. Stochastic Transport in Upper Ocean Dynamics II, Mathematics of Planet Earth, vol 11. Springer, 321–336.

[doi] [pdf] Jamet, Q., Mémin, E., Dumas, F., Li, L., Garreau, P. (2024). Toward a stochastic parameterization for oceanic deep convection. Stochastic Transport in Upper Ocean Dynamics II, Mathematics of Planet Earth, vol 11. Springer, 143–157.

[doi] [pdf] [code] Li, L., Mémin, E., Tissot, G. (2023). Stochastic parameterization with dynamic mode decomposition. Stochastic Transport in Upper Ocean Dynamics, Mathematics of Planet Earth, vol 10. Springer, 179–193.

[doi] [pdf] [code] Thiry, L., Li, L., Mémin, E. (2023). Modified (hyper-)viscosity for coarse-resolution ocean models. In Stochastic Transport in Upper Ocean Dynamics, 273-285. Springer, Cham.

[doi] [pdf] Tucciarone, F., Mémin, E., Li, L. (2023). Primitive equations under location uncertainty: analytical description and model development. Stochastic Transport in Upper Ocean Dynamics, Mathematics of Planet Earth, vol 10. Springer, 287–300.

[doi] [pdf] Fiorini, C., Boulvard, P.-M., Li, L., Mémin, E. (2023). A Two-step numerical scheme in time for surface quasi-geostrophic equations under location uncertainty. Stochastic Transport in Upper Ocean Dynamics, Mathematics of Planet Earth, vol 10. Springer, 57–67.

Presentations

Invited Talks

[slides] Li, L. (Mar. 2025). Stochastic modeling in geophysical fluid dynamics. ANGE Project-Team Seminar, Sorbonne Université, Paris, France.

[slides] Li, L. (Oct. 2024). Stochastic modeling in geophysical fluid dynamics. CALISTO Project-Team Seminar, Centre Inria d'Université Côte d'Azur, Valbonne, France.

[slides] Li, L. (Sep. 2024). Stochastic modeling in geophysical fluid dynamics. Seminar at Research Center for Mathematics and Interdisciplinary Sciences, Shandong University, Qingdao, China.

[slides] Li, L. (Nov. 2022). Stochastic transport in an idealized ocean-atmosphere coupled model. AIRSEA Project-Team Seminar, Centre Inria de l'Université Grenoble Alpes, France.

Selected Talks

[slides] Li, L. (Juin 2026). Numerical study of passive scalar advection by turbulent random flows. Journées des GDRs "Mécanique des Fluides Géophysiques et Astrophysiques" et "Navier-Stokes 2.00", Toulouse, France.

[slides] Li, L. (Sep. 2025). Stochastic approaches to air–sea boundary layer dynamics. 6th STUOD Annual Workshop, ICMS The Bayes Centre, Edinburgh, UK.

[slides] Li, L. (Oct. 2024). A stochastic formulation of the Ekman-Stokes model. Atelier sur la représentation des fines échelles océaniques dans les simulations numériques, Ifremer, Plouzané, France.

[slides] Li, L. (Sep. 2024). A generalized stochastic formulation of the Ekman-Stokes model with statistical analyses. 5th STUOD Annual Workshop, Inria Rennes, France.

[slides] Li, L. (Sep. 2023). Uncertainty quantification of mesoscale air-sea interaction under transport noise. 4th STUOD Annual Workshop, Ifremer, Plouzané, France.

[slides] Li, L. (Sep. 2022). Stochastic transport in an idealized ocean-atmosphere coupled model. 3rd STUOD Annual Workshop, Imperial College London, UK.

[slides] Li, L. (May 2022). Stochastic transport in an idealized ocean-atmosphere coupled system. EGU General Assembly, Vienna, Austria.

[slides] Li, L. (Apr. 2021). Stochastic modeling of mesoscale eddies. EGU General Assembly.

[slides] Li, L. (Sep. 2019). Stochastic modeling of mesoscale eddies in oceanic dynamics. Workshop on Frontiers of Uncertainty Quantification in Fluid Dynamics, Pisa, Italy.

[slides] Li, L. (Apr. 2019). Oceanic dynamics under Location Uncertainty - Towards a consistent stochastic modeling. Workshop Conservation Principles, Data and Uncertainty in Atmosphere-Ocean Modeling, Potsdam, Germany.