

# Redouane Lguensat

Postdoc Researcher

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## Machine Learning for Physical Oceanography

### Research Interests

**Machine Learning, Computer Vision, Numerical Modeling, Data Assimilation, Remote Sensing**

### Current Position

Since 03/2020 **Postdoctoral Researcher**,  
Laboratory: LOCEAN/Sorbonne Université & LSCE/CEA Saclay  
Team: NEMO R&D; Science Advisor: Julie Deshayes and Venkatramani Balaji (Princeton Univ.)  
Funding: 2-yrs Postdoctoral Grant (Make Our Planet Great Again)

### PhD Thesis (10/2014 - 10/2017)

Topic **Learning from Ocean Remote Sensing data: from Analog methods to Deep Learning**  
Institution IMT Atlantique (ex Télécom Bretagne) /Université Bretagne Loire  
Supervisor Prof. Ronan Fablet  
Committee

- Prof. Sylvie Thiria - Université Paris VI (Chair)
- Prof. Antonio Turiel - Institut de Ciències del Mar, Spain (Reviewer)
- Prof. Marc Bocquet - Ecole des Ponts- ParisTech (Reviewer)
- Dr. Bertrand Chapron - Ifremer
- Dr. Pierre Ailliot - Université de Bretagne Occidentale
- Dr. Clément Ubelmann - CLS

### Professional Record

01 Dec 2019 – **Separation of wave/eddy processes from SSH measurements** *CNRS Postdoc researcher - MEOM team; IGE; Grenoble Alpes University, Grenoble, France*  
29 Feb 2020 Numerical Models, Deep Learning, Computational physics  
  
01 Dec 2017 – **Inversion of SWOT mission data using data-driven methods** *CNES funded Postdoc researcher - MEOM team; IGE; Grenoble Alpes University, Grenoble, France*  
30 Nov 2019 Numerical Models, Deep Learning, Computational physics  
  
01 Nov 2014 – **Data-driven interpolation of geophysical dynamics using analog methods** *PhD student - LabSTICC; IMT Atlantique; Bretagne-Loire University, Brest, France*  
31 Oct 2017 Stochastic filtering, Analog methods, Data Assimilation, Deep Learning

- Apr – May 2016 **Sea Altimetry Mapping using Analog Data Assimilation** *Visiting PhD student - Ocean University of China - MIT lab*, Qingdao, China  
Analog Hidden Markov Models, Sea Level Anomalies, Multi-Scale Reconstruction.
- Avr – Sep 2014 **Solving nonlinear non-convex inverse problems under sparsity constraints.** *Research intern - CEA Saclay - Cosmostat team*, Saclay, France  
Convex/non-convex optimization, Sparsity, Greedy algorithms, Proximal algorithms
- Jul – Aug 2013 **Study of electric vehicles charging strategies and their impact on the smart grid** *Research intern - IRISA - OCIF team*, Rennes, France  
Smart grid, Game theory, Reinforcement Learning.

## Awards and Grants

- Nvidia Graphics Processing Unit (GPU) card grant through the Nvidia Developer GPU grant program
- CNES Postdoctoral grant (2yrs) to conduct research at IGE Grenoble
- EURASIP Ranked second at the "3 min thesis" competition of EUSIPCO 2016 Budapest, submitted video can be seen here <https://youtu.be/bp6m0Xf7BJY>
- "Norman Miller's Prize" Best Student Poster at IEEE/MTS OCEANS'16 Conference in Shanghai, China
- "Morocco Science Award" 2016 Delivered by the "Moroccan Scientific Community", a science communication initiative run by a team of volunteers covering different areas of expertise. The prize was given for the category "3 min thesis"

## Education

- 2014–2017 **Doctor of Philosophy (PhD) in Computer Vision.** *IMT Atlantique*, Brest, France  
[www.imt-atlantique.fr](http://www.imt-atlantique.fr) (formerly known as Telecom Bretagne) / Thesis supervisor: Prof. Ronan Fablet
- 2011–2014 **Engineer's degree, major: Image Processing and Remote Sensing.** *IMT Atlantique*, Brest, France
- 2013–2014 **Research master degree "Sciences, Technologies, Santé", SISEA, major: Image Processing.** *Université de Rennes I*, Rennes, France
- 2011–2012 **Bachelor's degree: Mathematics.** *Université de Bretagne Occidentale*, Brest, France
- 2009–2011 **Preparatory classes for French "Grandes Ecoles"** *CPGE Mohamed V*, Casablanca, Morocco, *MPSI/MP\**

## Publications (H-index: 8; >200 citations; source Google Scholar)

Review paper

Submitted

- M. Sonnewald, **R. Lguensat**, Jones, D. C., Dueben, P. D., Brajard, J., and Balaji, V. (2021). "Bridging observation, theory and numerical simulation of the ocean using Machine Learning", submitted to Environmental Research Letters

Journal papers

Submitted

- M. Sonnewald and **R. Lguensat**. "Revealing mechanisms of change in the Atlantic Meridional Overturning Circulation under global heating", submitted to JAMES.  
Accepted
- H. Frezat, G. Balarac, J. Le Sommer, R. Fablet, **R. Lguensat**. "Physical invariance in neural networks for subgrid-scale scalar flux modeling" *Physical Review Fluids*. ((JCR, IF 2.51))
- X. Sun, M. Zhang, J. Dong, **R. Lguensat**, Y. Yang, X. Lu. "A Deep Framework for Eddy Detection and Tracking From Satellite Sea Surface Height Data" *IEEE Transactions in Geoscience and Remote Sensing*, 2020. ((JCR, IF 5.85)).
- **R. Lguensat**, Viet, P. H., Sun, M., Chen, G., Fenglin, T., Chapron, B., and Fablet, R. "Data-driven Interpolation of Sea Level Anomalies using Analog Data Assimilation." *Remote Sensing*, 2019. ((JCR, IF 4.50))
- **R. Lguensat**, P. Tandeo, P. Aillot, M. Pulido and R. Fablet, "The Analog Data Assimilation" *Monthly Weather Review*, 2017. ((JCR, IF 3.43))
- R. Fablet, P. Viet, **R. Lguensat**, P-H Horrein and B. Chapron, "Spatio-Temporal Interpolation of Cloudy SST Fields Using Conditional Analog Data Assimilation" *Remote Sensing*, 2018. ((JCR, IF 4.50))
- R. Fablet, P. Viet, and **R. Lguensat**. "Data-driven Methods for Spatio-Temporal Interpolation of Sea Surface Temperature Images". *IEEE Transactions on Computational Imaging*, 2017. ((JCR, IF 4.01))
- Y. Yang, J. Dong, X. Sun, **R. Lguensat**, M. Jian, X. Wang. "Ocean Front Detection from Instant Remote Sensing SST Images". *IEEE Geoscience and Remote Sensing Letters*, 2016 ((JCR, IF 3.83))

#### Conference papers

- Submitted
- ...
- Accepted
- **R. Lguensat**, R. Fablet, J. Le Sommer, S. Metref, E. Cosme. K. Ouenniche, L. Drumetz, J. Gula. "Filtering Internal Tides From Wide-Swath Altimeter Data Using Convolutional Neural Networks". IGARSS 2020: IEEE International Conference on Geoscience and Remote Sensing, Hawaii, USA.
- **R. Lguensat**, W. Jones, A. Charantonis, D. Watson-Parris. "The 2020 Climate Informatics Hackathon: Generating Nighttime Satellite Imagery from Infrared Observations". Climate Informatics Conference 2020, Oxford, UK.
- Harder et al. "NightVision: Generating Nighttime Satellite Imagery from Infra-Red Observations" Climate Change AI workshop, NeurIPS 2020. Vancouver, Canada.
- **R. Lguensat**, J. Le Sommer, R. Fablet, S. Metref, E. Cosme. "Learning Generalized Quasi-Geostrophic Models Using Deep Neural Numerical Models" Machine Learning and the Physical Sciences workshop, NeurIPS 2019. Vancouver, Canada.
- H. Chergui, K. Tourki, **R. Lguensat**, M. Benjillali, C. Verikoukis, M. Debbah, "Classification Algorithms for Semi-Blind Uplink/Downlink Decoupling in sub-6 GHz/mmWave 5G Networks." IWCMC19: International Wireless Communications and Mobile Computing Conference. Tangier, Morocco.
- **R. Lguensat**, M. Sun, R. Fablet, E. Mason, P. Tandeo, G. Chen. "EddyNet: A deep neural network for the detection and classification of ocean eddies" IGARSS 2018: IEEE International Conference on Geoscience and Remote Sensing. Valencia, Spain.
- R. Fablet, P. Viet, and **R. Lguensat**. "Data-driven assimilation of irregularly-sampled image time series" ICIP 2017: IEEE International Conference on Image Processing, Beijing, China.

- **R. Lguensat**, M. Sun, G. Chen, T. Lin, R. Fablet, Spatio-Temporal Interpolation of Altimeter-Derived SSH Fields Using Analog Data Assimilation: A Case-Study In The South China Sea. IGARSS 2017 : IEEE International Geoscience and Remote Sensing Symposium, Fort Worth, Texas, USA.
- **R. Lguensat**, R. Fablet, P. Ailliot and P. Tandeo, An Exemplar-based HMM framework for nonlinear state-space models. EUSIPCO 2016 : IEEE European Signal Processing Conference, Budapest, Hungary.
- **R. Lguensat**, P. Tandeo, P. Ailliot, B. Chaperon and R. Fablet, Using archived datasets for missing data interpolation in ocean remote sensing observation series, MTS/IEEE OCEANS'16, Shanghai, China.
- R. Fablet, P. Viet, **R. Lguensat** and B. Chapron, Exploiting ocean observation and simulation big data to improve satellite-derived geophysical products: Analog strategies. BiDS'17: Big Data from Space Conference. Toulouse, France.
- P. Tandeo, P. Ailliot, B. Chapron, **R. Lguensat** and R. Fablet, The analog data assimilation: application to 20 years of altimetric data, Climate Informatics 2015, Boulder, Colorado.
- **R. Lguensat**, P. Tandeo, R. Fablet and P. Ailliot, Non-parametric Ensemble Kalman methods for the inpainting of noisy dynamic textures. ICIP 2015 : IEEE International Conference on Image Processing, Quebec City, Canada.
- **R. Lguensat**, P. Tandeo, R. Fablet and R. Garelo, Spatio-temporal interpolation of Sea Surface Temperature using high resolution remote sensing data, OCEANS'14, St. John's, Canada.
- S. Dimitrov, **R. Lguensat**, Reinforcement Learning Based Algorithm for the Maximization of EV Charging Station Revenue, Mathematics and Computers in Sciences and Industry (MCSI 2014), Varna, Bulgaria.

#### PhD thesis

- **R. Lguensat**, Learning from Ocean Remote Sensing Data. PhD dissertation, IMT Atlantique/Univ. Bretagne Loire, 2017.

#### Master thesis

- **R. Lguensat**, Nonlinear optimization under sparsity constraints: Algorithms for solving nonlinear inverse problems. Master SISEA, Universite de Rennes I, 2014.

#### Technical Reports

- S. Rjiba, **R. Lguensat**, E. Mason, R. Fablet and J. Le Sommer. "Convolutional Neural Networks for the Segmentation of Oceanic Eddies from Altimetric Maps", 2018.

## Invited conferences and workshop talks

- Virtual seminar: "History Matching for the tuning of climate models", AI4ES seminars, Barcelona Computing Center, Feb 2021.
- Invited talk: "Physical Oceanography meets Deep Learning"; Data Science for the future, a workshop of Global Science Week 2019, Grenoble, France.
- Talk on "Hybrid ocean numerical models: Physics + Deep Learning" at AI4Climate seminar, LOCEAN lab, March 2019, Paris, France.
- Talk on "Quasi-geostrophy driven Deep learning" at the LEFE/MANU AI & Ocean Atmosphere workshop, February 2019, Rennes, France.
- Talk on "EddyNet: a deep neural network for the detection and classification of oceanic eddies" at

Gdr-ISIS/CNES TSI joint meeting, October 2018, Paris, France.

- Talk on "Delving Deep in the ocean with Deep Learning" at Grenoble Data Club, March 2018, Grenoble, France.
- Talk on "Analog Data Assimilation" at Stochastic Weather Generators (SWGGEN), 17 May 2016, Vannes, France.
- Talk on the use of historical datasets in geophysics at a joint Seminar between the MIT Lab and Vision Lab of Ocean University of China, 19 April 2016, Qingdao, China.

## Teaching/Supervision

### French "Qualification MdC" 2018, Section 61

- (Since 2020) Master Data Engineering EHTP (Morocco): 4h introduction to deep neural networks + 1h30 tutorial. Materials can be found here: [https://github.com/redouanelg/TeachingMaterials/tree/master/EHTP\\_DataEng](https://github.com/redouanelg/TeachingMaterials/tree/master/EHTP_DataEng)
- (2015-2016) IMT Atlantique: 64h of supervised work/exercise class on Statistics, Probability, Digital communication theory, Image and signal processing.
- Supervision of several Master students:
  - IMT Atlantique: Hamza Ameer (2015), Mael Bompais (2016), Phi Hyunh Viet (2016), Mohamed Fannane (2017), Saifeddine Rjiba (2018)
  - Univ Grenoble Alpes: Audrey Monsimer (2019), Mickael Lalande (2019)
  - Sorbonne University: Homer Durand (2021)

## Spoken languages

Arabic-Amazigh Native speaker  
English Fluent

French Fluent  
Chinese A2 level

## Participation to scientific societies, conference committees and reviewing activities.

Workshop  
organisation

- **Co-convener** at vEGU21. Session: "Machine learning for Earth System modelling"
- **Co-convener** at AGU'2020 fall meeting. Session: "Innovation and Exploration in Observed and Model Oceanographic Data Using Interpretable Machine Learning"
- **Data Challenge chair** at Climate Informatics'2020 <https://ci2020.web.ox.ac.uk/organizing-committee>
- **Co-convener** at EGU'20. Session: "Machine learning for Earth System modelling"
- **Data Challenge chair** at Climate Informatics'19 <https://sites.google.com/view/climateinformatics2019>
- **General chair** of the *IndabaXMorocco* 2019, a scientific workshop for Artificial Intelligence in Morocco <https://indabaXMorocco.github.io>.
- Member of the organization committee of *Data Science & Environment 2017*: IMT Atlantique, international workshop, <http://conferences.telecom-bretagne.eu/dse2017/committees/>
- Organizer of PhD students day 2015: IMT Atlantique, Signal & Communications department, <http://conferences.telecom-bretagne.eu/jdsc15>

Scientific  
societies

- *EURASIP* member since 2016
- *IEEE* member since 2014
- *EGU* member since 2018
- *AGU* member since 2020
- Member in several French scientific societies: Gdr-Isis, SSFAM, etc..

Journal Club

- Organizer of the AI4Climate journal club since 2020

Reviewing  
activities

- Journals: Geophysical Research Letters, IEEE JSTARS, Proceedings A, Remote Sensing of the Environment, Journal of Atmospheric and Oceanic Technology, Mathematical Problems in Engineering, IEEE Transactions on Geoscience and Remote Sensing, Earth Space Science, Frontiers in Marine Science
- Conferences: Earthvision 2021, Climate Informatics'20/'19, AI4EarthScience 2020, IndabaXMorocco'19