

# DR. SHASHANK KUMAR ROY

Postdoctoral Researcher, Lab-STICC

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**Research interests** General state estimation and prediction problems in geosciences, Machine Learning, Deep learning for Data Assimilation, Weather and Climate modelling, Sequential state estimation, Physics-based Modelling and Simulation, Bayesian data assimilation, Gaussian processes, Markov chain Monte-Carlo methods, Generative modelling for probability distributions, Optimal transport applications, Dynamical systems, Data Science.

**Publications**

- [1] **4DVarNet-LU: An end-to-end Generative Model for Neural Data Assimilation**, Shashank K. Roy, Ronan Fablet. *In Preparation*
- [2] **Spatiotemporal Coherent Displacements for Ensemble-Based Neural Data Assimilation**, Shashank K. Roy, Ronan Fablet. *Submitted to Climate Informatics 2026*
- [3] **A note on the sensitivity of Lyapunov Vectors to trajectory perturbations**, Shashank Kumar Roy, Amit Apte. *Accepted(In Press), NPG, 2025. doi.org/10.5194/egusphere-2023-2168*
- [4] **Probing robustness of nonlinear filter stability numerically using Sinkhorn divergence** Pinak Mandal, Shashank Kumar Roy, Amit Apte, *Physica D*, 2022, *doi.org/10.1016/j.physd.2023.133765*.
- [5] **Stability of nonlinear filters - numerical explorations of particle and ensemble Kalman filters** Pinak Mandal, Shashank Kumar Roy, Amit Apte, *2021 Seventh Indian Control Conference (ICC), Mumbai, India, 2021, pp. 307-312, doi: 10.1109/ICC54714.2021.9703185*.

**Education**

<b>PhD, Physics, International Center for Theoretical Sciences</b>	Bangalore, India
Advisors: Prof. Amit Apte and Prof. Samriddhi Sankar Ray	July 2020 – Jan 2025
Title: A study of dynamical instability and filter stability using the ensemble Kalman filter. PhD awarded, Jan 2025.	
<b>International Center for Theoretical Sciences</b>	Bangalore, India
Masters in Physics, <i>GPA: 7/10</i>	July 2017 – December 2020
Mentors: Prof. Amit Apte, Prof R. Loganayagam	
<b>University of Delhi</b>	New Delhi, India
Bachelors in Physics (Honours) <i>Percentage: 87 %</i>	July 2014 – July 2017

**Seminar/ Conf. Presentations**

- Performance Gains and Advantages of 4DVarNet in End-to-End Learning for Data Assimilation** Shashank Kumar Roy, Ronan Fablet, *EGU General Assembly 2025, Vienna, Austria, 27 Apr–2 May 2025, EGU25-4300, doi.org/10.5194/egusphere-egu25-4300*.
- Automatic differentiation for 4DVar data assimilation with single layer quasi-geostrophic dynamics** Space Application Center, India Space Research Organisation (ISRO) Ahmedabad, India

## Projects

**Workshop lecture: AI for Data Assimilation - 4DVar & 4DVarNet for Ocean dataset,**  
National Atmospheric Research Laboratory, Department of Space, GOI. Tirupati, India.  
**4DVarNet: A neural network model for data assimilation** Seminar, Department of Data Science, IISER Pune. India

**Tutorial on 4DVarNet: A neural data assimilation framework**, BIRS-CMI Mathematical and computational foundations of climate modelling, Chennai Mathematical Institute. India

**4DVarNet-LU: An end-to-end trainable ensemble model for data assimilation.** Oceanix, Lab-STICC, IMT Atlantique

Generates an ensemble of reconstructions based on a positional-uncertainty model based on using Gaussian random fields, given a sequence of observations Aug – Jan 2026

**Neural-ODE approach to weak-4DVar with sparse and noisy pseudo-altimetry observations** , Oceanix, Lab-STICC, IMT Atlantique

Solving a 4DVar optimisation problem for quasi-geostrophic model and LBFGS, SGD, etc. as optimisers leveraing automatic-differentiation in PyTorch. August – Dec 2019

**Sequential filtering algorithm for high-dimensional chaotic system with partial and noisy observation** , Mentor: Prof. Amit Apte, Semester Project, ICTS August – Dec 2019  
Implementing ensemble kalman filter for Lorenz-96 ode to compute conditional distribution.

**Cytoplasmic streaming driven by Surface flows using Vector Spherical Harmonics**

Mentor: Prof Vijay Kumar Krishnamurthy, Biophysics Group at ICTS  
Analytical solution of Stokes equation for spherical geometry for bulk flow inside a sphere driven by a surface flow May – August 2018

**An Interdisciplinary Study of Light Pollution in Indian Context (Extension)**

Late Dr.N.Rathnasree, Ex-Director, Nehru Planetarium) and Dr Ashok Kumar, Department of Physics, Ramjas College .  
University of Delhi under Innovation Project Scheme 2015-2016 (RC302) Oct 2015 – Nov 2016

## Academic Visits

**Prof. David Greenberg's Lab, Hereon Zentrum** Hamburg, Germany. Jan 2024 – Feb 2024

**University de Grenoble, Host: Dr. Julien Lessomer** Grenoble, France

**Department of Data Science, IISER Pune, Host: Prof. Amit Apte** Pune, India

## Teaching experience

**Teaching assistant, Computational Tools for Climate Science, Climatematch Academy, US** A course on climate data analysis and modelling for understanding and answering questions through coding in python and jupyter notebook. My role as a teaching assistant was to initiate discussions, motivate questions and guide students though the coding exercises. July 2023

**Teaching assistant, Department of Data Science, IISER Pune, India, DS4233: Time Series** Course on basic time series analysis and modelling. Curating Jupyter notebooks for demonstrations and taking tutorial sessions. Jan-April 2023

**Advanced Physics Subject Matter Expert (Chegg.com)** July 2020- July 2021  
Freelance Tutor for solving university level doubts and problems for students.

<b>Licences and Certifications</b>	<b>NVIDIA</b> , Deep Learning Institute [1] Applications of AI for Anomaly Detection [2] Accelerating Data Engineering Pinelines [3] Fundamentals of Deep Learning <b>IBM</b> , Qiskit [1] Quantum Computation -Certified Associate Developer [2] IBM Quantum Challenge 2021 Achievement - Advanced <b>Neuromatch Academy</b> - Deeplearning Course and Project <a href="#">view</a> <b>Imperial College London</b> -Online course on Data Assimilation <a href="#">view</a>	Summer 2022 Issued on July 2022 Issued on Feb 2022 Issued on Feb 2022 Januray 2022 June 2021 August 2021 11-15 July 2022
<b>Achievements</b>	Secured 10th best score in IBM Quantum Challenge Department of Atomic Energy Fellowship for pursuing PhD in Physics Joint Entrance Screening Test AIR-95, Percentile-98.8 and IIT-JAM 2017, AIR-259 Awarded ISC-2014 School Topper in Science, 3rd at district level, Senior Secondary Exam 2014	2021 2019 2017
<b>Conferences and Workshops</b>	<b>Conference on Nonlinear Systems and Dynamics 2022, IISER Pune, India</b> , Presented a poster titled, "Reconstructing Covariant Lyapunov Vectors using Nonlinear Filtering" Dec 2022 <b>ECMWF-ESA Machine Learning for Earth Observation and Prediction</b> 14-17 Nov 2022 Workshop on machine learning and data assimilation on using earth observations data. <b>Qiskit Global Summer School on Quantum Machine Learning, IBM</b> July-August 2021 Summer School focusing on quantum machine learning formalisms and algorithms with hands-on experiemnts via IBM-Quantum lab. <b>ICTS Workshop on Climate Studies</b> July-Aug 2021 Talks and lectures on climate modeling, topics relevant to climate change and related policies. <b>Indo-US Workshop on Recent Advances in AI ML for Climate Sciences</b> Nov 13-15 2021 Technology Innovation Hub, Indian Statistical Institute, Kolkata and IEEE GRSS Kolkata Chapter, on the problems and applications in climate data science <b>Meta- Heuristic Optimization, Machine Learning and AI-Workshop</b> March 8-12 2021 Talks and tutorials organized by SAMSI, on the theory and practical applications of metaheuristic optimization methods in statistics such as swarm and evolutionary algorithms. <b>Numerical Analysis in Data Science Workshop</b> August 26-27 2021 Workshop on inverse problems and uncertainty quantification, sensitivity analysis, Reinforcement Learning and dimension Reduction in time series. <b>The Fields Institute Second Symposium on Machine Learning and Dynamical Systems</b> September 2020 On the intersection of machine learning and dynamical systems theory to solve problems in representation leanring, analysis and prediction.	
<b>Technical Skills</b>	<b>Programming languages and frameworks</b> Pytorch, Python, Xarray, Pandas, Numpy, Scipy, Jax Familiar with C++, Fortran <b>Languages</b> English (advanced), Hindi (fluent)	