

# So Takao

Postdoctoral Research Scholar

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## EDUCATION

### PhD in Applied Mathematics

Imperial College London  
2016 - 2020

### MSc in Applied Mathematics (Pass with Distinction, 87/100)

Imperial College London  
2015 - 2016

### BSc in Mathematics (First class honour, 81/100)

Imperial College London  
2012 - 2015



## CAREER PROFILE

So Takao is a postdoctoral scholar at the California Institute of Technology, working on the intersection of machine learning and data assimilation. His interests involve (1) developing efficient inference techniques for probabilistic models such as Gaussian processes and stochastic partial differential equations, (2) developing machine learning models with physical, geometric or topological inductive biases, and (3) applying machine learning techniques to problems in weather or climate science. During 2021-2023, he was a Senior Research Fellow in Machine Learning for Climate Science at the UCL Sustainability and Machine Learning group. There, he lead the Met Office Academic Partnership workgroup on “Data science methodology for weather and climate” and initiated various collaborations across departments to work on problems related to climate change. He received his PhD in 2020 from the Department of Mathematics at Imperial College London, where he wrote his thesis on structure-preserving fluid models and MCMC techniques on Lie groups, advised by Prof. Darryl Holm.



## EXPERIENCES

### Postdoctoral Scholar Research Associate

California Institute of Technology

2024 - Present

- Principle investigator: Prof. Andrew Stuart
- Working on various projects involving Gaussian processes, data assimilation, uncertainty quantification and operator learning.

### Research Fellow in Machine Learning for Climate Science

University College London

2021 - 2023

- Principle investigator: Prof. Marc Deisenroth
- Worked on various projects to develop novel data assimilation algorithms using ideas from message passing, Gaussian markov random fields, stochastic (partial) differential equations, differential geometry and algebraic topology.
- Collaborated with the UCL Earth Science Department on various projects on sea-ice modelling.
- Supervised several BSc and MSc students.
- Lead the Met Office Academic Partnership workgroup on “Data science methodology for weather and

## PREPRINTS AND PUBLICATIONS

### Preprints

- Semimartingale driven mechanics and reduction by symmetry for stochastic and dissipative dynamical systems  
*Oliver Street, So Takao*  
arXiv:2312.09769 (2023)
- A geometric extension of the Itô-Wentzell and Kunita's Formulas  
*Aythami Bethencourt de León, So Takao*  
arXiv:2311.04439 (2023)
- Gaussian processes on cellular complexes  
*Mathieu Alain, So Takao, Brooks Paige, Marc Deisenroth*  
arXiv:2311.01198 (2023)
- Transport noise restores uniqueness and prevents blow-up in geometric transport equations  
*Aythami Bethencourt de León, So Takao*  
arXiv:2211.14695 (2022)
- A unifying and canonical description of measure-preserving diffusions  
*Alessandro Barp, So Takao, Michael Bethencourt, Alexis Arnaudon, Mark Girolami*  
arXiv:2105.02845 (2021)

### Publications

- Actually sparse variational Gaussian processes  
*Harry Jake Cunningham, Daniel Augusto de Souza, So Takao, Mark van der Wilk, Marc Deisenroth*  
International Conference on Artificial Intelligence and Statistics (2023)
- Iterative state estimation in non-linear dynamical systems using approximate expectation propagation  
*Sanket Kamthe, So Takao, Shakir Mohamed, Marc Deisenroth*  
Transactions on Machine Learning Research (2022)
- Vector-valued Gaussian processes on Riemannian manifolds via gauge-equivariant projected kernels  
*Michael Hutchinson, Alexander Terenin, Viacheslav Borovitskiy, So Takao, Yee Whye Teh, Marc Deisenroth*  
Neural Information Processing Systems (2021)
- Irreversible Langevin MCMC on Lie Groups  
*Alexis Arnaudon, Alessandro Barp, So Takao*  
Geometric Science of Information (2019)
- Modelling the climate and weather of a 2D Lagrangian-averaged Euler-Boussinesq equation with transport noise  
*Diego Alonso-Orán, Aythami Bethencourt de León, Darryl Holm, So Takao*  
Journal of Statistical Physics (2019)
- Implications of Kunita-Itô-Wentzell formula for k-forms in stochastic fluid dynamics  
*Aythami Bethencourt de León, Darryl Holm, Erwin Luesink, So Takao*  
Journal of Nonlinear Science (2019)
- The Burgers' equation with stochastic transport: shock formation, local and global existence of smooth solutions  
*Diego Alonso-Orán, Aythami Bethencourt de León, So Takao*  
Nonlinear Differential Equations and Applications (2019)
- Impacts of atmospheric reanalysis uncertainty on Atlantic Overturning Estimates at 25°N  
*Helen R. Pillar, Helen L. Johnson, David P. Marshall, Patrick Heimbach, So Takao*  
Journal of Climate (2018)
- Networks of Coadjoint Orbits: from geometric to statistical mechanics  
*Alexis Arnaudon, So Takao*  
Journal of Geometric Mechanics (2018)

### Workshop papers

- Short-term prediction and filtering of solar power using state-space Gaussian processes

*Sean Nassimiha, Peter Dudfield, Jack Kelly, Marc Deisenroth, So Takao*

NeurIPS workshop on Tackling Climate Change with Machine Learning (2022)

- Actually sparse variational Gaussian processes

*Jake Cunningham, So Takao, Mark van der Wilk, Marc Deisenroth*

NerIPS workshop on Gaussian Processes, Spatiotemporal Modelling, and Decision-Making Systems (2022)



## OSS CONTRIBUTIONS

Below is a list of open source softwares that I have been involved in developing:

**GPSat** - Python package to interpolate nonstationary geospatial fields from observation data using local Gaussian process models

**EPyStateEstimator** - Iterative state estimation in non-linear dynamical systems using approximate expectation propagation

**ExtrinsicGaugeIndependentVectorGPs** - A library implementing the kernels for and experiments using extrinsic gauge equivariant vector field Gaussian Processes