

Intelligent Earth

UKRI AI Centre for Doctoral Training in AI for the Environment

Open Day

Department of Physics

30/11/2023

Philip Stier (Physics), Hannah Christensen (Physics), Laura Stevens (Earth Sciences),
Louise Slater (Geography), Adrian Thomas (Biology), Yee Whye Teh (Statistics),
Stephen Roberts (Engineering), Andrew Markham (Computer Science)
Sophie Nixey (Intelligent Earth)



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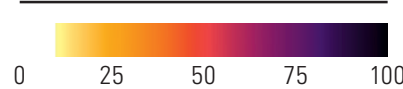
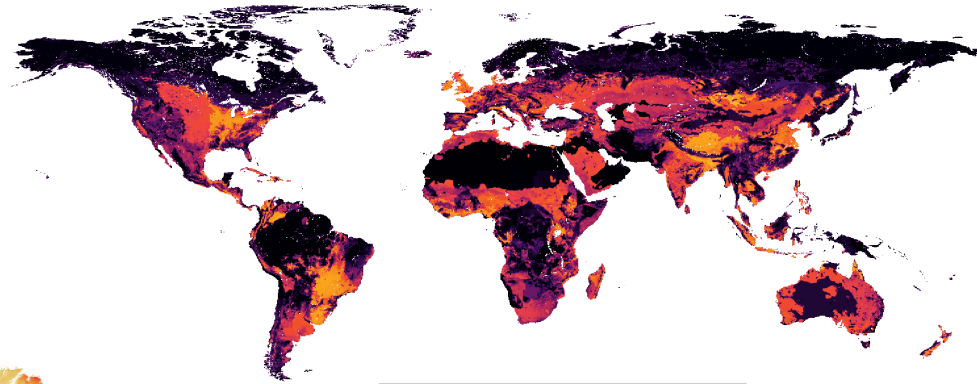


Earth is facing existential environmental challenges

Biodiversity loss

Natural hazards

Climate change



Biodiversity intactness index [%] (Natural History Museum, 2022)

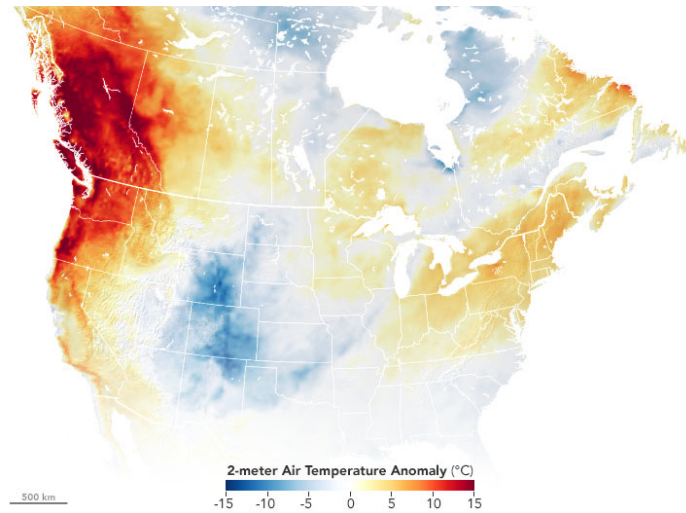


Floods in Germany causing 200 deaths in July 2021 (Science)

Air pollution



Air pollution kills an estimated seven million people worldwide every year (WHO)

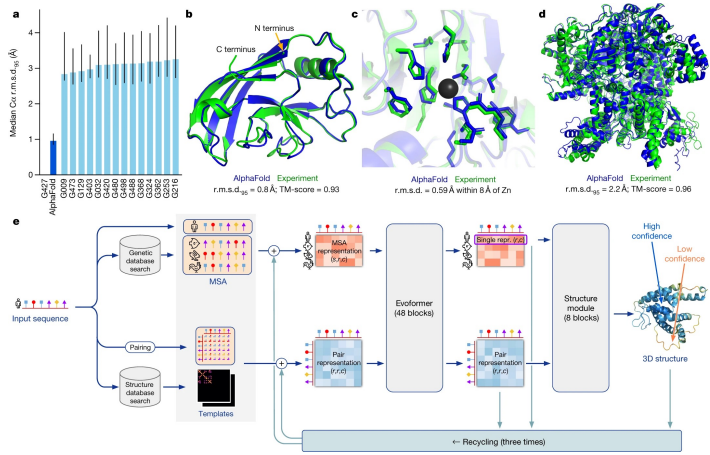


NASA Earth Observatory temperature anomalies on 27/06/2021

AI/ML are transforming sciences

AlphaFold

Weather prediction



Jumper et al., Nature, (2021)

Exoplanet Detection

A ubiquitous unifying degeneracy in two-body microlensing systems

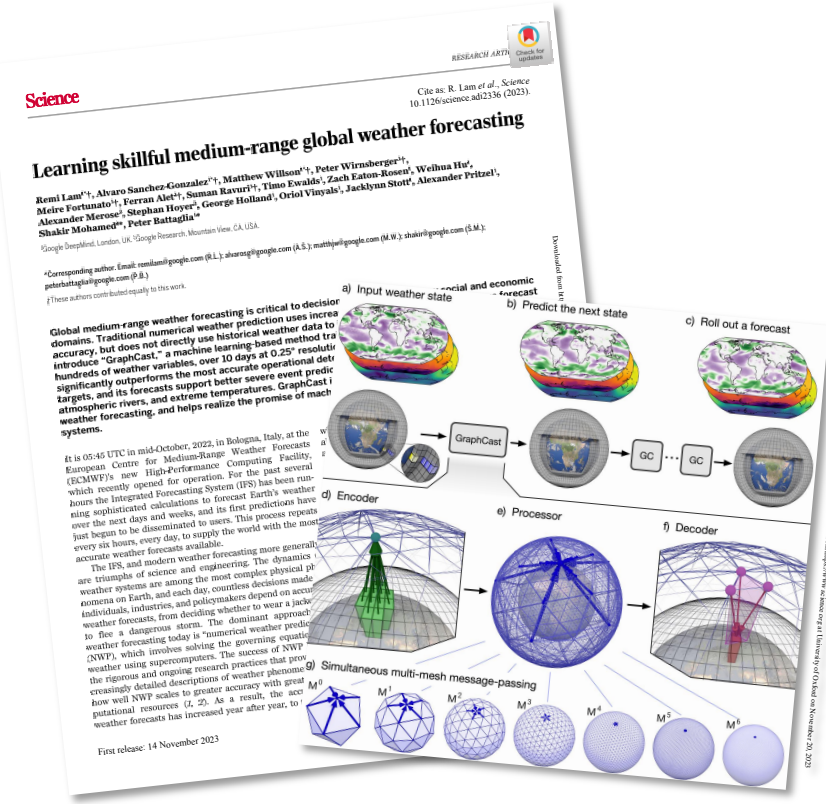
Keming Zhang^{1,2}, B. Scott Gaudi^{1,2} and Joshua S. Bloom¹

While gravitational microlensing by planetary systems¹ provides unique views on the properties of exoplanets, observations of a given two-body microlensing event can often be interpreted with multiple distinct physical configurations. Such ambiguities are typically attributed to microlensing and inner-orbit geometry, which are not directly measurable. However, there remains an unexplored degeneracy in off-axis microlensing events, which contains a magnification-independent reference frame², we present the discovery of the off-axis degeneracy, which unifies the close-wide and inner-orbit degeneracies, not only appears ubiquitous in microlensing events, but also reveals a new topology and, upon resolution, also reveals a new degeneracy. Our analysis demonstrates that degeneracies that are not strictly resolved by observations are related by simple common geometric configurations. Moreover, it is shown that in off-axis microlensing events, the existence of a deeper symmetry in the configuration space of the event is suggested. This suggests the existence of a deeper symmetry in the configuration space of the event.

We search for new types of microlensing degeneracy, by analyzing the parameter distribution of a large number of simulated microlensing events that exhibit nontrivial solutions. With our planetary microlensing events observed so far, the degeneracies have not been systematically found in nature. Our analysis has indicated that the degeneracies have an alternative interpretation, such as an inner-orbit degeneracy, which is not directly measurable. Our analysis demonstrates that degeneracies that are not strictly resolved by observations are related by simple common geometric configurations. Moreover, it is shown that in off-axis microlensing events, the existence of a deeper symmetry in the configuration space of the event is suggested. This suggests the existence of a deeper symmetry in the configuration space of the event.

Department of Astronomy, University of California, Berkeley, CA, USA. Department of Astronomy, The Ohio State University, Columbus, OH, USA. The email: kemingzhang@berkeley.edu

Zhang et al., Nat. Astron., (2022)



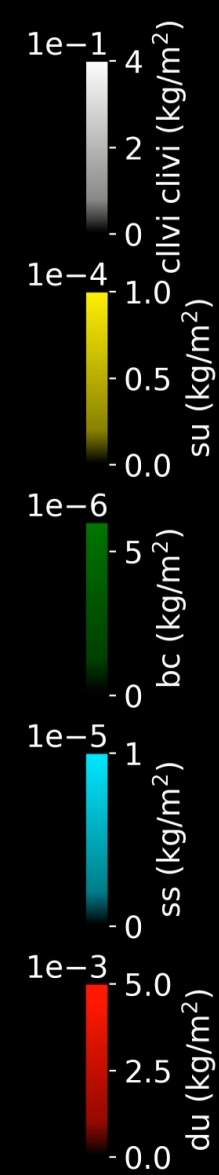
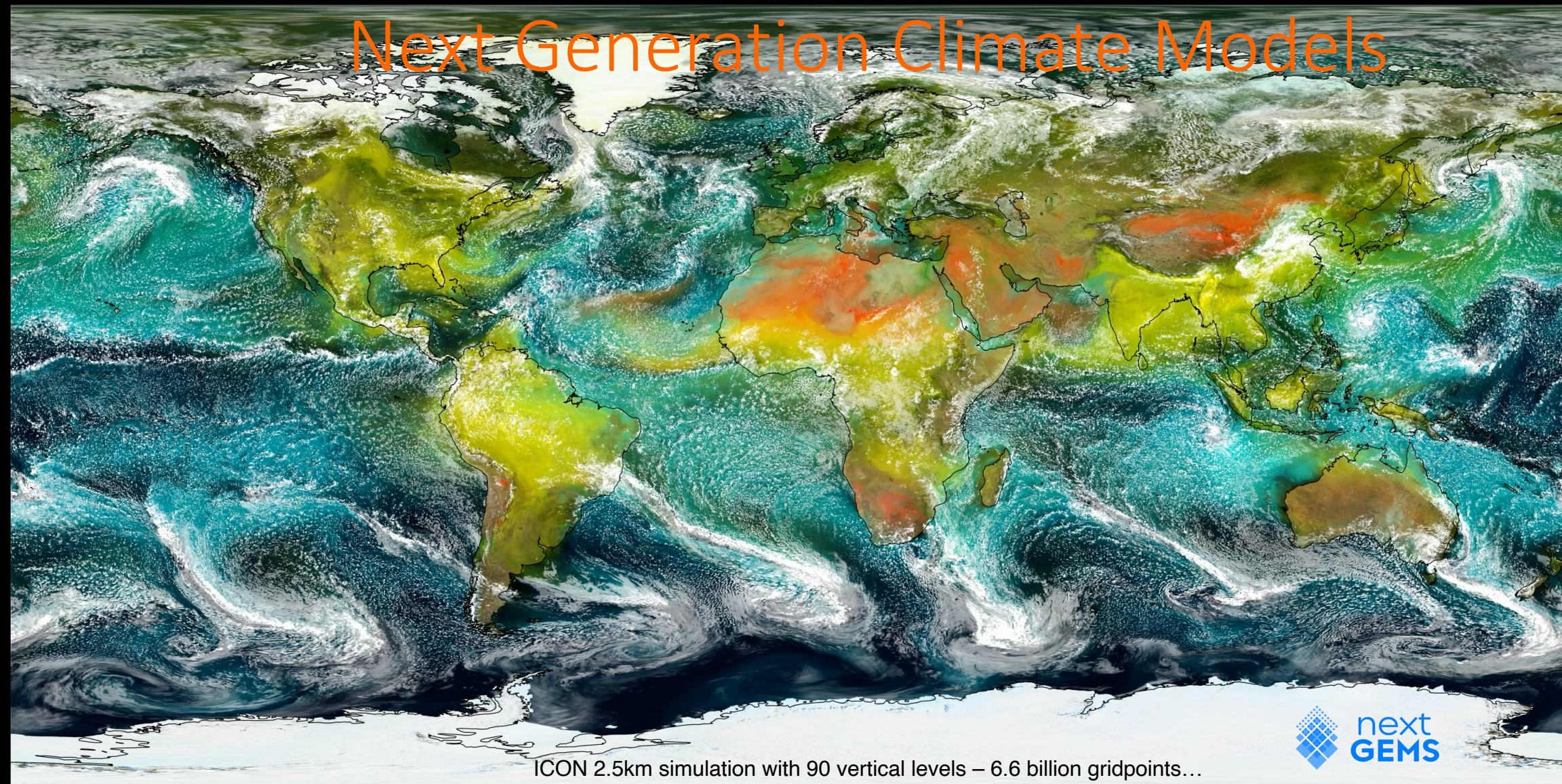
Lam et al., Science, (2023)



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Next Generation Climate Models



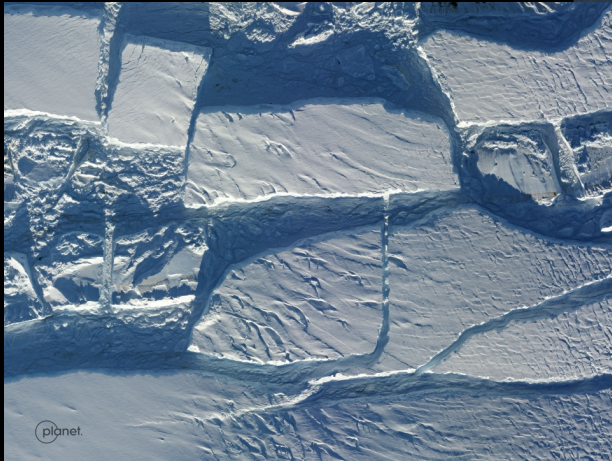
ICON 2.5km simulation with 90 vertical levels – 6.6 billion gridpoints...



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Next Generation Earth Observations



Planet CubeSat high resolution satellite data

Why Intelligent Earth?

- Numerous existential environmental crises
- Key science questions unresolved
- Vast and complex multimodal data
- Broad and deep domain expertise at Oxford and partners

We strive to train a new generation of PhD students equipped to tackle some of the most pressing environmental issues using AI...

... while advancing AI itself...

... in a positive and inclusive environment

Vision and Focus

Interdisciplinary PhD training programme with **two entry streams**:

- numerate environmental science backgrounds
- AI/ML, maths, statistics, physics,... backgrounds

Five closely connected themes:

- 1) Climate
- 2) Biodiversity
- 3) Natural hazards
- 4) Environmental solutions
- 5) Core AI/ML research on complex environmental science and data

Partners

Intelligent Earth departments:

- Department of Physics
- Department of Biology
- Department of Computer Science
- Department of Earth Sciences
- Department of Engineering Science
- Department of Statistics
- School of Geography and the Environment

Non-academic partners



Supervision

Intrinsically interdisciplinary for each PhD project:

- Joint supervision between environmental and AI academics from the Oxford CDT departments
- Additional non-academic advisor from partners, who also serves as host for a non-academic secondment
- Matching of students and supervisors will take place in the first two terms of the training programme.
- Primary department and supervisor will be assigned based on the focus of the project and the background of the student.

Projects

Intelligent Earth is a student-led programme:

- We do not advertise set projects. Students will be matched with supervisors based on interests and jointly develop their project.
- Exception: specific partner-led projects

We are planning for an annual intake of around 20 PhD students

Studentships are fully funded, including stipend, fees and a research and travel allowance

Training

- **Core courses** in foundations of AI/ML for environmental students and core courses in environmental science areas for data science students
- **Core skills training** for the full cohort, e.g. programming, version control,...
- **Advanced cross-cohort courses** focus on specific areas of AI, applied to grand challenges and datasets in environmental sciences
- **Professional skills training** with the Oxford Doctoral Training Centre
- **Research training**: three-month research project
- **Annual cross-cohort hackathons** co-organised with FDL and CDT partners and a **co-located cross-cohort CDT conference**
- **Weekly Intelligent Earth Seminars** (for the whole community)

The training will be individually tailored for each PhD student

What we are looking for

- We strive for inclusivity and diversity and seek to recruit candidates from a wide range of backgrounds – from the UK and worldwide.
- Applicants with a strong interest and motivation in the development and application of AI for environmental science and solutions.
- Intelligent Earth aims to develop and apply AI, hence candidates should have strong quantitative skills.

Two entry streams: for numerate environmental science backgrounds and for AI/ML, maths, statistics, physics backgrounds.

- A broad interest in some or all of the five Intelligent Earth themes.

Thank you for your attention!

Intelligent Earth CDT leadership team



Philip Stier >

Philip Stier (he/him)
Professor of Atmospheric Physics &
Intelligent Earth Director
Department of Physics



Hannah Christensen >

Hannah Christensen (she/her)
Associate Professor in Physical Climate
& Intelligent Earth EDI Lead
Department of Physics



Stephen Roberts >

Stephen Roberts (he/him)
Professor of Machine Learning
Department of Engineering Science



Adrian Thomas >

Adrian Thomas (he/him)
Professor of Biomechanics
Department of Biology



Andrew Markham >

Andrew Markham (he/him)
Professor of Computer Science
Department of Computer Science



Laura Stevens >

Laura Stevens (they/them or
she/her)
Associate Professor of Climate and Earth
Surface Processes
Department of Earth Sciences



Louise Slater >

Louise Slater (she/her)
Professor of Hydroclimatology
School of Geography and the
Environment



Yee Whye Teh >

Yee Whye Teh (he/him)
Professor of Statistical Machine Learning
Department of Statistics

Questions

- To be answered in the Q&A session