Institute of Computing for Climate Science

Summer School 2023

Participant Handbook

Cambridge, UK

10th — 14th July

Institute of Computing for Climate Science

UNIVERSITY OF CAMBRIDGE

Contents

Welcome

Dear Colleagues,

Welcome to the second annual ICCS Summer School! We're excited to have you, whether in person, or joining us virtually. ICCS is proud to host the summer school again in Cambridge, a vibrant, modern city with a colourful history, and we hope you will be able to enjoy much of what Cambridge has to offer this week.

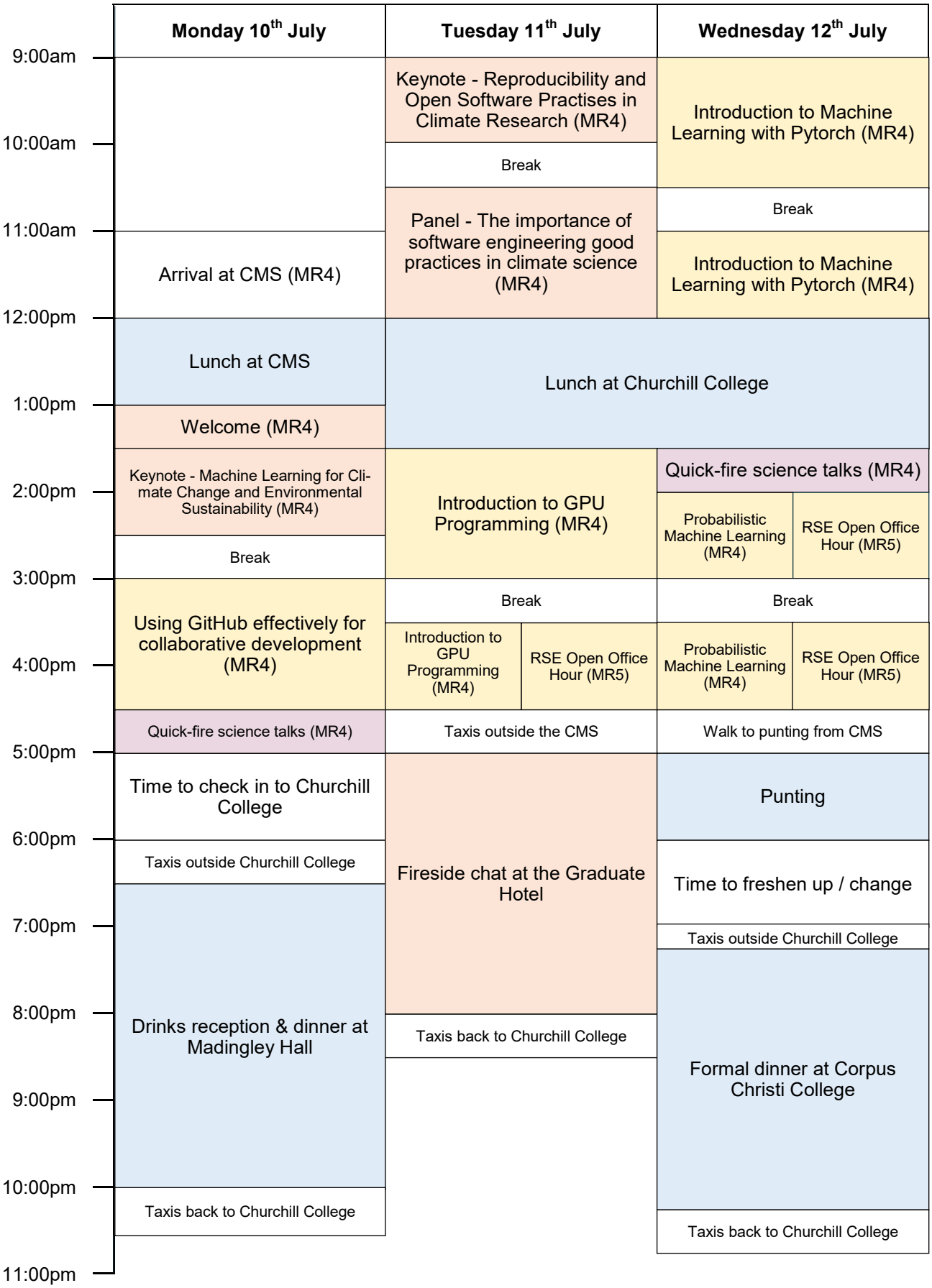
We have planned a dynamic program of scientific presentations, workshops, training and networking events over the next five days. Our focus will be on the best practice in software engineering methods for climate science research. In addition to providing training, we hope the summer school will be a great opportunity to forge collaboration, share knowledge and accelerate research progress.

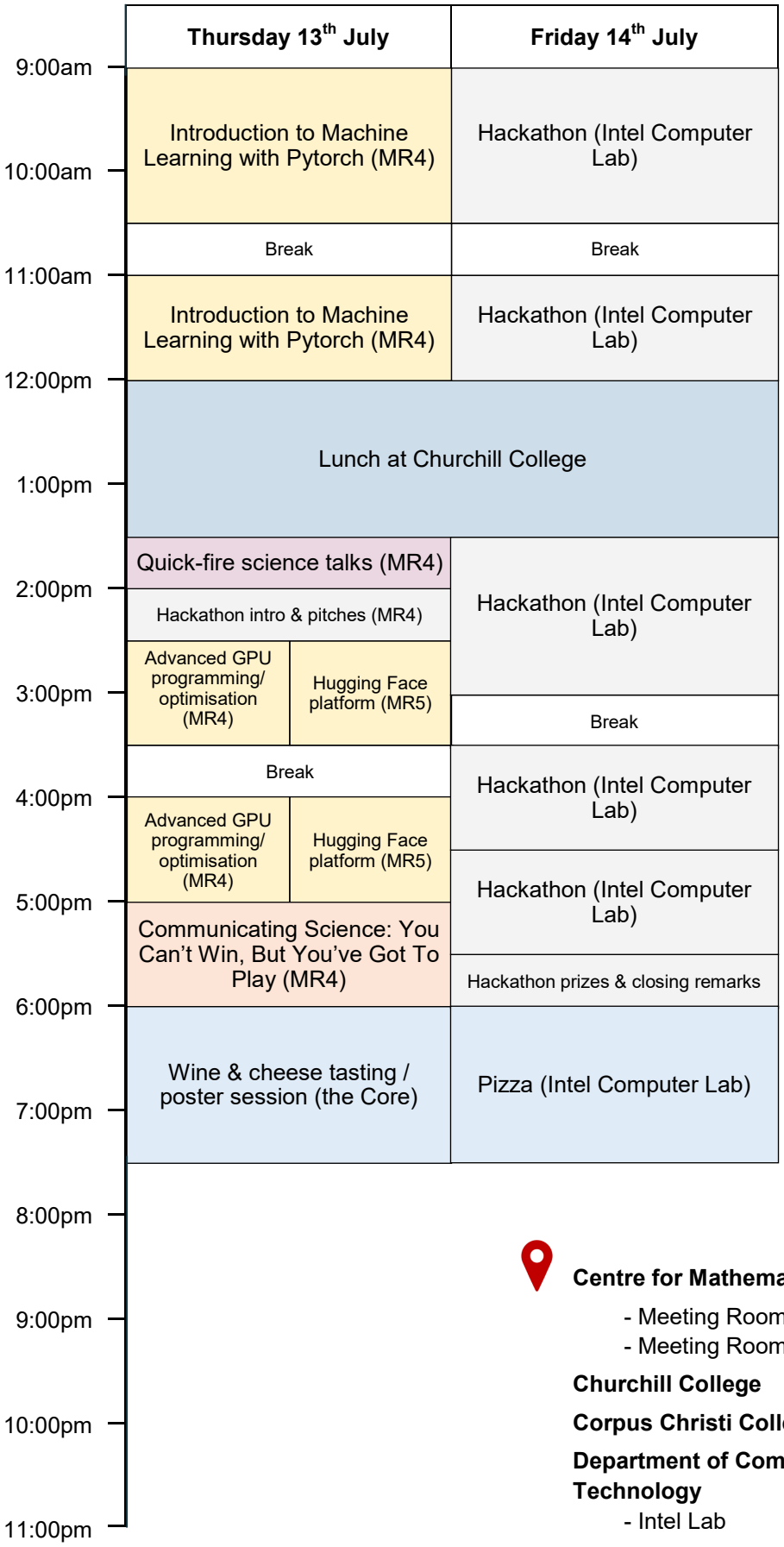
On behalf of everyone making the summer school possible, thank you for joining us and enjoy your week in Cambridge!

Emily Shuckburgh, Colm-cille Caulfield, Chris Edsall, Dominic Orchard and Marla Fuchs

ICCS Directorship

Programme at a Glance





Keynotes, panel, fireside chat and science communication talk

Teaching and practical sessions

Quick-fire science talks

Lunch, dinner and networking opportunities

Hackathon

Centre for Mathematical Sciences (CMS) - Meeting Room 4 (MR4) - Meeting Room 5 (MR5)	**Post Code** CB3 0WA
Churchill College	CB3 0DS
Corpus Christi College	CB2 1RH
Department of Computer Science and Technology - Intel Lab	CB3 0FD
Graduate Hotel	CB2 1RT
Madingley Hall	CB23 8AQ

Keynote - Machine Learning for Climate Change and Environmental Sustainability

Professor Claire Monteleoni, Choose France Chair in AI and Research Director at INRIA Paris

Date/time: Monday 10th July, 1:30 — 2:30pm

Abstract

Despite the scientific consensus on climate change, drastic uncertainties remain. Crucial questions about regional climate trends, changes in extreme events, such as heat waves and mega-storms, and understanding how climate varied in the distant past, must be answered in order to improve predictions, assess impacts and vulnerability, and inform mitigation and sustainable adaptation strategies. Machine learning can help answer such questions and shed light on climate change. Claire will give an overview of her climate informatics research, focusing on challenges in learning from spatiotemporal data, along with semi- and unsupervised deep learning approaches to studying rare and extreme events, and precipitation and temperature downscaling.

Speaker profile

Claire is Choose France Chair in AI and Directrice de Recherche at INRIA Paris, an Associate Professor in the Department of Computer Science at the University of Colorado Boulder, and the founding Editor in Chief of Environmental Data Science, a Cambridge University Press journal, launched in December 2020. She joined INRIA in 2023 and has previously held positions at University of Paris-Saclay, CNRS, George Washington University, and Columbia University. She completed her PhD and Masters in Computer Science at MIT and was a postdoc at UC San Diego. She holds a Bachelor's in Earth and Planetary Sciences from Harvard. Her research on machine learning for the study of climate change helped launch the interdisciplinary field of Climate Informatics. She co-founded the International Conference on Climate Informatics, which turns 12 years old in 2023, and has attracted climate scientists and data scientists from over 20 countries and 30 U.S. states. She gave an invited tutorial: Climate Change: Challenges for Machine Learning, at NeurIPS 2014. She currently serves on the NSF Advisory Committee for Environmental Research and Education.

Keynote — Reproducibility and Open Software Practises in Climate Research

Dr Kirsty Pringle, Project Manager for the Software Sustainability Institute at the University of Edinburgh

Date/time: Tuesday 11th July, 9:00 — 10:00am

Abstract

This talk will introduce the concept of reproducible research and discuss how we can help to shift research culture to overcome the barriers to reproducible research. It will introduce the FAIR (Findability, Accessibility, Interoperability, and Reusability) principles for both data and software and outline techniques researchers can adopt to improve reproducibility. The topic will be illustrated with examples drawn from across climate science. Finally, Kirsty will highlight useful resources and introduce some grassroots communities which are working to improve reproducibility in research.

Speaker profile

Kirsty is the Project Manager for the Software Sustainability Institute at the University of Edinburgh, the SSI is a national facility that works to cultivate better, more sustainable, research software to enable world-class research.

She has over 10 years of experience of developing and evaluating software for academic research, she is passionate about open research and is interested in using citizen science and public engagement to “open up” the research process. She has published widely on model development, air pollution modelling, climate model uncertainty and is currently working on a citizen science project on indoor airborne microplastics.

Kirsty is an active member of the Research Software Engineering community and was the RSE Theme Lead for the N8 CIR (2018 to 2020) where she worked to develop a community of research software engineers across the universities in the N8 partnership. She has also been a trustee of the Society for Research Software Engineering (2020-2022). She is a member of the NERC Digital Environment Expert network.

Panel Discussion — The Importance of Software Engineering Good Practices in Climate Science

Date/time: 10:30am — 12:00pm

Abstract

Writing code is critical to much of climate science, yet most climate scientists are not formally trained in software engineering. Across many scientific disciplines, climate science included, there has been a growing recognition of the importance of employing good practice software engineering techniques in order to support the scientific process. This panel will discuss the finer points of why software engineering practice is important for the field, what methods in particular are useful and why, how to grow in and spread good practice, and what the gaps are between techniques from the software engineering discipline and climate science research.

Chris Edsall, Co-Director (Research Software Engineering) at the Institute of Computing for Climate Science

Chris is a co-director of the Institute of Computing for Climate Science with a focus on software engineering. Within Cambridge University he is the Head of Research Software Engineering in Research Computing Services, acting Principal Software Engineer in the Cambridge Open Zettascale Lab and is a bye-fellow of Queens' College.

Kirsty Pringle, Project Manager for the Software Sustainability Institute at the University of Edinburgh

Kirsty is the Project Manager for the Software Sustainability Institute at the University of Edinburgh, the SSI is a national facility that works to cultivate better, more sustainable, research software to enable world-class research.

Marion Weinzierl, Senior Research Software Engineer at the Institute of Computing for Climate Science

Marion has a degree in Media Informatics from Ulm University, Germany, and a PhD in Scientific Computing from Technische Universitaet Muenchen, Germany. After her PhD, she did a 3-year postdoc in Solar Physics and Space Weather Prediction at Durham University, UK, and then worked as Computational Scientist at a x-ray technology start-up for two years. She then went back to Durham University to work as Research Software Engineer (RSE) in Advanced Research Computing (ARC), and also took on the role as Research Software Engineering Theme Lead at the N8 Centre of Excellence for Computationally Intensive Research (N8 CIR), where she led the RSE community and RSE leaders network, chaired the user group of the regional supercomputer Bede, co-lead the Bede support group, and co-founded and co-led the N8 CIR Women in High Performance Computing (WHPC) chapter. After 3.5 years at ARC Durham she has now just joined the RSE team at ICCS, Cambridge.

Paul Richmond, Engineering Lead at the Institute of Computing for Climate Science

Paul is a Research Software Engineer (RSE) and Engineering lead at the Cambridge Institute of Computing for Climate Science (ICCS). He is also a part time professor of Research Software Engineering at the University. He has a track record of RSE leadership and was one of the first of six EPSRC Early Career RSE fellows in the UK. At Sheffield, he built and lead a team of Research Software Engineers (RSEs) who facilitate world leading research across the entirety of the University. Paul has been heavily involved in the RSE leaders network within the UK and was previously the President of the Society of Research Software Engineering a charitable members organisation where he advocated for the role of RSEs. At Cambridge he leads the RSE team at ICCS where his team collaborates with the Virtual Earth System Research Institute (VESRI) centres by embedding good software engineering practice.

Sadie Bartholomew, Computational Scientist at the University of Reading

Sadie is a computational scientist working for the Computational Modelling Services (CMS) group within NCAS and based at the Dept. of Meteorology at Reading.

She works on open-source tooling related to the CF Conventions, for example cf-python, and on the ES-DOC project to deliver documentation infrastructure for model inter-comparison, notably at CMIP6 and beyond.

Her work generally involves a mixture of software engineering; data and metadata science and analysis; infrastructure development and maintenance; user support and training; and high-performance computing (HPC).

Fireside Chat

Dr Daniel Lee, Schmidt Futures, and Professor Emily Shuckburgh, Institute of Computing for Climate Science

Date/time: Tuesday 11th July, 5:00 — 8:00pm

Abstract

Join Daniel, Program Scientist at Schmidt Futures, and Professor Emily Shuckburgh, Director of the Institute of Computing for Climate Science (ICCS) and the Advisory Board Chair of the Virtual Earth Systems Research Institute (VESRI), for a fireside chat.

Together, they will provide an overview of VESRI's mission and approach to advance climate modelling, as well as ICCS's integral role in VESRI's research. Finally, they'll close by discussing several of the opportunities and challenges for building better climate models on the near-term horizon.

Daniel Lee, Program Scientist at Schmidt Futures

Daniel is a Program Scientist at Schmidt Futures, the philanthropic initiative of Eric and Wendy Schmidt. In this role, he co-leads the Virtual Earth System Research Institute (VESRI), which aims to improve the accuracy and credibility of major climate models by addressing some the hardest problems that challenge them. He also leads the Eric and Wendy Schmidt AI in Science postdoctoral fellowship program, which seeks to accelerate the next scientific revolution by applying AI to research in science, technology, engineering, and mathematics. In his leadership, Dan seeks to broaden and deepen the range of scientific approaches that address pressing societal issues.

Dan is a research scientist with 20 years of experience addressing interdisciplinary problems in neuroscience, genetics, materials science, and chemical engineering. The impact of his research has been featured in The Economist, Psychology Today, and Nature, and he has a record of publications in *Nature Neuroscience, Neuron, Science Advances, eLife*, and the *Proceedings of the National Academies of Science*. His research has been recognized through several international awards, including the NIH Pathway to Independence Award (K99/R00), NARSAD Young Investigator Award, and the Sleep Research Society Outstanding Early Investigator Award.

Prior to Schmidt Futures, Dan was a Senior Research Associate at the California Institute of Technology, co-founded and led several not-for-profit groups, and served as a Board Member for the Wiseburn Education Foundation. Dan holds a Ph.D. in Neuroscience from the Johns Hopkins School of Medicine and a B.A. in Molecular and Cell Biology from the University of California, Berkeley.

Emily Shuckburgh, Director at the Institute of Computing for Climate Science

Emily is Director of Cambridge Zero, the University of Cambridge's major climate change initiative. She is also Professor of Environmental Data Science at the Department of Computer Science and Technology.

VESRI Program Overview

The Virtual Earth System Research Institute (VESRI) aims to foster advances in the science of climate that may lead to transformative improvements in projections of climate change on timescales from decades to centuries and that are not easily realizable with existing funding programs. Potential for transformative improvements lie, for example, in jointly exploiting advances in models of the Earth system and its components, Earth observations, and computational tools, and in bringing tools and approaches from outside the climate sciences to bear within it. Ultimately, VESRI seeks to improve climate modeling, change the direction of multiple models globally, and to ultimately accelerate the pace of earth systems and climate research. Led by a scientific advisory board of world-leading climate scientists, research projects within VESRI were selected from the most promising research proposals arising from Schmidt Futures' global, multi-stage competition to address current weaknesses in climate models.

Schmidt Futures leverages its philanthropic model and technical expertise to fund and coordinate high-impact, high-risk research that falls outside traditional disciplinary boundaries. Through VESRI, we coordinate hundreds of climate and data scientists across seventeen countries, eight scientific research consortiums and over fifty research institutions to tackle some of the most difficult scientific and computational problems in climate modeling.

Further accelerating VESRI is the Schmidt Futures-funded Institute of Computing for Climate Science (one of four Virtual Institute of Scientific Software (VISS)) at the University of Cambridge, which advances climate sciences through computer science, software engineering, data science, and AI. Through these combined efforts, VESRI seeks to drive large-scale, catalytic, and transformative impact in climate modeling.

VISS Program Overview

The Virtual Institute for Scientific Software seeks to accelerate the pace of scientific discovery through the support and development of better quality, more sustainable scientific software. Starting with a network of four inaugural centers based at the University of Cambridge, Georgia Institute of Technology, the Johns Hopkins University, and the University of Washington, VISS will address the growing demand for high quality professional software engineers who can build dynamic, scalable, open software to facilitate accelerated scientific discovery across fields. The objective of these scientific software centers is to not only improve the quality of research and accelerate advancements, but to also support longer term platforms and systems that encourage best practice in open science. This will be achieved by providing scientific researchers with access to full-time professional engineers and state of the art technology and techniques such as high-end computing, massive databases, and machine learning.

Communicating Science: You Can't Win, But You've Got To Play

Joe Palca, Former Science Correspondent for National Public Radio

Date/time: Thursday 13th July, 5:00 — 6:00pm

Abstract

Once upon a time, the assumption was that most people lacked good information about science, and if they were given such information, they would use it to make appropriate decisions. This was known as the information deficit model. It is now clear that factors other than information appear to play an even more important role in decision-making. That doesn't mean providing clear, accurate information is no longer important. Far from it. Joe will explain why good science communication is more important than ever, as well as some tips on how to communicate clearly and effectively.

Speaker profile

Joe has been a science communicator for nearly four decades. Most that time was spent as a science correspondent for National Public Radio, but he also worked for the news sections of Science and Nature.

He came to journalism from a science background, having received a Ph.D. in psychology from the University of California at Santa Cruz where he worked on human sleep physiology.

Joe has covered a range of science topics — everything from biomedical research to astronomy. He is founder of the NPR Scicommers program, a collective of science communicators. In 2021 the Scicimmers moved to Boston University where it continues to thrive.

Joe has won numerous awards, several of which came with attractive certificates. In 2019, he was elected to the American Academy of Arts and Sciences.

With Flora Lichtman, he is the co-author of *Annoying: The Science of What Bugs Us* (Wiley, 2011).

Detailed Programme and Abstracts

Monday 10th July

11:00 — 12:00 **Arrival at Meeting Room 4 (MR4), Department of Applied Mathematics and Theoretical Physics (DAMTP), Centre for Mathematical Sciences**

12:00 — 13:00 **Lunch at DAMTP**

13:00 — 13:30 **Welcome and introduction** (MR4)
Emily Shuckburgh, Colm-cille Caulfield and Marla Fuchs, ICCS

13:30 — 14:30 **Keynote — Machine Learning for Climate Change and Environmental Sustainability** (MR4)
Claire Monteleoni, INRIA Paris

Please see page 6 for the abstract.

14:30 — 15:00 **Break**

15:00 — 16:30 **Using GitHub effectively for collaborative development** (MR4)
Alex Smith, Ben Orchard and Simon Clifford, ICCS

Working collaboratively on a piece of software can be hard - having to manually integrate changes, new and unexpected compile errors, silent wrong answers producing incorrect calculations. But it doesn't have to be this way! Using distributed version control via GitHub, allows code to be widely shared, transparently reviewed and automatically tested. This enables fast, asynchronous development between teams, continuous delivery to users and a platform for tracking development and fixing & reporting issues. However, this doesn't all come for free - you need to follow best practices and maintain the repository to reap the benefits.

In this session, ICCS RSEs will be assigned a repository and demonstrate how to assess and identify issues with an existing code-base, present best practices for documenting issues and fixing them, and show you how to create a detailed pull request that can be easily reviewed by a collaborator and how to setup continuous integration testing so that you can verify the code works as intended every time a change is made.
This session is also a great opportunity to see how ICCS RSEs could approach a repository you own and the service they provide to VESRI teams.

(Optional) Pre-reading:
Using Git and GitHub effectively
This covers the theory behind using Git as presented at the ICCS summer school last year. The session this year will greatly expand on the last few minutes of that presentation.

16:30 — 17:00 **Quick-fire science talks** (MR4)

Monday 10th July

16:30 — 16:40 **Reducing uncertainty in climate models through improved parameterizations of small scale processes** (MR4)
David Kamm, Sorbonne Université, Paris and M^{2}LInES

The NEMO modelling framework finds application in numerous climate models. Simulating Earth's climate and how it is changing means to solve a complex set of equations for a long period, usually hundreds of years. Given the small time scales of the processes involved and the limited available computational resources, this imposes numerical constraints on the spatial resolution of the simulation. Consequently, processes with a smaller physical length scale than the model grid can not be explicitly resolved, for example mesoscale eddies. The effects of these subgrid-scale processes on the larger scale climate system need to be approximated through parameterisations. Recent studies propose new methods to find and formulate parameterisations using machine learning tools, which promise improvements in the predictive skill of the model. With the prospect of introducing these into future versions of NEMO, their potential benefit is yet to be determined. We propose a new configuration to be used as a test protocol for subgrid-scale parameterisations. The configuration is of intermediate complexity and with an idealised basin geometry of the Atlantic and Southern Ocean. This allows for relatively cheap simulations even at very high horizontal resolution, while crucial aspects of the system like the meridional overturning circulation (MOC) or the antarctic circumpolar current (ACC) are still maintained. Effects of the subgrid-scale processes on the large-scale circulation are then diagnosed to evaluate the performance of their parameterisation.

16:40 — 16:50 **Using machine learning to emulate thermodynamic sea ice processes** (MR4)
Simon Driscoll, University of Reading and SASIP

Sea ice plays an essential role in global ocean circulation and in regulating Earth's climate and weather. Melt ponds that form on the ice have a profound impact on the Arctic's climate, and their evolution is one of the main factors affecting sea-ice albedo and hence the polar climate system. Parametrisations of these physical processes are based on a number of assumptions and can include many uncertain parameters that have a substantial effect on the simulated evolution of the melt ponds.

We perform perturbed parameter ensembles on the state-of-the-art sea ice column physics model, Icepack. These perturbed parameter ensembles - where these parameters are perturbed within their known ranges of uncertainty - show its prediction of key variables vary substantially after only a decade of simulation, and a Sobol sensitivity analysis on these uncertain parameter values shows the model output is sensitive to these parameters in a manner that varies both spatially and temporally.

Monday 10th July

16:40 — 16:50 Given this uncertainty and source of prediction error, we propose to replace the melt pond parametrisation with a data driven emulator. Neural networks are shown to be capable of learning this parametrisation and replacing it in the Icepack model without causing instability or drift - as a first step to understand the viability of this approach. Secondly, we train neural networks on observational and reanalysis data of both atmospheric and sea ice variables, targeting melt pond fraction and broadband albedo as output. We show that neural networks can learn to predict these targets, and thus discuss how data driven neural networks can replace the `parametric' parametrisation approach applied not only to sea ice models but also more broadly in climate modelling.

16:50 — 17:00 **Learning Equations for Subgrid-scale Parametrizations from Data: Promises and Challenges** (MR4)
Karan Jakhar, Rice University and DataWave

In state-of-the-art climate models, many important small-scale processes cannot be directly simulated due to limited computing power. These effects are represented using parameterizations, which often lead to biases and uncertainties. Recently, interest has grown in learning these parameterizations from high-resolution simulations. While deep neural networks have been successful in some cases, they can be difficult to interpret. Consequently, recent studies have shifted focus towards machine -learning methods that discover equations. We applied a common equation-discovery technique on widely used test cases to discover equations for the momentum and heat fluxes, correlate these equations to known mathematically derived parametrizations, illustrate the unphysical results of these fully interpretable but unsuccessful parametrizations, and propose improvements using physics-informed libraries, loss functions, and metrics. Our findings have implications for the parametrization of any multi-scale system.

17:00 — 18:00 **Time to check in to Churchill College**

18:00 — 18:30 **Meet outside Churchill College at 18:00 for taxis to Madingley Hall**

18:30 — 22:00 **Drinks reception & dinner at Madingley Hall**

22:00 **Meet outside Madingley Hall at 22:00 for taxis back to Churchill College**

Tuesday 11th July

09:00 — 10:00 **Keynote — Reproducibility and Open Software Practises in Climate Research** (MR4)
Kirsty Pringle, University of Edinburgh

Please see page 7 for the abstract.

10:00 — 10:30 **Break**

10:30 — 12:00 **Panel — The importance of software engineering good practices in climate science** (MR4)
Chris Edsall, Kirsty Pringle, Marion Weinzierl and Sadie Bartholomew
Moderator: Paul Richmond

Please see page 8 for the abstract.

12:00 — 13:30 **Lunch at Churchill College**

13:30 — 15:00 **Introduction to GPU Programming (Teaching)** (MR4)
Paul Richmond, ICCS

Accelerators such as GPUs are prevalent both within personal computing as well as within high performance computing systems. Compared with traditional CPU architectures, performance is leveraged through a design which favours a high number of parallel compute cores at the expense of imposing significant software challenges.
This introductory session will provide some insight into GPU architectures and provide a hands-on lab for developing GPU code using CUDA.

Prerequisite for hands-on lab: Basic understanding of the C programming language.

15:00 — 15:30 **Break**

15:30 — 16:30 **Introduction to GPU Programming (Practical)** (MR4)
Paul Richmond and Chris Edsall, ICCS

Please see above for the abstract.

15:30 — 16:30 **ICCS RSE Open Office Hour** (MR5)
Ben Orchard and Matt Archer, ICCS

Summer school attendees can book a session with one of the ICCS RSEs for advice or to discuss ongoing projects.

Tuesday 11th July

16:30 — 17:00 **Taxis to the Graduate Hotel for the fireside chat**
Meet at the Clarkson Road entrance of the Centre for Mathematical Sciences at 16:30.

17:00 — 20:00 **Fireside chat**
Daniel Lee, Schmidt Futures, and Emily Shuckburgh, ICCS

Please see page 11 for the abstract.

Followed by a reception with food stations, beverages and yard games.

20:00 **Taxis to Churchill College**
Meet outside the Graduate Hotel at 20:00 for taxis back to Churchill College

Wednesday 12th July

09:00 — 10:30 **Introduction to Machine Learning with Pytorch (Teaching)** (MR4)
Jack Atkinson, ICCS, and Jim Denholm, AstraZeneca

This session aims to teach the key theoretical concepts behind machine learning whilst also providing training on how to practically perform machine learning using the pyTorch framework.
We will cover both regression and classification, learning about key concepts and applying them in parallel exercises. Once complete participants will have examples of code for building, training, and running neural nets that could be adapted for their own applications.
We will also have some discussion of applying machine learning specifically within the geoscience domain.

Required Pre-Reading:
To make the most of the session we expect participants to arrive with a (minimal) base-level understanding of machine learning concepts. In addition to this we will also assume knowledge of some basic mathematics and python abilities.
Details of these can be found on the workshop GitHub repository, along with resources.

10:30 — 11:00 **Break**

11:00 — 12:00 **Introduction to Machine Learning with Pytorch (Practical)** (MR4)
Jack Atkinson, ICCS, and Jim Denholm, AstraZeneca

Please see above for the abstract.

12:00 — 13:30 **Lunch at Churchill College**

13:30 — 14:00 **Quick-fire science talks** (MR4)

13:30 — 13:40 **CGDycore.jl: A dynamical core for numerical weather prediction in Julia**
Oswald Knoth, CliMA

CGDycore.jl is a spectral element implementation of the compressible Euler equation on the sphere in Julia. The main application is numerical weather prediction. Oswald will give a short overview about the numerical methods and their implementation in the Julia code. Special emphasis is given to the grid structure and the parallel implementation via MPI. Finally he will present first ideas to make the code GPU portable.

Wednesday 12th July

13:40 — 13:50 **Tailoring data assimilation for models using discontinuous Galerkin methods**
Ivo Pasmans, University of Reading and SASIP

Discontinuous Galerkin (DG) methods are rapidly gaining popularity in the geophysical community. In these methods the model solution in each grid cell is approximated as a linear combination of basis functions. Ensemble data assimilation (EnDA) aims to bring the model closer to the truth by combining it with observations using error statistics estimated from an ensemble of model runs. It is known to suffer from several well-documented issues. We have tested whether the DG structure can be exploited to address the following three issues: 1) reduce the need for observation thinning, 2) reduce errors in gradients, 3) produce a more accurate localised ensemble covariance. Using an idealised test setup it is found that a strongreduction in error can be realised, especially for high DG orders. However, this does not result in a reduction of the error in the gradients. The DG basis is found to be expedient for scale-dependent localisation resulting in an ensemble covariance that is closer to the truth than one created using conventional, non-scale dependent localisation.

13:50 — 14:00 **Reduction of High-Dimensional Atmospheric Chemical Kinetics**
Levin Rug, TROPOS Leipzig and CliMA

Atmospheric chemistry consists of chemical mechanisms with up to thousands of individual species (chemical compounds). The changes of concentrations are determined by a highly coupled, stiff system of non-linear ordinary differential equations. Sophisticated solvers are needed to take care of the various present time-scales and to accurately describe the stiff dynamics, where changes in qualitative behaviour can happen almost immediately. These solvers cause bottlenecks when they are embedded into larger models, but chemistry is important for several processes, such as estimating Ozone concentrations or air quality in general. We aim to widen this bottleneck by creating a cheap representation of the relevant complex chemistry. We explore an analytical and a machine-learning based approach, both shall be sketched in the presentation.

14:00 — 15:00 **Probabilistic Machine Learning: From Bayesian Linear Regression to Gaussian Processes** (MR4)
Henry Moss, ICCS

In this talk, we will redirect our attention from neural networks to Bayesian machine learning algorithms. These methods, in contrast to the ones previously discussed in the summer school, offer the capability to quantify the uncertainty inherent in their predictions. As a result, they become indispensable tools for contemporary climate science researchers, particularly when incorporating ML-based natural science into broader decision-making processes. Without a precise understanding of the likelihood of specific critical events, it becomes challenging to make informed decisions. We will begin with a Bayesian version of simple linear regression before moving onto the more powerful Gaussian process.

Wednesday 12th July

15:30 — 16:30 **ICCS RSE Open Office Hour** (MR5)
Ben Orchard and Matt Archer, ICCS

Summer school attendees can book a session with one of the ICCS RSEs for advice or to discuss ongoing projects.

16:30 — 17:00 **Walk to punting**

17:00 — 18:00 **Punting**

18:00 — 19:00 **Time to freshen up/change**

19:00 — 19:15 **Taxis to Corpus Christi College**
Meet outside Churchill College at 19:00 for taxis

19:30 — 20:00 **Drinks reception at Corpus Christi College**

20:00 — 22:00 **Formal dinner at Corpus Christi College**

22:20 **Taxis to Churchill College**
Meet outside Corpus Christi College at 22:20 for taxis

Thursday 13th July

09:00 — 10:30 **Introduction to Machine Learning with Pytorch (Teaching)** (MR4)
Jack Atkinson, ICCS, and Jim Denholm, AstraZeneca

Please see page 20 for the abstract.

10:30 — 11:00 **Break**

11:00 — 12:00 **Introduction to Machine Learning with Pytorch (Practical)** (MR4)
Jack Atkinson, ICCS, and Jim Denholm, AstraZeneca

Please see page 20 for the abstract.

12:00 — 13:30 **Lunch at Churchill College**

13:30 — 14:00 **Quick-fire science talks** (MR4)

13:30 — 13:40 **Unveiling CliMA-Land: Advancing Land Modeling for Climate Research**
Renato Braghiere, California Institute of Technology, NASA Jet Propulsion Laboratory and CliMA

In the face of climate change, land models play a crucial role in predicting the behavior of energy, water, and carbon cycles. However, until now, these models have been limited by static parameters, leading to uncertain predictions. CliMA-Land is the next generation land surface model developed by the Climate Modelling Alliance (CliMA). Harnessing the power of remote sensing data and ground-based flux measurements, CliMA-Land is a modular platform that allows research across various scales, from the microscopic level of tissues to whole plants and entire ecosystems. It incorporates a state-of-the-art hyperspectral canopy radiative transfer scheme, simulates soil water movement, plant water transport, and stomatal regulation, enabling comprehensive analysis of water, carbon, and energy fluxes. Thanks to recent advancements in satellite observations and machine learning algorithms, CliMA-Land unlocks unparalleled opportunities for global vegetation monitoring. By directly utilizing and comparing ecological and radiometric variables, it yields spatial patterns of photosynthesis and transpiration that align significantly with existing data-driven products even before calibration. CliMA-Land also enables high-resolution simulations and represents a paradigm shift from plant functional types to plant traits, opening avenues for addressing critical scientific questions.

Thursday 13th July

13:40 — 13:50 **IPSL climate models on heterogeneous architectures**
Kazem Ardaneh, IPSL Climate Modeling Center

In recent years Graphics Processing Units (GPUs) have been developed rapidly and can efficiently overtake Central Processing Units (CPUs) in executing parallel workloads. Current trends lead toward the CPU-GPU heterogeneous computing era. GPUs have been widely adopted for high-performance computing thanks to their massively parallel architecture, high memory throughput, and energy efficiency. This is the reason why nowadays massively parallel codes are being ported and are used with GPU. The IPSL climate modes include the physical atmosphere-land-ocean -sea ice model based on the LMDZ/DYNAMICO, ORCHIDEE, and NEMO models. All of these models have distributed memory parallelism using MPI while the atmosphere-land models have also shared memory parallelism using OpenMP. To port these models for the next heterogeneous supercomputers, we have started to port the most computationally demanding parts of ORCHIDEE using the OpenACC protocols for the accelerator machines. The preliminary results show a speedup of ≈ 60, between a core of the CPU and an NVIDIA V100 GPU card, performed on the Jean-Zay supercomputer at IDRIS/CNRS. Our targeted parallelization is a hybrid MPI-OpenACC approach that combines the MPI among different nodes of CPU processors and the OpenACC on each GPU to make the most of the
computing resources on multiple GPU machines distributed around different nodes.

13:50 — 14:00 **Learning Zonal Jet Dynamics with Stochastic Latent Transformers**
Ira Shokar, University of Cambridge

Ira will present a deep-learning approach to deriving a reduced-order model of stochastically forced atmospheric zonal jets. The approach provides a six orders of magnitude speed-up in emulating the jets, over numerical integration, together with a lower-degrees-of-freedom latent representation of the system- used to yield insight into the underlying dynamics.

We consider the behaviour of zonal jets on a beta plane as represented by a two-dimensional model driven by stochastic forcing, which parameterises the turbulence due to baroclinic instability. This idealised model gives a useful analogue for week-to-week variations in the large-scale dynamics of the tropospheric midlatitude jet - the driver of European weather. We establish that the time evolution of the jets depends both on the nonlinear two-way interaction between the mean flow and the eddies and, crucially, the time history of the stochastic forcing. As a result, the current state or recent history of the system does not predict the forward evolution but instead determines a distribution of possible time evolutions.

Thursday 13th July

13:50 — 14:00 To model the flow, we utilise methods in manifold learning to learn a transformation to a latent representation of the system and then use a probabilistic transformer (a similar architecture to that of large-language models such as GPT) to model the stochastic latent dynamics. We verify the neural network's performance by comparing the statistical and spectral properties of an ensemble from the neural network, obtained via sampling in the latent space, with an ensemble of numerical integrations, with different realisations of the stochastic forcing- with identical initial conditions. To study jet variability, we use ensembles of trajectories in both the latent and observation space to quantify to what extent different system states are driven by deterministic or stochastic dynamics.

14:00 — 14:30 **Hackathon introduction and pitches** (MR4)
Paul Richmond and Dominic Orchard, ICCS

Watch this introduction video to find out more!
If you would like to suggest a project idea, please use the team hackathon ideas/pitches form to propose your project idea.

14:30 — 15:30 **Advanced GPU programming/optimisation** (MR4)
Paul Richmond, ICCS

Accelerators such as GPUs are prevalent both within personal computing as well as within high performance computing systems. Compared with traditional CPU architectures, performance is leveraged through a design which favours a high number of parallel compute cores at the expense of imposing significant software challenges.
This optimisation session will provide strategies for improving the performance of GPU CUDA code. A hands-on lab session will provide an opportunity to try out the ideas presented.

Prerequisite for hands-on lab: Basic understanding of the C programming language.

Thursday 13th July

14:30 — 15:30 **Hugging Face platform** (MR5)
Ben Orchard, ICCS

GitHub dominates as the central platform for open collaboration on software as a whole. But neither Git nor GitHub are convenient for sharing large, non-textual data. Machine learning projects often concern massive datasets and produce binary results (e.g. neural network weights) – and though you may share the process for obtaining these, they are likely expensive in terms of time and compute. Self-hosting these can be a similar challenge. This talk introduces Hugging Face as a consideration for making future climate science ML work further accessible. Hugging Face is an online platform for (public) ML projects, hosting thousands of cleaned datasets and pre-trained models along with documentation and usage. There is a clear focus on natural language processing, but the platform is also highly suited for hosting climate science ML projects such as neural network parameterizations.

We also go over a method for automatically mirroring an existing GitHub repository to Hugging Face.

15:30 — 16:00 **Break**

16:00 — 17:00 **Advanced GPU programming/optimisation** (MR4)
Paul Richmond and Chris Edsall, ICCS

Please see page 25 for the abstract.

16:00 — 17:00 **Hugging Face platform** (MR5)
Ben Orchard, ICCS

Please see above for the abstract.

17:00 — 18:00 **Communicating Science: You Can't Win, But You've Got To Play** (MR4)
Joe Palca, National Public Radio

Please see page 14 for the abstract.

18:00 — 19:30 **Wine & cheese tasting / poster session**
Location: Centre for Mathematical Sciences

Friday 14th July — Team Hackathon

Location: Intel Lab, Department of Computer Science and Technology

Watch this introduction video to find out more!

If you would like to suggest/pitch a project idea, please use the team hackathon ideas/ pitches form to enter your details.

Schedule:

09:00 — 10:30	**Hackathon**
10:30 — 11:00	**Break**
11:00 — 12:00	**Hackathon**
12:00 — 13:30	**Lunch at Churchill College**
13:30 — 15:00	**Hackathon**
15:00 — 15:30	**Break**
15:30 — 16:30	**Hackathon**
16:30 — 17:30	**Hackathon group presentations** Judges: Colm-cille Caulfield, Dominic Orchard and Laura Cimoli
17:30 — 18:00	**Hackathon prizes and closing remarks**
18:00 — 19:00	**Pizza and drinks**

Participants

Aleksandra Higson

Science Communication Intern, ICCS

Aleksandra is currently interning with ICCS as part of her MSc in Science Communication at Imperial College London where she is involved in making climate science more accessible to the public and boosting ICCS visibility within Cambridge and online. Her background is in Health and Human Sciences, which she studied at Durham University. She is particularly interested in the value of combining qualitative research together with technological developments to tackle contemporary challenges in health and environment. She has assisted in nutrition research concerning Bangladeshi people living in the UK, and is currently writing her thesis on the impact of smartwatch advertising on self-tracking behaviours.

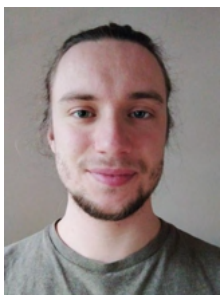
Alexander Smith

Research Software Engineer, ICCS

Alex is an ICCS RSE helping the VESRI science teams produce maintainable, efficient, tested research software. Alex has a PhD in Computational Physics (Bath, 2019) and worked for 3 years as a Software Engineer at MathWorks (creators of MATLAB/Simulink), before joining ICCS at the University of Cambridge (2022-Present).

Alexis Barge

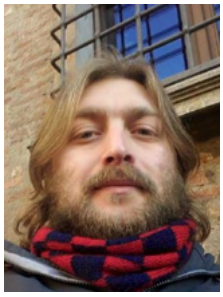
Research Engineer, M^2LInES



Alexis is currently research engineer in the oceanography research team (MEOM) of the Institute of Geosciences and Environment (IGE). He is working on the development of tools to couple deep learning based engines and standard oceanographic CFD models. He holds a PhD obtained in 2018 from Université De Lyon in numerical physics of fluids. His research focused on the study and the modelling of rough-wall induced turbulence and transport of solid particles.

Ali Aydogdu

Research Scientist, SASIP



Ali holds a PhD in physical oceanography from the Ca' Foscari University of Venice and Euro-Mediterranean Centre on Climate Change (CMCC; Bologna) on data assimilation (DA) in regional and coastal scales. He studied variational and ensemble DA techniques as well as observation network design methodologies (OSE/OSSE). He had his post-doc at Nansen Environmental and Remote Sensing Center (NERSC; Bergen) on ensemble-based data assimilation techniques using adaptive moving mesh models with applications on Arctic sea-ice. He visited NCAR within the visitor programme of CISL before starting his current position as a research scientist at CMCC where he coordinates data assimilation activities in regional and coastal scales including Mediterannean and Black Sea MFSs involved in CMEMS MFCs. He has taken part in several European projects including SESAME, MyOcean and JERICO as well as DASIM and REDDA in collaboration with US. He is a member of the OceanPredict data assimilation task team (DA-TT). He teaches at the Università di Bologna in data assimilation.

Andrew Charbonneau

PhD Student, CliMA

Andy is a third-year graduate student in the Applied Physics department at Caltech, working on the augmentation of climate models with artificial intelligence for improved forecasting. Before coming to Caltech, he received his bachelor's degree in Physics from Princeton University (specializing in quantum systems and optimization), and was raised around Washington D.C. His previous work specializes on neural differential equations for snow depth forecasting, and his ongoing work involves the investigation of hybrid physics/AI models in storm surge forecasting.

Ben Orchard

Research Software Engineer, ICCS

Ben is a software engineer with background in functional programming (Haskell) and compiler tools (CamFort, Fortran refactoring suite). Heavy open source user, light contributor. Keen about highly type-directed code. Avid Japanese learner.

Carlos Garcia Jurado Suarez

Research Software Engineer, UW Scientific Software Engineering Center (SSEC)

Carlos is a Principal Software Engineer with the UW Scientific Software Engineering Center (SSEC). As part of SSEC, he leads Software Engineering and Machine Learning (ML) projects in collaboration with researchers to develop robust and scalable scientific software.

Carlos has over 25 years of experience building software. Before joining SSEC, he was an Engineering Director at Outreach, a local Seattle startup. He led a team of 10 engineers and scientists, developing ML models and systems for a real-time conversational assistant.

Ching Yui Myles Ng

Summer Research In Mathematics Intern, ICCS

Myles is an undergraduate mathematics student at Cambridge from Macau, currently doing a project using machine learning methods to map ocean circulation currents. He is interested in the integration of software in different areas of applied mathematics and physics.

Chris Edsall

Co-Director (Research Software Engineering), ICCS

Chris is a co-director of the Institute of Computing for Climate Science with a focus on software engineering. Within Cambridge University he is the Head of Research Software Engineering in Research Computing Services, acting Principal Software Engineer in the Cambridge Open Zettascale Lab and is a bye-fellow of Queens' College.

Chris Kent

Senior Scientist and PhD Student, DataWave

Chris is a Senior Scientist within the Monthly to Decadal Variability and Prediction group at the Met Office and started a part-time PhD at the University of Exeter in January 2022, focusing on bifurcations within climate forecast ensembles. Chris joined the Met Office in 2012 working on the interactions between climate variability, climate change and human systems, with a focus on food security. Chris joined the Monthly-to-Decadal group in 2019. Prior to this, Chris obtained a degree in Ocean Science from Plymouth University and worked on satellite oceanography for over four years at a private research company.

Colm-cille Caulfield

Co-Director (Mathematics), ICCS

Colm-cille is Professor of Environmental and Industrial Fluid Dynamics and Head of the Department of Applied Mathematics and Theoretical Physics at the University of Cambridge. He is Co-Director (Science) of the Institute of Computing for Climate Science (ICCS) and Editor of the Journal of Fluid Mechanics. He is interested in instability, turbulence and mixing in stratified fluids, with a particular recent focus of using a combination of physics-informed and data-driven methods to improve the characterisation and parameterisation of heat transport in the world's oceans.

Daniel Lee

Program Scientist, Schmidt Futures

Daniel is a Program Scientist at Schmidt Futures, where he supports the Virtual Earth Systems Research Institute (VESRI). Dan is a research scientist with 20 years of experience utilizing high throughput and large scale-research approaches toward tackling interdisciplinary scientific problems in neuroscience, genetics, materials science, and chemical engineering. He has a record of leading high-impact research with publications in Nature Neuroscience, Neuron, Advanced Materials, eLife, Science Advances, and the Proceedings of the National Academies of Science. His research has been recognized through several awards, including the NIH K99/R00 Pathway to Independence Award, NARSAD Young Investigator Award, and the Sleep Research Society Outstanding Early Investigator Award. Before Schmidt Futures, he was a Senior Research Associate at the California Institute of Technology and co-founded and led several not-for-profit groups. Dan holds a B.A. in Molecular and Cell Biology from the University of California, Berkeley, a Ph.D. in Neuroscience from the Johns Hopkins School of Medicine, and completed his postdoctoral fellowship in Behavioural Genetics at the California Institute of Technology.

Danny Huang

Programme, Communications and Training Manager, ICCS

Danny is the Programme, Communications and Training Manager for the Institute of Computing for Climate Science and has a background in physics and engineering. Danny values supporting academics and researchers in achieving project success and maximizing impact, and is keen to contribute to the full project life cycle, from proposal development to generating impactful research findings.

David Kamm

PhD Student, M2LInES

David is a PhD candidate at Sorbonne Université, Paris. Throughout both his bachelors degree in physics and masters degree in climate physics, he began to focus more and more on the mathematical formulation of our Earths climate system and its representation in numerical models. David wants to improve current climate models by introducing new ways of parameterising subgrid-scale processes and sees this as an excellent use-case for machine-learning techniques.

Dominic Orchard

Co-Director (Computer Science), ICCS

Dominic is a computer scientist with a broad background in both the theory and practice of programming. He co-directs the Institute of Computing for Climate Science at the University of Cambridge and also holds a Senior Lecturer position in the Programming Languages and Systems group at the School of Computing, University of Kent.

Elliott Kasoar

Research Software Engineer at STFC

Elliott is a Research Software Engineer at the Science and Technology Facilities Council. He is currently developing workflows for machine learnt interatomic potentials to study metal-organic frameworks.

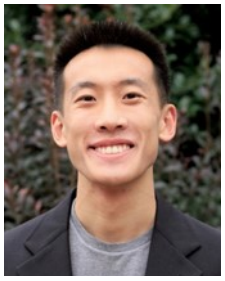
Emily Shuckburgh

Director, ICCS

Emily is Director of Cambridge Zero, the University of Cambridge's major climate change initiative. She is also Professor of Environmental Data Science at the Department of Computer Science and Technology.

Eric Mei

PhD Student, FETCH4



Eric is an incoming PhD student at the University of Washington, where he will be working with Alex Turner and Greg Hakim to study atmospheric methane. He completed a Bachelor's and Master's of Science in Environmental Engineering at Georgia Tech.

Felix Jochum

PhD Student, DataWave

Felix has a master's degree in meteorology and is currently working as a PhD student at the Goethe University Frankfurt. His research focuses on the representation of nonlinear orographic gravity waves in a ray-tracing-based gravity wave parameterization. For this purpose, he is running idealized mountain wave simulations and attempting to relate nonlinear dynamics to linear theory using machine learning techniques.

Giomaria Usai

Research Intern, ICCS

Gio is a maths student at the University of Nottingham. He is going into 4th year, specialising in Mathematical Physics and Applied Maths. His research interest are relativistic hydrodynamics (topic of his master’s dissertation) and oceanography (topic of his current internship). After his MMath he would like to pursue a PhD, possibly in Australia.

Hengdi Liang

Postdoc, CliMA

Hengdi recently obtained her Ph.D. in oceanography from the University of Southern California, and will join Professor Raffaele Ferrari's lab at MIT as a postdoc. She will be a member of the Climate Modeling Alliance (CLiMA), working on ocean biogeochemistry modeling. She is deeply fascinated by the intricate relationship between the ocean and the climate system, and is eager to explore the role of the ocean within this complex dynamic.

Henry Moss

Early Career Advanced Fellow, ICCS

Henry is a machine learning researcher specialising in Bayesian methods. His main interest is in applications where it is important to understand model uncertainty, i.e for climate model calibration or automatic equation discovery.

Ira Shokar

PhD Student, AI4ER, University of Cambridge

Ira is studying for a PhD, under the supervision of Professor Peter Haynes FRS and Professor Rich Kerswell FRS, as part of the Atmosphere-Ocean Dynamics group and as part of the UKRI Centre for Doctoral Training in the Application of Artificial Intelligence to the study of Environmental Risks.

Ira's research is currently focused on using Machine Learning to determine the predictive nature of turbulent fluid flows, specifically investigating the Beta-Plane System - an idealised model analogous to the tropospheric mid-latitudinal regions of our atmosphere, that govern jet streams.

He is using Machine Learning to learn the dynamics of the system in order to produce a forecast or long-term emulation that can dramatically reduce the associated computational cost compared to numerical integration. In learning the underlying dynamics he uses Machine Learning to find a Reduced Order Model to find the inertial manifold that the system lies on, however, the Beta-Plane System is a stochastically forced system with a non-stationary manifold, requiring a probabilistic map.

Ivo Pasmans

Postdoc, SASIP

Ivo is a postdoc at the University of Reading working on the Scale-Aware Sea Ice Project (SASIP). His main research interest is the adaptation of data assimilation methodologies to the peculiarities of the new neXtSIM_DG sea ice model. In particular, how to exploit the features of the discontinuous Galerkin solver in data assimaltion and how to deal with the non-Gaussianity of error distributions using novel machine learning-data assimilation hybrid approaches.

Jack Atkinson

Research Software Engineer, ICCS

Jack is currently a research software engineer at the ICCS. He previously worked as a researcher in the fields of fluid mechanics, atmospheric modelling, volcanology, and space weather at the University of Cambridge and the British Antarctic Survey. His research interests lie mainly in geophysical fluid dynamics, numerical modelling, and computing, though he has also done data analysis and modelling for the sport of archery.

Karan Jakhar

PhD Student, DataWave

Karan is a third-year PhD student at Rice University working in Environmental Fluid Dynamics group. His primary research interest lie in harnessing the power of machine learning techniques to enhance Earth systems modelling.

Kazem Ardaneh

Research Engineer, IPSL climate modeling center

Kazem is a computer scientist. His main interests lie in solving large scale challenging multidisciplinary problems. He has a PhD in computer science focused on developing/adapting massively parallel numerical codes for multi-physics problems and running codes on supercomputers. Currently he works at IPSL/ CMC on adapting the numerical codes for next heterogeneous architectures.

Laura Cimoli

Research Fellow, ICCS

Laura is an ICCS Research Fellow in the Department of Applied Mathematics and Theoretical Physics at the University of Cambridge. She is a physical oceanographer interested in ocean dynamics and their role in the climate system. Her research focuses on deep and abyssal ocean circulation and how it contributes to the sequestration and redistribution of tracers, such as anthropogenic heat and carbon. She mostly employs global hydrographic data and inverse methods to investigate the (poorly observed and modelled) deep ocean and its decadal variability.

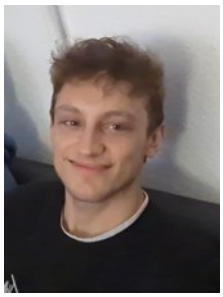
Lee Bardon

PhD Student, CliMA

Lee is interested in using hybrid, multi-scale modelling methods, along with observational data, to better capture the structure and dynamics of complex systems in time and space. More specifically, he seeks to help improve understandings of marine microbial ecosystems and biogeochemical models, and how they are represented in coupled climate models.

Levin Rug

Master Student, TROPOS Leipzig, former guest of CliMA



Levin is a master student of mathematics in Halle (Saale), Germany. In his studies, he focusses on differential equations and optimal control. Differential equations immediately sparked his interest when he came across them, because they describe complex dynamics so elegantly. In general, he is interested in understanding dynamics of nature. Optimal control makes use of our understanding of these equations to achieve certain goals by relying on given laws. This culminates in his work for the Leibniz-Institute for Tropospheric Research (Leipzig), where he is diving into the subject of machine learning in order to accelerate the prediction of concentrations of chemical species. These are determined by high-dimensional, stiff systems of (ordinary) differential equations. Such systems are generally considered too expensive to be included in climate and weather models. In future, he hopes that chemistry might be considered to increase accuracy of climate models and improve our understanding of climate processes.

Marion Weinzierl

Senior Research Software Engineer, ICCS

Marion has a degree in Media Informatics from Ulm University, Germany, and a PhD in Scientific Computing from Technische Universitaet Muenchen, Germany. After her PhD, she did a 3-year postdoc in Solar Physics and Space Weather Prediction at Durham University, UK, and then worked as Computational Scientist at a x-ray technology start-up for two years. She then went back to Durham University to work as Research Software Engineer (RSE) in Advanced Research Computing (ARC), and also took on the role as Research Software Engineering Theme Lead at the N8 Centre of Excellence for Computationally Intensive Research (N8 CIR), where she led the RSE community and RSE leaders network, chaired the user group of the regional supercomputer Bede, co-lead the Bede support group, and co-founded and co-led the N8 CIR Women in High Performance Computing (WHPC) chapter.

After 3.5 years at ARC Durham she has now just joined the RSE team at ICCS, Cambridge.

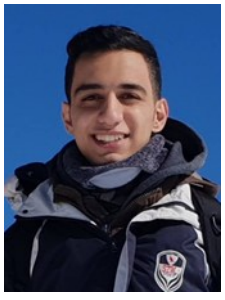
Marla Fuchs

Executive Programme Director, ICCS

Marla is the Executive Programme Director for ICCS, based in the Department of Applied Mathematics and Theoretical Physics within the University of Cambridge. She has worked in a variety of industries including nuclear fuels, inkjet technology, and carbon consultancy. She studied mechanical engineering at Rensselaer, in New York and went on to complete an MPhil in Engineering for Sustainable Development at the University of Cambridge. She has over a decade of experience leading successful programmes within higher education.

Moein Darman

PhD Student, DataWave



Moein is working on interpretability of Deep Neural Nets for turbulent flows.

Nathanael Efrat-Henrici

Software Engineer, CliMA

Nathanael is a software engineer at CliMA as part of the Schmidt Scholars program. He is currently working broadly on the atmosphere model, with a focus on developing and integrating a modal aerosol model. He is interested in the limitations of simple aerosol models and high-performance computing.

Oleksii Bulenok

Student, Microphysics team, CliMA

Oleksii is a final-year graduate student pursuing a degree in Computer Science at Jagiellonian University in Kraków, Poland. Throughout his academic journey, he has dedicated his focus to courses that revolve around modelling, simulations, and machine learning. He enjoys contributing to open-source projects, particularly those with more complex challenges. He is actively involved in open-source geoscientific research software projects implemented in Julia and Python, recently focusing on atmospheric simulations, and leveraging GPU and distributed-memory parallelism in Python (PySDM & Numba-MPI projects).

He enjoys engaging with challenging projects that require technical expertise and offer opportunities to learn from other disciplines, including mathematics and physics. He is also passionate about bridging high-performance computing with clean-code principles in research software engineering and beyond.

Oswald Knoth

Research Adviser (external), CliMA

Oswald is the main developer of the Chemistry-Aerosol-Transport code MUSCAT which is coupled online to the weather forecast code COSMO of the German Weather Service and the Cut-Cell code ASAM (asam.tropos.de). He works with the latest developments in the design of global weather and climate codes. His theoretical research is concerned with the development of multirate time integration schemes for low Mach number compressible flows.

Paul Richmond

Engineering Lead, ICCS

Paul is a Research Software Engineer (RSE) and Engineering lead at the Cambridge Institute of Computing for Climate Science (ICCS). He is also a part time professor of Research Software Engineering at the University. He has a track record of RSE leadership and was one of the first of six EPSRC Early Career RSE fellows in the UK. At Sheffield he built and lead a team of Research Software Engineers (RSEs) who facilitate world leading research across the entirety of the University. He has been heavily involved in the RSE leaders network within the UK and was previously the President of the Society of Research Software Engineering a charitable members organisation where he advocated for the role of RSEs. At Cambridge he leads the RSE team at ICCS where they collaborate the Virtual Earth System Research Institute (VESRI) centres by embedding good software engineering practice.

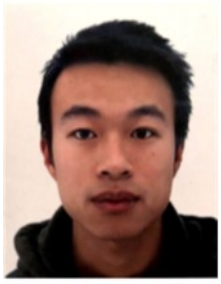
Petr Dolezal

PhD Student, AI4ER, University of Cambridge

Petr is a PhD student at the University of Cambridge, working under the supervision of Prof Keshav and Prof Shuckburgh at the Department of Computer Science and Technology.

His current research focuses on the modelling of renewable electricity systems, large continental-scale power grids, with a specific emphasis on the input weather variables that drive these systems. He aims to address the limitations of probabilistic modelling, which relies on historical weather data and is thus limited to a narrow range of scenarios.

Phan Dang Toai



PhD Student, SASIP

Phan is a second year PhD student in Applied Mathematics at the Laboratoire Jacques-Louis Lions, Sorbonne University in Paris. His research interest are differential equations and their applications to fracture modelling and climate studies.

Rafa Santana

Research Fellow, SASIP

Rafa is a physical oceanographer with expertise in the dynamics of coastal, sub- and mesoscale ocean variability. His focus is to improve our understanding of ocean and sea-ice dynamics using observations, numerical modelling, and data assimilation. Currently, he is a research fellow at The University of Auckland working on the Scale-Aware Sea Ice Project (SASIP). At SASIP, his research targets understanding ocean-ice interactions in Antarctic using the sea-ice model neXtSIM.

Renato Braghiere

Research Scientist, CliMA

Renato is a Research Scientist at the California Institute of Technology and NASA Jet Propulsion Laboratory, where he develops new generation Earth system models, which are required for more assertive climate projections in order to help scientists and policymakers to address issues related to climate change.

His research aims to better represent mechanistic processes of land surface models with the goals of: (i) understanding fundamental controls of land photosynthesis including the radiative transfer in vegetation canopies, as well as root uptake of water and nutrients; (ii) using state-of-the-art process-based models and remote sensing to refine local and global representations of the carbon and water cycles; and (iii) developing more informed projections of plant growth, especially under future climate scenarios.

Sam Madge

Foundation Scientific Software Engineer, DataWave

Sam is a Scientific Software Engineer with a background in physics working for the Met Office. His current work is on emulating parameterisations and data assimilation with machine learning. Although he has also worked with NHS data to help create a liver disease case finding algorithm and helped in Deepmind's research nowcasting research. He is further interested in trying to exploit XR for visualising data and training meteorologists as well as other potential uses.

Sam Oliver

Programme Administrator, ICCS

Sam is the Programme Administrator for the Institute of Computing for Climate Science. He is responsible for the operational aspects of ICCS, and largely oversees the organisation of our events, including the summer school.

Simon Clifford

Research Software Engineer, ICCS

Simon has been a RSE at Cambridge and the ICCS for 18 months. Originally trained as a chemist, he was a researcher, systems administrator and currently works as a research software engineer.

Simon Driscoll

PhD Student, SASIP

Simon is researching machine learning and emulation of sea ice processes, as part of the SASIP project, based at the University of Reading. He has formal training/qualifications in mathematics, mathematical modelling, as well as a doctorate in physics from the University of Oxford, and previous experience in geoengineering and volcanic eruptions. He is very excited about all things machine learning!

Sizhe Chen

PhD Student, University of Cambridge

Sizhe is a physical geographer. He has a background in atmospheric and climate science. He is currently a first year PhD student in the Department of Geography.

His research aims to apply machine learning methods and use climate proxy fingerprints to generate historical AMOC strength. The Atlantic meridional overturning circulation (AMOC) is a key driver of the global climate system. Despite its importance, direct and continuous mooring measurement of AMOC only started in 2004, which is too short to quantify multidecadal and longer-term variations. Climate-proxy fingerprints have been widely seen as a useful tool to reconstruct AMOC strength beyond the instrumental period. In his project, he is planning to use the AMOC climate-proxy fingerprints and machine learning methods to reconstruct AMOC at high temporal resolution for the past 2000 years.

Sophie Turner

PhD Student, AI4ER, University of Cambridge

Sophie is a first year PhD student in atmospheric chemistry at the University of Cambridge. She is attempting to improve the efficiency of atmospheric photolysis simulations with the Met Office's climate models.

Tom Meltzer

Senior Research Software Engineer, ICCS

Tom is a Research Software Engineer with a background in atomic and molecular physics. He has been developing scientific code for over 10 years and is particularly interested in high performance computing.

Zhang Huanyuan

Postdoc, LEMONTREE

Zhang is a post-doctoral researcher at the University of Oxford. He researches plant functional traits, African forests restoration, African forest carbon cycles and is the author of the CRAN package.

Zourkalaini Boubakar

PhD Student, INRIA Paris

Zourkalaini is a PhD Candidate at INRIA-Paris joint with Sorbonne University. He works with Prof. Claire Monteleoni in the Artificial Intelligence for Climate Change & Environmental Sustainability within Claire's Climate & Machine Learning Boulder-Inria Team. He graduated with an MSc Informatics for Climate Change from the West African Science Service Center on Climate Change and Adapted Land Use in collaboration with Joseph Ki-Zerbo University. Before joining INRIA, he was a Research Assistant in Data Science and Artificial Intelligence at WASCAL Competence Center within the Data Management Dept. Team and has a Bachelor's degree in Computer Science from the University of Lomé.

His research interests revolve around the intersection of climate science and machine learning, particularly, machine learning research for renewable energy forecasting and planning. His research focused on renewable energy forecasts and the impacts of extreme weather on future demand. His long-term goal is to build innovative and efficient AI-based solutions for sustainable development.

Logistical Information

Venues

A map of all venue/accommodation locations can be found on the 2023 ICCS Summer School webpage.

Contacts

Email contact during the summer school: iccs@maths.cam.ac.uk

Slack

We have created a channel for virtual announcements and networking on Slack. This is where we will make announcements throughout the week.

Code of conduct

The open exchange of ideas and the freedom of thought and expression are central to the aims and goals of the summer school; these require an environment that recognizes the inherent worth of every person and group, that fosters dignity, understanding, and mutual respect, and that embraces diversity. We are dedicated to providing a safe, hospitable, productive, and harassment-free and discrimination-free environment for everyone attending, regardless of ethnicity, religion, disability, physical appearance, gender, or sexual orientation. In particular, we expect all the participants to use welcoming and inclusive language, to be respectful of differing viewpoints and experiences, to gracefully accept constructive criticism, to focus on what is best for the community, and to show empathy towards other community members. We expect everyone to communicate openly with respect and consideration for others, treating each other as equals. It is important to remember that a community where people feel uncomfortable or threatened is neither healthy nor productive.

There is no tolerance for unwelcome, hostile, or disruptive behaviour or speech that intimidates, creates discomfort, or interferes with a person's participation or opportunity for participation at event. Participants asked to stop any harassing behaviour are expected to comply immediately. Participants violating these standards may be expelled from this and future events.

If you witness or are subject to unacceptable behaviour, please talk to one of the ICCS leadership: Dominic Orchard or Marla Fuchs.

Travel	Please see our travel information for travelling to/from the summer school via air, train and coach.
From Cambridge train station	There is a taxi rank outside the main Cambridge station and buses run frequently between the station and city centre (to/from Emmanuel Street/St Andrew's Street). The 'Universal' bus service route (see above) also picks up/sets down at Cambridge train station.
Accommodation	Attendees who have requested accommodation at Churchill College during registration would have received an e-mail on 22nd June from Sam Oliver with the information they need.
Catering	Catering is fully vegetarian. Those who submitted further dietary requirements during registration would have received an e-mail on 27th June from Sam Oliver with regards to how they will be accommodated.
Staff	Staff and volunteers will be wearing red staff lanyards across the week to identify themselves. Please ask them for any help.
Arriving on 10th July	If you're arriving on Monday 10th July, we will supply spaces for you to leave your bags at the Centre for Mathematical Sciences.
Fire alarms	If fire alarms go off in the CMS, the assembly point is on the lawn outside of reception. If they go off in the Computer Lab, the assembly point is outside the front of the building.
First aid	In both the CMS and the Computer Lab, please go to the reception if you have a first aid emergency.
Covid-19 precautions	While no precautions are mandatory, we ask that all attendees respect the caution that others may be exercising. We will provide Covid tests for those who wish to take them, and we will be monitoring the CO2 level in MR4 and ventilating appropriately.

Water

There is a water cooler for refilling water in the common room for Pavilion D, accessible through the Central Core.

Timing

Timing is key for the taxis to the fireside chat on Tuesday and the formal dinners – please don't be late!

Dress code

There is no dress code for the week, with the exception of the Corpus Christi dinner on the Wednesday evening, where the recommended dress code is smart casual.

Zoom links

Zoom link for all sessions in MR4:

https://maths-cam-ac-uk.zoom.us/j/96046041141?pwd=aGdRTWZGOGlVUkgyZ3ltckVCNE0wZz09

Zoom links for all sessions in MR5:

https://maths-cam-ac-uk.zoom.us/j/95187162632?pwd=R3FMaXNkODNwaTlYRDdwZ29kZDNXZz09

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