



UNIVERSITY OF LEEDS

CANDIDATE BRIEF

Research Fellow in Machine Learning for African Storm Prediction, National Centre for Atmospheric Science (NCAS), Faculty of Environment



Salary: Grade 7 (£37,099 - £44,263 p.a. depending on experience)

Reporting to: Professor Doug Parker

Reference: ENVNC1019

Fixed term for 24 months to complete specific time limited work.

Location: University of Leeds (with scope for hybrid working)

We are open to discussing flexible working arrangements.

Overview of the Role

Tropical storms are inherently chaotic, on timescales of a few hours, and therefore daily forecasts of rainfall always have uncertainty. For this reason, “nowcasting” – the communication of real-time observations and short-range (0-6 hour) predictions, is vitally needed across the African continent. However, very few people in Africa currently benefit from nowcasting information.

Through the application of innovative meteorological research to harness satellite data, we are already delivering nowcasts of high-impact storms to Tropical Africa. The new methods you create will lead to improved nowcasting information, released in real time on existing online platforms (<https://science.ncas.ac.uk/swift/> and <https://eip.ceh.ac.uk/hydrology/sub-saharan-africa/nowcasting/>) and the FASTA smartphone app being supported by the National Centre for Atmospheric Science (NCAS) at Leeds, and the UK Centre for Ecology and Hydrology (UKCEH). In this way the results of your research will be used to deliver real-time information to users in Africa.

In delivering the real-time nowcasting services, our aim is to provide the capabilities needed for African national weather services and private sector companies to enhance their delivery of weather forecasts and ensure access to high-quality weather information for African populations. We have formal partnerships with a number of African weather services and other organisations. These partners will collaborate in this project, particularly in evaluation and implementation of methods, but also in our support for capacity-building in Africa. Ultimately, better preparedness and informed decision-making using nowcasting information will improve climate resilience and save lives and livelihoods.

The project is led by the UK’s National Centre for Atmospheric Science (NCAS) at the University of Leeds and will be a collaborative enterprise between the Schools of Mathematics, Computing and Earth & Environment in Leeds, and the UK Centre for Ecology and Hydrology (UKCEH) in Wallingford. Our collaboration with UKCEH is long-standing and has led to many successful outputs over the years.

Main duties and responsibilities

As a Research Fellow in Machine Learning for African Storm Prediction, you will conduct original research leading to an improvement in the fundamental science



underpinning operational storm nowcasting for Africa. In particular, we aim to develop machine-learning methods to address the challenging problem of prediction of storm initiation. Recent research has shown the importance of a number of physical “drivers”, including soil moisture patterns and boundary-layer convergence lines, which combine to cause the initiation of storms. Through a combination of novel real-time observations and use of weather prediction models, we will apply this knowledge to the creation and evaluation of machine-learning methods.

A key element of the work will be to innovate in the creation and application of verification and evaluation methods for the predictions. These approaches will be informed by our long-standing links with stakeholders and organisations in Africa.

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You will work with other project members in Leeds and externally to create new machine learning-based forecasting methods and implement these in our real-time delivery of products for Africa.

- Practical implementation of algorithms for real-time nowcasting, collaborating with others in the project to apply our theoretical and observational learning;
- Conducting original research on the fundamental principles underlying the nowcasting of tropical storms with machine learning. This will involve:
 - Application of machine-learning methods to the prediction of convective initiation, exploiting a range of observable “drivers” of initiation;
 - Innovating in the statistical verification and evaluation of nowcasting products;
- Preparing scientific papers and reports;

You may also be involved in the following:

- Contributing to capacity-building with African partner organisations;
- Pro-actively seeking funding for expansion of the activity, working with other members of the team to write proposals to solicit funding.

These duties provide a framework for the role and should not be regarded as a definitive list. Other reasonable duties may be required consistent with the grade of the post.



Qualifications and skills

Essential

- A PhD in a relevant field, or equivalent professional experience, with demonstrated expertise in both the theory and application of a broad range of machine learning approaches;
- Evidence of an appetite for solutions-focussed research and innovation;
- A good track record of written communication, such as leadership of scientific papers;
- The ability to communicate effectively in groups and in formal presentations;
- Evidence of the ability to work as part of a team.

Desirable

- Experience of meteorology and forecasting;
- Experience of deep-learning methods;
- Willingness to travel to Africa to liaise with clients and partners.

Additional information

The NAIAR project:

Tropical storms are very unpredictable, changing very rapidly - explosively - over timescales of an hour or so. For this reason, predictions are naturally very uncertain. Very often, the most important information people need regarding a storm hazard is what is happening now, and some information about how the storm likely to move and develop in the next couple of hours. This process is called "nowcasting" and in the USA, nowcasting of tornados saves many lives every year. The lack of weather radars in most African countries means that nowcasting is almost completely absent, but during recent projects (GCRF African SWIFT and NFLICS), we have shown that satellite methods can provide useful nowcasting of storms too. The new Meteosat Third Generation (MTG) satellite will provide even better data coverage, from about 2024, at higher frequency and finer spatial scale. There is a tremendous opportunity to innovate in the creation of new nowcasting methods and communicate them to weather services, organisations and the public across Africa.

While existing satellite nowcasting methods have some skill, they also have major shortcomings. They work by extrapolating observed patterns forward in time, but are not constrained to obey the laws of physics, and unphysical predictions commonly



occur. The most challenging problem in storm nowcasting is to predict the initiation and subsequent development of new storms in future: there is no accepted way to do this, and our considerable knowledge of the physics of initiation is not being exploited. It takes about 30 minutes to generate these nowcasts, and when their accuracy is degrading after an hour or two, their use becomes limited. The NAIAR project aims to create useful 6-hour nowcasts.

Nowcasting is an obvious application where new data-science methods, in particular machine learning, have the potential to make a massive impact. NAIAR will conduct fundamental research to understand and improve the performance of these data-driven solutions, on the basis of the underlying physics and fluid dynamics of storms. For instance, existing methods can extrapolate an image of a storm forward in time using machine learning to predict its future movement or growth, but the result may grow and be distorted in shape in a way which is incompatible with the laws of physics. These unrealistic predictions are obvious to an experienced forecaster but ordinary users of the data will be vulnerable to the consequences of inaccurate nowcasts. When nowcasts are used to predict hazards such as floods, unphysical solutions could lead to bad decisions.

NAIAR aims to combine machine-learning, theoretical fluid dynamics, operational prediction and meteorology, to create innovative approaches to nowcasting of tropical storms. The project will develop ML methods which are fast, and which obey physical laws, like the weather prediction models. Recent advances in physical understanding, and the new data offered by MTG, will be used to create statistical nowcasts of storm initiation and its subsequent evolution. The project will apply these methods through NCAS and UKCEH's existing web-based and mobile-phone communication portals delivering information to Africa, and support colleagues in Africa to exploit the methods locally.

Weather prediction research at the University of Leeds

The University of Leeds is recognised to be (e.g. Shanghai Index) one of the top centres in the world for research into weather and climate. It is a vibrant and multidisciplinary research centre, and an excellent environment in which to build a career in weather and climate science.

This project is led by the UK National Centre for Atmospheric Science (NCAS), a NERC Centre hosted at the University of Leeds. The project also involves the UK Centre for Ecology and Hydrology (UKCEH), in Wallingford. Our collaboration with



UKCEH is long-standing and has led to many successful outputs over the years. We also collaborate strongly with the UK Met Office (MOAP): project Co-Investigator John Marsham is Chair of our Met Office Academic Partnership (MOAP), and a number of Met Office staff are based with us in the University.

Within the University of Leeds, our Priestley Centre for Climate Futures coordinates multidisciplinary and transdisciplinary research across campus. The Leeds Institute for Fluid Dynamics (LIFD) also coordinates interdisciplinary research and teaching, with various application areas. We have particular strength in the application of climate science to benefit developing countries in the Global South, and won the Queen's Anniversary Prize for 2021 for our work in this area. Our work on storm prediction in Africa, which is the focus of this project, was one important part of that award.

Within Leeds, this project will be conducted in partnership across the Schools of Earth & Environment (SEE), Mathematics and Computing. There are already strong links between these schools, with a number of joint projects and studentships. The project's Principal Investigator, Doug Parker, has a joint position between SEE and Mathematics, and is Coordinator of NCAS Science at Leeds.

The Faculty of Environment has received a prestigious Athena SWAN silver award from [Advance HE](#), the national body that promotes equality in the higher education sector. This award represents the combined efforts of all schools in the Faculty and shows the positive actions we have taken to ensure that our policies, processes and ethos all promote an equal and inclusive environment for work and study.

Find out more about the [National Centre for Atmospheric Science](#) and [its relationship with the School of Earth and Environment](#)

Find out more about the [FAAM Airborne Laboratory](#)

Find out more about the [School of Earth and Environment](#)

Find out more about the [Faculty of Environment](#)

Find out more about our [Research and associated facilities](#)

Find out more about [equality](#) in the Faculty.



Working at Leeds

We are a campus based community and regular interaction with campus is an expectation of all roles in line with academic and service needs and the requirements of the role. We are also open to discussing flexible working arrangements. To find out more about the benefits of working at the University and what it is like to live and work in the Leeds area visit our [Working at Leeds](#) information page.

Our University

At the University of Leeds, we are committed to providing a culture of inclusion, respect and equity of opportunity that attracts, supports, and retains the best students and staff from all backgrounds. Whatever role we recruit for we are always striving to increase the diversity of our community, which each individual helps enrich and cultivate. We particularly encourage applications from, but not limited to Black, Asian, people who belong to a minority ethnic community; people who identify as LGBT+; and disabled people. Candidates will always be selected based on merit and ability.

Candidates with disabilities

Information for candidates with disabilities, impairments or health conditions, including requesting alternative formats, can be found on our [Accessibility](#) information page or by getting in touch with us at foehr@leeds.ac.uk.

Criminal Record Information

Rehabilitation of Offenders Act 1974

A criminal record check is not required for this position. However, all applicants will be required to declare if they have any 'unspent' criminal offences, including those pending.

Any offer of appointment will be in accordance with our Criminal Records policy. You can find out more about required checks and declarations in our [Criminal Records](#) information page.

