**Call Reference: DN619854**

*Met Office tendering on behalf of BEIS.*

**To register your interest, see notes at the end of this page. Registering interest requires no proposal detail at this stage and carries no obligation to bid.**

**Please note that this Expression of Interest is open to UK operating and registered organisations.**

**Grant Funds for the period 1st April 2023 – 31st October 2024**

**Expressions of Interest for: Strategic Priorities Fund (SPF) ExCALIBUR**

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| **Title** | **Amount** | **fEC @100%** | **fEC @ 80%** |
| Joint UK Land Environment Simulator (JULES) model design | **£300,000** | £300,000 | £240,000 |

**Key Dates**

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| **Estimated Publish of Call:**  *(Start of bidding period).* | **w/c 11th July 2022**  *A notification email will be sent to parties who have formally registered their interest by way of clicking on the ‘Register Interest’ button displayed below the opportunity on the ProContract portal* |
| **Estimated Bidding Period:** | **Monday 11th July 2022 – Friday 7th October 2022** |
| **Estimated Award of Call:** | **w/c Monday 23rd January 2023** |
| **Estimated Delivery Period:** | **Year 1: 1st April 2023 – 31st March 2024**  **Year 2: 1st April 2024 – 31st October 2024** |

**Background to the ExCALIBUR Programme**

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Radical changes to supercomputer architectures are on the horizon. The current simulation codes, that much of UK science relies on, are designed for current supercomputer architectures. These codes will, at best, not be able to fully exploit the power that the supercomputers of the mid-2020s will deliver; at worst, they will run slower on those machines than they do now. Future computers will be more energy efficient and so the longer we rely on the current approach, the more expensive the solution will be. Therefore, it is essential that we invest now in redesigning those simulation codes so that they perform well on the future generations of supercomputers.

ExCALIBUR will meet this challenge by delivering research and innovative algorithmic development to redesign the high priority simulation codes to fully harness the power of future supercomputers across scientific and engineering applications. It will achieve this by bringing together an unprecedented range of UK domain experts, mathematicians and computational scientists who will identify common issues and opportunities in the high priority simulation codes and focus their combined scientific expertise and resources to accelerate toward interdisciplinary solutions.

The programme objectives have been designed to specifically address the benefits sought:

1.            Efficiency - The UK’s most important scientific simulation codes will be able to harness the power of the supercomputers of the mid-2020s resulting in an increase in scientific productivity for a given investment.

2.            Capability – Capitalising on this efficiency will enable the UK to continue to push the boundaries of science across a wide range of fields delivering transformational change in capability.

3.            Expertise – A new, forward-facing, interdisciplinary approach to RSE career development will position the next generation of UK software engineers at the cutting-edge of scientific supercomputing.

ExCALIBUR is built around four pillars: separation of concerns; co-design; data science; and investing in people. These pillars describe the fundamental principles that guide the development of research under ExCALIBUR and are designed to ensure that the outcomes are future proofed against the constantly evolving landscape of hardware design. It will be delivered through six main activities: the redesign of a core set of simulation codes (use cases) chosen to span a wide range of science domains; knowledge integration across the programme through widely applicable cross-cutting themes; application of learning from these activities to a second wave of use cases; exploratory research to identify and develop emerging high-performance algorithms in areas with significant potential impact; an interdisciplinary Research Software Engineer knowledge integration activity; and an annual capital investment to support the development of novel test beds to enable co-development with industry.

**Summary of Requirement:**

**Activity description:**

JULES (<https://www.metoffice.gov.uk/research/approach/collaboration/jwcrp/jules>) is a community-based surface model that is used in weather and climate modelling to determine the exchange of energy, water and carbon between the surface and the atmosphere, as well as predicting the evolution of surface and sub-surface land states such as temperature and moisture. It is an essential model component across all time and spatial scales and includes critical processes such as the terrestrial water and carbon cycles. As the majority of weather and climate impacts occur on the land it is also a vital component to help understand extreme impacts and risks, providing information for weather and climate services on mitigation, adaptation and infrastructure planning. JULES can be run on its own (stand-alone) using an atmospheric forcing dataset or as part of an atmospheric model (coupled) which includes all of the land/atmosphere feedbacks. Currently a different technical solution is used for these two applications, which means that new scientific innovations that are often developed in the stand-alone system are not easy to implement within the coupled system, introducing a barrier to new scientific capabilities and understanding. This activity will seek to unlock the massive potential of the wider scientific community through the separation of concerns between the scientific understanding and development of the JULES code base, and the technical coupling and control level code required to run the science.

In additional to the technical coupling challenges, the current computing architecture limits some of the more computationally expensive applications. For example, the spin-up of soil carbon states is restricted to low resolution domains of the order of 100s of km, because it can take 100s to 1000s of years of model simulation for these states to converge.  However, each point in the domain evolves independently from the others, so utilising exascale computing and GPU technology could deliver step changing capability for such applications.

Moreover, a well-designed technical coupling framework along with optimal use of exascale computing will enable new massive computationally expensive components to be utilised, such as very high-resolution inundation models. These components run at resolutions of the order of 1m using time-steps of the order of 1s to determine how environments, such as cities, that have been inundated by water will evolve.  This could have a step change on impact and hazard warnings for such environments.

These developments will be achieved in two stages. The first will develop a common interface between the JULES and the LFRic (<https://www.metoffice.gov.uk/research/approach/modelling-systems/lfric>) code bases to enable a seamless component coupling and develop a stand-alone JULES app by leveraging the LFRic infrastructure to enable a separation of concerns.

The second stage will develop the LFRic infrastructure to ensure that the stand-alone JULES driver includes all of the current JULES control level functionality, including sub-time-stepping for atmospheric forcing data and flexible I/O, and enable the system to run on exascale computing, utilising GPUs. These developments will be used to demonstrate the potential step change in speed-up that can be obtained for a global soil carbon spin-up application at 0.5-degree resolution.

Finally, a desirable outcome will be the investigation and recommendation for the most appropriate method for facilitating the coupling of multiple land components, to enable the inclusion of models with more complex meshes, such as hydrological response unit domains, or which are computationally more demanding, such as city scale inundation modelling. This will enable community initiatives such as Hydro-JULES to be easily coupled into the more complex weather and climate models.

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| **Anticipated outputs or results:** This activity will: develop a JULES app that only builds the surface and control parts of the LFRic infrastructure, hence minimising the overhead to the community; evaluate the new system within a number of standard testing frameworks; develop NGMS software infrastructure to include current JULES control level functionality; enable the JULES mini-app to exploit exascale computing with the use of GPUs; evaluate the speed-up that for a global soil carbon spin-up application at 0.5 degree resolution using exascale computing; assess and evaluate options for coupling multiple land components and make recommendations that enable the inclusion of larger compute components to be achieved. |

**Eligibility**

The following criteria must be met by UK organisations submitting a bid against Strategic Priorities Fund (SPF) funded Calls to be eligible to apply or be awarded funds against this Call:

* Must be a UK operating and registered organisation.
* Consortium bids are eligible; a lead partner must be nominated for payment and agreement purposes and all parties must be UK operating and registered organisations. Details of all consortium members must be provided.
* Funding can only be used to fund new activity for the costs incurred.
* The activity must last the full duration of the Grant Award Term specified
* There must be a willingness to work with Authority and other organisations and individuals associated with the SPF Programme.

**How to Apply:**

The above Expression of Interest is advertised on the Met Office ProContract e-Tendering portal called ProContract. To access and register your interest you will need to log onto the ProContract portal via this link: tenders.metoffice.gov.uk

You may need to search for the Call reference: **DN619854**

**You will need to register your company (if you have not already done so) and register your interest against the opportunity before you are able to access the tender documents.**

If you require guidance or ‘how to’ instructions – see the supplier manuals on the right-hand side of the supplier home page.

**Online Discussions between Bidders and the Met Office:**

There is a Discussions function on ProContract which shall be used to provide all further information regarding this opportunity including any changes to time scales, scope or clarifications. This function must be used by bidders to submit all clarification questions.