NATURAL ENVIRONMENT RESEARCH COUNCIL

Storm Risk Mitigation

Call for proposals

Closing date 16:00 on 25th March 2010

1. Summary

Proposals are invited for a major new research programme on **Storm Risk Mitigation through Improved Prediction and Impact Modelling**. This £4.9m programme directly relates to the delivery of NERC Natural Hazards Theme – *to enable better forecasting and mitigation of hydro-meteorological hazards* – and UK Government's strategic goals with respect to the adaptation to, and mitigation of, climate change. This programme will contribute towards Living With Environmental Change (LWEC) objectives.

This call is for proposals to address each of the three main deliverables of the programme. Up to £4.2m is available for the call, with up to £2.1m to address Deliverable 1 (Numerical Weather Prediction) and up to £1.05m to address each of Deliverable 2 (Climate Science) and Deliverable 3 (Impacts). It is expected that three consortium-style grants will be funded, one to address each of the deliverables.

Proposals for this call are invited from eligible UK researchers; see the NERC Research Grants Handbook for eligibility criteria.

The closing date for proposals is 16:00hrs on 25th March 2010

2. Background

Rationale:

Storms have had an increasing social and economic cost over recent years and are likely to be the main cause of loss of life or assets in the UK over the next few decades. The negative societal impacts caused by adverse weather are disproportionately influenced by extremes. Furthermore, with climate change, the costs associated with storm impacts are likely to increase. This has highlighted the need to improve the quality of forecasting of storm track and intensity (a) in the short-term (0-48 hours) through numerical weather prediction (NWP) and (b) in the long-term (over decades and with evolving climate change) through improved climate prediction. On both timescales there is a need to improve forecasting of impacts.

Several research gaps need to be filled with regard to the prediction of mid-latitude storms, particularly extra-tropical cyclones, to inform short-term mitigation strategies against the impacts of hazardous weather such as high winds and heavy rain. Given the high degree of influence of storms on other natural hazards—such as riverine, groundwater, pluvial and coastal flooding, ground stability (including landslides) and coastal erosion—in addition to their effects on the built environment, ecosystems and agriculture, there is a requirement for

improved linkage with impact models to better inform policy and enable preventative measures to minimise risks associated with such storms. There is a need to improve the way in which information flows between numerical weather prediction, climate models and impacts models.

This programme has been structured into three interconnected deliverables. The first deliverable is particularly focussed on increasing our understanding of, and capability to predict, structures at the mesoscale in extra-tropical cyclones, to help improve quality of forecasting in the short-term through numerical weather prediction. Cyclones have a major role in producing large rainfall accumulations over short periods (the order of a day), leading to fluvial and some pluvial flooding. They are also central to both direct wind damage and coastal flooding through storm surges and waves. The second programme deliverable is focussed on increasing our understanding of the role of key physical processes within extra-tropical cyclones and how these will be affected by climate change i.e. over the long-term. Other storms which also cause serious impacts, such as mesoscale convective systems, are not included in this programme. The third deliverable from the Storms programme will focus on determining how to use more effectively the finest resolution achievable from numerical weather predictions (about 1 km) in order to deal with impact modelling issues such as downscaling and sensitivity of model outputs for catchment or coastal applications, or both.

The research programme is being commissioned within the context of widespread, substantial, and growing international funding for storm research (e.g. USA, EU countries and Japan), and an essential part of the programme will be engagement with international activities, such as the WMO THe Observing system Research and Predictability EXperiment (THORPEX) Programme.

NERC Strategy:

The programme has been developed as part of the Natural Hazards Theme and will address the need to increase the capability to forecast the impacts of hazardous weather (in particular heavy rain, and high winds) and thereby contribute to meeting one of the three foundation areas of the Natural Hazards Theme Action Plan: to enable better forecasting and mitigation of hydro-meteorological hazards.

The programme will directly address NERC Natural Hazard strategy challenges relating to storms, floods, coastal erosion, and improvement of integrated risk assessment and scientific advice. The storm challenge has the highest priority in the Natural Hazards Theme Report (http://www.nerc.ac.uk/research/themes/hazards/), and this programme is aimed at improving:

(i) predictive capability of models with respect to extreme wind and precipitation;
(ii) knowledge about the change in the frequency and intensity of storms under global warming conditions; and
(iii) improved knowledge of the coastal sea surface response to extreme storm conditions and how well the current generation of models deal with it.

It is anticipated that this Research Programme will make a significant contribution to the Living With Environmental Change programme, specifically Objectives A - to build effective mitigation, adaptation and resilience to climate change, including preparedness for changes to the intensity and frequency of extreme events; and D – to protect human, plant and animal health by predicting how [..] hazards and other factors will alter under environmental change.

Programme objective and deliverables:
The objective of the programme is to improve short and longer term forecasting of storms and their impacts on catchments and coasts.

This objective will be achieved through three integrated deliverables:

Deliverable 1: Numerical Weather Prediction (NWP)—increased understanding of, and capability to predict, mesoscale structures in extra-tropical cyclones.

Deliverable 2: Climate Science—improved understanding of how climate change and natural variability will affect the generation and evolution of extra-tropical cyclones.

Deliverable 3: Impacts—improved ability to use numerical weather predictions and climate model output for storms impact modelling.

3. Scope of the call

Up to £4.2m is available for this call, where this is 80% of the full economic cost, with up to £2.1m to address Deliverable 1 (Numerical Weather Prediction) and up to £1.05m each to address Deliverables 2 (Climate Science) and 3 (Impacts).

Proposal requirements:

Proposals are required to:

- address one deliverable per application; the deliverable being addressed must be clearly identified in the application;
- address all of the questions within that particular deliverable (see detail below and Science Plan);
- include milestones and deliverables that the project can be monitored against;
- include details of coupling activities to the other deliverables within the programme;
- contain at least two eligible institutions;
- be of up to three years in duration, unless exceptional reasons can be given that are accepted and agreed by the moderating panel;
- be developed in the format of costed work-packages; and
- have a grant start date of September 2010.

The inclusion of tied studentships and short post doctoral positions is welcomed.

Proposals are invited to address the following three deliverables:

Deliverable 1: Numerical Weather Prediction—increased understanding of, and capability to predict, mesoscale structures in extra-tropical cyclones.

The focus of this deliverable is on the mesoscale to convective scale (roughly 1-50 km) within extra-tropical cyclones, because this is the scale of many organised structures in such cyclones that are not fully understood. As a result of this, and the paucity of much routine observational data, NWP models currently show relatively poor predictive capability at these scales. This resolution is at the coarse end of that needed for impact models.

Proposals should address the following questions.

(a) *How are potential vorticity and moisture anomalies generated in cyclonic storms, what is their morphology, and what consequences do they have for the weather?*
This should provide initial guidance for measurement case studies and new parameterisations for modelling/data assimilation. It should incorporate high-resolution modelling, results from previous measurement case studies and longer-term datasets, and eventually the results of the measurement part of this programme. Research on cloud microphysics is included where there are direct consequences for diabatic heating rates.

(b) How can these physical processes be parameterized for NWP, both at very high horizontal resolution (~1 km) and at resolutions that are more appropriate for longer-range prediction (10-20 km)?

(c) *What is the real-world structure of cyclonic storms at the meso-convective scale?* The focus should be on both detailed case studies using the FAAM aircraft and other high-resolution measurements, and longer-term studies using routinely-acquired data to place the case studies in context. The outputs of this question should feed directly into the other two questions for this deliverable. The initial and follow-up planning of the measurement case studies should be guided by the outputs of the other questions in this deliverable.

(d) *How can we improve numerical weather prediction models and data-assimilation methods for better "nowcasts" and forecasts of cyclonic storms at meso to convective scale?* The answers to this question should guide the measurement case studies from a model weakness assessment, and are expected to concentrate on balance issues and nonlinearities in the data-assimilation problem. This should feed on the new measurements and the new sub-grid parameterisation schemes.

Proposals are encouraged to link with LWEC partners, particularly the Met Office, and international programs such as THORPEX.

Links to Deliverable 2 (Climate Science): The NWP deliverable should inform the climate science deliverable by identifying the physics that plays a role at resolutions below roughly 50 km, which is sub-grid scale for climate models.

Links to Deliverable 3 (Impacts): The NWP deliverable should provide information on the probability density function structure of precipitation and wind at the smallest resolution. It should communicate with the impact studies to be aware of output useful for them.

Deliverable 2: Climate Science—improved understanding of how climate change and natural variability will affect the generation and evolution of extra-tropical cyclones.

Understanding how climate change will affect extra-tropical cyclones is of crucial importance. There remains large uncertainty in current predictions of storm activity and limited understanding of the key physical processes involved. Proposals should address these issues, with a focus on how the key physical processes within cyclones will respond to anthropogenic forcing. It is envisaged that high-resolution models, capable of resolving the structures of extra-tropical cyclones, will play a central role in addressing this deliverable. Climate change will also affect extra-tropical cyclones through changes in the mean environment within which storms evolve (for example, temperature gradients, wind shear and moisture). However, there is considerable uncertainty in the predictions of these changes. It will be important to assess the implications of this uncertainty for predictions of changes in extra-tropical cyclone characteristics. In addition, the potential for changes in extra-tropical cyclones to influence large-scale atmospheric circulation is of great relevance.

Many of the impacts of extra-tropical cyclones arise from small-scale structures that are not well represented in current climate models. Proposals aiming in part to assess the consequences of this for climate prediction would be particularly welcome.

Proposals should address the following questions.

(a) How will climate change affect the generation and evolution of extra-tropical cyclones? How large are these effects compared to natural variability?

(b) Which physical processes are most important, and which predicted changes are most robust?

(c) How important are the features and processes that climate models poorly represent due to their limited resolution?

Proposals should highlight links to other national activities, particularly those of LWEC partners and international programmes, for example CMIP5 (the Fifth Coupled Model Intercomparison Project).

Links to Deliverable 1 (numerical weather prediction): By failing to resolve mesoscale structures in extra-tropical cyclones, climate models poorly represent impacts at small spatial scales. The outcomes of the NWP research should contribute to an assessment of this issue.

Links to Deliverable 3 (Impacts): One of the key links between the impacts and climate science deliverables in this programme is addressing uncertainty in climate model projections. Central to this is identifying model outputs that may be particularly robust across climate model projections, but still informative for climate impacts studies.

Deliverable 3—improved ability to use NWP and climate model output for storms impact modelling.

There is a need to improve the forecasting of storm impacts over both the short term (numerical weather prediction) and longer term (climate projections) timescales. Storm impacts (i.e. the consequences of heavy or persistent rainfall or high wind, such as riverine, groundwater, pluvial and coastal flooding; ground stability, including landslides; and coastal erosion) demand that impact models and storm predictions are better linked in order to better inform policy and enable preventative measures to mitigate risks associated with such storms. Limitations in current modeling techniques include aspects such as (i) the accuracy of extreme wind forecasts used to force surge and wave models for coastal flooding, (ii) incomplete understanding of the air-sea momentum transfer process, and (iii) the appropriate and integrated post-processing of NWP and climate predictions of storm precipitation for riverine flood predictions. Satisfactory solutions will require impact modellers, weather forecasters and climatologists to work together. Development of novel methodologies may be appropriate.

Research on storm impact modelling should use the current generation of numerical weather prediction and climate model outputs, but could also take advantage of upcoming developments in these models through a staggered programme start, i.e. developments arising from Deliverables 1 and 2. A key requirement for Deliverable 3 is to demonstrate benchmark methodologies for analysing storm impacts that are transferable to next generation NWP and climate change products.

Proposals should address the following questions.

(a) *What storm impact model (or multi model cascade) features, and catchment and coastal* processes*, are the most sensitive to projections of future changes in storms, and thus how robust/uncertain is our understanding of current and future storm impact risk?*

(b) *How can probabilistic future climate and NWP model output best be used for meaningful predictions of storm impacts for catchment and coastal management?*

(c) *How can storm impact models be improved with next generation NWP and climate models, (such as improved prediction of extreme wind for surge and wave modelling, or improved extreme rainfall prediction for fluvial flood modelling)?*

Proposals are expected to include cross-cutting techniques and targeted impact modelling. Methods might include probabilistic predictions, NWP hind-casting of storms, scenarios of frequency, intensity and process change in storm variables (wind and precipitation), “end-to-end” impact modelling, “seamless forecasting” combining climate, NWP and impact models, impact response surface modelling, uncertainty analysis, integrated post-processing of model output statistics (such as targeted bias correction), statistical downscaling and verification of NWP/climate models at scales relevant for impact modelling.

Proposals should seek to build on the outcomes of the NERC Flood Risk from Extreme Events (FREE), EU FP6 programme FLOODsite and Flood Risk Management Research Consortium (FRMRC/FRMRC2) programmes, and address focused research on storm impacts. Links are encouraged with relevant LWEC partners, particularly the Environment Agency (Please contact Sean Longfield sean.longfield@environment-agency.gov.uk)

Links to the Numerical Weather Prediction Deliverable and the Climate Science deliverable are integral to this deliverable and are addressed above.

Topics that are out of scope include the following.

- Tropical and high-latitude storms
- Direct impacts from wind damage
- Mesoscale convection systems
- Pluvial flooding
- activities that duplicate those within the Changing Water Cycle programme (see the Changing Water Cycle announcement of opportunity for more detail, which is expected to be published on the website in early 2010).

Following the award of grants, successful PIs will be required to attend a workshop to develop the links between the programme deliverables. It is expected that this workshop will be held in Autumn 2010.

4. Eligibility

Applications are invited from eligible UK researchers (see the NERC Research Grants Handbook for eligibility). Each applicant may submit no more than one proposal as Principal Investigator or Co-Investigator and may only be involved as Co-Investigator in one other (i.e. a maximum of two).

5. Application Procedure

Applications must be submitted using the Research Councils Joint Electronic Submission system (Je-S). Please select the Scheme – 'Directed' and the Call – 'Storm Risk Mitigation'

To use this system, the applicant's Research Organisation must be registered as a Je-S user. Full details are available on the Je-S website. Further information can also be obtained by contacting the Je-S Helpdesk by email at JeSHelp@rcuk.ac.uk or by telephone on 01793 444164.

Applicants must ensure that their application is received by NERC by 4pm on the closing date. Applicants should leave enough time for their application to pass through their organisation's Je-S submission route before this date. Any application that is received after the closing date, is incomplete, or does not meet the eligibility criteria will be returned to the applicant and will not be considered.

The Principal Investigator must submit form Je-SRP1 (NERC) detailing the financial request, together with the Case for Support and other attachments. All attachments submitted through the JeS system must be completed in single-spaced typescript of minimum font size 11 point, Arial font, with margins of at least 2cm.

The Case for Support should comprise:

- A Previous Track Record for each Research Organisation, not exceeding 2 sides of A4 for each Institution and a common Description of the Proposed Research not exceeding **12** sides of A4 (including all necessary tables, references and figures).
- Justification of Resources for all Directly Incurred Costs, Investigator effort, use of pool staff resources and any access to shared facilities and equipment being sought. This should be completed as a separate case and a separate attachment in the Je-S

system. Up to an additional 2 sides of A4 for each Research Organisation may be used for this purpose. The justification of resources for Consortium applications should also include full justification of facility costs included as estimates on applications, e.g. FAAM (HPC costs do not need to be included but justification for the use of the facility should be covered).

- A detailed description of the proposed management structures and plans, data management requirements (data management costs will be covered at the programme level), participant responsibilities, and scheduling chart. This should not exceed 2 sides of A4.
- CVs for each named research staff post and Visiting Researcher (up to 2 sides of A4 for each CV).
- CVs for all Principal and Co-Investigators named in the proposal (up to 2 sides A4 for each CV).

In addition to the normal requirements for research grant proposals, the Case for Support should include details of all associated collaborations and co-funding (proposed and secured).

All applications must include an Impact Plan; however, as this programme will have an overarching Impact and Knowledge Exchange plan, applicants are invited to focus on specific activities as they relate to their proposed programmes of work. All costs for the impact plan must be included within the project budget. Full guidance on writing and submitting Impact Plans can be found at: http://www.nerc.ac.uk/funding/application/impactplans.asp

Data Management will be funded centrally by the programme and should not be costed into proposals. However, Principal Investigators will be responsible for providing their data to the data management centre and should ensure that they have sufficient resource within their proposal to support this activity. Applicants are also required to provide an outline of their anticipated data management requirements, but not the costs, within their proposal.

For further details please refer to the NERC Research Grants Handbook and the guidelines for consortium grant applications.

6. Assessment

Proposals will be assessed against the following criteria under the Research Programmes Funding category:

Science Excellence
Fit to Requirements
Risk-Reward
Cost Effectiveness
Impact

Details on the funding categories can be found in the Background and Guidance Notes for Reviewers at: http://www.nerc.ac.uk/funding/application/referee/

Applications will be internationally peer reviewed and final funding recommendation made by a moderating panel. There will be an opportunity for PIs to respond to the reviewers comments. Feedback will be available to applicants upon request once the funding decision process has been completed.

7. Timeline

AO Published: Dec 2009
Proposal Deadline: 25th March 2010
Outcome Published: September 2010

Following the award of grants, in Autumn 2010, a workshop will be held to bring the consortium PIs together to coordinate and develop the links between the programme deliverables. Attendance at the workshop from project PIs will be compulsory.

8. Programme Management and Reporting Requirements

All awards issued as a result of this call will have detailed terms and conditions that reflect the directed nature of the Storm Risk Mitigation call.

The success of this programme will depend on the close interaction and coupling of the three deliverables. Therefore a workshop will be held between the successful Principal Investigators and the programme Advisory Group to develop a plan that will facilitate the creation of the required links. Additional funds will be made available to support activities within this plan.

Proposals funded under this call must:

- comply with standard NERC reporting requirements;
- contribute to the programme's Knowledge Exchange activities;
- comply with the programme's integration plan;
- comply with the programme's media policy; and
- comply with the programme's data management policy.

It is anticipated that this programme will be managed in conjunction with the NERC Changing Water Cycle programme, with a joint Executive Board and Management Team. There will be cross linkages and close interaction between the Programmes' Advisory groups.