

Storm Risk Mitigation through Improved Prediction and Impact Modelling



1. Introduction

This *Implementation Plan* details the method of execution of the *Storm Risk Mitigation through Improved Prediction and Impact Modelling (Storm Risk Mitigation) Research Programme*, the science of which is laid out in the Research Programme's *Science Plan*. This plan describes the implementation of the three *Deliverables* in the 5 year research programme.

The *Implementation Plan* is a living document which will be periodically updated to address programme delivery issues such as on-going liaison between projects, science meetings, reporting and general programme coordination activities.

2. The Research Programme's Objective

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

3. Delivering the Research Programme

The above Programme *Objective* will be achieved through three science *Deliverables*, which are detailed in the programme's *Science Plan*.

Deliverable 1: Numerical Weather Prediction—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 outputs for storms impact modelling.

The programme will be delivered via one grant round (see Section 5), and each deliverable will be implemented at approximately the funding level indicated below.

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

- (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?
- (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 to convective scale?
- (d) How can we improve NWP models and data assimilation methods for better “nowcasts” and forecasts of cyclonic storms at the meso to convective scale?

It is anticipated that this deliverable will be implemented through a single consortium style grant of approximately £2.1m.

Question (a) should provide initial guidance for measurement case studies and new parameterisations for modelling and/or 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 deliverable. Research on cloud microphysics should be included where there are direct consequences for diabatic heating rates. *Question (c)* should focus 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 *Question (c)* should feed directly into the other questions. The initial and follow-up planning of the measurement case studies should be guided by the outputs of the other questions in this deliverable. The answers to *Question (d)* should guide the measurement case studies from a model weakness assessment, and should concentrate on balance issues and nonlinearities in the data-assimilation problem. This will feed on the new measurements and the new sub-grid parameterisation schemes.

This deliverable should show clear links 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 structure of the probability distribution function 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.

- 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?

It is anticipated that this deliverable will be implemented through a single consortium style grant of approximately £1.05m

There remains large uncertainty in current predictions of storm activity and limited understanding of the key physical processes involved and this deliverable should address these issues, with a focus on how the key physical processes within cyclones will respond to anthropogenic forcing. High-resolution models, capable of resolving the structures of extra-tropical cyclones, should play a central role in addressing this deliverable. Climate change affects 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, so 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, and this deliverable should start to assess the consequences of this for climate prediction.

This deliverable should link 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 research 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: Impacts—improved ability to use NWP and climate model output for storms impact modelling.

- 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)?

It is anticipated that this deliverable will be implemented through a single consortium style grant of approximately £1.05m

This deliverable requires impact modellers, weather forecasters and climatologists to work together. Development of novel methodologies may be appropriate. To address research on storm impact modelling this deliverable should use the current generation of NWP and climate model outputs, but could also take advantage of upcoming developments in these models. A key requirement for this deliverable is to demonstrate benchmark methodologies for analysing storm impacts, which are transferable to next generation NWP and climate change products. This deliverable should include cross-cutting techniques and targeted impact modelling. Methods could involve 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.

This deliverable should seek to build on the outcomes of key Research Council programmes, such as Flood Risk from Extreme Events (FREE) and FLOODsite and Flood Risk

Management Research Consortium (FRMRC/FRMRC2), and address focused research on storm impacts. Links should be made with relevant LWEC partners, particularly the Environment Agency.

Links to the Numerical Weather Prediction and the Climate Science sections of this programme are integral to the success of this deliverable.

4. Programme Management

The *Storm Risk Mitigation Programme* will be managed in conjunction with the *Changing Water Cycle Programme*. A joint Programme Executive Board, Programme Management Team and Science Management Team will be established. The Programme Advisory Group and Grant Moderating Panel will remain separate.

4.1 Programme Executive Board (PEB)

The *Storm Risk Mitigation Programme* will be managed by NERC Swindon Office in conjunction with the *Changing Water Cycle Programme*. The joint PEB will be chaired by NERC and include the chairs of the Programme Advisory Groups and a representative of any co-funders and stakeholder/user groups.

4.2 Programme Advisory Group (PAG)

A Programme Advisory Group (PAG) will advise the PEB on the delivery of the *Storm Risk Mitigation Programme*. The PAG will consist of national and international experts, including representation from end users and some original members of the Storms expert writing group. It will be chaired by Professor Dennis Peach, the chair of the expert writing group. The PAG will work closely with the Science Management Team and the Programme Administrator. The PAG will be appointed by NERC by Q4 2009/10.

The **key responsibilities** of the PAG (working with the SMT) will be to:

- f* advise on all aspects of the *Storm Risk Mitigation Programme* to ensure that the scientific issues identified in the Science Plan are being addressed
- f* with the programme Principal Investigators and the Programme Executive Board, develop a plan to integrate the three science deliverables and monitor the implementation of this plan
- f* monitor and advise on the progress of projects against the programme's *Objective* as necessary to ensure delivery of the *Storm Risk Mitigation Programme*
- f* identify the key results and messages from the programme to convey to the user community
- f* advise on managing the risks to the programme

Members of the PAG may also participate in Grant Moderating Panels, along with other independent experts (including members of the NERC Peer Review College) to evaluate the proposals and make funding recommendations to NERC.

4.3 Grant Moderating Panel (GMP)

A Grant Moderating Panel (GMP) will have the responsibility for assessing research proposals, both in terms of quality of proposed science and their ability to deliver the requirements of the *Storm Risk Mitigation Programme*. It will consist of national and international experts in the field, representatives nominated by any co-funders and at least one member of the NERC Peer Review College. These assessments will inform the PEB's decisions on the award of funding to deliver the programme's *Objective*.

4.4 Programme Management Team (PMT)

A joint Programme Management Team for the *Storm Risk Mitigation Programme* and the *Changing Water Cycle Programme* will be established. There will be three important processes involved in programme management: that of science co-ordination, knowledge exchange co-ordination and programme administration, and these roles will work closely together to provide effective management of the programme. The PMT will include a programme administrator who will be based at the NERC Swindon Office and will be responsible for the administrative aspects of the programme: administering the grants process and assisting the SMT (see Section 4.5).

4.5 Science Management Team (SMT)

The Science Management Team appointed by the *Changing Water Cycle Programme* (please see the *Changing Water Cycle Implementation Plan*) will take responsibility for the co-ordination and management of the *Storm Risk Mitigation Programme*.

The SMT will be responsible for the day-to-day management and coordination of the programme, and will work closely with the Programme Administrator based in the Swindon Office in the delivery of its responsibilities. Both the SMT and the Programme Administrator will report to the NERC Executive Officer, also based in the Swindon Office.

The SMT will continue to develop the implementation plan (this document), plus a data management plan in conjunction with BADC. The SMT will also be responsible for the development and implementation of the Knowledge Exchange Plan and resourced to deliver it. They will collaborate with all scientists in the programme in the coordination of KE and liaise closely with users and stakeholders to ensure the successful delivery of the KE plan.

The SMT will work to ensure coordination between the science deliverables for the *Storm Risk Mitigation* programme. They will also take responsibility for the integration between the common elements and groups of the *Storm Risk Mitigation* and *Changing Water Cycle* programmes.

The SMT will organise workshops to facilitate interaction across the programme as well as annual meetings, and will provide the secretariat function for the PAG and the PEB. The SMT, together with the Programme administrator, will administer the awards process, feeding back information to unsuccessful candidates and, where necessary, negotiating modifications to the work plan and/or finances of successful applications. The SMT will also be responsible for the monitoring and reporting on behalf of the whole programme, including annual reporting and the completion of output performance measures (OPMs). In addition, the SMT will maintain an overview of the scientific progress made against the programme objectives. The SMT will liaise with all programme participants, facilitate the development of the community and develop the links between this programme and international collaborators.

The SMT will be responsible for the maintenance of the *Changing Water Cycle* and *Storm Risk Mitigation* web sites. It is anticipated that the research highlights from the programmes will be included on the web sites.

The SMT will be appointed by NERC by the end of 2009.

4.6 Open call component

The open call component of the *Storms Risk Mitigation Programme* will be overseen by the PMT and projects will report regularly (at a minimum annually) on progress through NERC's Reporting and Outputs Database. The reports will be discussed by the PAG at their meetings.

4.7 Risk management

The PEB, together with the SMT and the PAG, will be responsible for managing the risks to the overall programme. In the event that a project develops a problem with delivery that cannot be solved by the PI and his or her team, the SMT and/or members of the PAG will, at the request of the PEB, discuss options with the PI for how these can be addressed to ensure the delivery of the science over the lifetime of the programme.

5. Programme timetable and open call

An Expert Group was appointed in September 2009 to draft the Science and Implementation plans on which this announcement of opportunity is based. These were submitted for approval by NERC in December 2009.

An open 'Research Programme' call will be made for proposals to deliver the programme's science deliverables and achieve the programme *Objective*. The mechanism for this will be an announcement of opportunity for full bids in December 2009 with the following timetable:

December 2009	Announcement of Opportunity
March 2010	Full bid deadline
Summer 2010	Panel meeting
Autumn 2010	Workshop (PI's and PAG) to develop integration plan

The full proposals will be internationally peer-reviewed and final funding recommendations made by a moderating panel, consisting of a sub-set of members from the Programme Advisory Group (PAG) plus independent experts. PIs will be given the opportunity to respond to Peer Reviewer feedback. Proposals are required to have a starting date of September 2010, which will give a six month window in which funded proposal will start.

It is anticipated that three projects will be funded with a budget of £4.2M, with up to £2.1M to address deliverable 1 and up to £1.05M each to address deliverables 2 and 3.

Funded proposals must:

- comply with standard NERC reporting requirements
- contribute to the programme's *Knowledge Exchange* activities
- comply with the programme's data management policy
- comply with the programme's media policy
- identify links to the other programme deliverables, and comply with the programme's integration plan
- identify collaborations with other national and international programmes, and capitalise on these where possible
- include milestones and deliverables to ensure the science outputs are delivered effectively

Following the funding decision, a workshop will be arranged between the programme's Principal Investigators and the PAG to develop a funded integration plan that will facilitate the links between the three programme deliverables.

6. Science Plan

The *Science Plan* for the *Storm Risk Mitigation Programme* is available as a separate document on the NERC website and should be read prior to submitting a proposal.

7. Partnerships and Collaboration

Collaborations between UK scientists, research institutions, disciplines and other national and international programmes are strongly encouraged, where appropriate, in order to deliver more effectively the programme's *Objective*.

8. Knowledge Exchange

The main aim for Knowledge Exchange (KE) in the *Storms Risk Mitigation Programme* will be to facilitate the communication and application of the science delivered from this programme to a variety of users including policy makers, and industry. This will be achieved through various activities coordinated by the SMT, for example, policy placements within Government Departments and production of policy relevant information such as updates, briefings and summaries. It is also anticipated that this will include Knowledge Transfer Placement Fellowships.

A Knowledge Exchange plan will be developed as part of the role of the SMT, who will work closely with PIs, users, stakeholders and partners to ensure the successful implementation of activities.

9. Data management

NERC requires that research programmes implement a data management scheme which covers practical arrangements during the programme and subsequent long-term availability of the data set. In line with the NERC data policy (<http://www.nerc.ac.uk/research/sites/data/policy/>) the data from the Programme will be lodged with the appropriate NERC Designated Data Centre.

The British Atmospheric Data Centre have agreed in principle to develop a data management plan for the Storms Risk Mitigation Programme, and to manage the data ensuring that it is lodged at the appropriate data centre.

The data management plan will be resourced centrally by the programme, but Principal Investigators will be responsible for providing their data to the data management centre and ensuring that they have sufficient resource within their proposal to support this activity.