C4I: Project Description

Community Climate Change Consortium for Ireland

1 Introduction

A Community Climate Change Consortium for Ireland has recently been established, with Headquarters at Met Éireann in Glasnevin, Dublin. This consortium (C4I, for short) will eventually have participation by all university and other groups active in climate research. It will be centred around a Regional Climate Analysis, Modelling and Prediction Centre (RCAMPC) based at Met Éireann.

By the end of a four-year period we will have made considerable advances towards achieving the following objectives:

- A Consolidated Consortium of Climate Change Researchers in Ireland
- A Regional Climate Analysis, Modelling and Prediction Centre (RCAMPC)
- A User Interface between the Modelling Centre and Irish Researchers
- A Computer Network, interfacing the RCAMPC to users
- A Powerful Educational Facility for Students of Environmental Science
- Greatly Improved Opportunities for Participation in European Programmes
- A Comprehensive Plan for Continuation of the Consortium

The C4I Project is funded through three channels. The Higher Education Authority is providing approximately 33% of the funding, under its Programme for Research in Third-Level Institutions (PRTLI). Funding will be available for two postdoctoral scientists and a post-graduate student for the C4I Project. Funding is also being provided by HEA for a computational Grid, with nodes in TCD, UCD, and NUIG. The Grid will provide a computational resource far beyond anything currently available in Ireland. The remaining funding comes from the Environmental Protection Agency, under the National Development Plan (33%) and from Sustainable Energy Ireland (33

2 Objectives and Targets

The overall objective of the Community Climate Change Consortium for Ireland is to consolidate and intensify the national effort in climate change research. We will achieve this by building a capability for carrying out regional climate modelling in Ireland, and putting in place a framework and a mechanism whereby the entire community of environmental scientists in Ireland can benefit from a Regional Climate Modelling and Prediction Facility.

The specific *targets* of the C4I Proposal are:

1. A Consolidated Consortium of Climate Change Researchers in Ireland

   C4I will consolidate, coordinate and greatly extend the work currently being carried out by small groups in local pockets of expertise around the country. It will bring cohesion to currently disparate research in climate change. It will greatly increase the international profile of Irish climate scientists, and substantially improve our chances of attracting funding under upcoming European research actions.

2. A Regional Climate Analysis, Modelling and Prediction Centre

   The Centre, based at the HQ of Met Éireann in Glasnevin, will be a focus of excellence in climate change, with a critical mass of expertise in climatology, dynamical meteorology, numerical analysis and advanced parallel computing. The Regional Climate Model (RCM) to be implemented will be based on the HIRLAM model (High Resolution Limited Area Model). This model has been developed in the international HIRLAM Project, by a consortium of which Ireland (specifically, Met Éireann) is a member. The Centre will provide a vital service to climate and environmental scientists throughout the country. It will provide substantial assistance to scientists studying climate change, to assist them in utilizing the climate model output for their analysis, to interface their applications models to the main RCM and to carry out integrations with appropriate configurations of the RCM.

3. A Computer User Interface to the RCAMPC and the Grid

   Each research institute in the consortium will have a computer link to the RCAMPC. This will give them access to the most powerful computational resource in the country (of the order of 250 Gigaflops). Model and code development can be done remotely; standard internet links can be used for this purpose (`telnet`, `ssh`). Extensive computational tasks involving large data volumes may be done more effectively during visits to the Centre,

4. A Powerful Educational Facility

   Outside Met Éireann, there is no activity in dynamical modelling of the atmosphere. University students have little opportunity to learn about simulation and prediction of atmosphere and climate systems by hands-on use of real state-of-the-art models. The RCM will be available to university groups wishing to use it for educational as well as research purposes. An easy-to-use graphical

user interface (GUI) will be implemented for use with the RCM. It will enable students to run the model easily, for example to study the climate effects of changing parameters and forcings.

3 Grid-enabled Computational Physics of Natural Phenomena

The present project is closely allied to, and includes a component of, another major project which is funded by the Higher Education Authority under its Programme for Research in Third-Level Institutions (PRTLI), Cycle 3–Phase 1. That project, 'Grid-enabled Computational Physics of Natural Phenomena', is being coordinated by the Dublin Institute for Advanced Studies, and is in association with NUI-Galway, University College Dublin, Met Éireann, Armagh Observatory, Dublin City University, Grid-Ireland (TCD, UCC, NUIG) and HEAnet.

The purpose of the HEA proposal is twofold. Firstly, it aims to facilitate cooperation between Irish scientists studying natural phenomena, ranging from earthquakes to climate change to supernova explosions, and to provide them with a forum in which to compare and discuss their research. Secondly, it aims to use new and rapidly moving developments in information technology and electronic communication to provide an order of magnitude increase in the facilities available for research and training in this area through provision of a powerful computational grid.

The HEA proposal envisages a Computational Grid[1] with nodes in DIAS, TCD, UCD, and NUIG. It will provide a powerful computational resource for Irish geophysicists and astrophysicists. The total computational speed of the Grid will be of the order of 250 Gigaflops (2.5×10^{11} floating-point operations per second). Funding is provided for two postdoctoral scientists and a doctoral student (including equipment, travel and overheads). They will be based at Met Éireann HQ, and they will implement the HIRLAM Model on the Grid and carry out climate simulations.

4 Description of the Research Work

The purpose of Community Climate Change Consortium for Ireland (C4I) is to consolidate and intensify the research effort in this country. The consortium will establish a capability to address climate issues of vital national concern in an effective, coordinated way. At the core of C4I will be a Regional Climate Analysis, Modelling and Prediction Centre (RCAMPC) to simulate the detailed climate of Ireland and model the climatic consequences of changes in radiative forcing.

There are initially two components in the consortium:

1. **Modelling Centre:** The Regional Climate Analysis, Modelling and Prediction Centre will be based in the HQ of Met Éireann in Glasnevin.

[1]The concept of Grid computing is easily explained by analogy with the electrical power distribution grid. The user 'plugs into' the grid and uses the resources needed for his/her computational task. Grid developments are being aggressively promoted in both the United States and Europe at the moment. It is clearly going to be a key research tool in the future.

2. **System Work:** Specialized work on parallelization and on Grid Computation will be undertaken at University College, Dublin (UCD).

4.1 Regional Climate Analysis, Modelling and Prediction Centre at Met Éireann

The Centre, at the Headquarters of Met Éireann in Glasnevin, will be a centre of excellence where detailed, high-resolution simulation of the climate of Ireland can be carried out using state-of-the-art computer models. By appropriate management structures, the Centre will be tightly coupled to environmental research groups in the universities, and will serve as a focus of expertise for quantitative analysis of climate change and its impacts; this is the essence of C4I.

4.1.1 Regional Climate Modelling

The grid resolution of GCMs used for climate modelling is typically about 2.5°, representing an ability to resolve features of size not smaller than 500 km (twice the grid interval). This is adequate for a general representation of the global climate, but quite inadequate for the simulation of the detail and pattern of change in a region the size of Ireland. A proven method of generating more precise, accurate and detailed information on a national scale is by use of a regional climate model (RCM). Such a model has a typical resolution of 0.5°, allowing representation of features down to scales of approximately 100 km. By the technique of double nesting, even greater resolution over Ireland is feasible.[2]

An RCM is integrated over a limited geographical domain. Conditions on the domain boundaries are provided from a GCM run on a coarser grid. If the RCM does not simulate the ocean explicitly, ocean conditions are also provided by the global model. Thus, there is consistency between the two model solutions, regional and global, but the regional model provides significantly more detail, resolution and precision. The Regional Climate Model is capable of producing guidance at a resolution far better that anything which is currently available from international centres. At the same time, the configuration of the RCM (embedded in a global model) ensures that all the information present in the GCM is transferred accurately and efficiently to the higher-resolution model.

4.1.2 The HIRLAM Model

The value of an RCM for modelling and predicting future climate change on a national scale has already been demonstrated in other centres. The operations of RCAMPC will be based on the HIRLAM model (High Resolution Limited Area Model). This model has been developed in the international HIRLAM Project, by a consortium of which Ireland (specifically, Met Éireann) is a member. The HIRLAM model is the basis of operational short-range weather forecasting in Met Éireann. However, the

[2]The operational version of HIRLAM used for short-range forecasting at Met Éireann is run in doubly-nested mode, the inner area having a resolution of approximately 10 km.

model is also suitable for application to regional climate simulation, and this is the configuration which will be implemented at RCAMPC.

4.1.3 Boundary Conditions from GCMs

The boundary conditions for the regional simulation will be provided by a long-range integration of the Global Climate Model at the Hadley Centre in Bracknell. This information is generated as a matter of course, in the process of global simulation, and the Hadley Centre has indicated a willingness, and indeed, enthusiasm, to provide such data for regional climate studies. As an alternative, the model of the Max Planck Institute for Climate Studies in Hamburg can be used. Finally, the European Centre for Medium-range Weather Forecasts (ECMWF) in Reading is currently undertaking a comprehensive re-analysis (ERA-40) of the atmosphere for the past forty years. The results of this re-analysis will be available shortly and will provide essential data for historical model runs and for validation of the regional climate model.

4.1.4 Outline of research at RCAMPC

Once the scientific team is in place, the primary tasks are to install the regional climate model on a local computer system, to acquire the necessary boundary data, to establish the interface to this data, and to begin the simulations. The climate, as it has evolved over the past several decades, will be simulated by the model, and compared to the historic record. This validation process is an essential preliminary step to the more ambitious task of simulating future climate.

We envisage running the RCM on **decadal time-slots**. Thus, the current climate of the regional model is established by driving it with boundary data from GCM output spanning the period 1991-2000. This permits the validation and verification of the RCM output against currently available climatological observations. It is absolutely essential to ensure that the configuration of the RCM is such as to produce a realistic current climatology. However, as the HIRLAM model has already been shown to be capable of this in the Swedish context, we have every confidence that it can be done for Ireland without undue difficulty.

Climate impacts of future changes in GHG concentrations are then assessed by running the RCM for a future decade, for example 2041-2050 or 2081-2090. For these, the boundary data come from the GCM century-long runs with modified radiative forcing. The regional model will then produce the fine detail of climate changes which is so vital for planning responses on a national scale.

It is crucial to establish which physical factors are pivotal in influencing the Irish climate in future decades. Given our geographical location, it is clear that the influence of the Atlantic Ocean will be large. We will carry out a series of model sensitivity studies to determine the priorities for research. Without anticipating the outcome, it is clear that the following aspects will be of importance:

- Lateral Boundary Conditions
- Ocean-Atmosphere Interactions: fluxes of heat, moisture and momentum
- Treatment of the Atmospheric Boundary Layer

- Representation of Surface Processes. Effects of Changes in Vegetation
- Parameterisation of Convective and Stratiform Clouds and Condensation.

It will be impractical to carry out research in all areas, but we will have close contacts with the modelling teams at Met Éireann, at six other national centres where the HIRLAM model is run operationally and, of course, with the Rossby Centre, where similar sensitivity studies have been done. Also, the precise expertise of the scientific team will influence which aspects of the model are investigated locally and which are undertaken by teams in other centres. We envisage inviting scientists from other modelling groups to visit the RCAMPC for periods, and to have our scientists spend some time at other centres, to learn from their experience and to ensure excellent contacts.

An area of special importance for regional modelling is the handling of lateral boundary conditions (LBCs). After a short transient phase, essentially all information on the state of the atmosphere flows in through the boundaries; the influence of the initial state is negligible. It is crucial that this process is correctly simulated, and that spurious boundary effects are eliminated. The research team at Met Éireann have specific responsibilities in the HIRLAM Project for investigation of LBC treatment. Dr Aidan McDonald has worked intensively on this problem for the past two years, and significant advances have been made. This knowledge and expertise will be available to the climate modellers.

Following the sensitivity studies, and the establishment of the optimal configuration of the model, a series of impact studies will be carried out. It is insufficient to perform just one model run for each scenario. Due to the many uncertainties of the model and driving data, an *ensemble* of model runs is required. However, as the RCM may be run for discrete decadal periods, and not necessarily for a full century, this is computationally feasible (obviously, ten decadal runs may be done in the time for a single century run, and ten is a reasonable ensemble size).

Details of climate change for Ireland are then produced by climatological, dynamical and statistical analysis of the model ensemble. The use of ensembles of runs has the additional significant advantage that an objective measure of reliability of model predictions may be produced. This is essential, given the levels of uncertainty involved. The availability of the powerful Computational Grid makes ensemble modelling a practical proposition.

4.2 Grid Computing Work at UCD

Future energy and environmental strategies will require unprecedented computational accuracy and resolution for understanding how global changes are related to events on regional scales where the impact on people and the environment is greatest. Achieving such accuracy means simulating regional climate change with very high resolution. Such high level of detail and realism requires enormous computational capacity. Indeed climate prediction has been recognized as a computational 'Grand Challenge Problem' since the emergence of supercomputers. Furthermore the interdisciplinary nature of climate modelling demands that researchers in diverse disciplines should

have access to an exploratory computational environment a so-called 'virtual computational laboratory' in which future scenarios can be 'played out'.

The linking of observational data sites, computers, experimental sensors, huge data archives and other resources into a virtual computational laboratory describes the thinking behind current developments in large scale computing technologies. Collections of distributed, heterogeneous computing resources in different institutions and countries used as an ensemble to execute large-scale applications. This flexible infrastructure is increasingly based on computing clusters which networked across institutions creates a powerful virtual computing environment. So-called Grid computing provides 'on demand' access to computing, resources distributed analysis of large data sets and distributed computing.

The aim of the UCD Work Package is to develop a 'Grid Computing' climate model re-engineered from the High Resolution Limited Area Model (HIRLAM). Model and code development will be done on a 'micro-grid' that includes both distributed and parallel computing machines (accessed through the Centre for High Performance Computing and Applications, UCD) and so mimics larger grid dynamics. This will provide an application testbed for developing and testing of climate modeling codes. Included are a heterogeneous network of Beowulf PC clusters, a 12 processor SGI Origin2000 and a 4 processor SGI Power Onyx equipped with an InfiniteReality visualisation engine. The HEA/PRTLI-funded project 'Grid-enabled Computational Physics of Natural Phenomena' will provide access to 3 128-node PC clusters linked by a fast network.

The UCD work will focus on interoperability, scalability and performance:
Interoperability. A Community Climate code must operate efficiently on PC based distributed memory computers, shared memory computers and hybrid systems. Memory hierarchies are complex and bandwidth issues dominate. New approaches to model development are required to achieve performance on a range of platforms.
Scalability. The community nature of Climate Models means that scientists at different geographical sites may incorporate advanced submodels — new parameterisations, climate processes such as clouds, chemical interactions, surface and subsurface water transport. Modifications and extensions must be easily done for to sustain an experimental framework. Component programming fits well within the framework of Grid computing but components must be scalable and communication between components must be efficient.
Performance. The model must be efficient on a wide range of computing platforms to support long-time and fine-grid simulations.

A Computational Grid is a combination of parallel and distributed systems. (It is a misconception to view Grid computing as a substitute for High Performance Computing - it enhances the use of parallel HPC machines). Models for parallel systems involve, for example, message passing libraries and shared memory; models for distributed (grid) systems involve remote procedural calls and distributed objects. Both approaches need to be combined in a coherent manner with concern for interoperability, scalability and performance.

Some of the issues to be addressed involve:

- Language/programming models such as MPI-2, Open MP, mpC recognizing

that a programming model should support several levels of granularity as well as locality in computation/data.

- Performance analysis and code optimization.
- Grid generation and grid mapping.
- Algorithmic methods to tackle issues such as dynamic load balancing, parallel linear solvers, parallel event simulation and parallel mesh adaptation.
- Verification methods employing simulation and experimental data.

4.3 Dublin Institute of Advanced Studies

DIAS is coordinating the PRTLI-funded project 'Grid-enabled Computational Physics of Natural Phenomena', which is related to the current project. For the immediate future, it is planned that the Climate modelling work is carried out by Met Éireann. On a longer timeframe, the School of Cosmic Physics of DIAS is very interested in developing its own additional expertise and involvement in the general areas of Atmospheric Physics, Meteorology and Climatology which are of obvious and growing importance. This presents further opportunities for synergies between climate modellers and fundamental research in climatology.

4.4 Collaboration with other National Bodies

Contact has been established between Met Éireann and several other organizations engaged in environmental research, and informal discussions have taken place to establish the likely relevance and importance of a consortium and modelling centre. It is clear that there is a high level of support for the centre, and that a focus of excellence and a coordination of national research efforts would be of significant benefit to a wide range of groups. Further contacts will be made, to explore potential synergies and to establish more formal relationships with these and other bodies.

5 Project Management

5.1 Management of the Regional Climate Analysis, Modelling and Prediction Centre

The Regional Climate Analysis, Modelling and Prediction Centre will be based at the Headquarters of Met Éireann in Glasnevin. Overall responsibility for the Centre will rest with Dr Peter Lynch, Assistant Director of Met Éireann. We plan the following staff complement:

- 1 Project Manager and Director of RCAMPC
- 1 System Manager with extensive computer expertise
- 1 Technical Assistant with relevant computer expertise

- 2 Post-doctoral Research Scientists
- 1 Post-graduate Student

5.1.1 Responsibilities of the Project Manager

The Project Manager will have responsibility for running RCAMPC. He/she will also have overall responsibility for C4I, the Community Climate Change Consortium for Ireland. This will include establishment and maintenance of close cooperative links with climate scientists throughout the country, organization of meetings and colloquia, running training courses and tutorial sessions and liaison with EPA and HEA. Specifically, the Project Manager shall:

- Be Responsible for the Operational Management of the Regional Climate Analysis, Modelling and Prediction Centre
- Lead, contribute to and co-ordinate the scientific work of RCAMPC
- Prepare a comprehensive Scientific Plan of activities, taking cognizance of guidance from the Project Monitoring and Advisory Committee (PMAC); see §5.1.3 below
- Submit Scientific Plans and Annual Budgets for examination and approval by PMAC
- Keep accounts of all income and expenditure for the Project, and provide statements to PMAC each quarter
- Prepare quarterly Progress Reports and a comprehensive Annual Progress Report on RCAMPC and C4I
- Ensure effective liaison between RCAMPC and and environmental scientists using the modelling facilities
- Coordinate the research in the C4I consortium. Travel regularly to the participating institutes to ensure good communication and co-ordinate the different Sub-Projects
- Chair the Climate Model Applications Group, CMAG (see §5.1.5 below)
- Prepare and distribute a quarterly C4I E-Newsletter
- Organize meetings, colloquia and training courses as appropriate, in consultation with PMAC
- Represent the Project in negotiations and discussions with outside bodies
- Establish and maintain collaborative contacts with relevant organizations in Europe engaged in climate change modelling
- Ensure that the work specified in the contract with EPA is carried out
- Ensure that the work specified in the contract with HEA is carried out

5.1.2 Responsibilities of the System Manager

The System Manager will be responsible for the maintenance and documentation of the Computer Systems (hardware and software) of the Regional Climate Analysis, Modelling and Prediction Centre. The System Manager will have overall responsibility for the HIRLAM Climate Modelling System, as implemented on the ECMWF Computer system and on the HEA Computational Grid. Specifically, the System Manager shall:

- Ensure proper operation and maintenance of the Computer Systems of the Regional Climate Analysis, Modelling and Prediction Centre
- Ensure proper development and documentation of the climate modelling software of the Regional Climate Analysis, Modelling and Prediction Centre
- Be responsible for regular cycles of climate integrations, including monitoring and validation
- Be responsible for the establishment of programming standards as regards, *e.g.*, structuring of programs, documentation of programs and program efficiency
- Be responsible for checking that these programming standards are observed
- Advise the participating institutes in connection with implementation of new versions of the Reference Climate System
- Assist the participants of the Project in their experimentation with the Reference version of the RCM, at ECMWF and on the Grid
- Co-ordinate the preparation and production of comprehensive technical documentation for the Reference System
- Organize meetings, colloquia and training courses as appropriate
- Implement an easy-to-use graphical user interface (GUI) to the HIRLAM Regional Climate Model, to enable students to use it for climate modelling studies
- Maintain a computer extranet communications system (C4INeT) and an open C4I Web-site
- Ensure that, at any time, a Reference Version of the Climate Modelling System is available for implementation on computer systems at the participating institutes
- Undertake other appropriate tasks, as required by the Project Manager

5.1.3 Project Monitoring and Advisory Committee

A Project Monitoring and Advisory Committee (PMAC) will be established, comprising representatives from the funding agencies and from the participating institutes. Details are yet to be agreed.

5.1.4 Project Work Plan

A comprehensive Work Plan for the Regional Climate Analysis, Modelling and Prediction Centre will be drawn up by the Project Manager, and will be finalised within two months of commencement of the project. The Project Manager shall consult all interested parties in drawing up this plan. The research and development work set out in the plan shall be divided into Work Packages (WPs). For each WP a detailed specification of the work, including time-tables and targets, will be prepared, and a person responsible for the WP will be identified. This person must carry out the full body of work identified in the WP specification and coordinate the work of other scientists as appropriate. The Project Manager will be in daily contact with the staff but will also require formal reporting on a quarterly basis. A revised Work Plan shall be presented to PMAC annually.

5.1.5 Climate Model Applications Group (CMAG)

It should be stressed that the regional climate centre will provide a valuable resource for all environmental scientists in Ireland. The RCM will play the role of a **Community Climate Model**. Scientists without specific expertise in modelling may still benefit from it by formulating experiments to be carried out with the model. The scientific team at RCAMPC shall provide an appropriate level of support to the environmental community in this regard, through a Climate Model Applications Group. The Climate Model Applications Group shall be chaired by the Project Manager.

The RCM will be available to university groups wishing to use it for educational as well as research purposes. An easy-to-use graphical user interface (GUI) will be implemented for use in the HIRLAM Model. This will enable students to run the model easily, for example to study the climate effects of changing parameters and forcings.

5.2 Management of the Work at UCD

The Team Leader for the Work Package on Grid Computation of Climate Change models will be Dr Neil Hurley (UCD). The Research Team will include Dr Tahar Kechadi, Dr Alexey Lastovetsky and Dr Ted Cox.

Dr Neil Hurley has extensive experience with large scale parallel computing projects. His experience is both at a project management level and at an algorithmic development level. In particular he has experience of optimising a large meteorological package from the European Centre for Medium Range Weather Forecasting (ECMWF), to exploit the special features of the SR2201.

Dr Kechadi contributes research expertise in the areas of parallel prcessing on heterogeneous distributed systems — which is the basis of the grid computing environment. Additional expertise also lies in parallel algorithms, parallel architectures, scheduling, graph partitioning and dynamic load balancing, skills necessary for optimisation of codes. Dr Lastovetsky is responsible for the development of a parallel computing language mpC — a high-level parallel language (an extension of ANSI C) — designed specially to develop portable adaptable applications for heterogeneous networks of computers. Expertise relevant to dynamical meteorology lies in the general discipline of Fluid Dynamics. Dr Ted Cox has research interests and expertise in

fluid dynamics including internal and free surface waves in stratified fluids, transonic flows and boundary layer dynamics.

6 Outputs and Deliverables

6.1 Benefits to be Derived

The consortium will establish a capability to address climate issues of vital national concern in an effective, coordinated way. The benefits to be derived from the establishment of C4I are manifold. It will

- Give us the capability to address climate change questions specific to National needs
- Bring cohesion to the currently disparate research effort in Ireland
- Provide a research focus which will greatly enhance opportunities for Irish scientists to participate in EU environmental programmes
- Improve coordination of existing research by establishing research groups with continuity and critical mass
- Ensure the future viability of environmental research in Ireland by supporting post-graduate students

6.2 Benefits to Irish Environmental Scientists

The goal of C4I is to coordinate climate research in Ireland. The function of the Regional Climate Analysis, Modelling and Prediction Centre is to serve as a powerful resource for environmental scientists in a wide range of areas, especially to provide results which can be incorporated into effective environmental policies/legislation. Modelling is a means to an end. Applications which may be investigated using RCM outputs include:

- Hydrology: river catchment models; Flood-risk models.
- Agriculture: Crop management models; Animal desease models.
- Fisheries: Marine currents; level of nutrients.
- Forestry: Carbon storage potential; forest stress.
- Natural Environment: habitat changes; conservation.
- Energy resource management: wind and wave climatology. Coastal erosion.
- Tourism: Length of season; Ultra-violet radiation levels.
- Insurance: storm damage risk; commercial losses.

- Human health and welfare: desease occurrence; indoor comfort.

We anticipate exploitation of the RCAMPC resource by Irish scientists working in all these areas.

6.3 Continuation of the Project

The proposed project is a long-term project (four years for Phase 1, reduced from five years due to funding constraints). We anticipate that it will develop in a step-wise fashion, starting with the establishment of the central modelling facility, and expanding to embrace the climate change research work of all university and other groups. We envisage that the work will continue as a permanent endeavour when ongoing funding is secured. Once Phase 1 is up and running, the issue of long-term funding will be seriously addressed.

7 Facilities

Met Éireann has adequate facilities to host the Regional Climate Analysis, Modelling and Prediction Centre. Office accommodation and infra-structural support, as well as access to computer equipment will be provided for the scientific team of the RCAMPC. Met Éireann has a complex network of computer equipment. There is a Local Area Network linking the systems. A powerful computational platform, an IBM RS/6000 SP has recently been acquired and the HIRLAM model has been implemented and run on 36 parallel processing elements. There is a dedicated communication channel to ECMWF's powerful computational facility. There will be a portal at Met Éireann to the HEA Computational Grid, giving access to the most powerful computational resource in Ireland (on the order of 250 Gigaflops).

At UCD there is a a heterogeneous network of Beowulf PC clusters, a 12 processor SGI Origin2000 and a 4 processor SGI Power Onyx equipped with an InfiniteReality visualisation engine. Currently there is a submitted PRTLI proposal on 'Grid-enabled Computational Physics of Natural Phenomena' which if successful will provide further access to three 128-node PC clusters linked by a fast network.