Memorandum of Understanding

Co-operation between Met Éireann and University College, Dublin

1. Introduction

This memorandum sets out the terms of an agreement between Met Éireann and University College, Dublin (UCD) to cooperate in the establishment of a joint activity in teaching and research in meteorology. A formal cooperative arrangement will be of significant benefit to both Met Éireann and the University.

1.1 Background to the Project

In many countries, formal links exist between the National Meteorological Service and a university or academic institution. It has been found that State and academic activities in meteorology complement each other, and that collaboration between State and university bodies yields substantial benefits for both. Links range from simple agreements for cooperation in training to the joint management of major research centres.

Ireland is one of the very few countries in Europe without a Department of Meteorology in any of its universities. It is also exceptional in having no formal link between the National Meteorological Service and a university or academic institution. Progress in the development of the science of meteorology is hindered by the lack of facilities and by the very limited research activity in this country.

2. Objectives of the Collaboration

Here we itemise some of the main objectives of a formal link between Met Éireann and UCD. The primary goals are:

- To raise the level of research in meteorology and climatology
- To facilitate students to enter this field
- To contribute to the training and research needs of Met Éireann
- To foster international cooperation and collaboration
- To enhance the regional climate modelling capability
- To provide independent authoritative opinion on meteorological matters

2.1 Academic Arguments

Meteorology is an important branch of science, with major economic and social relevance. It is founded on the fundamental principles of fluid dynamics and thermodynamics and

draws on a wide spectrum of physical theory. Meteorology is studied in about 65 universities in the USA. The University Corporation for Atmospheric Research, UCAR, with 66 Members and 20 Affiliates, supports, enhances, and extends the capabilities of the university community, nationally and internationally [see `www.ucar.edu`]. There are meteorology departments in universities in almost all European countries.

Ireland is exceptional in having no Department of Meteorology in any of its university colleges. There is a small amount of activity in climatology in some Irish colleges. This is primarily focused on analysis of precipitation and other climate statistics. There is some research in atmospheric physics in Physics Departments, but no activity in dynamic meteorology and little that could be classified as basic research. The only research in dynamic meteorology is that carried out in Met Éireann. This is limited to work of direct use in operational forecasting.

It is without question that progress in meteorology in this country is severely hampered by the lack of adequate stimulus from the academic sector. This is regrettable, as international research in the atmospheric sciences is intense and very significant progress is being made. Met Éireann finds it increasingly difficult to ensure that staff are adequately trained, and that practical forecasting techniques develop in accordance with best practice elsewhere.

2.2 Economic Arguments

Meteorology is of crucial importance to the national economy. Agriculture, Energy, Construction, Transport, Communications, Tourism, Fisheries and Forestry are all highly sensitive to weather factors. The economic implications of improvements in meteorological knowledge are profound. For example, gross agricultural output for Ireland for 2001 was 4,876MEuro. A 1% increase in agricultural production (including reductions in losses) enabled by better weather guidance would equate to almost 50MEuro, a substantial saving to the economy.

Recent stormy weather has resulted in huge financial losses, and the insurance industry is most anxious about trends of rapid growth in the value of claims. A severe storm in Ireland typically causes damage costing of the order of 100MEuro. There is great concern that the frequency of severe storms has been on the increase. In-depth analysis of the climate of Ireland is a matter of urgency. A meteorological research centre at UCD would be in a strong position to undertake such study, and would be in a good position to attract funding from the re-insurance sector.

2.3 Climate Change

The current consensus view among scientists is that human activities (primarily, the burning of fossil fuels) are causing significant changes in the global climate, and that these changes are likely to have deep and possibly disastrous consequences for the welfare of mankind. Vital questions appertaining to the climate of Ireland remain unanswered; our current knowledge is seriously defective. With agriculture as our main industry, we in Ireland must anticipate probable changes, so that we can respond in such a way as to optimise benefits and minimise adverse consequence.

Currently, research in Ireland into climate change is seriously deficient. Met Éireann has recently established the Community Climate Change Consortium for Ireland (C4I),

with UCD as a leading participant. A Regional Climate Modelling and Prediction Facility has been set up at Met Éireann headquarters in Glasnevin. The Higher Education Authority is providing approximately 33% of the funding, under its Programme for Research in Third-Level Institutions (PRTLI). The remaining funding comes from the Environmental Protection Agency, under the National Development Plan, from Sustainable Energy Ireland (SEI) and from Met Éireann itself. Met Éireann is linked to the Department of Environment, Heritage and Local Government.

This is a long-term project, and ongoing funding will be required. UCD has an excellent record of attracting funding for research. Working together, Met Éireann and UCD would be well-placed to establish a more permanent climate modelling facility.

3. Training and Research Requirements of Met Éireann

Met Éireann has an ongoing requirement for personnel trained in meteorology. Typically, one or two meteorologists and four or five ancillary scientific staff are recruited annually. Although required only to have honours Leaving Certificate mathematics, the majority of the ancillary staff are graduates. Under present arrangements, meteorologists are trained in the U.K. This is far from ideal, as there is no control over the structure or content of courses. It is also extremely expensive.

In the future, the trend will be towards employing staff with more specialised qualifications. The division between professional and support staff is blurring. A policy change, whereby recruitment of staff with more specialised qualifications is increased, is anticipated, which will result in a greater number of meteorological graduates per annum being employed by Met Éireann.

Met Éireann also has a pressing requirement for ongoing specialist training. A university meteorology centre could provide basic training at diploma and degree level for Met Éireann staff and also refresher training in specialist areas such as numerical weather prediction, radar and satellite meteorology, climate modelling, and so on.

Several Met Éireann staff are currently undertaking graduate and post-graduate studies in mathematics and physics so as to acquire qualifications necessary for promotion. If university courses in meteorology were available, they would be selected by such staff, and would be more appropriate to their needs and to the needs of Met Éireann.

Current research at Met Éireann is focused primarily on the development of computer models for short-range weather forecasting. This is an area of rapid scientific advances internationally, and it is essential to maintain an intensive research programme. A university meteorology centre could undertake research in numerical weather prediction at a leading scientific level, similar in nature to the research currently undertaken in the framework of the `Hirlam` Project (High-Resolution Limited Area Model Project). This would also be of direct benefit to the operational outputs of Met Éireann.

4. The Board of Management

It will be necessary to monitor the implementation and operation of the cooperative arrangements. It is essential that the interests of both partners be represented. This will be ensured by the appointment of a *Board of Management*, comprising a Chairperson, and two members each from Met Éireann and UCD. The Chairperson will be agreed between the partners. The Chairperson will report twice annually to the Director of Met Éireann

and to the President of UCD. Detailed Terms of Reference of the Board of Management will be drawn up in consultation between Met Éireann and UCD.

The Board of Management will be responsible for the development and implementation of the curriculum for post-graduate Higher Diploma/ M.Sc. courses and will obtain approval of them by the Faculty of Science and the Academic Council. The design of the courses will be undertaken in close consultation with Met Éireann and with all relevant Departments in the University. Close coordination with appropriate courses in allied programmes of study within UCD will be necessary.

The Board of Management will also be responsible for the development of joint research programmes.

5. Academic Programme

There are advantages with both under-graduate and post-graduate courses. Initially, courses will be at post-graduate level. However, during the period of agreement, under-graduate courses will be developed. UCD will offer the following teaching programmes:

5.1 Post-graduate Diploma/M.Sc. in Meteorology

The course aim will be to provide the scientific background needed for work in all branches of applied meteorology. This course will run annually for 12 months beginning from September. The course will be modular in structure to enable it to be taken as either a full-time one-year course, or on a part-time basis over a longer period. Practical work in several component modules, course work examinations and dissertations will contribute to the final assessment. The course will be available from September 2004.

Entry Requirements: Prior knowledge of meteorology will not be necessary. The normal requirement for this course is a good honours degree in a physical, environmental or engineering science. Offers of places may be conditional on meeting certain requirements, such as standard of degree, funding and English proficiency.

Location: Department of Mathematical Physics, UCD

Course Content: The course content will be worked out in detail by the Board of Management but will include [mandatory] modules in the following general areas

- Dynamic Meteorology
- Physical Meteorology
- Synoptic Meteorology
- Climatology

As far as possible, additional [optional] modules will be provided, in areas such as

- Numerical Weather Prediction
- Satellite and Radar Meteorology
- Oceanography
- Tropical Meteorology
- Meteorological Applications

A post-graduate Higher Diploma in Meteorology, or an M.Sc. programme with a major Atmospheric Science component, will be attractive and accessible to a wide variety of students.

5.2 Undergraduate Courses in Meteorology

Initially, modules on meteorological topics, suitable for undergraduates, will be developed and will be available to students with appropriate backgrounds in mathematics and physics. Modules may be taken by both undergraduate and postgraduate students. During the course of this agreement, a more comprehensive undergraduate programme in meteorology and oceanography will be developed.
The Higher Diploma/M.Sc. in Meteorology will be monitored by the Board of Management. This Board will also consider undergraduate courses in Meteorology.

5.3 Joint Research Programme

It is expected that the Meteorology and Climate Change group established under this cooperative initiative will develop a strong research programme. Research funding will be sought, collaborative research links developed and from the outset PhD students and postdoctoral fellows employed.

5.4 WMO Recognition

Recognition of the courses will be sought from the World Meteorological Organisation (WMO). This will facilitate participation by students from throughout the world, who may be funded through WMO Training Programmes. Recommendations of WMO will be taken into consideration in the decisions on course design and content.

6. Teaching Staff

A recent Policy Statement of the American Meteorological Society (AMS Bulletin, March, 1999) recommended that a minimum of three full-time staff are required to establish and maintain a comprehensive undergraduate programme in atmospheric science. This is a goal to be aimed at during the project.

Initially, teaching staff will be as follows:

• One Chair Position

– This will be a five-year contract, funded by Met Éireann (Salary *plus* Superannuation *plus* PRSI).

• One Lecturer

– This will be funded by UCD [from the Higher Diploma/M.Sc. fees and research overheads].

Both positions will be in the Department of Mathematical Physics.

It is anticipated that these two positions will advertised early in 2004. Met Éireann will be entitled to nominate a representative to serve on the Selection Board for positions associated with this cooperation.

7. Centre for Meteorology and Climate Research

UCD will establish a Research Centre for Meteorology and Climate in the Department of Mathematical Physics. The Professor of Meteorology will be the Director of the Centre.

8. Opportunities for Meteorology Graduates

We expect the courses provided through this agreement to qualify graduates for work in National Meteorological Services, commercial meteorological services, research in industries which require weather and climate predictions, research in universities and research institutes, and as meteorological consultants.

Met Éireann: Opportunities at Met Éireann have been mentioned above. Currently, Met Éireann recruits on average two meteorologists and about five ancillary scientific staff annually. The majority of ancillary staff are also graduates, though that is not strictly required. If courses of the sort envisaged above were available, graduates from them would be well-placed in competitions for employment at Met Éireann. The recruiting policy of Met Éireann will be reviewed in the light of the developing collaboration with UCD.

Other Organizations: There are outlets in many other European National Meteorological Services. The European Centre for Medium Range Weather Forecasts (ECMWF), based in Reading, employs approximately one hundred graduates, and there are ongoing opportunities for suitably qualified people. Several other centres of meteorological research in Europe also have continuing requirements for expertise. One may mention the Hadley Centre (of the UK Met Office) in Bracknell and the Max Planck Institute in Hamburg.

Further Study: A research group in Meteorology at UCD will enable students who have come through the M.Sc. programme to proceed to PhD degrees. It would also be the aim of the group to attract able students from the EU and elsewhere to the PhD degree programme in UCD.

It would be the intention to develop links and exchange programmes with other research and teaching centres. The Meteorology Department of Reading University has a most extensive programme. There are further opportunities at the Department of Applied Mathematics and Theoretical Physics (DAMTP) in Cambridge, at several other British universities, at universities in every other western European country and at about 65 US and Canadian universities.

Commercial Opportunities: Private meteorological practice is a growth area. Consulting meteorologists specialise in a wide range of areas, such as Industrial Meteorology, Environmental Meteorology, Aviation Meteorology and Legal and Forensic Meteorology. There is also a trend towards provision of operational meteorological services to the media by private companies. This may grow significantly in the coming years.

Climate Change: Climate change is an area of growing concern. Opportunities in environmental agencies, and in industries which are strongly affected by climate factors, are expected to increase considerably in coming years. Insurance companies require access to reliable meteorological and climatological expertise. For example, the re-insurance company *'Munich Re'* currently employs a team of fifteen meteorologists.

9. Funding

It is highly improbable that outside funding can be attracted unless the leading partners (Met Éireann and University College, Dublin) demonstrate commitment by substantial material support for the venture. Overall, we envisage a balanced provision of resources between the partners.

Under the terms of this agreement, Met Éireann agrees to provide funding for the salary of one staff member at Professorial level, study-time and other appropriate support

for its employees registered for degrees at UCD, appropriate facilities for students undertaking projects, appropriate computer resources at ECMWF, library facilities at Met Éireann, and access to the Learning Resources Centre at Met Éireann.

UCD will provide one full-time Lecturer as a direct pay expenditure, together with general support which will include office space and space for students, PC's and advanced computing facilities, library facilities, administrative support and other academic services all covered under indirect expenditure. An annual supplies budget for operating costs will also be provided as direct non-pay expenditure. Met Éireann and University College, Dublin will endeavour to jointly seek additional funding for further staff.

Met Éireann staff participating in the meteorological programme will pay fees at the normal rate. However, UCD will provide bursaries for two Met Éireann students each year, sufficient to cover the cost of their fees.

9.1 Research Funding

A recent funding application to the Environmental Protection Agency (EPA), made jointly by Met Éireann and UCD, has been successful. Funding is being provided for the establishment of a Community Climate Change Consortium for Ireland. Funding has also been awarded by HEA, in the recent PRTLI cycle, for regional climate modelling. This will support two post-doctoral researchers and a postgraduate student.

Met Éireann has been successful in attracting substantial EU funding for meteorological research during the past few years, under the Environment and Climate Programme and the Training and Mobility of Researchers Programme. Meteorology is recognised by the European Union to be of vital importance to the well-being of the Community. Major research funding will be provided in the Sixth Framework Programme. In view of the critical economic importance of weather and climate, there is a reasonable expectation that such funding will be ongoing. It could support a high level of post-graduate and post-doctoral research in meteorology in Ireland.

A meteorological research centre would be in a good position to attract funding from the re-insurance sector. This possibility will be studied by the Board of Management.

10. Duration of the Project

The Project should commence in January, 2004. It will be of five years duration, ending in December, 2008. Progress will be reviewed in early 2007. However, we have every expectation of a continuation of the collaboration.

11. Signatures

Director, Met Éireann	President, UCD
Date	Date

Annex 1: The Partners in the Collaboration

The partners, University College, Dublin and Met Éireann, have very significant strengths which are complementary and which give assurances of a fruitful collaboration.

University College, Dublin

UCD has a long tradition of excellence in the field of Mathematical Physics and other disciplines relevant to meteorology. The study of meteorology involves application of theory and techniques from a remarkably wide range of areas of applied mathematics, physics and geophysics. It provides a valuable opportunity for exploiting knowledge and expertise by application to an area of critical practical importance. There are excellent prospects for fruitful cooperation of meteorologists with experts in Departments of Mathematical Physics, Experimental Physics, Geology, Environmental Studies, Geography, Agriculture and Agricultural and Food Engineering. The synergistic benefits of such inter-departmental and inter-faculty contacts are well known.

Met Éireann

Met Éireann, the Irish Meteorological Service, has been the National Meteorological Service for sixty-five years. The primary rôle of the organization is to meet the national requirement for high-quality weather forecasts and associated services, with optimum efficiency and value for money. Met Éireann has considerable expertise in the science of meteorology and in its applications over a wide range of areas. The work of the Research Division is primarily in the area of Numerical Weather Prediction (NWP). The Division has responsibility for designing and maintaining the automatic data analysis and forecasting systems. The main focus of research in the Division is in the area of numerical algorithms for NWP, in particular the development of semi-Lagrangian time-stepping schemes. We have also carried out innovative work on digital filtering initialization for NWP. As a result of top-class research work and excellent scientific publications over the past two decades, the organization has earned an international reputation and is highly regarded in the NWP community.

Met Éireann has valuable contacts with a wide range of international organizations in both meteorological operations and research.

Annex 2: Additional Information

12. Tradition of Meteorology; Ongoing Contributions

A large number of Irishmen have been active in meteorology or in areas directly related to it, and have made contributions of the first rank. One may mention Beaufort, Boyle, Joly, Kelvin, Robinson, Scott, Stokes and Tyndell, but there have been many others.

The tradition is continuing, but mainly abroad, where Irish scientists are making substantial contributions to meteorology. J Ray Bates is Professor of Meteorology at the Niels Bohr Institute of Astronomy, Physics and Geophysics, in the University of Copenhagen. He is currently engaged in climate modelling. Dr A J Hollingsworth is Head of Research and Deputy Director at the European Centre for Medium-range Weather forecasts (ECMWF), the world-leading centre of its kind. Brendan McWilliams is Head of Administration at EUMETSAT. All of these are former employees of Met Éireann. There are several Irish meteorologists in influential positions in US universities.

At home in Ireland, the research team at Met Éireann has made substantial advances in the area of numerical weather prediction, has established an international reputation and produces peer-reviewed publications in leading journals. Staff of Met Éireann play a significant part in the international `Hirlam` (High-Resolution Limited Area Modelling) Project.

13. Computational Resources at ECMWF

As a Member State of ECMWF, Ireland is entitled to an allocation of computer time at the European Centre. As ECMWF has one of the most powerful and advanced computer systems in the world, this represents a substantial resource. It is used by meteorology departments in several European universities. As part of the collaboration, the meteorology centre at UCD will have access to this resource.

14. ECMWF Training Courses

ECMWF provides an annual series of training courses in dynamical meteorology and numerical weather prediction. The lecture notes of these courses are available on the Member State web-site of the Centre. These would prove invaluable in the design and delivery of courses in these areas.

15. EuroMET Training Project

A collaborative project, EuroMET, has been set up to address the education and training needs of professional meteorologists in Europe. The goal is to establish a multi-media network-based service to support education and training in the participating countries. There are some 24 participants, Met Éireann among them. This project, which is EU-funded, is likely to lead to more extensive cooperation in the future. There is an opportunity for further partners to join the project. It has clear relevance for the design and delivery of courses in dynamic and synoptic meteorology and in related areas. Such multi-media network-based training modules can be of great value in support of more conventionally based courses.