ANNUAL REPORT 1976

European Centre
for Medium Range
Weather Forecasts

ANNUAL REPORT 1976

including 1 November—31 December 1975

presented to the Council

by the Director, Dr. A.C. Wiin-Nielsen

European Centre for Medium Range Weather Forecasts

CONTENTS

Illustrations

Dr. Erich Süssenberger
First President of the Council

FOREWORD

On November 1, 1975, the Convention establishing the European Centre for Medium Range Weather Forecasts entered into force. A year has passed since then. The Director of the Centre and its staff have made good use of this time. They have been very active and have made considerable progress in all fields. This applies to the scientific programme of the Centre, and this also applies to the problem of the acquisition of the computer, to operational questions and to the Administration. Excellent work has been done in all these fields in spite of the great many difficulties which do crop up in a build-up phase.

The United Kingdom, as the host country, has in the meantime taken steps in order to ensure that construction of the seat of the Centre on the beautiful premises at Shinfield Park can begin shortly.

At the end of the Centre's first year there is, therefore, reason to be content with what has been achieved and to look into the future with confidence.

On behalf of the European Centre I would therefore like to express to the Government of the United Kingdom and to the Director of the Centre and its staff of the Member States sincere thanks and to extend to them my best wishes for prosperous development.

E. Süssenberger

INTRODUCTION

The first Annual Report of the Director of the European Centre for Medium Range Weather Forecasts formally covers the period from November 1, 1975 when the Convention came into force, to the end of 1976. Since the report is the first Annual Report it is, however, appropriate to include a brief description of the major events leading to the existence of the Centre.

History

The creation of the Centre as an international intergovernmental organisation took place over a period of several years. The early development of the original ideas of European co-operation in science and technology and the particular history of the project leading to the establishment of the Centre have been described by Dr. E. Süssenberger, The Chairman of the Interim Committee and the first President of the Council, in a paper: "An Example of European Co-operation in Meteorology", published in 1972 by Servico Meteorologico Nacional, Portugal as part of the Proceedings of a Symposium held in connection with its 25th Anniversary. The following developments are extracted from the paper:

October, 1967: Council of Ministers of the European Communities adopts a resolution that the Member States (Belgium, France, Federal Republic of Germany, Italy, Luxembourg and the Netherlands) are willing to implement an energetic programme to promote scientific and technical research. The Council of Ministers require the Working Party on Scientific and Technical Policy of the Medium Term Economic Policy Committee to examine the opportunities for co-operation in the following six fields: information, science and telecommunications, new means of transport, oceanography, metallurgy, nuisances and meteorology.

February, 1968: The established expert group in meteorology stops its work for almost a year when the European Community came into a political crisis.

End of 1968: The Council of Ministers requests the expert group to continue its work.

March, 1969: The expert group submits its first report suggesting co-operation in six areas. Two of the proposals obtain the approval of government representatives:

1) Major operations in modern meteorology.

2) Meteorological equipment projects.

The idea of a joint meteorological computing and research centre equipped with sophisticated information processing hardware and engaged in medium-range weather forecasts is mentioned at this point.

October, 1969: The Council of Ministers adopts the concept that other European countries outside the European Community should be invited to participate. Austria, Denmark, U.K., Ireland, Norway, Portugal,

Spain, Sweden and Switzerland are invited and agree in principle to participate. Finland and Yugoslavia joined later in the common projects.

April, 1970: An expanded expert group starts to work on the possible establishment of a European Meteorological Computing Centre.

August, 1971: The expert group submits its report leading to the writing of the convention and protocol.

There followed:

October, 1973: The convention is signed.

November, 1975: The convention comes into force.

The "Convention establishing the European Centre for Medium-Range Weather Forecasts" and the "Protocol on the Privileges and Immunities of the European Centre for Medium-Range Weather Forecasts" were signed in Brussels on October 11, 1973 by the following countries: Belgium, Denmark, Federal Republic of Germany, Spain, France, Greece, Ireland, Italy, Yugoslavia, Netherlands, Portugal, Switzerland, Finland, Sweden and the United Kingdom. Shortly thereafter Austria acceded to the Convention giving a total of 16 countries.

The Convention, according to Article 22, would "enter into force on the first day of the second month following the date of its ratification, acceptance or approval by no less than two-thirds of the signatory States, including the State in which territory the headquarters of the Centre are located, provided that the total contributions by these States amounts to at least 80 per cent of the total contributions. . ." The conditions quoted above were satisfied at the end of September, 1975 bringing the Convention into force on November 1, 1975. At the time of writing the Convention has been ratified by all sixteen countries except Italy. Furthermore, Turkey has become a Member State as of May 1, 1976. A Co-operation Agreement has been concluded with the World Meteorological Organisation and one is being negotiated with the Government of Iceland.

Interim Period
Interim Committee

After the signing of the Convention it was decided to establish an Interim Committee acting for many purposes in the role of the Council. However, as long as the Convention was not ratified the final authority remained with the Committee of Senior Officials, chaired by Mr. C. Silver, U.K. This Committee had the power to make financial committments for COST projects.

The Interim Committee established a Scientific Advisory Committee, chaired by Dr. H. Reiser, Federal Republic of Germany, and a Finance Committee, chaired by Mr. M. Deloz, Belgium, to anticipate the implementation of Articles 7 and 8 of the Convention.

Planning Staff

It was furthermore decided to establish a small Planning Staff with responsibility for formulating:

1) Scientific and technical plans for the first five years of the Centre.

2) Plans for the staffing of the Centre.

3) Plans for temporary and permanent quarters.

4) A plan of activities for five years enabling the Council, when established, to determine the ceiling of expenditure for implementing the programme of activities of the Centre following the entry into force of the Convention.

The Director Designate was appointed and assumed his duties by January 1, 1974. A group of six members of the Planning Staff was assembled by July, 1974. (A. Wiin-Nielsen, Director Designate, and Dr. L. Bengtsson, Mr. D. J. Clark, Mr. E. Knighting, Mr. J. Labrousse, Miss J. Rider). During 1975 the Planning Staff was expanded and by November, 1975 the following people had been serving on the Planning Staff:

Wiin-Nielsen, A; Baede, A; Bengtsson, L; Blades, E; Burridge, D; Charlewood, J; Clark, D. J. (April 1974 – August 1975); Dinshawe, A; Hollingsworth, A; Janjic, Z. (May 1975 – July 1976); Khoury, J. (Miss Rider); Knighting, E; Labrousse, J; Larsen, G; Llewellyn, J; Newson, R; von Noorden, W. D; Petersen, K; Russell, A. M; Sadourny, R. (May 1975 – November 1975); Söderman, D. (April 1975 – October 1975); Storer, N.

Considering the objectives of the Centre given in Article 2 of the Convention, it was decided at an early date that the development by 1979 of a medium-range prediction model suitable for operational use should have the first priority in the Centre's five year plan. With this goal in mind the Planning Staff considered the requirements for staff, buildings and technical facilities. Two goals had to be fulfilled for planning purposes, i.e. the completion of the Headquarters Building at Shinfield Park by late 1978 and the acquisition of a computer system at about the same time. It became obvious that a considerable scientific and computer staff was needed to reach these goals. Consequently, a plan for the staffing of the Centre during the period 1975 – 1980 was developed leading to full staffing shortly after the occupation of the Headquarters building.

Computing Facilities

To reach these goals the Centre needed interim computer facilities. A Service Agreement with Control Data Limited was put into operation on August 26, 1975. This agreement gave the Centre access to a CDC 6600 installed at John Scott House in Bracknell providing for increasing use of the computer as staff and scientific activities expanded during the formative years. In December the Service Agreement was changed to a Lease Agreement, allowing the Centre unlimited access to the computer. In addition, an agreement was made with the U.K. Meteorological Office to purchase time on its IBM 360/195. These computer facilities are adequate for the initial period of the scientific work of the Centre, but are of course totally inadequate for any operational use. The present use of the computer facilities is described in the report from the Operations Department.

Temporary Headquarters

The temporary headquarters of the Centre is on the 4th and 5th floors of Fitzwilliam House in Bracknell. Adjacent to the computer facility at John Scott House the Centre occupies space used by the computer operations manager and his staff, programmers and computer users.

Programme of Activities

The major task of the Planning Staff during the Interim Period was to formulate the programme of activities of the Centre for the five years following the entry into force of the Convention. The starting point for this work was the original planning document (COST/138/71) with annexes. The programme of activities, prepared during 1974 and 1975, centred around the goal of producing operational forecasts before 1980. The plans were discussed at several meetings of the Interim and Finance Committees and

were approved in principle by the Interim Committee at its last meeting. The final version including the ceiling of expenditure was adopted by the Council at its first session in November 1975. The major elements of the programme of activities were:

1) Decision on acquisition of computer system (March, 1977).

2) Completion of computer wing at H.Q. (May – July, 1978).

3) Completion of H.Q. building (June – December, 1978).

4) Operational forecasting commences (late 1979 or early 1980).

To achieve these goals the Research Department was organised into a number of sections whose work is described in the report from that department. The Operations Department was similarly organised into sections in order to operate present computer facilities, develop the software systems, develop the meteorological operations, and prepare for the acquisition of the computer system at Shinfield Park, as described in the department's report.

Headquarters Agreement

In the early stages of the planning the Centre participated vigorously in the drafting of the Headquarters Agreement between the U.K. Government and the Centre. This work was completed and it was possible for the Headquarters Agreement to be initialled by The Honourable Mr. David Ennals, then Minister of State, Foreign and Commonwealth Office, and the Director in connection with the first session of the Council in London, November 1975.

Building Plans

The planning and design of the Headquarters Building was carried out by the Property Service Agency, Department of the Environment, during the Interim Period with the active participation of the Planning Staff. The work resulted in a preliminary design of a Headquarters Building satisfying the overall requirements as well as the ceiling on total space. The major units of the building will be:

1) Office space for staff in the Directorate, Secretariat, Department of Research, Department of Operations and Department of Administration.

2) A library.

3) A reproduction and printing room.

4) Computer Hall with paper store, tape archive, mechanical and electrical work shop, computer users' and staff rooms.

5) Technical facilities for the computer (stand-by power generators, no-break systems, air conditioning, etc.).

6) Conference Room for Council and Committee Meetings.

7) Lecture Theatre seating 125 people.

8) Class Room (teaching and workspace).

9) Staff restaurant and kitchen.

10) General Conference Concourse.

During the year implementation of the plans was started. A careful study of the computing needs of the Centre led to the issue of an invitation to tender in July and evaluation of the tenders was completed in December. The number of staff was increased in accordance with the programme of activities: the fall in the value of the pound sterling, which increases the relative cost of maintaining commitments in their home country by non-UK staff members, led to two resignations and a lesser response than expected to notifications of vacancies. The Council adopted the salary scales of the Co-ordinated Organisations and application for membership has been made; meanwhile the Centre enjoys observer status and its representative attends the regular meetings.

RESEARCH DEPARTMENT

The Problem

It is now common practice for national weather services, especially those in extra-tropical latitudes, to prepare their short range weather forecasts by numerical methods, using large computers to integrate the equations which govern atmospheric motions. The meteorological observations provide a starting point and forecasts for two or three days ahead can be made quite successfully. Research has also been carried out to determine why the atmosphere has its general climatological structure of temperature, humidity, etc., and this involves computations for perhaps a hundred or more days rather than the two or three days of the short range forecast. The objectives are quite different. The short range forecast calls for prediction with accuracy of the development and movement of weather-bearing systems, which generally have a lifetime of about a week. The larger computations are not so concerned with the detail of the weather-bearing systems as with the establishment of the reasons for our climate. In the short range forecasts we can neglect some of the slow-acting physical effects, such as the changes in sea-surface temperatures and the effect of the variation of the sun's altitude on radiational effects, but we need to know with precision just what the state of the atmosphere is at the beginning of the forecast period. The long-term computations are not concerned with the detail of the initial atmospheric state, but are concerned with representing properly all the physical processes which are important for the atmosphere, such as the incoming radiation from the sun, the transfer of energy at the earth's surface, and so on.

In forecasting for four to ten days ahead both the initial detail and all the physical processes are important; the detail because some of the weather systems will have died to be replaced by a new generation, and the physics because this will determine the birth-places and the life-cycles of the systems. The amalgamation is indeed a challenging problem calling for both deep physical insight and new methods of numerical analysis.

The atmosphere is a compressible fluid and we describe its behaviour through the Navier-Stokes equations for the dynamical motion of a fluid, and the thermodynamic equations which are concerned with the energy sources, sinks and transfers. There are two main thermodynamic equations, one for the exchanges of heat, which determine temperatures, and one for the water-vapour in the atmosphere; the latter is most important owing both to latent heat effects and to precipitation mechanisms, while rain and snow are themselves weather. Even supposing that there were no forces or energy transfers at all, the system of equations is so complicated that no analytic solutions are likely to exist and we have recourse to using numerical methods to give the solution at a number of discrete points. The arithmetic involved is so great in volume that it is necessary to use a very large, powerful computer to complete the calculations in a reasonable time. When we consider the physical and dynamical forces which are actually present in the atmosphere the volume of computation is considerably increased and to calculate the atmospheric developments over ten days in the reasonable time of ten hours will call for a computer capable of carrying out 50 million operations per second.

There are two sets of problems of rather different kinds. The first is the expression in mathematical terms of all the processes that are thought to be of importance; we expect to account for frictional drag at the surface differing with land use and state of sea, the effects of mountains and orography in general, the heat and moisture passed between the earth's surface and the atmosphere, the effects of solar and terrestrial

radiation, the effects of clouds and so on. The second set of problems concerns the computations themselves. We need to define a system of integrating the basic equations with respect to time which is both stable and economic; the choice for investigation is quite wide, e.g. using finite differences, orthogonal functions, finite elements. Since the forecasts are to be made each day the need for an economic integration system is of real importance.

There is an additional problem which arises because when we move from continuous to discrete representations of atmospheric motions we define a scale, and motions which are smaller than this scale cannot be accounted for. Yet we know that there are important meteorological motions in the smaller scale range. For a number of reasons, including economy, we cannot expect to compute with a grid length of much less than 150 km; within this scale there may be thunderstorms, changes in orography and nature of the surface, frontal systems with very variable rain, turbulent mixing and so on. All of these sub-grid scale motions will have an effect on the development of weather systems and must be accounted for even though they are too small to be properly represented. We have to do this by expressing their effects in terms of larger scale fields of motion, temperature and moisture. This parametric representation calls for deep physical insight allied to mathematical modelling.

As a first step towards development of a forecasting model the Research Department has made a detailed study of the global numerical models developed at the Geophysical Fluid Dynamics Laboratory, Princeton and at the Department of Meteorology, University of California, Los Angeles, UCLA. These research groups have been leading the development of numerical models for climate simulations and extended weather forecasting.

A number of ten day forecasts have been made using these models. The results confirm studies made elsewhere, that the accuracy of prediction for a week or so ahead depends on the size of weather systems, and the successful prediction of the large scale features was encouraging, particularly as this does not usually hold in operational numerical forecasting. The importance of using a large number of grid points to obtain a fine resolution was also clearly demonstrated. Figure 1 shows some of the results of these experiments.

Structure

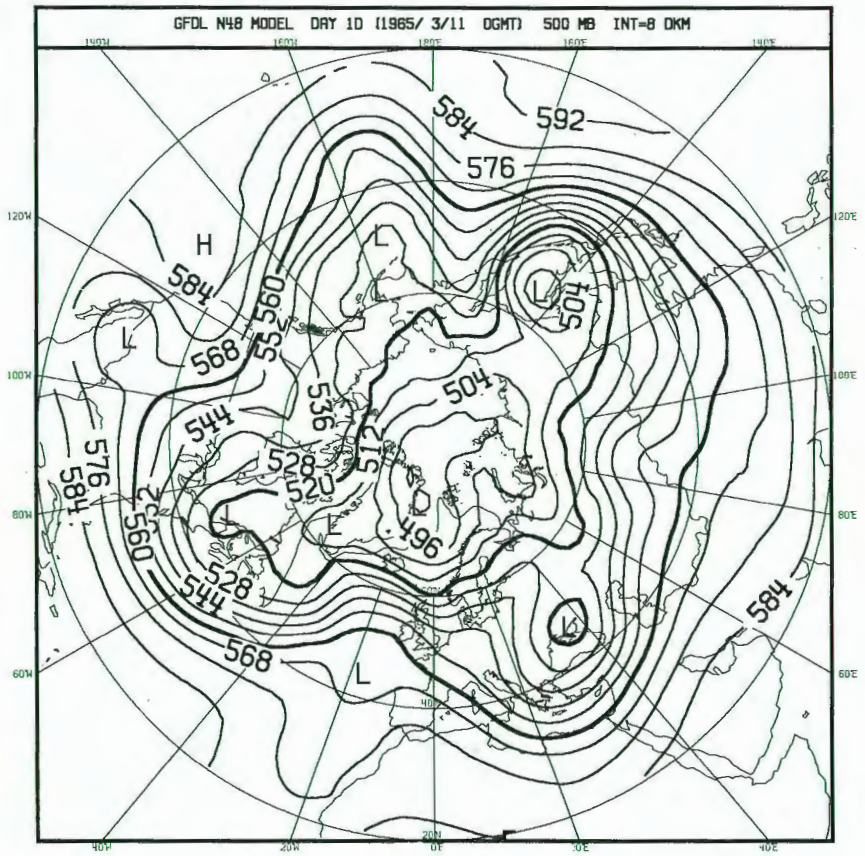
The main emphasis in the scientific activities of the Research Department is on the development of an operational forecasting system, in agreement with the programme of activities. The development has been split among four activities which are, of course, very interdependent.

Diagnostic Section

This section is responsible for organising the data stream on which the daily forecasts will be based, providing an efficient and flexible system for the input and output of data and results. Additionally, the group will develop diagnostic and verification programmes and create a data base from observational data and predictions. The methods presently used for verifying numerical forecasts for a day or two ahead are unsatisfactory for more extended forecasting and more relevant verification methods are being sought.

The research activity in the last year has been concentrated mainly on developing verification and diagnostic systems. The verification system developed has been used to verify the global numerical experiments described above.

Objective and comparatively simple procedures for verification are essential in the practice of weather prediction, particularly for extended periods. Methods have been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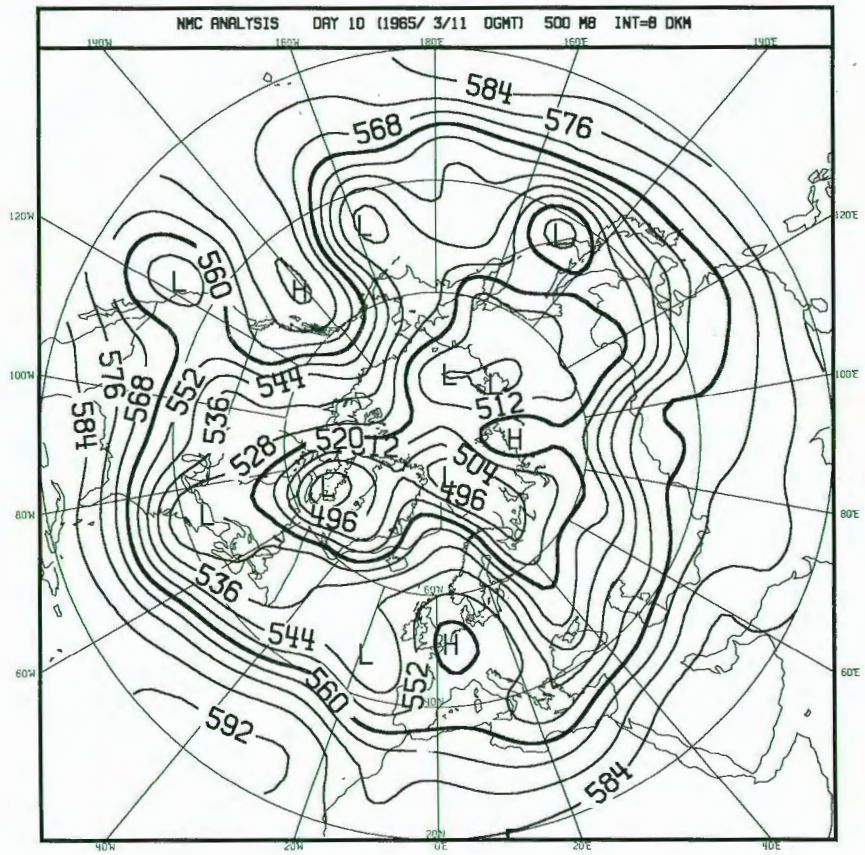
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developed for examining the forecasts according to the zonal wave number, in three spectral intervals corresponding to the very long, slowly moving waves (wave numbers 1 – 3), the more rapidly moving baroclinic waves (wave numbers 4 – 9) and the shorter wave components (wave numbers 10 – 20).

Data Assimilation Section

This section is charged with developing a system of global analysis, making use of all the different sorts of data which are or will be available, and an initialisation scheme conforming to the prediction equations.

The main efforts of the analysis and initialisation section have been directed towards the design and implementation of an operational analysis system with the capability of providing initial data for the forecasting model and building up a data base of analyses for general use, as well as providing a starting point for the development of FGGE level IIIb data sets.

The analysis is based on the so-called "optimum interpolation" which uses the statistics of past meteorological observations to search for and correct errors in the current observations and to ensure that neighbouring observations are in conformity with one another. An analysis system which takes account of past statistics is essential now that asynoptic meteorological observations are of many different kinds (e.g. ordinary synoptic observations, observations of temperatures and winds from satellites, observations from buoys at sea etc.) with very different error patterns.

Numerical and Dynamical Section

This section is concerned with establishing the basic equations of the model for use in operational form and also the computational scheme for their integration with time. A variety of schemes needs examining including those which conserve statistical and integral properties of atmospheric variables, such as energy and enstrophy (square of the vorticity); great attention is being paid to semi-implicit integration schemes and also to spectral representation.

The solution of the forecasting equations proceeds step by step in time and the time steps should be made as long as possible in order to save on the use of computer time; if they are too long the computation is unstable and meteorologically valueless. Computations referring to areas near the poles require short time steps unless special techniques are designed to allow longer steps to be taken; research into these special filtering techniques has been brought to an experimental stage.

The experiments have been performed using a global barotropic model with simulated data as well as real observations. These data sets each have a strong flow directly across the poles and consequently provide a severe test of the filtering technique. The filtering procedure developed at ECMWF has in this test case given very satisfactory results and will be used in the Centre's first operational model.

A ten-day 500 mb forecast produced by the Centre compared with the observed 500 mb pattern.

The finite difference formulation of the forecasting equations needs more attention than in numerical models used for short range forecasting. In the latter we are mainly concerned with accuracy in the processes governing movement in order to predict the timing of the weather systems as correctly as possible. When the integrations are carried out for longer periods it is also necessary to ensure that the statistical properties of the numerical model are as similar as possible to those of the governing equations in their continuous form and to the real atmosphere. Finite difference formulations which conserve energy and enstrophy have been tested using a global barotropic model. Forecasting experiments carried out for 20 days using real initial data indicate, at least from a purely subjective assessment, that the inclusion of energy and enstrophy conserving constraints gives superior results. The most successful of these finite difference formulations will be used in the Centre's first operational model.

In addition, the need to conserve enstrophy, using a staggered grid for economy in computer use, is being tested in a full scale global model.

In another experiment using the GFDL model the computation of horizontal derivatives by finite difference methods has been replaced by a computation using spectral methods to assess the value of the latter. In this experiment the use of the more economical semi-implicit integration technique will also be evaluated. The programming of the Centre's operational forecasting model is being designed in such a way that both grid point and spectral representations can be implemented using explicit as well as semi-implicit integration methods.

The structure of the Centre's first operational model is given in Table 1. The adiabatic part of the computation has been programmed and the first test experiments have started.

The computation is programmed in a very flexible way and horizontal and vertical resolutions can easily be changed. The first versions will have the same vertical levels as the GFDL-model in order to carry out comparisons. A limited area version of the model has also been developed for experimental purposes and will be used mainly by the parameterisation section; its use increases the number of experiments which can be carried out with the limited computing facilities available to the Centre during the build-up phase.

Domain	global (limited area can be used)
Co-ordinate system:	latitude/longitude sigma (normalised surface pressure)
Grid:	regular latitude/longitude with an irregular vertical spacing of the levels
Time-integration scheme:	leap-frog (centred)
Finite difference scheme:	staggered, energy and enstrophy conserving

Table 1

This section is concerned with the incorporation of sub-grid scale processes in the model.

A detailed survey of current methods for the parameterisation of the sub-grid scale physical processes in atmospheric models has been carried out. Special emphasis has been placed on three areas that are considered most important: radiative transfer taking into account the presence of clouds, the planetary boundary layer and precipitation processes with special attention paid to the convective processes. Other areas, which are very poorly understood or which are considered less important have been left for later consideration. Among them are the effect of steep mountains, the parameterisation of ground characteristics such as snow cover, ground wetness, vegetation, and the prediction of the ocean surface temperature.

Programmes for the inclusion of the sub-grid scale physical processes in the prediction model are being constructed; the first set of programmes will be based on the methods used by GFDL, for they are well-understood and thoroughly tested, but it is intended to develop and test other, different methods of parameterisation. For example, a study is being made of the differences that arise when the radiation calculations include multiple as well as single scattering and when emissivity calculations are replaced by cooling to boundaries approximations.

An experiment has also been carried out using a high resolution model to compare the effect of radiation using different assumptions for the cloud distribution. In the reference model the clouds were specified climatologically and in the comparative experiment they were diagnosed from the vertical motion and the humidity field predicted by the model. Interesting differences occurred after five model days; the interactive model (where the clouds were predicted) created in general more eddy available potential energy. A report of the experiment is being prepared.

Another study is in progress to evaluate the effects of varying vertical resolution on baroclinic waves and of the importance of fine resolution near the tropopause and in the boundary layer for describing the growth of these waves. It is expected that this work can be used to study a number of important questions which have not been adequately treated to date. Studies are also being made of the effects of horizontal resolution on the parameterisation of a single physical process taken by itself and, more importantly, taken in conjunction with parameterisation of the other processes.

OPERATIONS DEPARTMENT

Structure

The work of the Operations Department has been divided during the year between two principal objectives; the planning of computing facilities to be installed at the Shinfield Park Headquarters and the provision of interim computing facilities for the current research and development work of the Centre.

Computing Facilities Headquarters

In May 1975 the Centre issued preliminary notification of their requirement for a computer system to be installed in 1978 at the Headquarters, Shinfield Park, to help meet the tasks with which the Centre is charged, in particular daily operational weather forecasting, research pertinent to these forecasts, and making the forecasts, data and computing facilities available to the member countries. The preliminary notification to manufacturers was intended to give them warning of the kind of system that would be called for by a more detailed request for proposals.

Following this preliminary notification exploratory talks took place with manufacturers who wished for more information about the requirement. Mr. Tor Bloch, of CERN, and Dr. D. Burridge of the Centre visited the USA in November, 1975, to survey the state of development of high speed, powerful computers and submitted a report to the Centre.

There followed six months of intensive effort in close collaboration with the Research Department which culminated in the issue in mid-July 1976 of an Invitation to Tender for the Computer System for ECMWF. This document presents a detailed description of the use to be made of the computer system, a summary of the estimated requirements, and concludes with the formal conditions of tender and the proposed conditions of contract.

It has long been clear that computers such as the IBM 360/195 and CDC 7600 would not be powerful enough for the development and implementation of operational medium range forecasting, and that a computer of about five times their speed would be necessary, with a central memory of about 10^6 words and a secondary storage of about 2×10^8 words. There will be few such computers in the next five to ten years and it seems unlikely that sophisticated operating systems will be developed for them. Since the Centre does not have the capability of developing such software it is envisaged that a front-end computer will be installed, with all the normal facilities of a modern operating system, controlling the work on the number-crunching computer as well as carrying out the data-handling tasks.

The Centre needs to communicate with the outside world, both for acquiring data and distributing forecasts, as well as making available some of its computing facilities to Member States. These data problems seem to be best solved by installing mini-computers dedicated to line tasks.

Thus we have three levels of computing; a powerful number-cruncher front-ended by a medium size computer or computers, themselves front-ended for transmission purposes by mini-computers.

The required computing facilities may be summarised as a system with at least the following configuration:

(i) *Main computer system*

Main computer	50 MIPS
Central memory	10^6 words
Mass storage	2×10^8 words, 4 data paths
Card reader	1000 cards/minute
Line printer	1000 lines/minute
Operator console	

(ii) *Front-end computer system*

Main computer(s)	3 MIPS
Central memory	3×10^6 bytes
Mass storage	3×10^9 bytes, 4 data paths
Line printers	4 at 1000 lines/minute
Magnetic tape units	9 at 6250 bpi 9-track
	125 ips, 4 data paths
Card readers	3 at 1000 cards/minute
Card punch	
Visual display units	12
Plotters	4
Microfilm recorder	
Telecommunications	20 lines, 9600 bps

(iii) *Main computer/Front-end computer interface*

Nominal data transfer rate 10^7 to 2×10^7 bps.

Valuable assistance in the preparation of the Invitation to Tender was given by a group of experts during three meetings with the staff. The group consisted of:

Mr. T. Bloch (CERN, Geneva, Switzerland).
Dr. D. Henze (Bundesminister des Innern, Federal Republic of Germany).
Mr. A. Monod-Broca (Ministère de l'Industrie de la Recherche, France).
Mr. R. Longbottom (Central Computer Agency, Civil Service Department, United Kingdom).
Mr. N. Spoonley (University of London Computer Centre, United Kingdom).

The Invitation to Tender was sent to the representatives of each Member State to ensure that the computing industries in those states would be aware of the existence of the invitation, and additionally to a number of computer manufacturers. The recipients are aware of the time-table of the Centre's activities and the date by which the computing system must pass its acceptance tests.

A further visit to the USA by members of the Operations Department took place in September, 1976, in order that the Centre be fully aware of the latest developments in large-scale computers and to obtain information from the users of such systems. Visits were made to several computer manufacturers and to the Los Alamos Scientific Laboratory, the National Center for Atmospheric Research, the Naval Research Laboratory and the NASA Langley Research Center.

Tenders from computer manufacturers were received on Monday, 11 October as requested. The tenders were evaluated by a special Tender Evaluation Board which by mid-December had prepared for the Director a report containing recommendations concerning the selection of computers for installation at Headquarters. Council will consider the acquisition of computer facilities at Headquarters in March, 1977.

Interim Computing Facilities

These facilities consist of a CDC 6600 computer which has been installed by Control Data Limited at John Scott House, close to the Centre's temporary accommodation at Bracknell, for use by the Centre. In addition, an agreement has been made whereby the Centre may use a limited quantity of time on the U.K. Meteorological Office IBM 360/195 – 370/158 computing complex (COSMOS).

The CDC 6600 computer was accepted for use by the Centre in August 1975 and the configuration was enhanced in September 1976 by the addition of two disks with a control unit and two magnetic tape units. This enhancement allows the Centre to do significantly more computing and augments the system capability; it also simplifies the task of running large numerical computations in parallel with the shorter jobs. The configuration is shown in Table 2.

CONFIGURATION OF CDC COMPUTING SYSTEM AVAILABLE TO ECMWF AT JOHN SCOTT HOUSE (including upgrade)

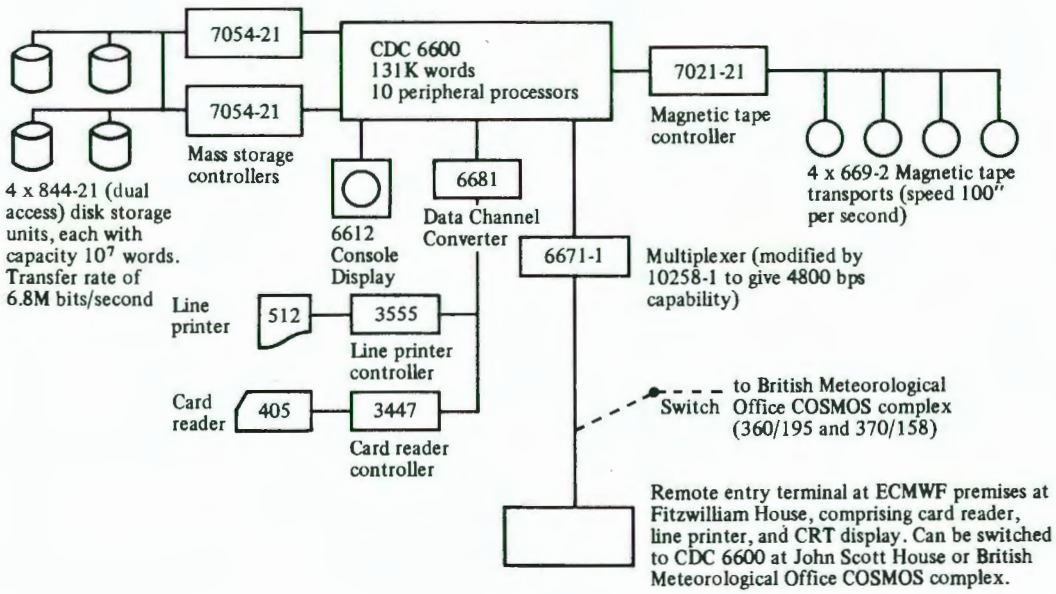

Table 2

The initial service agreement with Control Data Limited allowed this computer to be used for 40 hours a week initially, rising to 70 hours a week in August 1976. The increasing usage of the CDC 6600 as more staff have joined the Centre is shown by the increase in the number of jobs per month from about 2000 in March to more than 3000 at the end of the year. In December the service agreement was changed to a lease agreement which allows the Centre unlimited access to the computer.

The U.K. Meteorological Office COSMOS system has been used to a limited extent for various special activities, including experimental forecasts with the GFDL model and the preparation of performance evaluation tests for the computing facilities to be installed at Headquarters. Sufficient time remains under the present agreement to perform two or perhaps three more experiments in 1977 and 1978.

Submission of jobs to both computing systems, in particular to the COSMOS system, has been made by means of a Remote Job Entry terminal with a card reader and line printer. This terminal can be switched relatively straightforwardly between one system and the other.

The need for an off-line graphics system was met by the installation in May of a Varian STATOS electrostatic plotter; the resolution of this type of equipment has proved adequate for the needs of the Centre. Software has been developed at the Centre to represent meteorological data as contour lines.

ADMINISTRATION DEPARTMENT

Structure

The Administration Department consists of four sections, namely, Finance, Personnel, Supplies and General Services and Linguists, with the following tasks and responsibilities.

Finance Section:- Implementation of Financial Regulations, preparation of ceiling of expenditure estimates and budget, cash and accounts, periodic statements of accounts, accounting of assets, etc.

Personnel Section:- Staff legislation, recruitment of staff, and staff management including payment of salaries and allowances, and expenses incurred in the course of duty.

Supplies and General Services:- Market surveys, implementation of tendering and contract procedures for the acquisition of equipment, furniture and supplies, organisation of conference facilities, archiving and library services and supervision of maintenance of temporary headquarters.

Linguists Section:- Translation of documentation for Council and Finance Committee, Scientific reports and other miscellaneous letters and texts, into the working languages of the Centre, i.e. English, French and German.

In addition to the work of these four sections, the Administration Department also assists the Director of the Centre in carrying out the secretarial tasks of the Council and the Finance Committee. Between 1 November 1975 and 31 December 1976 three sessions of the Council and five sessions of the Finance Committee took place.

Finance
Ceiling of Expenditure

The ceiling of expenditure for implementing the programme of activities of the Centre over the five years following the entry into force of the Convention was unanimously approved by the Council at its first session.

Originally two ceilings were fixed, one based on the actual membership of 13 States, amounting to £18 million, and one based on the expectation that three additional States, Greece, Italy and Portugal would become Member States in the course of 1976, amounting to £20.4 million. The programme of activities is now based on the latter ceiling with certain funds blocked pending the accession of Italy.

The distribution of the ceiling of expenditure over the five years 1976 to 1980 was fixed by the Council at its second session in May as:

	Ceiling 1	**Ceiling 2**
1976	£1130K	£1300K
1977	2320K	2590K
1978	3570K	4650K
1979	5530K	5950K
1980	5480K	5910K

In November 1976, as a consequence of inflation in the United Kingdom, the Council adopted an adjustment of 1.324% to the ceiling of expenditure, based on the increase in the national contributions required to finance the 1977 budget estimates.

Scale of Financial Contributions

The Scale of Financial Contributions from the Member States is based on the Gross National Product figures for the years 1971–1973 and has been updated to include Portugal, Turkey and Greece as they became Member States.

The First Budget

The Budget for the first financial year of the Centre incorporates revenue and expenditure estimated for the planning period preceding the entry into force of the Convention, i.e. April 1974 to October 1975, and the following period including the calendar year 1976.

The main items in this budget are:

Total revenue	£1,850,587
Expenditure	
Staff salaries, etc.	£742,269
Provision of computer facilities	£373,471
Other expenses	£261,818
Total	£1,377,558

Estimated Expenditure 1977

The corresponding estimated edpenditure in 1977 is:

Staff Salaries, etc.	£1,737,200
Provision of computer facilities	£714,400*
Other expenses	£518,800
Total	£2,970,400

Investment of Funds

In accordance with the provision of the Financial Regulations, the Centre invests such funds as are not needed for immediate requirements. The Centre deposits the funds not needed in a Special Deposit Account, for which an interest rate of 12½% is currently paid by the Centre's bank. This present method of investment of funds was approved by the Finance Committee, which recommended its continuation until it was considered appropriate to reconsider the question of investment.

Personnel Staff

On 1 November, 1975, the date on which the Convention entered into force, the contracts of all members of the planning staff of the Centre terminated automatically. However, at its first session the Council approved the extension of contracts of the planning staff, until 31 January 1976 at the latest.

All staff were, in fact, given new contracts from 1 January, 1976 based on the salary scales and allowances for staff of the Co-ordinated Organisations serving in the United Kingdom.

The table of staff requirements for 1976 contained 74 posts, including three posts added in the course of the year for two linguists and a linguists' typist. Of these posts 18 were blocked pending availability of funds from the contributions of Greece, Italy and Portugal.

Four posts were unblocked as Greece and Portugal became Member States.

In addition four consultants were employed by the Centre on contracts ranging between six months and one year.

* £352,000 blocked pending decision on acquisition of computer system to be installed at Headquarters, Shinfield Park.

B.

At 31 December, 1976, there were 53 members of staff. Some details are given in Annex 1.

Staff Regulations

The Staff Regulations, as compiled before and applied during the interim period, were provisionally adopted by the Council at its first session. At the same time the Finance Committee was requested to re-examine these Regulations in the light of the decision to apply for membership in the Co-ordinated Organisations.

Social Security and Medical Health Insurance

The Council has adopted the Co-ordinated Organisations' Pension Scheme Rules, and the Centre has concluded a Supplementary Agreement with the Government of the United Kingdom with regard to the exemption of non-resident staff of the Centre from all compulsory contributions to the United Kingdom National Security Scheme. Negotiations are still continuing with regard to the extension of these exemptions to the U.K. staff members.

B. The staff at 1 November, 1975

EDUCATION

During the last two years ECMWF has arranged two seminars of interest not only to the Centre but also to the Member States.

Seminar 1975

The first of these seminars was on the scientific foundation of medium range weather forecasts. It was held at the Meteorological Office College, Shinfield Park between 1 and 12 September, 1975. The purpose of this seminar was to summarise for the Centre itself the up-to-date knowledge concerning the problems to be faced and to perform in part ECMWF's general educational function. The seminars were attended by more than 40 participants, drawn from the Member States, in addition to the lecturers and Centre staff.

The main lectures were given by Professor Pierre Morel, Laboratoire de Météorologie Dynamique, Paris, Dr. Kiku Miyakoda, Geophysical Fluid Dynamics Laboratory, Princeton, U.S.A. and Dr. Cecil Leith, National Center for Atmospheric Research, Boulder, U.S.A. Professor Morel dealt with problems associated with the observational system and the collection, analysis and assimilation of meteorological data into numerical weather prediction. Dr. Miyakoda reviewed existing methods of representing the physical processes in mathematical terms and the numerical procedures adopted for carrying out the integration with time. Dr. Leith described progress in the use of stochastic processes for improving weather prediction, paying attention to the uncertainties in the initial state and in the representation of the physical processes. Contributions on individual topics were presented by Professor G. Fischer, University of Hamburg, Mr. A. Gilchrist, U.K. Meteorological Office and members of the Centre's staff.

Seminar 1976

A second seminar on the treatment of the boundary layer in numerical weather predictions was held on 6 – 10 September, 1976, also at the Meteorological Office College, Shinfield Park. This seminar was attended by 39 participants in addition to the lecturers and Centre staff. The main lectures were given by Professor Fritz Wippermann, Institut Für Meteorologie, Darmstadt and Dr. Jim Deardorff, National Center for Atmospheric Research, Boulder, U.S.A. Professor Wippermann dealt with problems connected with analytic studies of the planetary boundary layer and Dr. Deardorff described progress in the parameterisation of the planetary boundary layer in large scale numerical models. Contributions on individual topics were presented by Dr. J.-C. André, Météorologie Nationale, Paris, Dr. E. Augstein, Max-Planck-Institut für Meteorologie, Hamburg, Dr. S. Bodin, Swedish Meteorological and Hydrological Institute, Norrköping, Sweden. Dr. N. Busch, Research Establishment, Risø, Denmark, Dr. S. J. Caughey, Meteorological Research Unit, Cardington, Bedford, Dr. R. Hide, U.K. Meteorological Office, Bracknell and Dr. N. Thompson, Chemical Defence Establishment, Salisbury, Wiltshire. In addition contributions were made by members of the Centre's staff.

Proceedings of the two seminars have been published and distributed to the delegates and the Member States.

VISITING SCIENTISTS

During 1976 the Research Department had three visiting scientists, Dr. W. Blumen from Colarado State University, Boulder, U.S.A., Dr. D. Gauntlett from Australian Numerical Meteorological Research Centre, Melbourne, Australia and Dr. I. Rutherford from Atmospheric Environment Service, Montreal, Canada. Dr. Rutherford also serves as Head of the Data Assimilation Section.

LIBRARY

The Centre is building up a scientific and technical library covering its major interest. Towards the end of 1976 the number of book titles was about 150 and the number of journals to which the Centre subscribes around 30.

The COUNCIL and its COMMITTEES

The Council is composed of up to two representatives of each member State, one of whom is usually the head of the national meteorological service. In addition, a representative of the World Meteorological Organisation (WMO) is invited to attend the Council sessions as an observer.

President of Council: E. Süssenberger, F.R.G.

November 1975 – December 1976

L. Vuorela, Finland

December 1976 –

Vice President of Council: L. Vuorela, Finland

November 1975 – December 1976

M. Mittner, France

December 1976 –

The Council held its first session on 4 – 6 November, 1975, following the entry into force of the Convention establishing the European Centre for Medium Range Weather Forecasts on 1 November, 1975. At this time thirteen States had deposited their instruments of ratification of the Convention. These were:

Austria	Yugoslavia
Belgium	Netherlands
Denmark	Finland
Spain	Sweden
Federal Republic of Germany	Switzerland
France	United Kingdom
Ireland	

Portugal subsequently deposited its instrument of ratification on 26 November, 1975 and became a Member State on 1 January, 1976, Turkey deposited its instrument of accession to the Convention on 16 March, 1976 and thereby became a Member State on 1 May, 1976, and Greece deposited its instrument of ratification on 20 July, 1976, becoming a Member State on 1 September, 1976.

It is hoped that one more signatory State, Italy will become a Member State in the very near future.

The first session of the Council was opened by Dr. Süssenberger, Head of the German Meteorological Service, who had presided over the Meetings of the Interim Committee governing the operation of the Centre in the period preceding the entry into force of the Convention. The first meeting of this session was held in public, and after the speech of welcome by Dr. Süssenberger, the Council was addressed by Dr. Davies,

C.

D.

E.

F.

G.

Secretary General of WMO, Dr. Mason, Head of the United Kingdom Meteorological Service, speaking on behalf of the Government of the host country to the Centre, Dr. Schregardus, Head of the Netherlands Royal Meteorological Institute and Vice-Chairman of the Interim Committee of the Centre, and Mr. Silver, Chairman of the COST Committee of Senior Officials of the Council of the EEC.

At this first session the Council elected Dr. Süssenberger as its President, and Professor L. A. Vuorela (Finland) as Vice-President. The Council also appointed Dr. A. C. Wiin-Nielsen as Director of the Centre.

Two further sessions of the Council were held in 1976, the second session on 11 and 12 May and the third on 16 – 18 November.

Finance Committee

The Finance Committee is composed of representatives of those four Member States paying the largest contributions to the Centre, and representatives of three other Member States designated by the remaining Member States. In the first year the Committee was composed of representatives from the following States:-

i) *Those four paying the largest contribution*

Federal Republic of Germany

France

Netherlands

United Kingdom

ii) *Those designated by the remaining Member States*

Belgium

Denmark

Spain

Chairman, Finance Committee – M. Deloz, Belgium. The Finance Committee held five sessions between 11 November, 1975 and 31 December, 1976.

Scientific Advisory Committee

The Scientific Advisory Committee is composed of twelve members selected by the Council in their personal capacity. In the first year one vacancy existed as only eleven of those selected were able to accept the appointment. This vacancy was filled after a decision of the Council in November, 1976 on the candidate to be invited.

The Scientific Advisory Committee met twice in the course of 1976, and made recommendations to the Council on a number of matters arising from the programme of activities of the Centre.

A list of members is given in Annex 3.

C. *Reading left to right*
Dr. von Noorden, Deputy Director, Administration,
Dr. Süssenberger, President of the Council
Dr. Wiin Nielsen, Director and Mr. Asmussen, Denmark.

D. *The President and Mr. Deloz, Chairman, Finance Committee.*

E. *Mr. Deloz and Mr. Vandenplas, Belgium.*

F. *The President, Dr. Süssenberger, the Director,*
Dr. Wiin-Nielsen and Mr. du Chaxel, France.

G. *Mr. Kemper and Mr. Kitchenberg, both of Federal Republic of Germany, and Dr. von Noorden.*

H.

Communications Advisory Committee

In addition to these two Committees the Council established an Advisory Committee on Communications between the Centre and the Member States whose mandate is as follows:

i) to evaluate the requirements of the Member States with regard to the products to be made available to them by the Centre;

ii) to evaluate the means of distribution considering the above-mentioned requirements.

iii) to evaluate the various methods by which the computer may be used by the Member States of the Centre;

iv) to analyse the technical problems related to the above-mentioned items;

v) to analyse the cost and cost effectiveness of alternative methods of implementing the various proposals resulting from this study.

The Committee is composed in the same way as is the Finance Committee.

Chairman Advisory Committee on Communications, D. Söderman, Finland.

The Advisory Committee presented its first progress report to the Council in November 1976, and is continuing its work.

Working Group on Computer Acquisition

Council also established a Working Group with terms of reference – to assist in assessing the financial and other aspects of the acquisition of the computer system taking into consideration only those bids considered acceptable by the Tender Evaluation Board.

The membership is:

Belgium	France
Denmark	Netherlands
Federal Republic of Germany	Sweden
Spain	United Kingdom

The Chairman of the Scientific Advisory Committee was also invited to participate.

H. Fifth Session of the Finance Committee, October, 1976.

Annex 1

Staff at 31 December, 1976

Director:	A. C. Wiin-Nielsen	Denmark
Deputy Director, Research Department	L. O. Bengtsson	Sweden
Deputy Director, Operations Department	J. Labrousse	France
Deputy Director, Administration Department	W. D. von Noorden	F.R.G.

Distribution of staff by grade and nation

	Grade						
	Hg*	A	B	C	L	F**	Total
Belgium		2					2
Denmark	1	3					4
F.R.G.		4			1	1	6
France		3	3		1		7
Ireland		2					2
Italy		1	1				2
Yugoslavia			1				1
Netherlands		3					3
Sweden		3					3
U.K.		13	8	2			23
Totals	1	34	13	2	2	1	53

* Hors grade
** Finance Comptroller

2 consultants were also employed by ECMWF at 31 December, 1976.

Annex 2

Members of Scientific Advisory Committee

Chairman:	J. S. Sawyer	U.K.
Vice-Chairman:	F. Mesinger	Yugoslavia
	J. R. Bates	Ireland
	D. J. Bouman	Netherlands
	B. R. Döös	Sweden
	E. Eliasen	Denmark
	K. Hasselmann	F.R.G.
	E. Holopainen	Finland
	J. van Isacker	Belgium
	P. Morel	France
	S. Palmieri	Italy
	F. Wippermann	F.R.G.
	B. R. Döös	W.M.O. Representative

Annex 3

International meetings attended by members of staff

1976

2–6 February	WMO E.C. Intergovernmental Panel of FGGE Geneva.	Director
5–9 March	Global Telecommunications System/ Technical Group, Geneva.	J. Labrousse
21–26 March	Scientific Advisory Committee, Max-Planck-Institute, Hamburg.	Director
22 March – 9 April	WMO Global Data Processing System, Global Telecommunications System, Geneva.	J. Labrousse
31 March – 2 April	JOC – Working Group on Numerical Experimentation, Exeter.	Director L. Bengtsson
4–10 April	JOC Study Group Conference on the Development of Numerical Models for the Tropics, Exeter.	Director L. Bengtsson
21–23 April	JOC Working Group Meeting on climate and data bases, Princeton.	L. Bengtsson
4–7 May	GARP Study Group – Conference on Airflow over and around Mountains, Sveti Stefan, Yugoslavia.	Director Z. Janjic
10–14 May	WMO Meeting of Experts for the development of a Data Management Plan for FGGE, Geneva.	L. Bengtsson
27 May – 5 June	Preparatory Committee of WMO Executive Committee, Geneva.	Director
10–11 June	Advisory Committee on Communications, Helsinki	J. Labrousse L. Bengtsson
22 June	ESA – Space Meteorology Working Group. Neuilly-sur-Seine.	L. Bengtsson
24–30 June	JOC-XII, Nairobi.	Director
19–23 July	Third Session of the Inter-governmental Panel on the FGGE, Geneva.	Director (as JOC Representative)

30 August – 4 September	Joint DMG/AMS International Conference on Simulation of Large-Scale Atmospheric Processes. Hamburg.	K. Arpe L. Bengtsson D. Burridge A. Hollingsworth E. Knighting
5–18 September	Visit to computer manufacturers in USA.	J. Labrousse R. Brinkhuysen E. McIntosh
29 September	ESA Space Meteorology Working Group, Shinfield Park, U.K.	L. Bengtsson
3–10 October	Working Group on Numerical Experimentation, Montreal.	Director L. Bengtsson
11–15 October	Information Workshop for the Preparation of the FGGE Data Management Plan, Geneva.	G. Larsen
11–16 October	WMO Symposium on Interpretation of Broad-Scale NWP Products for Local Forecasting Purposes, Warsaw.	L. Bengtsson
19–21 October	Advisory Committee on Communications, Helsinki.	J. Labrousse R. Newson
29 October	Visit to French Meteorological Office.	K. Petersen
1–12 November	Commission for Basic Systems, Extraordinary Session, W.M.O. Geneva.	J. Labrousse R. Newson
8 November	Ditto	L. Bengtsson
15–19 November	FGGE Planning Meeting on tropical wind observing ship allocation and ship utilisation in the southern hemisphere, Leningrad.	L. Bengtsson
21–28 November	Visit to computer manufacturers in USA.	K. Petersen D. Dent
6 December	Climatology meeting, Commission of the European Communities, Brussels.	Director
7–8 December	Working Group on Numerical Experimentation, Bracknell.	Director L. Bengtsson
7–10 December	Graphics Conference, Helsinki.	K. Peterson
9–10 December	FGGE Level IIIb Board of Review, Bracknell.	Director
13–17 December	Meeting of Experts for the Development of a Data Management Plan for the FGGE, Shinfield Park, UK.	G. Larsen

Annex 4

Publications by members of staff

Arpe, K, L. Bengtsson, A. Hollingsworth, Z. Janjic	A Case Study of a 10 Day Prediction, ECMWF Technical Report No. 1.
Bengtsson, L. (Ed)	Proceedings of seminars on The Treatment of the Boundary Layer in Numerical Weather Prediction. Reading, 6–10 September, 1976. ECMWF 1976.
Bengtsson, L.	Four-dimensional assimilation of meteorological observations. GARP Publication Series No. 15, WMO/ICSU, 1976.
Bengtsson, L.	A suggested procedure for Continuous Data Assimilation. Proceeding of the JOC Study Conference on Four-Dimensional Data Assimilation. The GARP Programme on Numerical Experimentation, Report No. 11, 1976
Burridge, D.	The use of semi-implicit methods in solving the hyperbolic equations for numerical weather prediction. Computational Methods in Classical and Quantum Physics. Edited by M. B. Hooper, International Tracts in Computer Studies. (Advance Publications Ltd.) 1976.
Hollingsworth, A.	The effect of spherical geometery on momentum transports in simple baroclinic flows. Quarterly Journal Royal Meteorological Society (1976), 102, 901–911.
Labrousse, J.	Le système de telecommunications du Centre Européen pour la Prévision Météorologique a Moyen Terme. Journal des Telecommunications. September, 1976.
Labrousse, J.	Le Résume d'Echange de réseau de l'Organisation Météorologique Mondiale. Journal des Telecommunications, Âout, 1976.
Wiin-Nielsen, A.	Atmospheric predictability on various scales. Die Naturwissenschaften. 63 p. 506–512. Springer, 1976.
Wiin-Nielsen, A.	On geostrophic adjustment on the sphere. Beiträge zur Physik der Atmosphäre. 49 Bd. p. 254–271. 1976.
Wiin-Nielsen, A.	On the kinetic energy of the divergent and non-divergent flow in the atmosphere. Tellus, Vol. 28, No. 6, 1976.