

# 15<sup>th</sup> Met Office Scientific Advisory Committee Meeting (10-12 November 2010) Chairman's Report

## *Met Office Response*

### 1. Introduction

MOSAC, under its new broader terms of reference, considered for the first time the foundation weather and climate science programme of the Met Office, and the new organisational structure conceived in response to the seamless nature of the science. In its 2½ day meeting MOSAC received presentations from the Director of Science, the Head of Science Programmes, the three Deputy Directors and 13 other staff. Overall, it recognised the high quality of the science presented to it, the relevance of this science to customer requirements, and the enthusiasm of all those who presented and discussed it. The Committee congratulated the MetO on its good operational NWP scores in the past year and its performance in emergency events. Its global weather forecasting is firmly within the bunch of three in the world with the highest skill.

In the NWP area 99 papers were published in the year, and 187 papers published in the last decade have received more than 15 citations. 81% of projects are estimated to have produced results that have been used in NWP and 49% to have had significant impact on the weather forecast scores. The Hadley Centre is widely recognised as being a, and perhaps the, world-leader in climate prediction and the related research.

*We very much appreciate the overwhelmingly positive comments of the Committee and their appreciation of the quality of work and enthusiasm of the staff. The Committee's comments on how we can do even better are very valuable to us and we expect to report further progress next year.*

### 2. New Organisational Structure

The Committee considered that remarkable progress had been made in developing and implementing the new organisational structure. The customer drivers of the Weather Science Directorate and of the Climate Science Directorates are clear. The Foundation Science Directorate is to be viewed in terms of the commonality of its science rather than its fundamental nature. The customer driver will therefore be from the other two Directorates. In order to keep cohesion in the Science Programme it will be necessary for the three Deputy Directors to communicate together regularly about strategic matters as well as day-to-day concerns.

*Good communication across the Science programme is essential if the new structure is to deliver to its full potential. The Deputy Directors and Heads meet fortnightly as a team to review the programme with particular emphasis on day-to-day concerns. We also have less frequent away-days to discuss more strategic issues; on occasions these also include the Strategic Heads to build greater awareness across the programme, and to gain their input and buy-in for the strategic development of the whole Science programme.*

A question was raised over whether in the long term the part-time Head of Integration and Innovation really fitted into the structure.

*This is a fair point, although this is only a 20% position. With the departure of Dr. Boucher to IPSL we are reviewing the position. It is possible that the senior science management team can cover the programme's needs for integration and innovation.*

It is important to keep in mind the full range of challenging and important prediction problems included in the new seamless science perspective: from kilometre scale

weather forecasting on hourly time-scales, through the weeks to decades time-scales, and on to century time-scale Earth System/climate projection. The range of talks presented and the discussions stimulated by them showed that the approach to R&D based on the seamless nature of the weather-climate prediction problem is already well embedded and the advantages are starting to be realised.

Three talks given to MOSAC by areas in Customer Applications suggested that the development from research to applications is developing well.

### **3. Some Cross-Programme issues**

Detailed modelling of convection has for some years played an important role in the interpretation of observations and the development of parametrisations. Enabled by modern computer systems, there is now the ability to perform such modelling on regions of scales of thousands of kilometres. The MetO is playing an important role in the NERC CASCADE Programme which is exploiting this ability. The Committee welcomed the profile given by the MetO to convective scale modelling and its relevance across the range of its time-scales of interest.

MOSAC continues to wonder whether the profile given to data assimilation is sufficiently high given its central role across the range of time-scales. The challenge of providing data for kilometre scale NWP is high, and so is that of providing data to initialise the longer time-scale predictions. The Committee recognises that not all areas can be in Foundation Science but further consideration will have to be given to the handling of Data Assimilation and also other areas that span the time ranges, such as Ensembles and Ocean Prediction.

*We agree that data assimilation is critical to our science and services and arguably could be placed in Foundation Science. However, the importance you give to kilometre scale NWP is one of the reasons for keeping it in Weather Science, but making sure that the linkages with other parts of the programme are strong. The same applies to Ensembles and Ocean Prediction and we already have a cross-cutting activity on seamless Ensemble Prediction Systems led by James Murphy; Chris Gordon is considering how we can improve the synergies in ocean modelling.*

*There is also a risk that too much of the programme collapses into Foundation Science. The argument for the current arrangement is that the global model is fundamental to everything we do including data assimilation. We will review the structure as we go forward and as the agendas of our customers and stakeholders change.*

The alignment between observations in operations and in both Observational Based Research and Weather and Climate Science needs to be improved, and the link between Satellite Applications and Climate Science should also be stronger.

*We agree. Although there are better links between Observations R&D in Operations and Observational-based Research in Foundation Science, there is much more to be done, including how developments in the UK observing system feed into data assimilation developments. Likewise the linkages between Satellite Applications and Climate Science need to develop further, particularly with the ESA Essential Climate Variables initiative in which we are involved. There is a good case for an Observations Theme which draws together operations and research, and weather and climate. We will provide an update on progress at the next MOSAC.*

### **4. Kilometre-Scale Weather Forecasting**

The Committee welcomed the fact that good progress has been made on the stratocumulus prediction problem that it has highlighted in previous years. However, as emphasised by the Head of Operations, the problem has not been solved. It is pleasing that the UKV (variable resolution down to 1.5km) is now competitive with the

UK4 (uniform 4km resolution). However there are important problems over the interpretation and evaluation of the skill of the fine grid-point rainfall predictions. The model also needs wider evaluation, such as against wind data. Good advances are being made in the necessary observational systems. The MetO is to be congratulated on successfully developing and starting to employ its own replacement radar system.

*There is no doubt that the implementation of the UKV model in operations has delivered a step-change in capability, but we recognise that this is only the beginning. Initialising forecasts, evaluating model performance and verifying forecast skill are all major science challenges. Also, the use of ensemble techniques will be vital, particularly in cases where the synoptic forcing is not strong, such as summertime showery outbreaks, and where there is the potential for high impact weather at the local scale. Progress on understanding the performance and improving the UKV system will be a high priority going forward.*

Two related challenges were made by the Committee. What observational system is required to realise the full benefits hoped for from the UKV? More particularly, what observational and forecast system is required to provide the high-profile forecasts for the Olympics and any emergency events that could occur at that time? The answer to the first question cannot currently be determined because the MetDB system to handle the observations is in need of significant attention. The Committee stressed that this must be given a very high priority.

*We agree and action will be taken.*

The Committee emphasised that the Olympics would be a very high profile time for the MetO. The MetO should make sure that it knows exactly what observational and forecasting system it would like to have in place and that it has a plan for making this occur.

*We have the LOCOG contract to provide forecasts for the major locations and we are making plans accordingly although the budget is limited. We are looking at some additional activities which we would fund ourselves. An Olympic Governance Board has been established to cover all aspects of delivery from science through to the web. The Phase 2 HPC upgrade will enable UKV ensembles to be run in situations where there is a risk of high impact weather, and we are also developing links with other parties, including academia, who will be making additional observations around London at that time. The potential to work jointly with DSTL is also under discussion.*

## **5. Some other NWP Issues**

The Committee continues to have concerns over the calibration of the ensemble weather forecasting system. In the absence of a coherent, computationally expensive set of hindcasts there will be difficulty in the operational interpretation of extreme events predicted by members of the ensemble system.

*This is an issue that all operational centres face and there is no obvious solution that would be computationally viable. It is also the case that some of the extremes we have dealt with recently have been exceptional and therefore probably not within a hindcast set (e.g. Cockermouth floods). This issue emphasises the importance of the man-machine mix in operational weather forecasting since the experience of the forecaster-on-the-bench is invaluable for recognising what the model does well and what it does not.*

Because of the computer time involved the MetO plans to run a very limited operational ensemble, perhaps 4 in number, of kilometre scale forecasts. These will be driven by synoptic scale differences at the boundary. The useful interpretation of such a small ensemble will be very challenging. Also, if the main sensitivity of the

fine resolution model on the short time-scale is associated with detailed atmospheric structure, e.g. humidity, within its region, then this should strongly influence the ensemble strategy.

*We agree, this is very challenging science and we are looking at how to balance the ensemble size with model resolution. Our current plans are to run a 12-member ensemble at 2.2km every 6 hours instead of 4 members at 1.5km; this slight reduction in resolution should not degrade model performance.*

*We also agree that the synoptic situation will drive the level of predictability for individual situations (e.g. Cockermouth floods were predictable because the synoptic forcing was strong whereas the Ottery St Mary event was not because it involved local thunderstorms). Our strategy for how and when to use ensembles needs to recognise this, with the right balance between uncertainties arising from the large scale boundary conditions and those that arise from local initial conditions and processes and interactions within the UKV domain. The former are relatively easy to handle whereas the latter are very challenging and need much more research.*

## **6. The Icelandic volcanic eruption**

The Committee congratulated the staff involved in all aspects of the provision of ash forecasts during this summer's eruption. The biggest sources of uncertainty were the height of the injection and the nature of the particles injected. There was discussion over the information that might be obtained from satellite data directly and from the inversion of this information using winds from weather forecast models. MOSAC considered that the MetO should leave the near volcano environment, its monitoring and forecasting to others.

In this summer's crisis the whole UK community had acted together in a remarkable manner. However this was done in an ad hoc manner. MOSAC considers that the lessons learnt should be articulated so that definite national plans can be made for any such future occurrence, indicating the expectations of the various players in the UK.

*The lessons learnt are being taken forward in the development of the Natural Hazard Partnership which involves government agencies and NERC research centres. We are already working closely with BGS to formalise these arrangements around volcanic ash, and now that the civil contingency aircraft is secured there should be better-defined national plans for dealing with such emergencies going forward.*

## **7 Some longer time-scale issues**

The Chair of the Hadley Centre Review Committee, now a member of MOSAC, summarised the very favourable comments of that committee on the Hadley Centre programme. MOSAC enthusiastically concurred with the excellence of its research.

In the MOSAC discussion of presentations to it, a number of aspects had implications for the continuing need for very high quality work to be done and to be seen to be done, and for high quality, responsible communication with users and the wider public. The growth of climate services is a very exciting prospect for the MetO. However there is an inevitable tension between the regional/local information the users would like ("require") and what is possible scientifically. In the development of climate services, care must be taken not to over- promise or to raise expectations too high. This tension has already been felt in the areas of seasonal forecasting and fine resolution UK Climate Programme data for later this century. A crucial process for the high-profile record of observed globally averaged temperatures is the quality control of observations on a day to day basis. This work depends on one person and so is vulnerable. A revision of the methods used for calibrating ship-based measurements of sea surface temperatures has led to new 1940s values outside the

previously proposed bands of uncertainty. The newer model runs suggest a reduced tendency for drought in the Amazon and consequent forest die-back compared with much quoted earlier projections.

*We recognise the vulnerability of the monitoring programme and we are considering how best to sustain this important area, potentially in collaboration, such as with the NOAA National Climate Data Centre. More generally the senior management team is actively looking at the whole question of succession planning and the need to identify potential gaps in expertise before they actually arise.*

## **8 Model system development**

The advantages of higher model resolution and better representation of the stratosphere are being well demonstrated at the MetO and elsewhere. It is clear that the representation of land surface and soil moisture are now needing urgent attention and MOSAC requested a paper on this aspect next year.

*Agreed. We hope to report significant progress in resolving these issues and in building even stronger cooperation with the NERC JULES community.*

MOSAC welcomed the development by the Research Councils, with active MetO involvement, of a programme whose aim is to determine what could be the components of the dynamical core of the future MetO model. Given the lead times involved, a strategic decision in this area will be needed in 1-2 years. For the shorter term, the MetO have developed options for dynamical core changes that could be included in the model.

The development of the representations of the wide range of physical, chemical and biological processes that will need to be included in a future Earth System Model will require a UK community effort.

*We are making good progress in establishing a joint core Earth System Modelling group with NERC and we hope to report on these developments next year. In particular the focus will be on holistic Earth System Modelling and the challenge of bringing all the various components together.*

## **9 Partnerships and collaboration**

The Committee felt that the Partnership Programme with other Met Services is developing well with clear advantages becoming apparent on both sides. Collaboration with NERC is also generally developing well. The MetO have recognised that in order to keep the internal and external community together it is necessary to reduce the frequency of significant model changes: just one per year is now the target. Questions such as who is allowed to write model code are now being considered. Particularly for the academic community, model usability is a very important issue. Partly for this reason, some of the UK community are using the off-the-shelf US model WRF. It can be argued that this diversity is good or on the other hand that it weakens the UK community effort. A very significant barrier to effective academic use of the UM on the NERC computing resource at the MetO is the current unavailability to them of the MetO data archive, and this barrier should be removed.

*We are working to improve the access through the shared system and hope to report some significant progress next year. In terms of UM usability, a technical workshop has been held with NERC scientists and a plan of action developed which will require a commitment of resource from both sides on technical developments. There may also be opportunities to engage our UM international users in supporting some of these developments. This activity is a priority for the new Science Partnership programme in the coming year.*



One long-standing collaboration with NERC has been in the land surface area using the model JULES. It was felt by the Committee that it would again be very useful to articulate the lessons learnt in this collaboration.

MOSAC discussed the MetO relationship with ECMWF. Collaboration is good at the scientist level. However the strategy to gain maximum synergy between the two research programmes is still not apparent. At an operational level, the Committee was told that better use could and should be made of ECMWF products.

*We are engaging with ECMWF on the development of their 10-year strategy and will be meeting with the incoming Director, Alan Thorpe, at an early stage to agree our relative roles and responsibilities and how we can improve the synergies between our respective R&D programmes.*

### **10 Super-computing resource**

The MetO now has a healthy 3 to 1 ratio between research and operational use of its super-computer (except in 3-week trials of new operational suites when it becomes 1 to 1). The use of this resource and the plans for the use of its upgrade were discussed and generally supported. In the longer term it appears that a European Climate Computing resource will be required to supplement the national resource and give the power that will be required to stay at the cutting edge of the subject but that no single European country will be able to afford. An update on the strategy for this was requested for next year.

*We have prepared a paper for Sir John Beddington which considers the range of future options for gaining the level of HPC capability that will be required. This includes possible approaches to European funding. We hope that by the next MOSAC there will be progress to report.*

### **11 The MOSAC Meeting**

The new ToR and format for the MOSAC meeting were considered by the Committee to have been generally successful. The papers sent to the Committee contained less depth than has often been the case before. This recognised the increased breadth and size of the material and the need to not over-burden members. However next year, a little more depth is requested. The presentations given to the Committee were generally of high quality and raised issues for discussion, a discussion which involved many from the MetO as well as the Committee.

*This year was an experiment to try shorter papers and more in-depth presentations. We will try to get the balance right next year without over-burdening the Committee!*