

16th Met Office Scientific Advisory Committee Meeting (9-11 November 2011)

Chairman's Report *(Comments in response from Met Office Chief Scientist shown in red)*

1. Introduction

In its 2½ day meeting MOSAC received presentations from the Chief Scientist, the three Deputy Directors, the Chief Meteorologist and 16 other staff. These presentations covered the breadth of the seamless weather-climate programme. The Chair of the Met Office Hadley Centre Review Committee was not able to attend, but fed in his summary of its meeting. The Chief Executive spoke at the beginning and end of the meeting and he and many other members of staff attended some of the sessions and took part in the discussions.

As usual, last year an agreed MOSAC Chair Report was presented to the Met Office Board and made available to the Public Weather Service (PWS) Customer Group. An innovation was that a written response was then communicated by the Chief Scientist to the Committee. This new aspect was welcomed by the Committee.

The Committee has usually been impressed with the material presented to it at the MOSAC meeting, but this year it was particularly so. The new organisational structure had bedded down well and a remarkable amount of good work had been achieved.

Andy Brown was congratulated on his successful filling in as Chief Scientist for a part of the year.

It was noted that in the year Met Office scientists had published 263 papers, with co-authors in over 400 institutions in 44 countries. Forecast scores were not highlighted this year.

2. Implementation Plan

The Science Strategy Implementation Plan was considered to be an excellent document. It described a good course for the development and application of the science which will maintain the world leading position of the Met Office and at the same time satisfy the requirements of its customers. The absence of any indication of target forecast skills on different time and space scales was commented on but it was noted that these may be given in other documents. It was considered that it would be useful to mention here the risks to the programme, both from internal and external sources. Internally these include the availability of both manpower and computer power. The external risk to the programme of reduced global observations from satellites could be very significant. It could also be useful to articulate the dependence on partners and where leadership from them will be sought.

The Science Implementation Plan has been a challenging document to create and the Committee's endorsement is welcomed. The comments on including major risks are well-made and we will add a further section to the plan that considers these. Over the next year, as our Science Partnership programme matures, we will also be seeking to clarify the roles of our various partners in delivering the plan.

Global observations are now being placed on the corporate risk register and we are working actively to influence the national and international agendas to mitigate these risks. Sir John Beddington has already called a national meeting to address continuity of funding for major global observing systems and has been fully briefed on this topic for his conversations with NOAA.

3. Collaboration

The increased profile of collaboration with NERC and with the UM Partners was warmly welcomed by the Committee. The scientific research that will lead to the core of the UK weather and climate models in the early 2020s is being performed in a Met Office/NERC jointly resourced programme (GungHo!), the first of its kind between the two organisations. The first phase of this programme is working well and the strong hope was expressed that the second phase would be supported by NERC to follow on directly from it.

The Joint Weather and Climate programme (JWCRP) with NERC and using the shared partition of the computer system at the Met Office is producing interesting science and successfully increasing collaboration with researchers in UK academia. However more resource, both in terms of people and computer power is needed to increase the pace of this activity.

We agree that the shared MONSooN system has been a huge success and is highly utilised. Besides the 3-5 times increase in capacity as part of the scheduled Phase II upgrade of the Met Office system this year, we are delighted that NERC has been successful in its bid to the RCUK e-Infrastructure call for an additional £1M investment. Both investments will significantly increase the pace at which the JWCRP can develop. We are also in productive discussions with NERC and our international UM partners on investing further in a core activity to provide enhanced technical support and development for the UM environment.

The aircraft jointly run by the Met Office and NERC continues to produce superb observational data, the basis for improving the processes represented in models. It is also the UK entry ticket to the international observational programmes, leading to access to data from the observational systems of many other countries. The UK aircraft is used for research almost double the time of comparable aircraft from other countries. The present aircraft lease agreement expires in January 2015. It is vital that the Met Office and NERC make the necessary moves towards a new arrangement at that time.

The strong endorsement from MOSAC for the continuation of the BAe146 Facility for Airborne Measurements (FAAM) aircraft is welcomed and very timely. With increasing pressures on NERC and Met Office budgets, prioritisation of major infrastructures will be essential and MOSAC guidance is very helpful. As part of the JWCRP Joint Facilities' Group, we have already established a Working Group looking at possible future funding options as a matter of urgency. We will report on progress at the next meeting.

The increasing number of UM Partners and the scope of this partnership was viewed as very positive. This enables a wider input to the evaluation of the UM and to its future development. However it was recognised that it could also lead to inertia in making model changes and that it will need effort to keep the partnership and the versions of the UM used by the individual partners together.

We recognise that this is a risk which we are seeking to mitigate by establishing a formal timetable for model updates that takes account of the needs of both operational weather forecasting and climate research. This has been made possible by bringing together our global model development within Foundation Science. Within our Science Partnership programme, we are also revisiting the arrangements with our UM international partners to ensure that they remain closely engaged in the plans for model development and can increasingly be involved in helping to deliver improvements, both scientifically and technically.

The involvement of Met Office staff in over 180 scientific committees, the new Met Office Academic Partnership and the partial funding of 63 PhD students in 16 UK universities were also welcomed.

4. Model development

The seamless perspective on the science of the Met Office is now reaching a challenging point at which the desire for a single system is confronted with an Earth System Model (ESM) of an increasing complexity; this is necessary for longer time-scales but may bring large over-heads and difficult computational challenges at short space and time-scales. The breadth of the ESM will imply the need for external leadership in some scientific areas where the Met Office does not, and should not, have the necessary expertise. The Committee considered that from the Met Office perspective the breadth of the ESM should be limited by the notion that the wider system should only be represented to the extent that it influences the climate system, and not for its intrinsic interest. However this wider interest in the Earth system will be important to NERC and to parts of academia, a tension that will need to be handled.

We agree fully with the committee's advice to focus our ESM activities on those aspects that directly influence the climate system and hence are likely to influence climate sensitivity going forward. Our Earth System Science programme is already delivering some important research on quantifying a range of Earth System feedbacks which is allowing us to focus on those that are likely to have the greatest impact.

Through the JWCRP we have developed a joint NERC-Met Office Earth System Modelling Strategy and are in the final stages of agreeing its implementation. This formally recognises that the expertise in components of the Earth System may often lie outside the Met Office, and that our unique role is our ability to bring these areas of science together within a holistic Earth System Model. I hope that next year we can report on these developments and demonstrate that substantial progress has been made.

At this point it has not been found necessary to vary parameter values in the schemes representing physical processes for different time and space scale prediction systems. However this may not continue to be the case.

Stochastic schemes and ensemble methods are planned to be used on all time-scales. The Committee was presented with the developing plans to deliver a seamless ensemble prediction system and the potential challenges. The design of the perturbations to the initial conditions on 1-day and 1-3 month time-scales will both need careful consideration.

The first phase of the GungHo! Project is focusing on horizontal schemes in a global domain. In phase 2 schemes for the vertical dimension will be investigated. It was cautioned by the Committee that very fine resolution regional models with steep topography may make demands on schemes that are very different from those of the global models.

In the nearer term there is a need to much improve tracer conservation in the model and for some years a revised model dynamical scheme that includes this aspect has been in development. Of the possible ways forward presented to it, the Committee encouraged a focus on getting this scheme into the UM in the next 2 years with an efficiency that is sufficiently improved for it to be viable.

Since MOSAC met, considerable progress has been made on improving the efficiency of the revised dynamics (Endgame) and it now looks as though it will be a real contender for inclusion in the operational suite next year.

Data assimilation (DA) and model development are increasingly closely linked and this will need to be taken account of in all model developments. There is a question over how seamless DA should be. DA provides a particular challenge on the very short and on the monthly to decadal time-scales. The current hybrid version of 4D-Var developed at the Met Office appears to be an excellent compromise between efficiency and accuracy.

MOSAC has correctly identified some major challenges for DA going forward. Although the concept of 'seamless' science, modelling and prediction is something we are striving for, it is not a 'mantra' but rather a guiding principle that we follow where it makes sense scientifically and delivers real benefits. It is clear that DA for UK short range forecasts and coupled ocean-atmosphere DA for extended range prediction pose very different problems which are being addressed through different approaches.

Evaluation of the performance of model schemes over the wide range of scales for which the UM is run will require consideration. The Committee suggested that there could be great value in developing a large series of test cases covering important phenomena and situations occurring over this range. The Committee was surprised that there was a continuing restriction on model testing associated with MetDB. It was assured by the CE that this would be a high priority to remove.

Model development taking account of all these aspects and the balance at every time-scale between model breadth, complexity and resolution and ensemble size will require clarity of thinking and leadership. The Committee would welcome a paper on the approach to model evaluation and forecast verification next year.

This is considered potentially the most challenging area of the programme particularly as resources, both staff and supercomputing, are limited. This is an area where would appreciate MOSAC guidance. I intend that next year, once we are familiar with the enhanced capability of the Phase II upgrade and other potential enhancements to the system, we present MOSAC with a well-argued strategy for the development of our modelling and prediction systems, which addresses the competing demands of resolution, complexity and ensemble size. It should demonstrate that we understand the compromises that we are making both scientifically and in our operational delivery.

5. Weather and Forecasting Operations

The Committee endorsed the plans to aim for a UK ensemble made up of 24 members, each with 2.2 km resolution, 12 from the latest start time and 12 from 6 hours before. It also supported the intent to move to a complete ensemble system, though the demise of the single highest resolution, deterministic forecast run would need careful planning with Operations. The current, pragmatic use of a 5-day extension of the 4km run not using a specific DA runs counter to this vision.

This point is well-made but demonstrates the value of the flexible modelling system that we have available. There is good evidence to support the added-value that this on-demand system provides, particularly for the extended range when we know that deficiencies in the global model (e.g. inland penetration of showers) will affect the long-range guidance we can provide. This problem would not necessarily be resolved by replacing the deterministic

forecast with an ensemble system so maintaining this kind of flexibility should remain part of our strategy.

There was discussion over whether the rather tight boundary on the UK model means that on occasion, such as for a polar low or a Spanish plume, it would be useful to have the flexibility to initiate special forecast runs with extended boundary regions. This would create practical difficulties but should be considered.

This is a solid recommendation from MOSAC and reiterates previous concerns. We will give this serious consideration and we accept that the current fixed positions of the boundaries may be detrimental to our forecast quality, especially in Spanish plume events. We will complete an assessment of the work required and report back to MOSAC next year.

The fact that the Met Office has developed and acted upon plans for special forecasting for the Olympics was welcomed. These include nowcasting and models run with 300m and 1km grids, and the inclusion of air quality prediction. The Committee would welcome a paper next year reporting on the science implemented during the Olympics.

The Committee was pleased to see the positive and constructive relationship between Forecasting Operations and R&D. The Chief Meteorologist noted that the 1.5km UKV was considered by forecasters to be best at precipitation but the older 4km model superior for clouds. The difficulty in quantitative evaluation of precipitation on the kilometre scale is a very real one. Stratocumulus infill was still a problem. There was a push for more 50:50 jobs with R&D as forecaster numbers increased. Automated sites and the role of the forecaster were discussed.

Since MOSAC there have been further constructive discussions with Forecasting Service Delivery (FSD), and as part of the Science CPD programme, a number of opportunities have been created for Science staff to 'shadow' FSD staff. Even the Chief Scientist plans to participate! A number of 'summer placement' research projects have also been advertised to be undertaken by forecasting staff this year. We are also investigating the opportunities and barriers to more fluid movement between science and forecasting professions.

The Committee recognised the current uncertainty surrounding the potential performance of the Phase 2 upgrade to the supercomputer and therefore the detailed configurations of the future operational suite. It hoped that next year it would see greater clarity around the future plans.

See comments above in Section 4 - we propose that once Phase II is in place, we will update our strategy for the development of our modelling and prediction systems, which we will present to MOSAC next year.

A paper on nowcasting developments is requested by the Committee next year.

6. Monthly-Climate

The Committee was shown recent experimentation indicating the possible importance for seasonal prediction in NW Europe of the 11-year solar cycle and the resolution of the stratosphere.

The very positive view of the Met Office Hadley Centre Review Committee was endorsed and congratulations were given for the prompt, efficient production of the large number and type of climate runs required for the next IPCC. Initial thinking about the next UK Climate Impacts Programme requirements was given. In the discussion of the availability of the necessary super-

computer resource, the possibility of having a national climate capability using a European HPC system was raised.

Since MOSAC met we can report that a major bid submitted through the JWCRP to the EU PRACE programme has been successful. This allocation of time on the German Tier 0 machine will allow us to run some very high resolution climate simulations, but will also test the viability of working on European HPC resources. We will report to MOSAC on the success of this venture. At the same time we are engaging in discussions around the EU on climate supercomputing, through the ENES and JPI-Climate activities.

7. Land surface, hydrology and atmospheric composition

The strategy the Committee had sought in the land surface area was presented to it and endorsed. The plans are centred around JULES, a national resource, and envisage other aspects being added to it and a focus on weather and climate impacts.

The Integrated Hydrological Cycle programme Working Group involved internal and external members and considers all time-scales. Already its work has led to an improvement in the prediction of light rainfall. Interesting results are being obtained on the hysteresis in the hydrological cycle for varying CO₂. The challenge to initialise soil moisture was noted.

The terrestrial water cycle will continue to be a major focus for us and since MOSAC there have been constructive discussions with NERC's Centre for Ecology and Hydrology (CEH) on resourcing JULES and developing a more strategic and joined-up approach, including planning for the next generation hydrological models. We would be happy to report on progress next year.

Congratulations were given for bringing the various strands in aerosols and air quality together with plans for future development.

8. Observational Research

Analysis of the data obtained from the joint aircraft has led to the development of a technique for radiative transfer inversion that is being evaluated for its wider suitability with satellite data. In addition to the major facility provided by the joint aircraft with NERC, the Civil Contingency Aircraft is now available to look at extreme events. The Cardington facility provides its own important measurements for stratocumulus and other phenomena, and also gives synergy with NERC ground based observations and with the aircraft.

The high work load successfully borne by the head of OBR during the recent period was recognised by the Committee.

9. Some other aspects

The Met Office was complimented on getting the members of the Natural Hazards Partnership together around a table. The Committee would welcome a paper on the strategy for developing Space Weather prediction next year.

After a presentation on Climate Services, the Committee again stressed the absolute necessity to retain scientific integrity. The Met Office must interact with the potential customer on its requirement and only agree to provide what is scientifically possible or likely to be so. The questions were raised on how the decision is made on what projects to go for and how the necessary

specialised knowledge of the customer's business is obtained, the answer being given that specific sectors are targeted and partners sought.

We fully endorse MOSAC's concerns about preserving the integrity of the science. It is for this reason that we have retained climate consultancy within the Climate Science programme to ensure that there is proper scrutiny of the products and services we currently provide.

Going forward, the Climate Service is being designed to ensure that there is a strategic approach to deciding which sectors to engage with and to understanding their specific needs, and that there is sufficient up-front investment in the applied science so that we address those needs in a scientifically robust manner.

The need for Continuous professional Development is even more necessary in a situation with level pay, and the Committee welcomed the fact that it was now explicitly discussed.