17th Met Office Scientific Advisory Committee Meeting (14-16 November 2012)

Chairman's Report with responses by the Chief Scientist

1. Introduction

For the first time, and consistent with the seamless weather-climate approach of the Met Office, MOSAC and the Hadley Centre Science Review Group (SRG) met at the same time. The aim of the SRG is to provide a review of their Climate Programme for the DECC and Defra customers. The two groups held separate sessions for about 6 hours in total and the rest of the time was spent in Plenary. The advantage of the joint meeting, allowing discussion of the breadth of the science, was felt by all to outweigh the disadvantages of a larger group and somewhat reduced ability to have detailed discussions in specific areas. It was concluded that the meeting model trialled this year should be continued next year but with the balance of sessions tilted slightly more to the separate sessions. The Report of the SRG is attached to this MOSAC Chair Report.

I am pleased that MOSAC and the SRG found the new format to be beneficial. We did too and we look forward to a similar arrangement next year but with the minor adjustments as proposed.

The Committees were welcomed by the Chief Executive and many other members of staff at the MetO attended some of the sessions and took part in the discussions. The Committee were pleased to have the involvement in the meeting of the two new Deputy Directors, Stephen Belcher and Gilbert Brunet in Climate Science and Weather Science respectively, both scientists of high quality and with good scientific management experience.

The overall view of MOSAC is that it has been an extremely good year for Met Office R&D. The seamless weather-climate approach to the research is already bearing fruit. One aspect of this is that it is relatively simple to introduce an interactive ocean into weather forecasting on sub-monthly time-scales, capitalising on the extensive testing of the coupled system in climate mode, and realise the increase in skill that this gives.

It was noted that the Met Office has retained its position as number 2 (to ECMWF) in global weather forecast skill, and that in the year its scientists had published 260 papers, with co-authors in 440 institutions in 40 countries, numbers very similar to the previous years.

The endorsement of MOSAC for our seamless approach to our science is very welcome and we too are pleased with the progress made this year which puts us in an excellent position to drive forward with the next stages of our science strategy.

2. Some highlights of the year

In previous meetings MOSAC had stressed the importance of the shop window that the Olympics provided for MetO capabilities. The MetO had felt that the implied infrastructure costs did not justify an international Forecast Demonstration Project as had taken place at some previous Olympics. However, responding very positively to the challenge provided by the eyes of the world being upon the event, new forecast developments were very successfully trialled by the MetO and world-leading forecasting capability was exhibited. MOSAC congratulated the MetO on the implementation of a suite including an hourly "nowcast", a 6 hourly 12 member

2.2km ensemble, an air quality model and a Weymouth Bay model with a 1/3 km atmosphere coupled to a 250m wave model. All this was well fronted by forecasters who became involved in the requirements of the Olympic competitors and exploited the new data they had available to them. The suite developed for the Olympics should provide an excellent prototype for the MetO to respond to increasing demands for Nowcasting and more detailed site-specific forecasts.

The delays in acceptance of the IBM P7 computer system created many difficulties that needed to be overcome during the year. Not the least of these was the development of the Olympics forecast suite. These delays and the eventual acceptance of the computer all meant considerable work for MetO staff.

Last year the Committee advised that an imperative was to significantly improve the computational efficiency of ENDGAME, the more accurate numerics for the core of the atmospheric model. The Committee was very pleased to hear that this was achieved. This clarifies plans for the development of atmospheric models at the MetO, ENDGAME providing the basis for this development. (It was anticipated that problems with ENDGAME in the limited area version were purely technical and would soon be solved.)

Last year a significant external risk to the programme posed by reduced global observations from satellites was noted. The Committee welcomed the fact that this risk is now perceived by the MetO to be lower.

3. High resolution forecasting for the UK

The Nowcasting Demonstration Project became real-time from end of March 2012 and proved its usefulness in both London2012 and in the summer floods. It is based on 1.5km grid models for the UK and for Southern England, the latter having better data assimilation but shorter forecast length. Real-time observations gathering, processing, and assimilation for such models are significant challenges. There is a primary need to develop quantitative techniques using the high resolution forecast system to justify the additional expense and establish a prioritisation of possible new observations. The pragmatic implementation of ensemble techniques with 12 members at 2.2km resolution has worked well. However the Committee feels that it is time to develop a proper scientific framework for ensemble modelling on this scale. There are a number of fundamental questions to answer after this excellent start. These include:

- What should be the balance between resolution, domain size and ensemble size?
- How should the different ensemble members be generated?
- What is the relative importance of initial state uncertainty and model representation error?
- How should the nesting in the larger-scale model be performed?
- How should the results be diagnosed for use by forecasters and is extensive hindcasting required to calibrate the system?
- How should the very high resolution probabilistic forecasts be evaluated?

In the longer term, there is also the question of whether a single slightly higher resolution run continues to make sense in a system that must be focused on probabilistic guidance for forecasters and other applications.

We welcome the very helpful advice of the Committee around our efforts to implement dynamical Nowcasting and the ensemble prediction system for the UKV. Making progress on all these fronts must be a key component of our strategy in Weather Science going forward. The Met Office convective scale prediction system is also critical to our emerging environmental prediction strategy which will form a key component of Weather Science in the next few years. We look forward to briefing MOSAC on these developments next year.

With the encouragement of the Committee, the relationship between the Operational and R&D parts of the MetO has improved immensely over the years, as testified by the Chief Meteorologist in his comments to the Committee. MOSAC is highly encouraged by this trend. Specifically, the new initiative in which researchers spend time on the 'bench' with forecasters is seen to be a positive development.

Last year MOSAC suggested that consideration be given to extending the boundary of the UK model for cases in which polar lows from the north or convective events from the south are possible. In the opinion of the Committee, the 4km European model is not a proper solution to this problem and it should be phased out. The 4km model strategy is inconsistent with the scientifically well-based move down to 1-2km grid size, for which the MetO is in the vanguard in operational forecasting. Apart from this element, the current plans were strongly endorsed by the Committee, though it wondered whether increased vertical resolution might also be necessary to make more progress with the stratocumulus problem.

We accept this criticism and agree that the implementation of the Europe-wide 4km model does not adequately address the concerns of the committee regarding the UKV boundaries. However, there are several pragmatic reasons why we made this decision at this time:

(i) We felt that the importance of implementing the probabilistic UKV system was paramount for the Olympics, to give us better forecasts of the risks of convective outbreaks. This would not have been affordable over a larger domain and indeed would have been difficult to accommodate alongside a larger domain 1.5km deterministic forecast.

(ii) The computational cost of the European 4km model is small relative to the UKV and it was deemed worth doing in terms of providing improved additional information for the larger domain versus the global model.

(iii) One of the drivers for the European 4km model comes from the renewables sector and indeed the costs of running the forecast are partially covered through commercial revenue.

We will review these decisions over the coming year and will report back to MOSAC next year.

A new surge model based on NEMO, the ocean model used by the MetO across the suite of its models should be developed and implemented as soon as possible to complement the forecasting suite.

We agree. We plan to present our new strategy on regional to local environmental prediction at the next MOSAC and this will form part of our plans.

3. Atmospheric chemistry

The UK air quality model is ready to be an integral part of the operational forecast suite as it is expected to be superior to any other available product for the UK. The Committee believes that Defra and other customers will be interested in this forecast and hopes that operational status will occur as soon as possible. The impact on radiative fluxes and cloud microphysics, including precipitation production, of the chemical constituents of the atmosphere and their interaction may be important on many time and space scales. In terms of observations, it is also possible for example that carbon flux measurements may help with understanding boundary layer physics. However there are still questions about the level of support for the chemistry module, UKCA, which has been developed in a partnership with NERC and led by Cambridge University. An integrated strategy to address the UKCA needs in climate and those in air quality forecasting would be welcome.

The Committee has correctly identified one of the weaker areas of our programme and the development of a much more coordinated approach to atmospheric composition across global Earth System Modelling and regional/local air quality forecasting is definitely needed. This must also take account of the increasing importance of the indirect effect of aerosols on cloud microphysics. We will provide MOSAC with an integrated strategy on atmospheric composition research and prediction at its next meeting.

4. Global forecasting

In operational weather forecasting the global model is run at 25km resolution and a lower resolution (60km) version has now started to be used also in the new seasonal forecast system, where it is coupled to an ocean model based on a ¼° grid. Running the seasonal system in hindcast mode has given very promising indications of increased skill in predicting, for example the nature of the westerly flow over the Atlantic and into Western Europe. This is an important determinant of European weather and its sensitivity to Arctic sea ice, solar variability and ocean-atmosphere interactions underlie this potential predictability. The fact that a similar increase in skill is not found in the N Pacific may need some investigation, though recognising that the model already had more skill in this region.

As noted earlier, the emphasis placed by the MetO on seamless prediction is starting to bear fruit. An important development over the past year has been the testing of a coupled atmosphere/ocean model for numerical weather prediction. Although run at a lower resolution compared to operational global model (60km compared to 25km), the coupled system has shown increased skill, particularly in the tropics.

However, predicting the mean climate and variability in the tropics continue to be a problem, particularly associated with rainfall. This should be a focus for increased attention as there is no doubt that tropical improvements will also lead to improvements in the European region as well as globally.

This remains one the biggest challenges in global modelling and the Met Office is not alone in struggling with this. There do not seem to be any easy or obvious solutions. This will be a priority for us in the coming year and we will work closely with our UM partners, particularly

Australia, and utilise the full range of models available to us. We would suggest that this should be a topic for next year's MOSAC.

5. Partnerships

The many partnerships that the MetO has were welcomed. The Committee supported the decision to keep the UM Core Partners number to 3 at the present time (Australia, S Korea and the UK). The sharing of scientific and technical problems is very positive and technical infrastructure is being developed to enable this activity. The Joint Weather and Climate Research Programme with NERC/Academia is successfully implementing its strategy, and NERC has a significant component of the new computer system at the MetO. The next UK Earth System Model (UKESM1) will be developed through this partnership. The Committee was very supportive of this but also stressed that very good coordination will be required to keep the development of the component systems together.

I am delighted to say that, since MOSAC, we have attracted an outstanding candidate, Colin Jones, to lead this activity.

There is a need to articulate the benefits of the collaboration in order to get continued buy-in from NERC at a time when its funding is being squeezed. There was a discussion of the balance between the need for structure in the partnerships and the downsides of too much bureaucracy. For example, a proliferation of science strategy committees would be unhelpful.

We agree that we need to continually articulate the benefits to NERC of our collaboration and equally help NERC to demonstrate the impacts of their investment in this area of research. We have already contributed examples of how NERC research has facilitated better forecasts, products and services as part of NERC's current review of its Centres and we are working with NERC on the development of its new strategy as we approach the Comprehensive Spending Review.

The scientific research that will lead to development of a new dynamical core for UK weather and climate models in the early 2020s is under way in a Met Office/NERC jointly resourced programme (GungHo!) and is proceeding well. A positive feature of the project is the significant involvement of the academic community.

MOSAC again noted the very strong case for the MetO and NERC to find ways forward on a new contract for their joint aircraft observational facility, The considerable direct value of this partnership to multiple aspects of UK science, and the fact that it is the entry ticket to international observational programmes, providing access to much wider, complementary observational data sets are critical, positive strategic considerations.

The value of a growing and mutually beneficial Academic Partnership to the MetO and those universities involved was confirmed. The importance of a continuing positive relationship with other universities was also noted.

The increased use of ECMWF forecast data and specified scientific collaborations with ECMWF were welcomed by the Committee, with the hope that this would be the basis for greater collaboration in future. It was noted that an increased use of ECMWF forecast data as boundary conditions for the mesoscale models would free up computing resources that could be spent on increasing the mesoscale model ensemble size. However it was also noted that the many global

services the Met Office provides over a tight forecast window, such as it role as a World Aviation Forecast Centre, requires its own global forecasting capability.

It is important that we justify why the Met Office invests in two world-leading global forecasting activities and this is something we debate on a regular basis. We have purposefully scaled down our operational activities in MOGREPS-15 and increasingly rely on ECMWF for our extended range forecasting needs; this is ECMWF's remit and it is right that we should look to them to supply the best forecasts. However as MOSAC has already noted, the benefits of a seamless modelling and forecasting activity from hours to decades are very substantial, and even without the customer demands for timely global forecasts, the scientific arguments for retaining an operational global system are very compelling.

6. Some other aspects

It was noted that, because of specific staff illness, the access to data through MetDB is still a problem. The Committee expects that the problem will be sorted very soon.

The Committee stressed that the MetO can only aspire to be at the top of the league of Meteorological Services if it continues to have the quality of scientists that it has, and noted that the low level of salaries and their continued decrease compared with academia and elsewhere is a threat to this.

The support for the meeting, the material provided and the talks were generally high quality. One exception was the quality of the projection of the slides, which was not helped by the design of some of them. (Another IT problem the Committee heard about was the lack of good video facilities). A second problem was the temperature of the seminar rooms that was extremely low, and certainly unhealthy for people who have just travelled from around the world to give feely of their time.