

NR23 Met Office Consultation Meeting

Present

Jon Dutton	Met Office	(Chair)
John Harrison	Met Office	
Linda Jennings	Met Office	
Darren Hardy	Met Office	
Jo Aston	Met Office	

Bronwyn Fraser	CAA
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Ian Lavine	American Airlines
Alexander Dawe	British Airways
Matt Davies	British Airways
Rory Lillington	British Airways
Dale Reeson	HAL
Paul Swinfen	Jet2
Darren Bunce	NATS
Conor Gillardy	Ryanair

Apologies

Malcolm Budd	Titan Airways
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Agenda

1. Introductions
2. National Capability and International MET commitments
3. MET services and developments
4. Further discussion and consultation questions
5. Closing remarks and summary of actions

1. Introductions

The meeting was opened at 1000 by Jon Dutton, Head Aviation Business in the Met Office. An outline of the day was provided and introductions from around the table made. Jon explained that the objective of the meeting was for the Met Office to engage with industry representatives on the planned activities proposed by the Met Office for the NR23 period (January 2023 to December 2027). A slide deck was used to drive the meeting, and these slides will be hosted on the Met Office website, with a voice over commentary for those unable to attend the consultation meeting in person.

Designation

The Met Office confirmed that the proposed activities are undertaken in accordance with the Met Office's designation as an Air Navigation Service Provider (ANSP), and are based around helping to ensure flight safety and efficiency. The activities highlighted are cost recovered via the en-route charging mechanism (unless specifically mentioned).

The service delivery and developments are driven by the Met Office's commitment to ICAO Annex 3 (Meteorological Services for International Air Navigation) and the Global Air Navigation Plan (GANP) in terms of UK services, Volcanic Ash Advisory Centre (VAAC) services and World Area Forecast System (WAFS) services. These activities are intended to also serve as enablers to meeting the Airspace Modernisation Strategy (AMS). Further, they are intended to support NATS effectively manage the airspace with respect to weather and airlines to enhance sustainability (for example through improved fuel efficiency and reduced holding).

Future supercomputing capability

It was explained that the Met Office has a strong reliance on powerful computers to drive the numerical modelling which forms the basis of its forecasts. The UK Government has invested £1.2 Bn in an enhanced supercomputing capability, which will deliver many billions of Pounds of socio-economic benefits over the next 10 years. This enhanced capability will help the Met Office to provide more accurate forecast products and services that will help enable successful delivery of the proposed NR23 service and developments.

The meeting sought clarification on a number of questions relating to the new supercomputer. It was confirmed that the £1.2 Bn investment is funded via central Government and there is no contribution via en-route funding. With regards the siting of the new supercomputer, it was confirmed that it is expected to be cloud based, rather than in situ at the Met Office premises in Exeter.

The meeting enquired about the driver for the Met Office investment in its supercomputing, and whether partnership activities with other organisations were sought to maximise benefits. The Met Office noted that the amount of observation data was increasing rapidly, and in order to process more data and undertake more complex modelling, enhancements beyond the capabilities of the

current supercomputer were needed. The Met Office works closely with a range of organisations, for example the US Weather Service for turbulence modelling and the National Center for Atmospheric Research (NCAR) for Eddy Dissipation Rates (EDR), and all science is peer reviewed. All data is also shared globally under World Meteorological Organisation (WMO) agreements.

The meeting also sought clarification on the running costs of the new supercomputer. It was confirmed that the investment cost included operational costs.

2. National Capability and International MET commitments

The Met Office explained that the primary aims of the Public Weather Service (PWS) are threefold; Services to the public (including support for UK resilience and severe weather, and civil contingencies), National capability (including Met Office infrastructure, observations and research) and International commitments (primarily contributions to EUMETSAT satellite costs and international subscriptions to the European Centre for Medium range Weather Forecasting - ECMWF and WMO). In response to a question raised, the costs of the PWS were confirmed as annual.

The Met Office summarised the extent to which aviation draws upon the composite elements of the PWS. Governance of the above areas is overseen by the PWS Customer Group, on which the CAA represents the interests of aviation.

There was focus on the International Commitments element of the PWS. The Met Office confirmed that WMO membership was £2.5m pa, ECMWF membership was £9m pa and EUMETSAT membership was currently £16.5 pa. The meeting discussed the benefits of satellite observations; these are fundamental to the Met Office's forecasting process, and help to enable future improvements to weather forecasts. Observations improve forecast accuracy by approximately 50%, and 75% of that improvement is directly attributable to observations from satellites. Satellite observations are also important in aiding meteorologists' understanding of the atmosphere so that they may add value to automated model output into products. Satellite data also helps the Met Office to calibrate its long term understanding of climate modelling. The meeting noted that 76% of observations come from space. However one slide highlighted that 4% of observations from space were annotated as 'non space'. The Met Office committed to provide detail on the nature of this 4%.

The Met Office reported that the biggest contributor to PWS is UK Government (specifically BEIS). The CAA contribution is currently £17m pa. Clarification was sought on the £1m of deferred revenue reported in the slide deck. The Met Office commented that this related to activities that are agreed by the PWSCG to be moved into the following year and are aligned with the BEIS portion of funding.

The meeting heard that the cost of the PWS was forecast to increase from 2023 due to the International Commitments element. This increase is attributable to a need to contribute to the EUMETSAT investment in next generation satellites. The meeting enquired if the Met Office was committed to this investment. The Met Office confirmed that it was and that this is a government

agreement between States. It was also highlighted that the current satellite capability was approaching end of life, hence there was a clear case to reinvest in this important capability. Indeed, the life of the current capability had already been extended beyond what was originally anticipated, which has kept the costs lower than expected. As a result, the cost of the new generation satellites are more representative of the true costs of running satellites. Whilst there remains some uncertainty in terms of timing of launch dates, any changes to this and to the cost presented are likely to be minimal.

The meeting asked if the costs in the Met Office proposal had accounted for the expected lifetime costs of the next generation EUMETSAT satellite capability. The Met Office confirmed that this was the case. The Met Office committed to provide details of the anticipated lifespan of these (in order to validate the costs submitted in the proposal document).

The Met Office provided an overview of the expected deliverables and benefits of the new supercomputer. Fundamentally this will enable the Met Office to significantly increase model resolution (both horizontally, vertically and temporal), and facilitate the increased use of ensemble forecasting techniques (i.e. probabilistic forecasts) both at a global and local level. The new supercomputer will also allow the introduction of new physics designed to improve forecast accuracy, and provide increased capacity to ingest significantly greater volumes of observation data.

The meeting asked about the expected improvements in accuracy expected from new supercomputer. The Met Office provided an example of the operationalisation of very high resolution models (300 metres) that are currently being trialled. The new supercomputer will enable this model to be operationally supported and extended over a wider area. Along with increased observations, very high resolution modelling will provide greater confidence in forecasting very localised Met impacts such as the onset and dissipation of fog over airports (enabling better decision making such as applying LVPs and flow rates).

3. MET services and developments

The Met Office then gave a presentation on proposed aviation MET activities during NR23. This broadly comprises 2 themes; Aviation Service Delivery and Aviation Development.

a. Aviation Services

UK Services

A range of UK products and services are proposed to be delivered, as at present. These largely reflect ICAO Annex 3 requirements such as TAFs, SIGMETs, and low level aviation products.

No significant changes are anticipated to the services over the period covered by NR23. The primary aim will be to maintain (and where possible improve the quality of the services) and also to reduce operational production costs (for example a 2.5% annual efficiency has been profiled into the costs).

The meeting enquired about services to meet the evolving need of Remotely Piloted Aircraft Systems. The Met Office confirmed that it was engaged in discussions with the CAA Innovation team, the CAA Met Authority and operators on the likely future requirements in this area. Focus on this activity is expected to increase through NR23, and an element of aviation science R&D resource has been allocated to identify future MET requirements and the activities needed to close the gaps between current capabilities and future needs. In a similar vein the importance of working closely with NATS on airspace management for UAVS was recognised.

World Area Forecast System (WAFS)

The Met Office is one of two World Area Forecast Centres designated by ICAO to provide global wind, temperature and hazard data to airlines. This activity is shared with the United States.

ICAO currently specifies a requirement to disseminate data at 1.25 degree horizontal resolution, which is equivalent to about 140 km. As such it is relatively coarse compared to what the Met Office is capable of providing.

A range of activities are proposed to improve WAFS output over the next 5 years (as described more fully in the Aviation MET Development section). Work has already started with the introduction of 0.25 hazard datasets in 2020.

Volcanic Ash Advisory Centre (VAAC)

The Met Office is one of nine ICAO designated VAACs. The area that the Met Office is responsible for is relatively small geographically, but includes Iceland, whose volcanoes have resulted in aviation impacts most recently in 2010 and 2014. Three Icelandic volcanoes are currently active at this time of the meeting, and are being closely monitored by the Icelandic Meteorological Office (IMO). The Met Office has a responsibility to provide Volcanic Ash Advisories (VAA), Volcanic Ash Graphics (VAG) and ash concentration charts. The process is regularly tested.

NR23 activities are intended to deliver a richer data service, whilst maintaining global consistency.

The meeting asked about the extent to which the VAACs consulted with one another on development activities. The Met Office confirmed that coordinating activities were managed through the ICAO mechanisms, in order to ensure standardised products.

General Aviation (GA)

The Met Office continues to be committed to contributing towards the safety of all General Aviation sectors. Several products and services are provided to enable this. The Met Office engages with General Aviation stakeholders through memberships and stakeholder relationship activities.

NATS

There are 2 primary elements to how the Met Office helps support the activities of NATS:

The first is an on-site team of meteorologists that are embedded into the en-route operations based at Swanwick, to support efficient airspace management through integrated MET information. NR23 proposes plans to increase the headcount (up to 9) and associated activities. This was planned for RP3 but delayed owing to the impacts of Covid and the resultant reduction in air traffic.

The meeting heard that the on-site team have helped NATS supervisors and have enhanced NATS' service provision by closing gaps that were evident through products alone before the on-site team was deployed. Regarding the increase in headcount, NATS relayed that this offers value in helping to develop a range of improved NATS products and processes. As such, the onsite team represented a good investment to aviation overall. The Met Office highlighted that a number of KPIs have been developed which are designed to objectively demonstrate the benefits of the service.

The second element comprises the products and datasets that are ingested into NATS information systems. The Met Office intends to work closely with NATS to help modernise the delivery of these products.

Space Weather

The Met Office is a member of the European ICAO space Weather Centre, known as the PECASUS consortium led by the Finland Meteorological Institute. There are 4 ICAO space weather centres globally.

The role of a space weather centre is to monitor the potential space weather hazards that may impact aviation, and issue advisories as necessary (which are distributed over SADIS).

The financial commitment from UK aviation is about £60k pa. This is a small proportion of the overall Met Office space weather centre cost, which supports a much broader commitment to UK Government resilience. The solar cycle is expected to lead to an increase in advisories issued over next 2-3 years.

The meeting discussed the cost recovery arrangement of the ICAO space weather centres. The arrangements for this are currently unconfirmed, however the impact for the UK is small compared to other States that have dedicated aviation space weather centres. The Met Office can provide more detail on the cost recovery activities led by ICAO on request.

Web visualisation

Three web visualisation services are provided by the Met Office, and the remit of these were summarised.

The Network Weather Resilience (NWR) tool is hosted on a cloud based platform. During NR23 the Met Office propose to transition the Aviation Briefing Service and HeliBrief from legacy infrastructure to a cloud based platform, potentially sharing the NWR platform.

b. Aviation MET Developments

The Met Office provided a summary of proposed aviation specific development activities. These activities are broadly informed by ICAO, GANP, AMS and CP1 activities.

World Area Forecast Service (WAFS)

The Met Office plans to increase the spatial and temporal resolution of WAFS data, in accordance with ICAO delivery timescales. The outputs from this activity are intended to support functions such as continuous descent, fuel efficiency and hazard avoidance.

3D hazard objects are also proposed to be created, for ingestion to flight planning systems, and single timestep .png WAFS significant weather charts will be phased out. An example of higher resolution hazard (turbulence) dataset output was provided. The creation of hazard objects will facilitate the easier ingestion of this data into flight planning or visualisation systems.

The creation of global higher resolution datasets results in very large files, hence it is recognised that there is a need to create a means of accessing discrete data sets (this is explained further in the Aviation Data Services Vision section).

The Met Office plan to implement the bulk of the WAFS changes and automate the WAFS significant weather production in 2023, reducing cost base by about £1m pa. It was explained that the timescales for ICAO consultation and ratification may result in a delay to implementing these changes until 2024. The meeting expressed disappointment that this important development may be delayed by ICAO by a year. For example, airlines have facilitated the ingestion of high resolution data and hazard objects into flight planning systems in anticipation of the original timescale. As such, any opportunity of accessing this data from 2023 would be appreciated. The Met Office recognised this and are working with ICAO to evaluate options to make the data available earlier, potentially under different labelling or as a trial product to bridge the 12 month delay period.

The meeting agreed on the importance of ensuring airline flight planners are prepared for the future changes to WAFS products. To that end the Met Office continues to work closely with a number of companies, and would be pleased to engage with the flight planning companies used by attendees, if not already doing so.

Volcanic Ash Advisory Centre (VAAC)

The Met Office summarised planned activities to develop VAAC London products. The primary focus in this area concerns the development of a new product – Quantitative Volcanic Ash (QVA). The QVA product is intended to build upon the existing VA concentration chart approach, to quantify the forecast amount of volcanic ash at flight levels up to FL600 and at a 0.25 degree horizontal resolution. The output would be presented in terms of concentration data and the probability of exceeding determined concentration thresholds at each grid point.

Driven by ICAO, all VAACs intend to develop this capability, to ensure global consistency of products. The product will also be made available in digital form (IWXXM and SWIM-compliant gridded data) in order that they may be easily consumed into flight planning systems and available to airlines.

The Met Office intend to provide this capability from November 2023 (when it will become an ICAO Recommended Practice). All VAACs will be required to provide this output by 2026 when it becomes an ICAO Standard.

The meeting commented that the development of this product would have particular benefits, especially given the recent experiences of some airlines affected by ongoing eruptive activity at La Palma and Etna (which erupts on a relatively frequent basis). Ingesting this data into flight planning systems will be useful in helping airline operators adapt their safety management systems and help mitigate operational risks effectively.

The meeting also agreed that the product helps better decision making in terms of airspace closures. The Met Office reported that it intends to run a VA webinar in 2022, when these development activities can be explored in more details and operators will have the opportunity to consider how best to integrate the product into decision making.

A question was asked whether the QVA product would have different timesteps to the 6 hours one currently provided in the concentration charts. The Met Office would refer back to the group with an answer to this question.

Aviation Data Services vision

The Met Office highlighted that the data enabled by the activities above will increase almost exponentially over time. Providing global dataset with such amounts of data is unviable in terms of file size and transmission costs. Given this, there is a requirement to develop solutions to make relevant and useable chunks of data available and easily accessible as SWIM compliant services.

The solution identified by the Met Office is to create a series of capabilities that can be accessed and used by all stakeholders with a requirement; such capabilities include sub-sets of gridded data (for a geographical area), 4D trajectory data (for a particular route) and site specific object data. The scope of services available would include WAFS, QVA, OPMET data and UK aviation products.

The meeting discussed the future access to MET data and products in detail. It was confirmed that data would be available on a global scale and would also be SWIM compliant. The data would be available to commercial providers and whilst the precise cost recovery mechanism was not yet confirmed the Met Office would ensure that the principle of making data available for safety and efficiency was maintained.

The meeting also considered the importance to end users of ensuring they have developed the ability to consume this data. It was also confirmed that there will be a period where the new data services would be provided alongside the legacy global datasets (the precise period to be

determined by ICAO), however both legacy and future services will be cloud based (hence less duplication of cost).

Web visualisation

NR23 sets out proposed plans to transition the Aviation Briefing Service and HeliBrief onto new cloud based technology, ideally on the same platform as NWR. In doing so, the Met Office will realise operational efficiencies for all of its web visualisation commitments on a single platform by removing the increasing costs of legacy web platforms.

A range of options to develop the Network Weather Resilience tool were discussed. Options include the development of airport specific forecast (for example Heathrow forecasts by hour for a variety of Met parameters), as well as hosting additional products and data being developed by the Met Office. Developing this capability would cost in the order of £300-500k. In hosting new data on NWR the Met Office also seeks to showcase data services by visualising them, whilst also enabling stakeholders to use the data if they are unable to directly ingest it into their systems.

The meeting heard the experiences of those who currently use NWR. Feedback received suggested that NWR was proving to be a valuable network planning tool, and the addition of new products and data would be beneficial. If all airports were to use the same tool it would become more valuable in terms of consistency throughout the network. The meeting proposed that it would be valuable for the Met Office to establish a working group to help gather Industry requirements and to determine the lifecycle plan for NWR.

Volcanic ash

The proposed work activities in this area comprise 2 elements, science R&D and observations capability.

In terms of science R&D the focus is on the development of the new QVA forecasts (as described elsewhere in this report), and improving the detection capability of SO₂ in the atmosphere.

With regards observations capability, the meeting heard that the Met Office suspended its airborne monitoring capability during 2020 as a result of a need to reduce the cost base of aviation MET brought about by the industry impacts from Covid. This capability remains unavailable at this time, though the Met Office are considering an enduring requirement for a new airborne capability, with various options under consideration such as a manned aircraft, or UAV. The cost to recommence this capability would be between £1-1.5m (to set up and equip the aircraft), then about 700k pa to run. The meeting explored the airborne capabilities that other VAACs have, such as VAAC Toulouse, and whether operating a capability on a cost sharing basis would be considered. The Met Office confirmed that VAAC Toulouse does not operate an airborne capability, however the Met Office have been exploring solutions on a 'shared asset' basis. The Met Office intends to invite solutions from the market and follow procurement rules to ensure best value for money and the most appropriate solution is identified.

The Met Office operates a network of 9 LiDARs that are used to observe volcanic ash concentrations through the atmosphere. The instruments deployed are nearing end of life, so options are being investigated which are both cheaper and more resilient. The costs are dependent on the solution identified but expected to be in the order of £800k to £1,400k over a 5-year period. The LiDAR network provides observations that help to validate the products issued by VAAC London, are ingested into dispersion modelling and help to convey the level of forecast confidence to stakeholders.

The meeting asked about the availability of LiDAR data. The Met Office confirmed that the data is available 24/7 but are only turned on during periods of heightened VA activity to preserve the units, and for routine testing. The meeting also heard that the LiDARs have the capability to detect ash up to cruising altitude.

Aviation science R&D

The Met Office reported that a team of applied scientists are dedicated to aviation specific R&D activities. There are 2 areas of focus; global en-route hazard forecasting and weather in UK airspace. Further detail on the specifics of these activities is available on request. The Met Office proposed to maintain these activities through NR23 with the intention that improved scientific capability is accessible through the previously discussed data services developments.

c. Performance measures

A range of KPIs have been agreed with the CAA to monitor the performance of Met Office products and services (in terms of accuracy, timeliness and compliance). Further details on these can be found in the Met Office NR23 Briefing Paper.

d. Finances

The Met Office reported that in 2020 it removed about £2m of aviation costs. The decision to do so was made in agreement with the CAA and was in response to the significant impacts experienced by the aviation industry resulting from Covid travel restrictions. The reductions were primarily met through the suspension of the civil contingency aircraft that provided an airborne VA monitoring capability, and delaying some aviation R&D and technical development activities.

In terms of finances for NR23, the proposed activities result in the service delivery element cost slowly decreasing over the period. This is primarily due to headcount reductions as automation comes in, primarily to the WAFS in 2024, and also due to a 2.5% efficiency applied each year.

The Aviation Service Development element is proposed to be higher in 2023 and 2024 – this is a result of proposed investment into a new airborne ash monitoring capability, replacement of the

surface based ash detection capability and aviation data services activities. The price then reduces from 2025.

The overall cost is proposed to increase in 2024, primarily as a result of investment into next generation satellite capabilities (as described elsewhere in this report).

The meeting made a request to see a summary of forecast versus actual cost for RP3. This would be a useful aid to validate the accuracy of the forecast costs for NR23. The Met Office confirmed that updated costs were presented to the CAA every 3 months and also the Unit Rate meetings. A summary of forecast versus actual cost for RP3 would be provided.

A question was asked about whether investment costs get passed on in one go, or are capex'ed over a period of time. The Met Office would typically consider options on a case by case basis, and in line with Government accounting and procurement rules.

4. Further discussion and consultation questions

The meeting's attention was drawn to a number of consultation questions which are listed in the slide deck. The meeting was invited to submit responses to these question via the online feedback form at <https://www.metoffice.gov.uk/services/transport/aviation/regulated/nr23> by 31 December 2021.

A summary of responses received will be reproduced at **Annex A**, along with actions to be addressed by the Met Office, following the response deadline data of 31 December 2021.

The CAA encouraged both attendees and those unable to make the consultation meeting in person to provide feedback, which will help inform CAA comment.

5. Closing remarks and summary of actions

The Met Office thanked everyone attending for their insightful and constructive comments. The Met Office committed to circulating a copy of the presentations that informed the discussions, along with this summary report.

An updated version of the Met Office NR23 briefing note, taking account of all the feedback received prior to, during and following the consultation will be provided in January 2022.

There was no other business raised and the meeting closed at 1400.

Summary of actions [Met Office]

1. Clarify that the 4% of observations from space that were annotated as 'non space' relate to.

2. Provide details of the anticipated lifespan of the next generation EUMETSAT satellite (to validate the costs submitted in the proposal document).
 3. Confirm the timesteps of the QVA product.
 4. Establish a working group to help gather Industry requirements and to determine the lifecycle plan for NWR.
 5. Provide a summary of the forecast versus actual costs for RP3 (to validate the accuracy of the forecast costs for NR23).
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Darren Hardy
Met Office
November 2021

Question 1**We asked**

Are you in **broad agreement** with the plans set out within this Paper?

You Said

-

We Will

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Question 2**We Asked**

Technological & Science developments: The proposal outlines an investment in capability, which is expected to enable significant improvements in fuel efficiency and hazard avoidance, as highlighted in the GANP, CP1 and AMS. To what extent do the technological and science initiatives outlined in this Paper meet your future operational plans?

You Said

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We Will

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Question 3**We Asked**

What assistance do you feel you may need from the Met Office in adapting systems to use our **SWIM compliant API services**, or is this something you may require in the future?

You Said

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We Will

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Question 4**We Asked**

Science developments: the Met Office propose to continue a range of aviation R&D activities focussed on the two broad themes; development of improved forecasts of global en-route hazards and improved understanding and forecasting of weather in UK airspace. Do you consider this to be the correct prioritisation of science cost and resource?

You Said

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We Will

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Question 5**We Asked**

There are references to developing **web-based visualisation capability** and specifically NWR.
Do you feel this continues to be a relevant and helpful direction of development?

You Said

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We will

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Question 6**We Asked**

Volcanic Ash Monitoring: there is a proposed continued investment in an environmental monitoring capability specifically in support of monitoring and predicting the impact of volcanic ash on UK aviation. To what extent would you consider this as a priority for investment of time and cost?

You Said

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We Will

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Question 7**We Asked**

Aviation contribution to National Capability and International Commitments, including the weather satellite capability: do you feel you have enough information describing why this investment is relevant?

You Said

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We Will

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Question 8**We Asked**

Notwithstanding the activities proposed in this paper, are there **any other products or services** that you consider to be necessary for the Met Office to develop/deliver during NR23?

You Said

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We Will

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Question 9**We Asked**

Are there **any other comments or questions** that you would like to raise in respect of the Met Office's NR23 proposals?

You Said