

PWS CUSTOMER GROUP PAPER

Paper Date: 24th April 2019
Title of paper: Summary of PAG-12
Agenda Item: 4.3b
Submitted by: Wyn Williams
Prepared by: Sarah Jackson

The PWSCG are asked to:

1. Note the report of the tenth meeting of the PWS Assurance Group (PAG), held on 12th March 2019; and
2. Agree to include the report as an annex to the minutes of this meeting.

Notes of the meeting are included in the Annex for information only.

Report to the PWSCG of the 12th Meeting of the PWS Assurance Group

The meeting took place at the Met Office, Exeter, on 12th March 2019. PAG members present were Wyn Williams, Denise Harker, Nick Davies, Ian Houlton and Sarah Jackson.

The PAG:

- agreed that the International Commitments Theme had been delivered;
- recognised the beneficial and innovative work which has been delivered across the National Capability Theme. However, there remains considerable risk that the Performance Metric for this theme will be missed. Even if it is met, they would like to see proactive action over the next FY to improve the performance of this measure and asked for a milestone relating to this to be added to next year's CSA;
- welcomed the approach set out by Paul Davies for improving the prediction of extreme weather. However, they questioned how it might work in practice without the benefit of hindsight and recognising that significant cultural change might be required to avoid confirmation bias. A trial of the approach is planned this summer and PAG would like to be kept informed of progress;
- were pleased to be informed that the Observations programme are set to exceed their efficiency target this year and their 5 year plan shows no escalating costs in future. They were impressed with the breadth of work and innovation ongoing within the Obs programme;

- noted the preparations for Spending Review being undertaken by the Secretariat and agreed the approach outlined for SR scenario planning was sensible. They asked the Met Office to develop the options discussed and assess the potential savings and impacts;
- endorsed the approach described for balancing funding across the Met Office and asked for it to be discussed further at the April PWSCG meeting.

**Annex A: Notes of the PWS Assurance Group 12th Meeting (PAG-12)
Held at the Met Office, Exeter on the 12th March 2019**

Attendance

Wyn Williams	PWSCG Chair
Denise Harker	PWSCG Independent Member
Ian Houlton	PWSCG Member
Nick Davis	PWSCG Member
Sarah Jackson	Head of PWSCG Secretariat
Derrick Ryall	Associate Director PWS & National Capability, Met Office
Dale Barker	Associate Director for Weather Science, Met Office
Richard Bevan	Associate Director of Operational Technology, Met Office
Paul Davies	Chief Meteorologist, Met Office
Jon Taylor	Associate Director of Observations, Met Office
Aileen Semple	Head of International Relations, Met Office
Richard Orrell	Deputy Head of PWS, Met Office
Catherine Dickson	Civil Contingencies Advisor, Met Office (notetaker)

Apologies

Colin Hold	PWSCG Member
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Actions

- Sarah to circulate the ensemble version of the 'Deterministic Global NWP Verification plot' with minutes of the meeting.
- Met Office to provide a road map detailing the options for improving of BestData temperature during FY19/20 and beyond. It should set out the pros and cons of the options, including deploying additional resource in the post-processing team and recommend a way forward. It should propose a PWS milestone for FY19/20 associated with improvements to BestData temperature forecasts.
- PAG asked to see the audit committee's report on cyber security and any statistics the Met Office has relating to cyber attacks.
- The Met Office should consider whether a milestone relating to new or improved civil contingency services should be added to next year's CSA.
- Derrick to draft two new data milestones before next PWSCG meeting. It was accepted that the existing milestones need to be replaced.
- Sarah to agree and communicate the mechanism for MoD having influence over satellite positioning.
- Aileen to confirm how the new ECMWF supercomputer compares to the current Met Office supercomputer.
- Agenda item to be added to April PWSCG regarding the 'Investment pot' approach to PWS planning and budgeting.
- Sarah to send dates for September and March PAG meetings.

Minutes

2. Annual Review of National Capability

Science - Dale Barker

Parallel Suite 42 is due for release today, weather permitting, which will amongst other things introduce hourly updating of the 5 day MOGREPS-UK (post meeting note – PS42 was made operational on 12 March). PWS Indicator 6.3 relating to global forecast accuracy has shown improvement in the last year, after a few years of stagnation. Dale then summarised the Met Office forecast statistics compared to other global model providers, see figure 1.

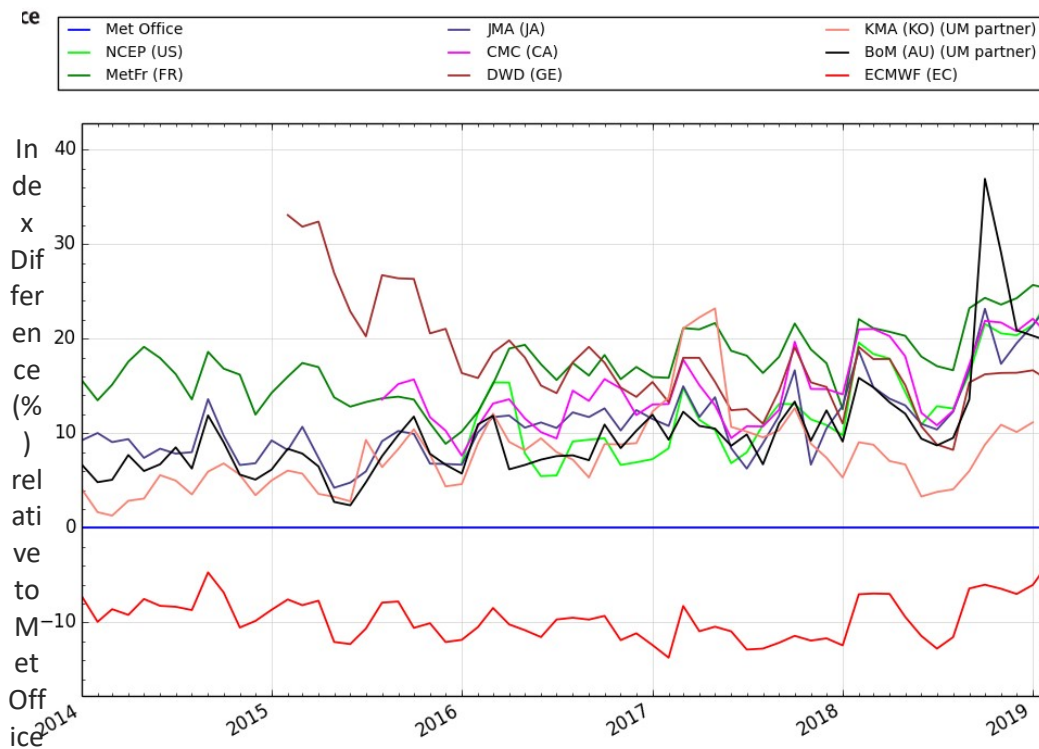


Figure 1 – Deterministic Global NWP Verification

In the last few months, the gap between the Met Office and ECMWF global deterministic models has narrowed, which has been attributed to the last Parallel Suite upgrade (41). Though the statistics show that the ECMWF perform better than the Met Office, Nick commented that the ECMWF model takes longer to run, and the speed of access to Met Office model runs is a benefit for the MoD. Experiments have indicated that roughly 1/3 of the difference in skill between ECMWF and the Met Office is attributable to ECMWF waiting longer for observations. With regards to the other deterministic global model providers, Dale explained the reason the Met Office performed better was due to more computing power and frequent upgrades.

Wyn asked whether there was an ensemble version of the same plot. Dale explained there was a global ensemble verification plot, and that it looked quite similar, though fewer centres choose to share their statistics.

Action: Sarah to circulate the ensemble version of the ‘Deterministic Global NWP Verification plot’ with minutes of the meeting.

Dale then moved on to verification of the post processed PWS data, which is the forecast data on the Met Office website and app. There are five metrics which are likely to be missed this year, see Figure 2.

Percentage difference from March 2019 target

Current	D1	D3	D5	D7
Tmin	-0.05%	1.07%	0.67%	-2.40%
Tmax	0.19%	-0.61%	-1.23%	-0.61%
T3hr	-0.04%	-0.12%	0.01%	-1.38%
Wspd	0.80%	1.70%	2.49%	1.62%
Wdir	0.51%	1.78%	1.72%	-1.68%
Weather	2.07%	3.49%	5.87%	8.63%

Figure 2 – PWS Post-Processed Verification 2018/19

Dale explained that at the extended range, the data is made up of a blend of Met Office and ECMWF data. The PAG were concerned that the temperature data is below target and skill had reduced at all lead times for all temperature metrics during FY19/20.

Denise explained that there was a lengthy discussion at the recent PWSCG MARG meeting surrounding broadcasters' perception that Met Office temperature data performs poorly when compared to observations and also to competitor forecast data (though statistics confirming this were not shared with the Met Office). This was a particular issue during the hot weather of summer 2018 and again recently during the unseasonably warm spell of February 2019 with Met Office comms and other media outlets mentioning the potential for record breaking temperatures and the data on the Met Office app and website being inconsistent with the prevailing story. It was acknowledged that improvements need to be made particularly in the extended range.

A new post processing system, Improver, is in development to change the way the Met Office post processes its data. There is therefore a balance to be struck between the amount of resource channelled into investigating issues on current architecture and the amount channelled into developing the systems of the future. A short-term fix could involve changing the blend of the data in the extended range, but it would take a number of months for the results to be seen. The PAG are mindful of the upcoming spending review, and that any damage done to the Met Office reputation in the short term could have lasting impacts. PAG would like Science to explore the options for improving the temperature metrics during FY19/20.

Action: Met Office to provide a road map detailing the options for improving of BestData temperature during FY19/20 and beyond. It should set out the pros and cons of the options, including deploying additional resource in the post-processing team, and recommend a way forward. It should propose a PWS milestone for FY19/20 associated with improvements to BestData temperature forecasts.

Technology - Richard Bevan

Richard highlighted some recent successes within technology. Transformation has been a success with continued adoption of cloud technologies, involving re-training many staff across the organisation. Successes also include the migration of NSWWS, CHEMET and the public website onto Amazon Web Services (AWS), with Hazard Manager in development. Richard described resilience as a strength this year, with all targets met. Cyber security remained a focus and staff have been upskilled to reflect the cyber threats associated with cloud infrastructure. The Met Office have been working closely with AWS to ensure there is clarity over where different obligations lie with respect to Met Office cyber security on the AWS cloud.

Action: PAG asked to see the audit committee's report on cyber security and any statistics the Met Office has relating to cyber attacks.

Key challenges for the technology directorate have include:

- **recruitment and retention** of staff. To counteract this, discussions have been had with the HR Pay Team and other innovative recruitment avenues have been explored, eg recruitment agencies and via apprenticeships. PAG were encouraged by the approach being adopted and recognise the value to the Met Office of being considered an organisation that develops high quality technologists. There are currently 20 apprentices within Technology, and others elsewhere within the Met Office.
- **Architecture** – in some cases temporary solutions are required to enable systems to operate in a manner which is consistent with the new T&E architecture and avoid creating further technical debt;
- **Costs**, with recent investment in better tooling (ServiceNow, Dynamics, Office365) being higher than in the past. Many of the new services are subscription based which is changing the balance of funding within the organisation. For example, ServiceNow, the new incident reporting tool, costs more to run but is delivering efficiencies and reducing costs elsewhere in the Met Office. In many areas however, the benefits of recent investment have not yet been realised as the change programme is still ongoing. **Retirement of legacy systems needs to remain a priority** so that the period of dual costs is minimised;
- **Supercomputer** there remains uncertainty over how big the next supercomputer will be, where it will be physically and the impact on downstream systems. Some options being considered could radically change the skills and support required in-house.

Forecasting - Paul Davies

Paul presented a new technique for getting more value from ensemble forecasts. He described the snow event of 1st Feb 2019, which for some areas across southern England, was poorly forecast. Ian commented that 9 inches of snow fell in Winchester, and this was not forecast. Traditional analysis of MOGREPS-UK indicated a risk of snow across SW England, but there was little signal for areas

further east. Analysis of the new 'Improver' forecasts for the period showed even less of a snow risk across the whole of southern England, though Paul explained that Improver is working correctly as it's designed to smooth the ensemble output rather than present extremes.

Paul is proposing a new technique, which enables the forecaster to sub-set the ensemble members so that only those whose evolution fits what is being observed are used. The US and China have reported positive results from such an approach and retrospective analysis shows that had it been used on 1st February it would have produced better guidance. This approach has been made possible as thanks to T&E with forecasters now, for the first time, able to visualise ensemble members in their operational forecasting software. There was a discussion on whether it would be possible to feed the preferred forecast into website and app forecasts to ensure consistency.

PAG welcomed the approach but questioned how it might work in practice without the benefit of hindsight and recognising that significant cultural change might be required to avoid confirmation bias. A trial of the approach is planned this summer and PAG would like to be kept informed of progress.

Observations – Jon Taylor

End of year targets across the observations programme were generally green. Jon explained that the ATD global target (Arrival Time Difference – the Met Office's current lightning detection system) was red due to old 1980s technology failing causing a degradation in performance. This technology can't be maintained; however it is due to be replaced by a new lightning detection network, LEELA, which will be pre-operational by end 2019 and fully operational by the end of 2020.

The PAG were pleased to be informed that the Observations programme are set to exceed their efficiency target this year and their 5 year plan shows no escalating costs in future. This is based upon existing requirements and does not include any increase in observations which may be needed to realise or measure the benefits from the next supercomputer.

Jon then gave updates on the various products and projects in development across Observations:

- **SurfaceNet** is the new cloud based observations collection and monitoring system, designed to replace the current MMS system. Once observations have been collected, quality control will be performed within the cloud environment before the data is transferred to ServiceHub. SurfaceNet will be flexible and scalable, so additional sensors and sites can be added easily. There will be a phased introduction but by early 2021 all old technology will be switched off. Additional benefits are that meteorologists can make and view observations from anywhere as it is web-based and will be available on a tablet. This will be a big benefit for defence meteorologists who will be able to submit observations from anywhere on the base. A PWS milestone was met in January 2019 with the new loggers being tested on the cloud and backward compatibility with the old MMS

system confirmed. End to end proof of concept has been confirmed with a single parameter (wind).

- **Mode-S** data is a new data source of wind and temperature measurements received from aircraft based observations. Currently a network of 6 receivers is gathering data and this is now being ingested as part of PS42. This provides a rich data source at low cost as the receivers are built on a Raspberry Pi. There is further network expansion planned to include receivers on every operational radar (except Cobbacombe Cross), which will give full UK coverage. This has enabled the wind profiler network to be switched off, delivering cost savings.
- **Leela** (Lightning Electromagnetic Emission Location via Arrival-time-difference) is the Met Office's lightning detection system replacement. Leela will be cheaper to run than the current ATD system and has been shown to detect more lightning strikes than the current system. During 2019, the full Leela network will be rolled out across the UK and Europe, with parallel running of ATD and Leela during 2020. Leela will become fully operational at the end of 2020. Options for exploiting the technology are being considered.
- **Water Vapour Measurements from Mode-S**. Water vapour measurements are currently a significant gap in knowledge. Knowing the amount of moisture in the atmosphere is a fundamental starting point for much of meteorology. A PhD is being jointly funded with Exeter University to explore the potential to retrieve water vapour measurements from the Mode-S navigational broadcasts that aircraft routinely make. If successful, this will be a cheap data source with only minimal maintenance and data transmission costs. It is the ultimate aim to install systems on all of the Met Office radar masts giving the potential to contribute 50,000+ profiles of total column water vapour.
- **WOW Citizen Science data**. The Met Office is learning how to use make best use of the large amount of observational data that the public input into the Weather Observations Website. Real time quality controlled data from WOW sites is now available in a trail system to Operational Meteorologists and was used during the last summer convective season. Long term the plan is to feed this data into Improver to improve first three hours' worth of data. Observations are also looking to improve the resolution of the WOW data by filling in data sparse areas, possibly by supplying farmers with amateur meteorological observing kit, or by some targeted marketing in specific localities.

Jon described the importance of resilience within the observations networks; yesterday three radars were out of operation across Scotland and in Dublin but the extent of the composite radar was largely unaffected (albeit quality degraded) due to the resilience built into the network. The later agenda item on Spending Review scenario planning explains that should significant cuts be required, one option PWSCG will need to consider is how much resilience is required.

The PAG were impressed with the breadth of work and innovation ongoing within the Obs programme and thanked Jon for his presentation.

PAG recognised the beneficial and innovative work which has been delivered across the National Capability Theme. However, there remains considerable

risk that the Performance Metric for this theme will be missed. Even if it is met, they would like to see proactive action over the next FY to improve the performance of this measure.

3. Customer Supplier Agreement and plans for FY19/20 – Derrick Ryall

The overarching strategy for the CSA remains unchanged with a fundamental focus on improving accuracy including warnings accuracy, nowcasting and post processing. With respect to reach, the view is that this now needs to focus on ensuring the authoritative voice rather than chasing numbers.

Discussion then moved onto milestones for 2019/20.

- Following the discussion with Dale Barker earlier in the meeting, an additional FY19/20 milestone for improving temperature accuracy needs to be added to those already proposed.
- The Hazard Manager migration milestone may need to be extended. This is one of the first big services to move into the cloud and will set the template for other services. There was a concern from PAG that Civil Contingency users may feel overlooked as there are no milestones relating to new or improved services this year. Derrick explained that there is a focus on underpinning technology this year, and generally services are thought to be in a good place. PAG asked the Met Office to consider whether an additional milestone could be added.
- Last year's data milestones will not be delivered. PWSCG has agreed that any solutions should be consistent with the new IT architecture and that it is sensible to develop a single solution to sub-setting data (ability to select a portion of data) which can be re-used on several projects. It is also recognised that due to the volumes of data involved this work is technically challenging. PAG agreed that the existing milestones would not be met and asked the Met Office to provide measurable service development milestones, consistent with the roadmap setting out revised timescales for delivering the functionality previously outlined in the CSA.

Action: Derrick to draft two new data milestones before next PWSCG meeting. It was accepted that the existing milestones need to be replaced.

Action: The Met Office should consider whether a milestone relating to new or improved civil contingency services should be added to next year's CSA.

4) Annual Review of International Commitments - Aileen Semple

Key areas of focus within the Met Office's International Commitments are technology, data policy and Public-private engagement. In terms of costs, international subscriptions are set to increase over the next 5 years and this is mainly due to increased satellite subscriptions from 2023/34 onwards. New satellites are due to become operational at this point, and since the lifetimes of the current satellites have been extended costs associated with downlinking, managing and disseminating the data will continue. This prompted a discussion on how UK organisations (the MoD specifically) can influence positioning of satellites. The correct procedure needed to be investigated, thus:

Action: Sarah to agree and communicate the mechanism for MoD having influence over satellite positioning.

Aileen went on to describe the efforts within the WMO, supported by Met Office teams, to improve the global coverage of observations. In order to forecast in the 5-7day range, observations are needed from all over the northern hemisphere, yet there are currently many data sparse areas. PAG found the graphic showing gaps in the global observing network particularly helpful. It was a busy year with changes in the WMO Permanent Representative from Rob Varley to Phil Evans. Penny Endersby will take over this role and the aim is to get her elected to WMO Exec Council at Congress in June.

At ECMWF there are a number of projects underway which could have financial implications for the PWS including the new data centre in Bologna, procurement of their new supercomputer and the new headquarters. ECMWF's new computer will be 2.7x the power of their current machine.

Action: Aileen to confirm how the new ECMWF supercomputer compares to the current Met Office supercomputer.

The Voluntary Cooperation Programme has achieved reductions of 10% and will meet this years' target. This is a WMO programme to help enhance the capacity of National Met Services in developing countries. The Secretariat will undertake its annual review of the VCP in April and report to PAG.

Although PAG remain concerned about the implications of future cost increases relating to international commitments, they consider that the International Commitments Theme has been delivered this FY.

5) Spending Review Preparations

Update on BEIS preparations and Value of the PWS – Sarah Jackson

BEIS finance team have visited the Met Office to gain more awareness of Met Office issues surrounding the spending review and the challenges relating to increasing satellite costs are understood.

BEIS are currently undertaking internal preparations for the spending review and have asked every group to come up with business cases. 15 key budget lines have been identified within the BEIS Business & Science group which is responsible for the PWS contract, and one business case has been developed for all Met Office budget lines. This includes all funding for PWS, satellite loans, the dividend, Hadley Centre, Supercomputer bid, Newton Fund, ECMWF headquarters..... The bid is dominated by the supercomputer and this may afford some protection to the smaller components of the bid. The business case sets out, amongst other things, the stark implications of the Met Office not receiving the money it needs. The section Sarah considers the weakest within the template is the Economic Case as there has been little work done within the Met Office on Economic Benefit. The most relevant assessment, given the bid covers a number of separate investments, remains the

London Economics Report, which was used to support the last Spending Review and drew heavily on the work done by Mike Gray on the Value of the PWS.

Immediate feedback from reviewers has been positive, however the case will come under further scrutiny during April. One aspect which might be challenged is why BEIS fund underpinning capability (through the PWS) which is for the benefit of other Government Departments.

Update on Met Office scenario planning – Derrick Ryall

In view of the need to respond to possible spending restrictions as part of the Spending Review, Derrick and others have been doing some scenario planning. This is more difficult this time around as a lot of the 'fat' was removed as part of the last spending review, consequently any cuts will result in a change to PWS services. Broad options for saving money include

- Reduce resilience, however impact would be more outages that last longer;
- Reduce capability scope, however this could have an impact on key customers;
- Slow transformation however, this could mean increasing cost supporting legacy systems and an inability to exploit science developments;
- Slow accuracy improvements however, this could again have an impact on customers and overall Met Office brand.

PAG agreed that this approach was sensible and asked the Met Office to develop these options and assess the potential savings and impacts.

A new approach to public weather service planning and budgeting – Derrick Ryall

Derrick then presented on a new idea to balance funding across the Met Office. The balance of funding across Met Office departments has always been based on historical levels with relatively little change. However rapidly changing science, technological and social changes mean this balance is probably no longer valid. It could be argued that the current situation limits exploitation of science into services and products, limits innovation and has the potential to lead to increasing costs of maintaining a vast array of systems.

A new model is being proposed but has yet to be considered by the Met Office Executive. This would involve

- 1) Establishing a PWS Programme Delivery Group, which would improve end to end project planning and engage more cross-office activity.
- 2) A zero-based review of current spending to better understand current costs and define key activities. 90% of Met Office budget would be spent on this releasing 10% investment pot
- 3) Introduction of a bid process for the Investment Pot, with opportunities defined by PWSCG, emerging strategy, the Executive, the Programmes themselves, as well as other key groups. These bids would be scrutinised internally by the Investment Committee before being put to PWSCG for prioritisation and approval.

PAG endorsed this approach, which Penny Endersby had discussed with Wyn in a recent meeting. PAG felt it would be helpful to undertake the zero-based review in advance of the Spending Review so the cost base is well understood but recognised that it is a fundamental change in way PWS plans and allocates money and may face some objections. It was also recognised that significant progress needs to be achieved before the new Chair takes office in October. This should be a substantial agenda item at the April meeting at which there will be a decision on whether to hold an additional PWSCG meeting over the summer to review progress.

Action: Agenda item to be added to April PWSCG regarding the 'Investment pot' approach to PWS planning and budgeting.

6) Review of Risk Register – Sarah Jackson

The proposed changes to the risk register were agreed.

7) AOB

Richard Orrell updated the group on the safety critical clauses within the AWS terms and conditions. The Met Office have presented a couple of use cases to AWS to see whether it falls foul of their clauses. AWS were non-committal but have agreed to take these use cases back to legal team in Washington for further clarification. This is important to clarify in terms of the general direction of cloud computing.

Dates of next meeting

Wyn mentioned there was a full Customer Group meeting in April, and he would like another CG or PAG in July to consider spending review preparations and review progress on the introduction of the new approach to PWS planning and budgeting, by which time it is hoped that initial findings from the zero-based review will have been completed.

Sarah will send dates for September and March PAG meetings to get them in the diary.

Action: Sarah to send dates for September and March PAG meetings.