
Met Office
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Make a difference with a coordinated response to emergency management
NORTHERN IRELAND

The Met Office's role in emergency preparedness and response

Executive summary

The Met Office is a Trading Fund within the Department for Business, Energy and Industrial Strategy (BEIS) and the official source of meteorological information in the UK. Legislation supporting the Civil Contingencies Act 2004 states that Category 1 responders must have regard to the Met Office's duty to warn the public and provide information and advice, if an emergency is likely to occur or has taken place.

The Met Office provides a number of services that help authorities prepare for and respond to emergencies that are caused or influenced by the weather. These include severe weather warnings and plume dispersion predictions. Linked to these services is the ready availability of advice from teams of Met Office forecasters, advisors and specialist scientists on the interpretation and impact of the weather during an emergency. If required, Met Office experts are ready to attend or teleconference into tactical/strategic command and control centres.

The Met Office's Public Weather Service provides a range of basic weather data and related warnings to help the UK public (and public sector partners, when appropriate) make informed decisions concerning the impact of the weather on their daily activities. The service makes a vital contribution to the protection of life, property and basic infrastructure.

The National Severe Weather Warning Service (NSWWS) provides severe weather warnings to the general public and emergency responders, giving up to seven days advance notice of disruptive weather conditions. These are updated regularly in the run up to the weather event.

The Environment Monitoring and Response Centre (EMARC) is one of the forecast production units at the Met Office. It provides specialist forecasts to the UK emergency services, relevant government departments, and the international community. It has continuous operational capability, which enables the Met Office to respond immediately to customers requiring meteorological information to deal with a range of environmental incidents, from chemical or radiological releases to biological hazards such as foot-and-mouth disease.

The Flood Forecasting Centre (FFC) provides daily guidance on all forms of flood risk across England and Wales, whilst the Scottish Flood Forecasting Service (SFFS) performs the same function across Scotland. The FFC and SFFS assist the Environment Agency, Scottish Envrionment Protection Agency and Natural Resources Wales in issuing tidal flood alerts/warnings for the UK mainland. Separate co-operative arrangements for flood risk assessment apply in Northern Ireland.

The Met Office Space Weather Operations Centre (MOSWOC) supplies daily detailed space weather forecasts to both the public and emergency responders. This helps fulfil its commitment to protect those parts of our infrastructure that are at greatest risk from severe space weather events.

Many of these services are 'free at the point of use' by Category 1 and 2 responders, as defined in the Civil Contingencies Act 2004. Occasionally, incidents may require the help of other specialised services that need additional funding. These services include the Met Office Civil Contingencies Aircraft (MOCCA), which is on permanent standby, and the jointly managed Facility for Airborne Atmospheric Measurements (FAAM) research aircraft, which can be deployed when available and which has appropriate onboard instrumentation for monitoring particulates and pollutants in the atmosphere, as well as for measuring the local meteorology.

This document describes the range of services provided by the Met Office to help authorities prepare for and respond to emergencies. It also acts as a guide to help readers interpret the information generated by these services.

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1. INTRODUCTION

The Met Office is a Trading Fund within the Department for Business, Energy and Industrial Strategy (BEIS), and is the official source of meteorological information in the UK. It provides a number of services to help the authorities prepare for and respond to emergencies.

The weather not only can cause an emergency, for example, flooding, but may exacerbate the impact of a range of emergencies, such as chemical releases, nuclear incidents, large fires or biological hazards, including foot and mouth disease. Legislation supporting the Civil Contingencies Act 2004 states that Category 1 responders must have regard to the Met Office's duty to give warning, and provide information and advice, to the public if an emergency is likely to occur, is underway or has already taken place.

This duty includes the issuing of severe weather warnings and plume dispersion predictions. In line with these services, teams of Met Office forecasters and specialist scientists will advise on the interpretation and impact of the weather during an emergency. A UK-wide team of Civil Contingencies advisors from the Met Office helps in the development and maintenance of severe weather risk registers. This team also handles the input to exercise and planning processes, and attends either in person or via teleconference incident command and control centres during weather-related emergencies.

In addition, the Met Office provides dedicated forecasts and warnings to Category 1 responders. For example, the Environment Agency, Natural Resources Wales and the Scottish Environment Protection Agency receive detailed rainfall forecasts and warnings for assessing the risk of flooding, on top of the National Severe Weather Warning Service described in this document. The Maritime and Coastguard Agency receives the Shipping and Inshore Waters Forecasts and warnings provided by the public marine forecasting team at the Met Office.

Further information on these latter services can be found at https://www.metoffice.gov.uk/public/weather/marine

This document focuses on the services available to UK emergency planners and responders, and aims to:

- explain the role of the Met Office in helping others prepare for and respond to emergencies
- describe the range of services available to emergency planners and responders
- provide guidance on interpreting the products.

1.1 Public Weather Service

The Met Office's Public Weather Service (PWS) provides a range of basic weather data and related warnings to help the UK public (and public sector partners, when appropriate) make informed decisions concerning the impact of the weather on their daily activities. The service, which is vital in its contribution to the protection of life, property and basic infrastructure, comprises:

- National Severe Weather Warning Service
- A range of forecasts available via the Met Office website
- National Meteorological Library and Climatological Archive
- UK and global response services
- Civil Contingencies Advisors
- Forecasting guidance from the Met Office Operations Centre
- General help and advice from the Met Office Customer Centre.

The Public Weather Service Customer Group (PWSCG) acts as the customer on behalf of the public for free at the point of use weather services and on behalf of Public Sector users of PWS outputs. It is responsible for setting the requirement and specifying the outputs, supporting research and development to meet future requirements, meeting international commitments on behalf of UK Government, providing underpinning data for stakeholders and authorising payment for the PWS from BEIS.

The PWSCG ensures that PWS services are aligned to the operational needs of the Met Office's public sector customers, and acts as these customers' guardian by determining the Met Office's underpinning operational capability.

Other services, such as those provided during environmental incidents (for example, the Volcanic Ash Advisory Centre and animal health services), are funded by the relevant leading agencies or government departments.

The vast majority of the services referred to in this document are 'free at the point of use' by Category 1 and 2 responders. Where additional funding may be required, this is stated in the document.

2. SEVERE WEATHER

2.1 National Severe Weather Warning Service

The Met Office provides the National Severe Weather Warning Service (NSWWS) to alert the public, civil emergency authorities and the Ministry of Defence in advance of severe weather conditions, so that mitigating action may be undertaken to reduce potential impacts. Warnings are issued when significant disruption to transport and communications is expected, but the ultimate driver is the potential risk to life and property.

The warnings are issued to emergency responders via email and text and to the public via the website and the very popular Met Office App. Responders can register to receive warnings via the Hazard Manager facility (Section 7.1), where they may specify their preferred delivery mechanism, weather warning categories and specific area of interest within the UK.

The warnings methodology, together with selected examples, are outlined below. A full description of the service including case studies and severe weather advice can be found at

https://www.metoffice.gov.uk/guide/weather/warnings

The warnings are formulated through 1) an assessment of the potential impacts of a severe weather event, and 2) the likelihood of those impacts occurring. Once the level of impact and the likelihood of occurrence have been determined, the warning is assigned a colour (yellow, amber or red) and positioned in a simple risk matrix.

The traffic light colour scheme, widely used in risk assessment, is familiar to all emergency responders and remains a convenient means of depicting the level of risk attached to a given event.

Red and amber issues, along with medium and high impact yellows, are all 'pushed' out to registered recipients of the warnings, as well as to the website, Hazard Manager and the App. Low impact yellow warnings are not currently 'pushed' and must be retrieved from the website, Hazard Manager or App by the user.

In most cases the regional/national Civil Contingencies Advisor (see Section 5) will brief their local emergency responders (via email) after a warning has been posted, giving additional background information and discussing the potential local impacts of the predicted event. Apart from the obvious benefits of local advisor expertise in interpreting each severe weather situation, the act of simply notifying responders is particularly relevant in the case of low impact yellow issues, where the responder may not have immediate access to either Hazard Manager (Section 7.1) or the website and may thus be unaware of the existence of the warning.

In spring 2018 the next generation of NSWWS was launched. Amongst the new features brought in was a simplified structure to the text, allied to new web graphics that were introduced in April 2017. The revised text format comprises three distinct sections namely;

i) The Weather Headline

ii) What to Expect

iii) Further Details

The 'Weather Headline' is a short, concise, description of the expected weather hazard in plain English. The 'What to Expect' section is where potential impacts from the weather are explained and will vary according to the position of the warning on the risk matrix. The 'Further Details' section allows for additional information such as rainfall totals, wind strengths and snow accumulations to be specified, together with other contextual information, all aimed at adding value and clarity to the warning.

In addition to the existing five severe weather categories (rain, wind, snow, ice and fog) two new categories were added at the request of emergency responders, namely thunderstorms and lightning.

2.2 Impact tables

To provide emergency responders and the general public with a more detailed listing of the outcomes they can expect for a given level of impact (very low/low/medium/high), impact tables have been compiled for each of the seven specified severe weather types, available at the end of this document (Appendix 1) or via; https://www.metoffice.gov.uk/guide/weather/severe-weather-advice

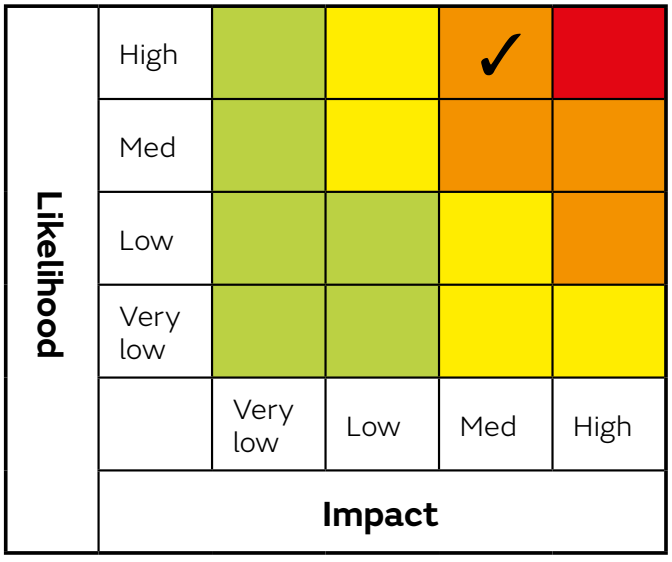

Figure 1 - The risk matrix used in all severe weather warnings.

2.3 Examples of warnings

Web version

Figure 2 shows an example of the severe weather warnings page on the Met Office website taken from a day in April 2018. All warnings in force on a particular day appear in vertical stack formation with red issues on top, followed by amber then yellow. Each warning displays its weather colour, category and validity period, followed by the weather headline and what to expect sections. Beneath these lies a link to the further details section which includes the risk matrix and a listing of those regions/countries and county authorities lying wholly or partly within the warning area.

To the right of the warnings list is a map of the UK showing all warnings in force on that given day. As well as a pan/zoom facility, users can highlight individual warning areas - important on a day when multiple warnings have been issued that overlap in both space and time.

On the day in question various yellow warnings for rain and snow had been issued across the length of the UK.

Figure 2 - The severe weather warnings page on the Met Office website as it appeared on 02 April 2018.

Email version

The majority of emergency responders receive severe weather warnings via email or text message. Figure 3 shows an example of an email-style warning for rain issued on 01 April 2018.

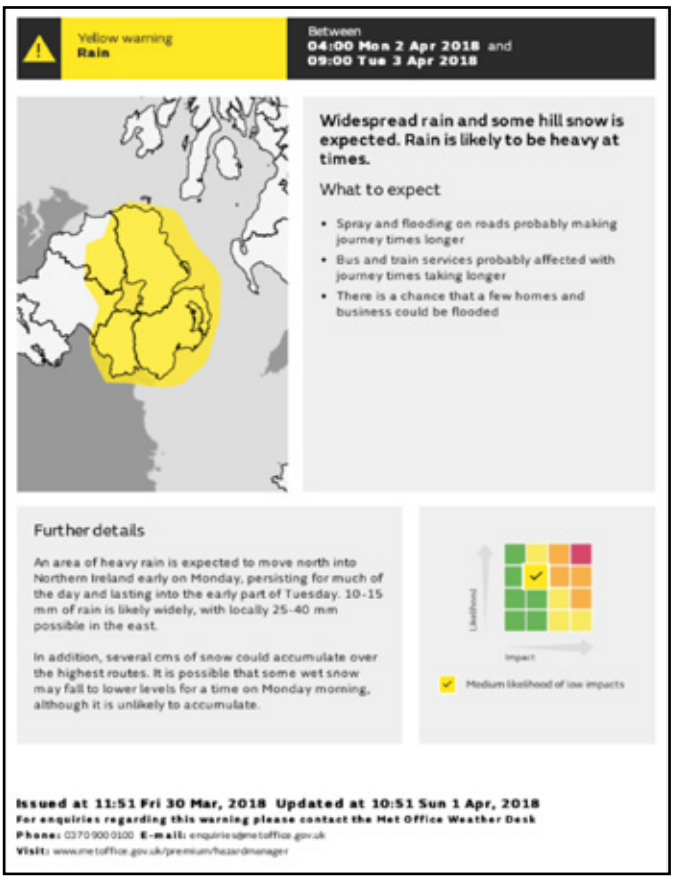

Figure 3 - An example of a severe weather warning in email format, as received on 01 April 2018.

3. COOPERATIVE ARRANGEMENTS FOR FLOOD RISK ASSESSMENT

Hydrological conditions in Northern Ireland differ markedly in Northern Ireland to other parts of the UK. There is an absence of large rivers systems and this makes a flood forecasting model based on the GB protocols less beneficial. Indeed many of Northern Ireland rivers are smaller and 'flashy' in nature with sudden rises in levels often followed by an equally sudden fall. This makes weather warnings for rain in particular even more important as rivers often respond more quickly rather than the time-lagged nature of large rivers elsewhere.

The Met Office liaises closely with DFI (Rivers), the lead government department for all forms of flooding in Northern Ireland. The two organisations exchange information on anticipated rainfall, river levels, ground conditions and tidal matters. The combination of meteorological and hydrological information then helps inform the type and level of rainfall warnings that are issued. As a result of the ongoing risk assessment and emergency planning protocols, responding agencies are well placed to minimise and mitigate the impacts of potential flooding.

4. ENVIRONMENTAL INCIDENTS

Products and services from the Met Office for responding quickly to an environmental incident are used primarily in short-term consequence management (for example, by providing predictions on the dispersion of pollutants released into the atmosphere). They also aid long-term recovery.

4.1 Environment Monitoring and Response Centre/ Hazard Centre

The Environment Monitoring And Response Centre (EMARC) is part of the Hazard Centre which was established in 2011. The Hazard Centre has a wide remit and is largely concerned with hazard impacts. Its work includes landslides, wildfire, volcanic eruptions, space weather and ice accretion on power lines. EMARC was originally set up in 1999 and provides specialist short-notice forecasts to the UK emergency services and government departments, as well as to the international community, operating 24/7 365 days a year.

In this way, the Met Office can provide an immediate response to emergency responders requiring meteorological information to help deal with a variety of environmental incidents. These may include chemical fires, radiological releases, large wildfires, or biological hazards such as foot-and-mouth disease or bluetongue.

In the event of an accident leading to the release of a hazardous substance in waters around the UK, EMARC provides services to the Maritime and Coastguard Agency (MCA) that are similar to the CHEMET service (section 4.3) used for the release of hazardous substances on land. The MCA itself has developed a National Contingency Plan that details the response to a pollution spillage from shipping or offshore installations. Were the incident to take place in international waters, the response would be collaborative, involving the national meteorological services of other countries.

The intention within the Hazard Centre is to compile a wide-ranging natural hazards database that will help forecasters gauge what future impacts might be, based on what has already been documented in previous events. In the following sections, we describe those Hazard Centre functions that are of greatest importance to emergency responders.

4.2 FireMet

When a major fire is first reported, Fire and Rescue Services need to determine a safe direction of approach, dependent largely upon the wind conditions at the time. The FireMet system, developed in collaboration with the Department for Housing, Communities and Local Government, uses the postcode of the incident to generate a 360-degree map showing those 30-degree sectors considered potentially unsafe for approach by fire appliances. This then allows incident command units and mobilising centres to coordinate the best possible route of approach using their knowledge of the local road network.

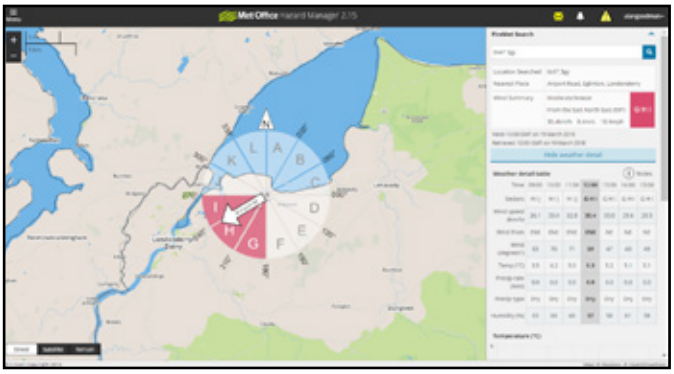

Figure 4 - FireMet data display, using Londonderry Airport as an example reference point.

FireMet also provides three hours' worth of hindcast and forecast weather data for the site and thus can assist with the initial response to the fire whilst the more detailed, longer term forecast information (CHEMET, see Section 4.4) is being prepared. In order to properly represent plume behaviour FireMet requires a minimum wind speed of around 6 to 7mph. Below these speeds the plume is too unpredictable and a safe upwind location can't be specified. FireMet is accessed via the Hazard Manager service (Section 7) and Figure 4 shows an example of the user display.

Plume modelling

Any major fire such as those at recycling plants, tyre storage sites or involving hazardous chemicals, will inevitably generate a dense plume of smoke whose direction of travel, speed and degree of vertical/ horizontal propagation will be determined by the prevailing weather conditions.

The Met Office can provide plume predictions during emergencies, in which Hazard Centre forecasters interpret data from the latest observations, as well as from dedicated computer models, to deduce the local weather conditions and the areas at risk from the pollutant. Local variations in wind speed and direction are important influences on dispersion.

Precipitation at the scene or downwind can wash the pollutant out of the atmosphere, leading to higher concentrations on the ground locally. The vertical temperature profile of the atmosphere determines the stability of the air, an important factor when considering how high the plume is likely to rise, and therefore the downwind distance it might travel and its behaviour close to hills.

Numerical Atmospheric-dispersion Modelling Environment

The Numerical Atmospheric-dispersion Modelling Environment (NAME) is used by the Hazard Centre to predict the movement of a wide range of pollutants in the atmosphere, including those resulting from fires, large chemical incidents, radiological releases, and volcanic ash. It is also used to predict the spread of airborne diseases such as foot-and-mouth.

On being notified of an incident forecasters will run the NAME simulation, after having input all available information, to predict the movement, deposition and dispersal of large plumes of material for periods ranging from hours to several days. The model produces a geographical display of the movement of the plume, showing the area at risk. One of the main problems when dealing with chemical or nuclear releases is accurately estimating the source term to determine how much of the chemical or radioactive material is present and exactly which radioisotopes are being released.

For this reason, initial NAME runs will often employ what is known as a default unit release, whereby in a radiological scenario the designated source term undergoes a specified rate of radioactive disintegration each second. For chemical releases, a default source strength of 1g per second of a tracer gas is used. Comparison of the resulting predictions of chemical/radioactive dispersion with real-time monitoring data ultimately leads to a much better estimate of the source term.

The response time for providing NAME output varies from 20 minutes for small-scale events to nearer one hour for a full 5-day prediction. NAME can be re-run as more details become available following an incident, providing more precise concentration and deposition values. In many cases, however, it is often some hours into the event before the composition of the chemicals or substances involved is fully known. An example of NAME output is shown in Figure 5.

4.3 Chemical incidents

In the event of an incident involving hazardous chemicals, local Fire/Rescue and Police services will contact the Met Office via the Hazard Centre's dedicated emergency phone line (see Section 8 for details). Typical scenarios are chemical spillages, chemical plant or oil refinery fires, and road traffic accidents involving the escape or ignition of a hazardous substance.

For small-scale events, the Hazard Centre produces meteorological guidance and a plume prediction, collectively known as a CHEmical METeorology (CHEMET) forecast. For larger events, such as the Buncefield Oil Depot fire in 2005, NAME is used to produce information on the plume behaviour over longer timescales and greater distances.

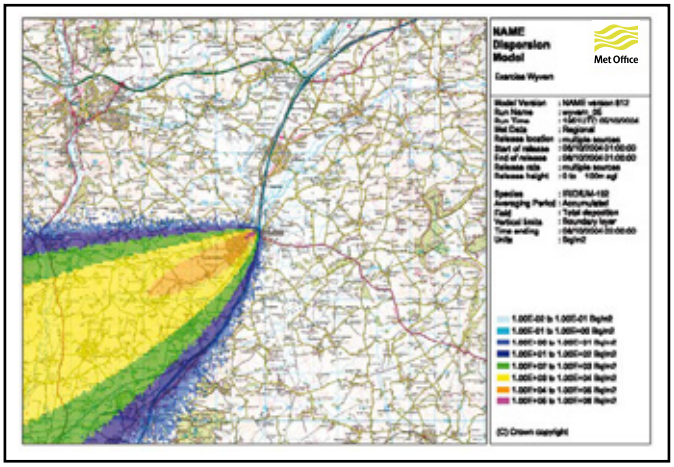

Figure 5 - An example of NAME output.

4.4 CHEMET

When the initial call to the Hazard Centre is made the Met Office meteorologist will request various information including the name of the organisation and contact details along with a summary and location of the incident, in order to build up an understanding of the situation and the prevailing weather conditions.

The CHEMET forecast package comprises a forecast form and a 'Plume below 100 metres map', emailed to the requesting organisation with a target turnaround time of 20 minutes. Regular updates can be requested for longer lasting incidents. The forecast form focusses on the wind speed/direction, expected weather and their combined effect on the behaviour of the plume. Additional weather data are provided to aid science and health agencies involved in the response.

The plume below 100 metres map depicts the expected spread of the plume (and resulting relative concentrations of the released chemical) within the lowest 100m of the atmosphere during the first three hours of the forecast, this then helping to inform decisions by the emergency services regarding possible evacuation or of alternative countermeasures. Those agencies interested in how the pollutants disperses throughout the atmosphere can request an additional map known as the 'Total Mass Column' map. Each CHEMET forecast is given a unique identification number and is posted on Hazard Manager. Figure 6 shows an example of a plume below 100 metres map for a site close to Belfast City Centre. PDF guides to both CHEMET and the additional CHEMET Pro service (see below) are available via Hazard Manager.

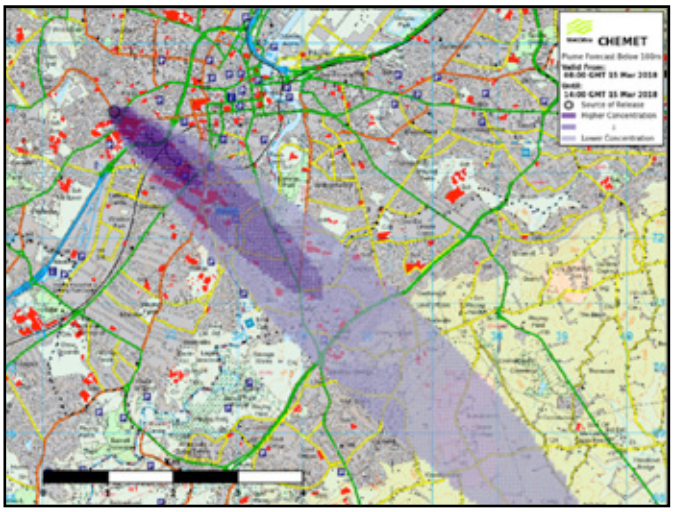

Figure 6 - An example of a CHEMET 'Plume below 100 metres' map originating from a site close to Belfast City Centre.

Chemical dispersion is rarely as uniform as depicted in the plume dispersion map, with the immediate surroundings, local topography and atmospheric structure combining to influence the pattern of dispersion. Furthermore, the presence of precipitation during a release will result in washout from the plume, leading to hotspots of contamination. In such situations a full NAME simulation of the release, with accompanying air concentration/ground deposition maps, backed up by local monitoring, would be necessary to obtain a complete picture of the predicted contamination. These additional maps form the core of the CHEMET Pro service.

CHEMET Pro

The CHEMET Pro service is an extension to the CHEMET service, providing emergency responders with predictions of pollutant air concentration, along with maps depicting the extent of wet, dry and total deposition over the area affected. The additional data is generated by NAME at the same time as the standard CHEMET product but with the same delivery time. Having such predictions to hand enables the level of exposure/contamination to the public and the environment to be more accurately assessed. Interpretation of the CHEMET Pro output requires a measure of expertise and, as a result, its use and availability is geared towards public health professionals who can make best use of the information.

Figure 7 shows an example of an air concentration chart produced for CHEMET Pro. The ranges of forecast chemical concentration are defined by a set of colours that together make up the plume, each colour denoting a range of air concentration an order of magnitude higher/ lower than the adjacent colour.

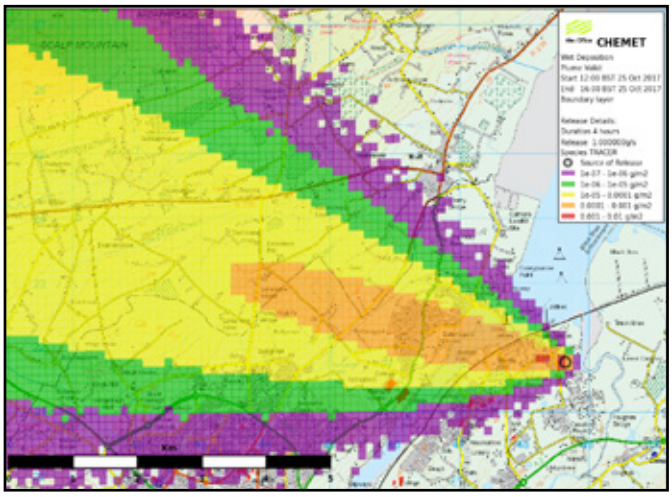

Figure 7 - A CHEMET Pro air concentration map produced for Carrakeel Industrial Park, Maydown, Londonderry.

4.5 Biological incidents and animal health

The Met Office, along with the Pirbright Institute and the Animal and Plant Health Agency, continues to support the Department for Environment, Food and Rural Affairs (DEFRA) in forecasting the spread of airborne diseases such as foot-and-mouth or bluetongue.

Such forecasts follow on from notification of an outbreak in the agricultural community. In the case of bluetongue, the forecast predicts the arrival of the virus on infected windborne midges from continental Europe. Since 2006 the bluetongue virus has been present on the near-continent, with an incursion of the virus into the UK occurring in August 2007. More recently, in the summer of 2017, the virus was detected on a group of cattle imported from France.

If another foot-and-mouth outbreak is detected, NAME will be run using high-resolution localised weather data. This will compile information on the outbreak, such as the numbers and types of livestock affected on-site and on neighbouring farms.

Assessing bluetongue risk involves the prediction of midge dispersal, based on research carried out by the Pirbright Institute. Each day, NAME is run to assess the dispersal of clusters of midges, which tend to become active around sunrise and sunset. Concentration plumes are produced based on the airborne spread of the midges from representative source areas on the near-continent.

In either case, using a geographic information system allows NAME output to be overlaid on to an Ordnance Survey map and then passed on to DEFRA. An example of this output relating to foot-and-mouth disease is shown in Figure 8.

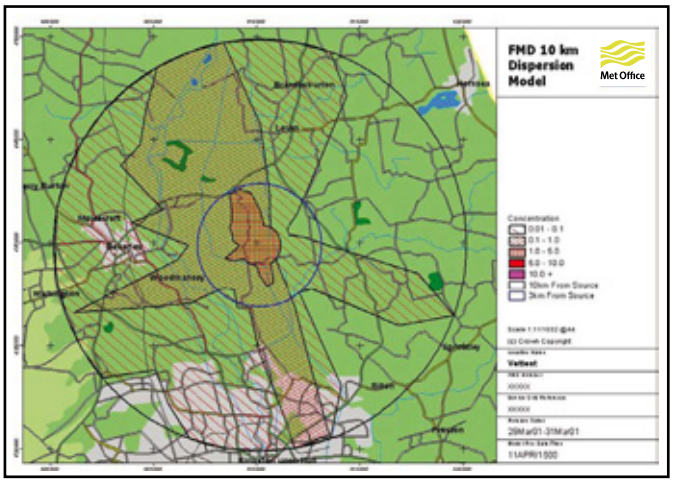

Figure 8 - An example of how NAME is used to predict the spread of Foot and Mouth disease.

4.6 Nuclear incidents

Following a small-scale nuclear incident, the response from the Hazard Centre would be similar to that for a chemical incident (as with the CHEMET service), in that the site operator would initially receive a map showing the area most at risk from contaminating material. A small-scale incident would typically involve the loss of small amounts of radioactive material from either a fixed nuclear site or nuclear products in transit, but would not be expected to affect a large geographical area.

Larger nuclear incidents require a different level of response. The accident at Chernobyl in 1986 - where around 8 tonnes of highly radioactive material was exposed to the atmosphere, resulting in widespread contamination – prompted the Met Office to develop the NAME model referred to previously. Its aim was to accurately predict the path of any future nuclear releases. Today, on notification of an accident, the Duty Forecaster runs the NAME simulation after having input all known information on the release.

Procedures and Communications following Release of Radioactive Material (PACRAM)

The PACRAM service operates in similar fashion to the CHEMET process with an initial request for assistance to EMARC made either by the site emergency controller or by the local Fire and Rescue Service. The initial call should be made as early as possible, when the suspected radioactive release is still within the site boundaries, prior to the declaration of an offsite nuclear emergency. In response the duty EMARC forecaster will prepare a forecast dispersion plume and attach it to the 'Forecast Information Form' which describes the expected weather conditions at the site for the next three hours. Both products are then sent to the site, Fire and Rescue and also RIMNET who will display the output on their system, to which various responders and government departments have access.

As with CHEMET the facility exists for generating maps showing predicted air concentration, along with wet/dry/total deposition of radionuclides. In most cases the magnitude and composition of the source term will remain unknown in the early stages of an incident, the plume depicting the dispersion of a notional unit release of radioactivity (1Bq or 10^{12} Bq). Only once further data, both from the site and from key offsite monitoring stations, has been received, can a full assessment of potential radioactive contamination be made. In an extended release one or more PACRAM updates will be required.

MoD commitments

For minor releases at military installations, the Hazard Centre provides a service almost identical to that for civil authorities, namely, an 'area-at-risk' map and PACRAM forecasts. For larger incidents, the Duty Forecaster or a Met Office Civil Contingencies Advisor may be deployed to the MoD in London.

Elsewhere, the Met Office provides NAME output for military incidents that may have international repercussions, with the Hazard Centre's role becoming one of support in such circumstances.

RIMNET – The Radioactive Incident Monitoring NETwork

Following the world's worst nuclear disaster, the Chernobyl accident in 1986, the UK Government developed a National Response Plan to ensure that any future similar emergency could be effectively managed. The National Response Plan, now replaced by the Nuclear Emergency Planning and Response Guidance was, and remains, a multi-departmental and multi-agency programme, with the Department for Business, Energy and Industrial Strategy (BEIS) as nominated Lead Government Department for overseas nuclear response. The RIMNET system lies at the heart of the National Response, and over the years has been developed as both a multi-purpose response tool and a platform for the effective coordination of the various agencies in an emergency response scenario. Central to the UK response to the Fukushima incident (Japan 2011), RIMNET is employed. in the UK response to any radiological event. It also has the potential to be used in non-radiological events.

RIMNET is managed by the UK Met Office, working in partnership with BEIS, on behalf of all UK government departments and agencies with a role in a radiological/nuclear emergency response, including Lead Government Departments for domestic (UK) nuclear events.

The RIMNET team and system provide:

- A bespoke IT interface (the response tool) utilised by multiple government departments and agencies across the UK.
- A network of 96 fixed gamma dose-rate monitoring sites across the UK (see Figure 9), automatically measuring, analysing and passing on information about background radiation levels 24 hours a day, 365 days a year. The automatic analysis tool undertakes real-time checks on radiation levels, and alerts a standby team to any abnormalities.
- An Approved Data Supplier Network providing supplementary data measurements, both routinely and during an emergency, including people, food and environmental monitoring results. This now includes a mobile gamma dose monitoring capability.
- The UK National Nuclear Database, in which all measurement and reference data is stored to facilitate analysis and presentation.

- A mapping and GIS system, including various layers such as population and agricultural information, alongside plume prediction modelling.
- Document management and distribution facilities.

RIMNET is more than just an IT tool. The IT system combines with procedures and dedicated facilities to aid in the management and coordination of any given emergency scenario. RIMNET development has created the ability to lead or support the UK command and control structure at either the local, regional or national level. Co-located within other Lead Government Departments, it ensures, along with other response tools, a fully integrated and effective response.

Providing RIMNET Support

The RIMNET Team provide support to both the RIMNET system user community and the wider response communities in a variety of ways:

- RIMNET system user support: as well as the provision of exercise and training programmes, the RIMNET Team manage a 'Current Event' folder during all Real and Exercise events that provides users with easy access to pre-formatted information in the major areas of documentation, plume prediction and monitoring data (see Figure 10 for an example from the Fukushima incident).
- An on-site presence: the RIMNET Team may be requested to attend user sites, such as BEIS and MoD, to provide immediate and in-depth access to system resources.
- National cells: the RIMNET Team attend other facilities as required, for example, COBR (Cabinet Office Briefing Room) or SAGE (Scientific Advisory Group to Emergencies).

Providing Information to Emergency Responders

The RIMNET system provides all users with access to the managed document store, the plume prediction model viewer and the National Nuclear Database, which stores reference data as well as up-to-date monitoring results from across the globe. The system also contains an inbuilt distribution system allowing for information to be distributed to non-users, including:

- Other government departments and agencies, who either have direct access to the RIMNET system or receive information messages.
- Local authorities – alerts utilising the Police National Computer and subsequent event updates direct to nominated fax and email contacts.
- The international community. The RIMNET team, on behalf of BEIS and the UK, lead on the use of international information and data exchange systems with the International Atomic Energy Agency and the European Union.

Dissemination of information is preceded by an initial alert that is sent via fax to a host local authority (HLA), and also to police control rooms via the police national computer. The alert is then disseminated locally by following agreed procedures. This initial alert notifies recipients that further specific information will follow in the form of 'information messages', which are sent by email to nominated email addresses.

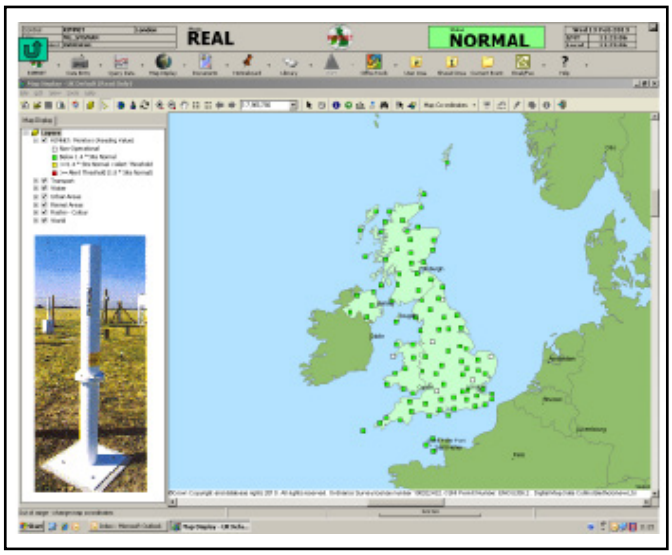

Figure 9 - The network of Gamma radiation monitoring sites across the UK.

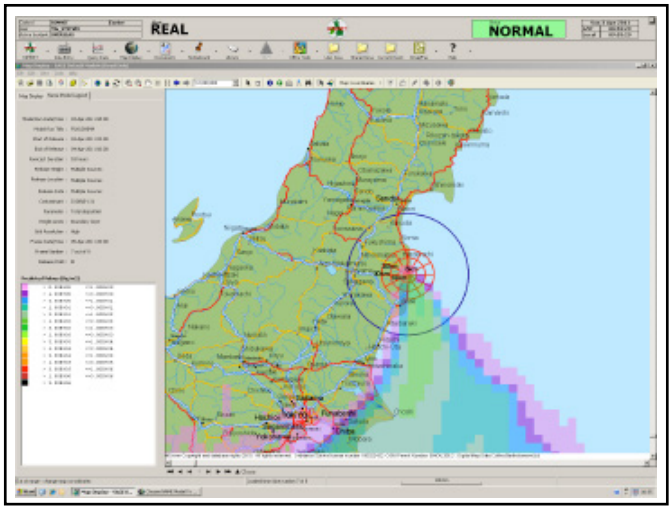

Figure 10 - An example of plume prediction from the Fukushima incident in 2011, as displayed on the RIMNET system.

4.7 Source Identification

By running NAME backwards in time the Met Office can determine the potential source of a particular measured pollutant. This is used where a pollutant has been detected, or where people or animals have exhibited symptoms, and there is a need to identify the source of the release or outbreak. An example from a system developed by the Met Office for RIMNET is given in Figure 11.

This shows the likely area of the source, based on three sensor detections across the South West of England. The deeper colours indicate the most likely location.

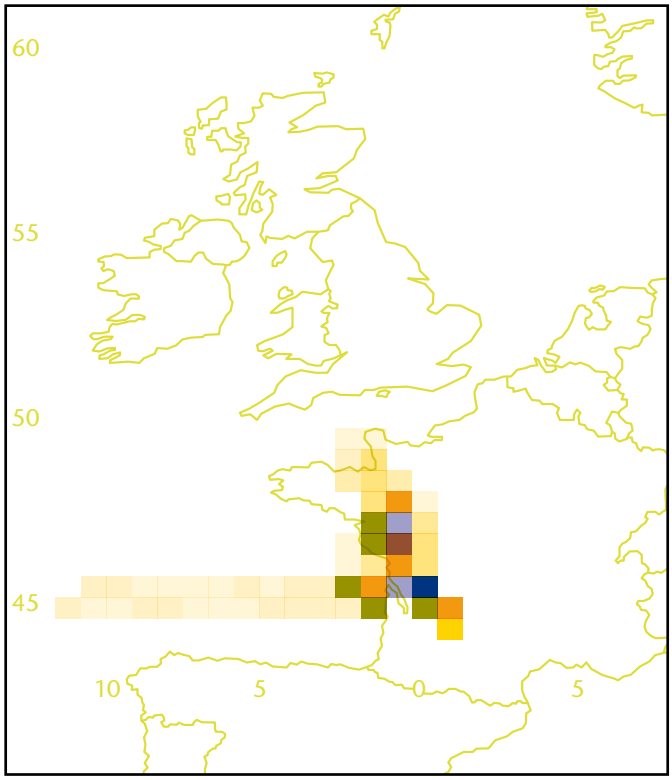

Figure 11 - Source identification derived from running NAME backwards in time.

4.8 Volcanic eruptions

The Hazard Centre has an international commitment as one of 11 designated Volcanic Ash Advisory Centres (VAACs) across the world, each with responsibility for a specific geographical sector. As the Met Office's sector of responsibility includes Iceland, advisories were provided following the eruptions of Hekla in 2000 and Grimsvötn in 2004 and 2011, as well as during the prolonged eruption of Eyjafjallajökull from March to May 2010.

The International Civil Aviation Organisation (ICAO) recognises the need to inform aircraft of the hazards posed by volcanoes, particularly the dangers from airborne volcanic ash. Not only can volcanic ash cause airframe damage, it can impair visibility and, more importantly, interfere with aircraft performance when drawn through the engine intakes, with potentially serious consequences.

In the event of an eruption, the responsible VAAC issues routine statements to the aviation community, detailing the latest position of the resulting ash plume and its expected movement during the subsequent 48 hours. The Hazard Centre uses a modified version of the NAME model to forecast the behaviour and trajectory of the plume. Output from this model is presented in a map-based graphical format, and can detail expected ash concentrations at various flight levels over a large area for several days after the initial volcanic activity.

During an event, the Hazard Centre liaises closely with the Icelandic Meteorological Office (during the 2010 eruption two Met Office Civil Contingencies Advisors spent a fortnight's detachment with their Icelandic colleagues), which is itself in close contact with the Nordic Volcanological Institute.

The Hazard Centre is provided with all the latest observational data as it emerges. This may be data from seismic surveys undertaken by the Nordic Volcanological Institute, or eyewitness accounts of current plume behaviour and volcanic activity. Additional visual observations may originate from aviators in the vicinity. Satellite pictures also provide valuable information on the spread of an ash plume. Sophisticated detection systems have been developed to make it easier for forecasters to identify ash plumes from satellite imagery. An example of a Volcanic Ash Advisory, communicated during the Eyjafjallajökull eruption in April 2010, is shown in Figure 12.

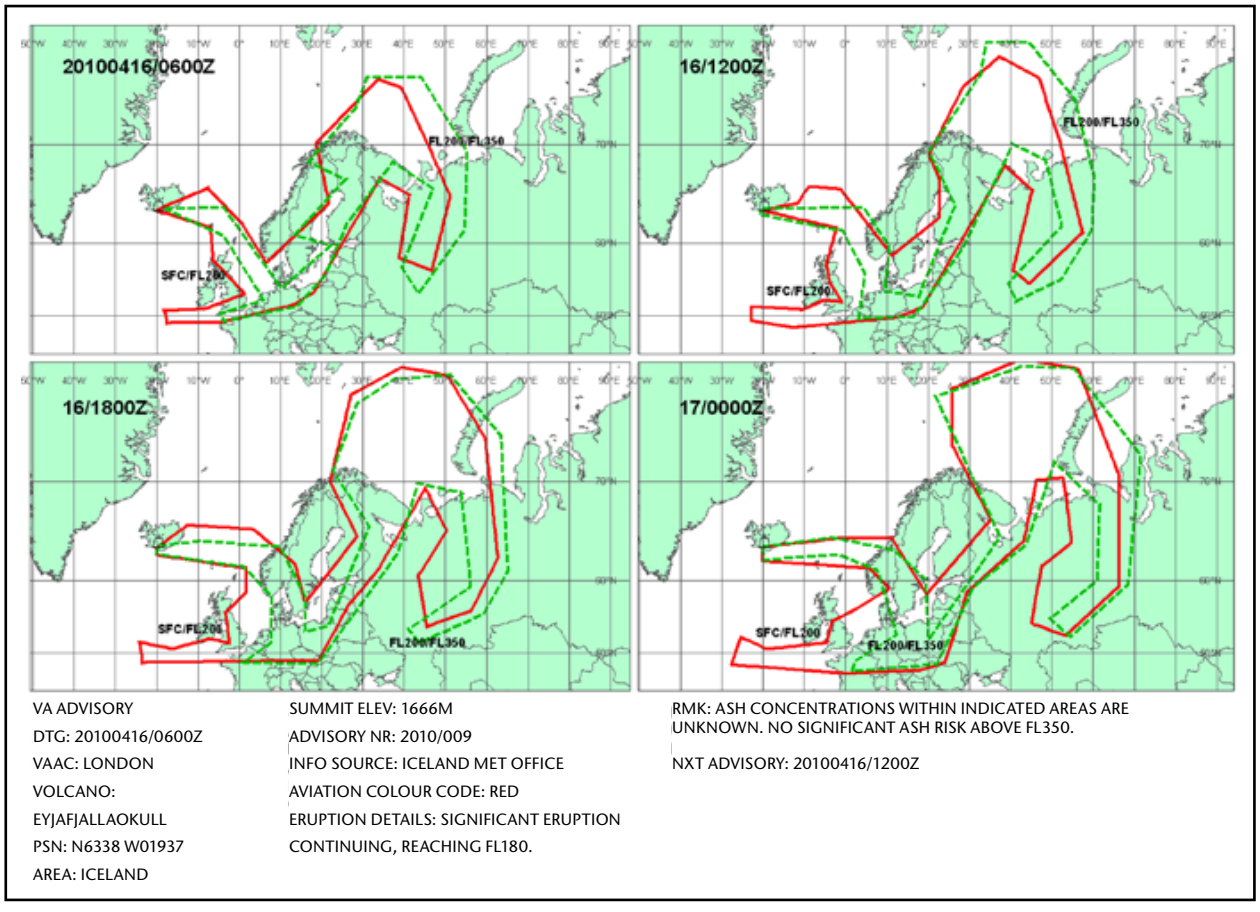

Figure 12 - Volcanic Ash Advisory issued during the Eyjafjallajokull eruption in April 2010.

4.9 Space Weather Events

In response to the government adding solar storms to the National Risk Register (NRR) of civil emergencies in 2011, the Met Office Space Weather Operations Centre (MOSWOC) was created to provide a UK operational space weather prediction centre to help protect the country from the serious threats posed by space weather events.

Space weather describes changing environmental conditions in near-Earth space. Magnetic fields, radiation, particles and matter, emitted from the Sun, can interact with the Earth's upper atmosphere and surrounding magnetic field to produce a variety of effects. The major impacts of an extreme event can roughly be divided into two areas: impacts on terrestrial technology and threats to equipment and health in space and at high altitude. These include:

- Power grid outages
- Disruption to Global Navigation Satellite Systems e.g. GPS, Galileo, GLONASS
- HF radio communications outages
- Satellite damage
- Increased radiation threat at high altitude.

Solar flares can cause high-frequency radio and GPS to perform erratically, and extreme geomagnetic storms can put power grids at risk. Space weather forecasts are therefore of crucial importance to those working in Civil Contingencies, as well as the Armed Forces, the electricity industry, satellite operators and the aviation industry.

The Met Office space weather advisor monitors the Sun on a 24/7 basis, using solar imagery (see Figure 13) and other satellite data. The analysis of this data is used to produce space weather forecasts. Warnings and alerts about radio blackouts, geomagnetic storms and radiation storms are issued as necessary.

Our space weather advisors work in partnership with the National Oceanic and Atmospheric Administration (NOAA), the Space Weather Prediction Centre (SWPC), and the British Geological Survey (BGS). During an extreme event they will also liaise with government departments, including BEIS and the Civil Contingencies Secretariat at the Cabinet Office.

MOSWOC will provide the latest data and model output as it emerges to ensure all sectors are prepared to deal with the current situation. Although MOSWOC will report on the space weather situation, communication about the impacts will be handled by the appropriate government department.

Since space weather and its impacts are not as well understood as terrestrial weather, Met Office Civil Contingencies Advisors work in conjunction with MOSWOC to help increase the level of knowledge among emergency responders. A pictorial summary of space weather-related impacts is shown in Figure 14. An extensive introduction to the subject, including frequently asked questions and the latest forecast, can be found on the Met Office website at:

https://www.metoffice.gov.uk/services/public-sector/emergencies/space-weather

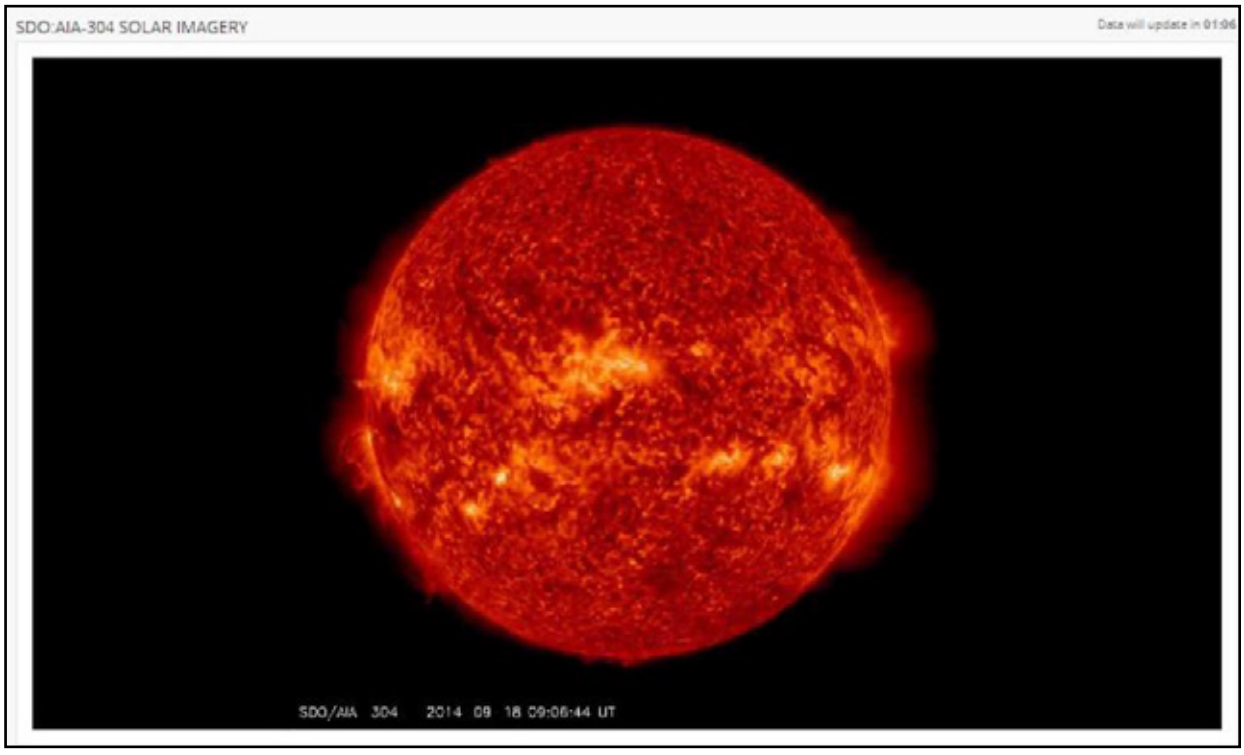

Figure 13 - An example of the solar imagery used in the Met Office Space Weather Operations Centre (MOSWOC).

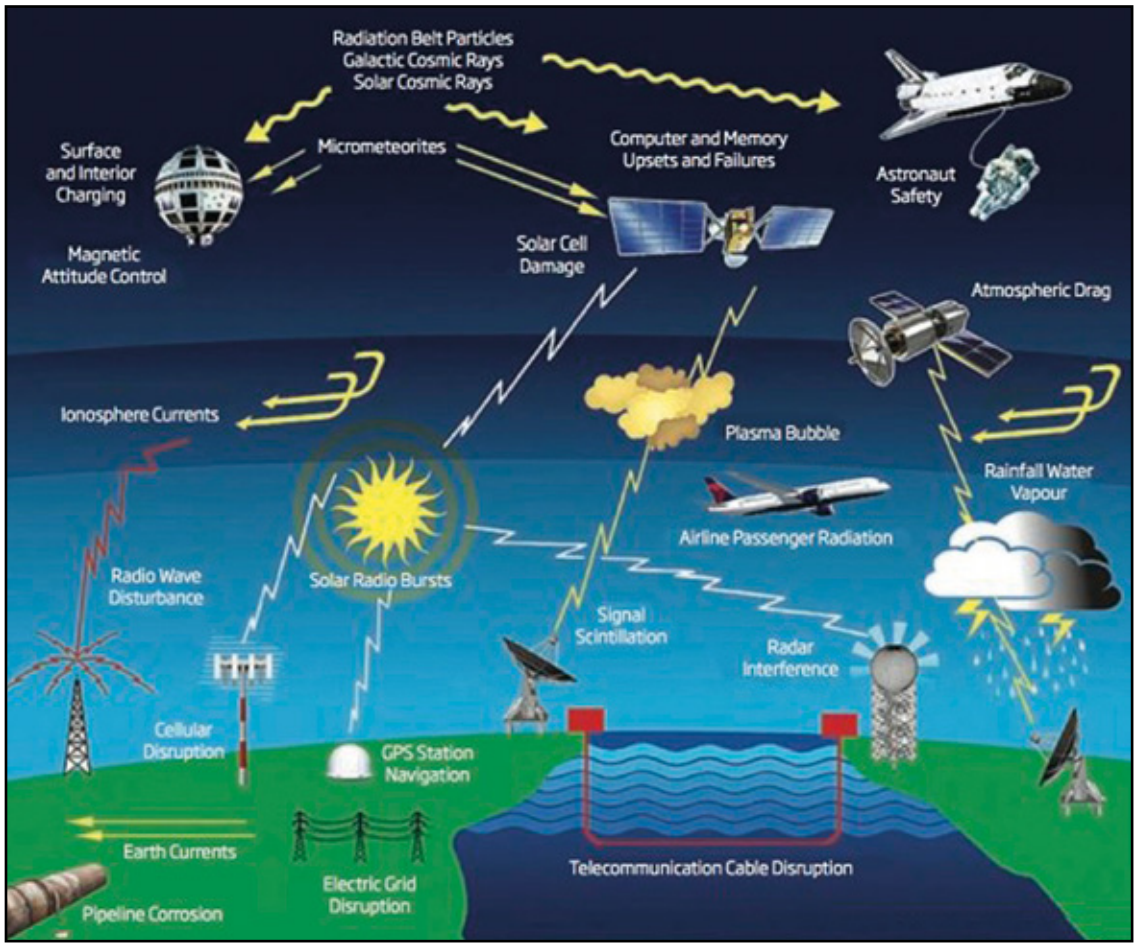

Figure 14 - Impacts of Space Weather © L.J.Lanzerottie, Bell Laboratories, Lucent Technologies Inc.

5. CIVIL CONTINGENCIES ADVISORS

In response to the Civil Contingencies Act 2004, the Met Office established a team of Civil Contingencies Advisors in 2005 to offer support to the resilience community. The following year, the team was expanded from six to 10. There are now a total of 15 advisors and 3 senior advisors covering the UK, led by the Head of Civil Contingencies. The posts are centrally funded as part of the Met Office's Public Weather Service commitment, and so the services offered by the Advisors are 'free at the point of use'.

Within Scotland, Wales and Northern Ireland the advisors liaise both with the local/regional resilience groups and directly with the elected national executives. Those based in England deal mainly with their local resilience fora. The geographical distribution of lead Advisors across the UK can be found in Section 8.

The Advisors' primary function is to serve as a regional/national point of contact for the Met Office within their respective resilience communities. This involves engaging with, and integrating into, regional and local emergency planning groups, so that emergency planners are fully aware of Met Office capabilities, from which they can derive maximum benefit when dealing with incidents in which the weather plays a role.

Among the principal tasks of the Advisors are i) real-time response to weather-related emergencies; ii) input to those emergency plans which are, in any way, weather sensitive; iii) involvement in exercises designed to test those plans; and iv) the promotion and demonstration of specific Met Office services.

The Advisors are available to the emergency planning community in order to:

1. Discuss predicted or ongoing severe weather events to help emergency responders assess the risk in their particular area and put preparations in place to mitigate the impacts. This includes raising awareness of all available meteorological information sources.
2. Participate in local severe weather-related tactical and strategic teleconferences.
3. Help in the preparation and participation of multi-agency exercises. These include severe weather exercises and any exercise where weather conditions have an influence on the management of the incident. Obvious examples are chemical, biological or radiological releases; but other events, such as large outdoor gatherings where crowd movements may be influenced by sudden changes in the weather, would also benefit from weather information. The Advisors are able to construct suitable scenarios or specialist products, such as simulated severe weather warnings, CHEMETs and PACRAMs (see Section 4), as injects to the exercise.
4. Provide guidance on the interpretation of Met Office services available to emergency responders by holding presentations, workshops and exercises.
5. Compile severe weather risk assessments, as used in community risk registers (see Section 6).
6. Provide information on the role of the Met Office during emergencies, and on its Severe Weather Warnings for use in local plans.

The Advisors will respond to requests for assistance from Command and Control Centres or Science and Technical Advice Cells (STACs), and attend incident or control centres if required. Given the distances involved, there may well be a period of initial support from Hazard Centre staff via teleconference to cover the time the advisor is in transit to the control centre.
The role of an Advisor during an incident is to:

1. Ensure the management team is aware of all the meteorological factors which could have an impact on the incident.
2. Ensure the consistency of meteorological information, and also ensure that all responders within the Command and Control Centre use this information.
3. Interpret this information for the responders, where required to do so.
4. Source other scientific advice available from the Met Office, and act as a point of contact between the Met Office and the responders. This frees up the responders' resources and enables them to focus on incident management.
5. Respond to weather-related media enquiries.
6. Arrange for the supply of routine forecasts and other information to aid in the recovery phase, if required.
7. Assist in the audit trail by documenting meteorological requests and responses.

6. SEVERE WEATHER RISK ASSESSMENTS

Since 2005, the government has carried out a classified assessment of the risks facing the UK. This is the National Risk Assessment, which is the basis for the public National Risk Register. The Met Office provides information to the Civil Contingencies Secretariat for the National Risk Assessment on the likelihood scores for three severe weather risks: heatwaves, severe gales and storms, low temperatures and heavy snow. The Met Office also serves as lead assessor of the risk from 'space weather'. Also included in the National Risk Assessment are risks such as those linked to drought and coastal, river, and surface water flooding.

The generic outcome descriptors for the three principal severe weather risks are listed below, together with the likelihood scoring scale (opposite).

Category 1 responders at the local level across the UK are required to carry out a risk assessment under the Civil Contingencies Act 2004, and to produce and maintain a public community risk register. Compiled by specially designated working groups within Local Resilience Forums/Strategic Coordination Groups, these registers are then passed on to the Forums/Groups themselves for approval and publication. The Advisors play an active role in these local risk assessment working groups, using their local knowledge and expertise to assess the likelihood of the severe weather risks occurring in that locality in the next five years.

The Advisors also contribute to impact assessment discussions with emergency responders, in order to help make a final estimate of the risk posed by each of the severe weather hazards.

Likelihood score	Descriptor	Likelihood over the next five years
1	Negligible	>0.0005% or .1 in 20,000 chance
2	Rare	>0.05% or >1 in 2,000 chance
3	Unlikely	>0.5% or >1 in 200 chance
4	Possible	>5% or >1 in 20 chance
5	Probable	>50% or >1 in 2 chance

H17 - Storm and gales	H18 - low temperatures/ heavy snow	H48 - Heatwave
Storm force winds affecting most of the area for at least six hours. Most inland, lowland areas experience mean speeds in excess of 55 mph with gusts in excess of 85 mph.	Snow lying over most of the area for at least one week. After an initial snowfall there is further snowfall on and off for at least seven days. Most lowland areas experience some falls in excess of 10 cm, a depth of snow in excess of 30 cm, and a period of at least seven consecutive days with daily mean temperatures below –3 °C.	Daily maximum temperatures > 32 °C and minimum temperatures > 15 °C over most of the area for at least five consecutive days.

7. ADDITIONAL SUPPORT AND ADVICE

The Met Office has a wide range of professional and technological resources to aid the emergency services and other Category 1 and 2 responders (as defined in the Civil Contingencies Act 2004) in the management of an emergency. These resources can be called on for both severe weather events and incidents where the weather will have a significant impact. Responders can therefore be sure of consistent and effective meteorological input to aid the management of the incident.

Hazard Centre forecasters can provide advice around the clock during severe weather or environmental incidents. Should a major incident occur, the Civil Contingencies Advisors may be called on to attend in person or via teleconference strategic and tactical command meetings, the Cabinet Office Briefing Room (COBR) or the Scottish Government Resilience Room (SGoRR).

With these possibilities in mind, and with the need to ensure emergency responders are fully up to date with the latest weather-related information, the Met Office developed a dedicated website aimed at providing a one-stop meteorological information source that is geared towards managing all weather-related incidents. This web portal is known as Hazard Manager.

7.1 Hazard Manager

Funded by the Met Office's Public Weather Service, Hazard Manager is designed to aid incident management teams in dealing with a variety of situations where the weather plays a significant role. Such situations would include major flooding, large fires, biological hazards, chemical and radiological releases, and tidal surges.

It also enables responders to monitor severe weather developments to help pinpoint where, within a region, resources are more likely to be productively deployed. The service aims to supplement the role of the Civil Contingency Advisors in providing consistent weather-related information and interpretation to responders.

The service is available to all Category 1 and Category 2 responders, on an organisational or individual basis. Registration for the service is achieved via the link:

https://register.metoffice.gov.uk/register/hazardmanager/government.html?service=hazardmanager

Figure 15 shows the welcome page and the varied choice of functionality available to users.

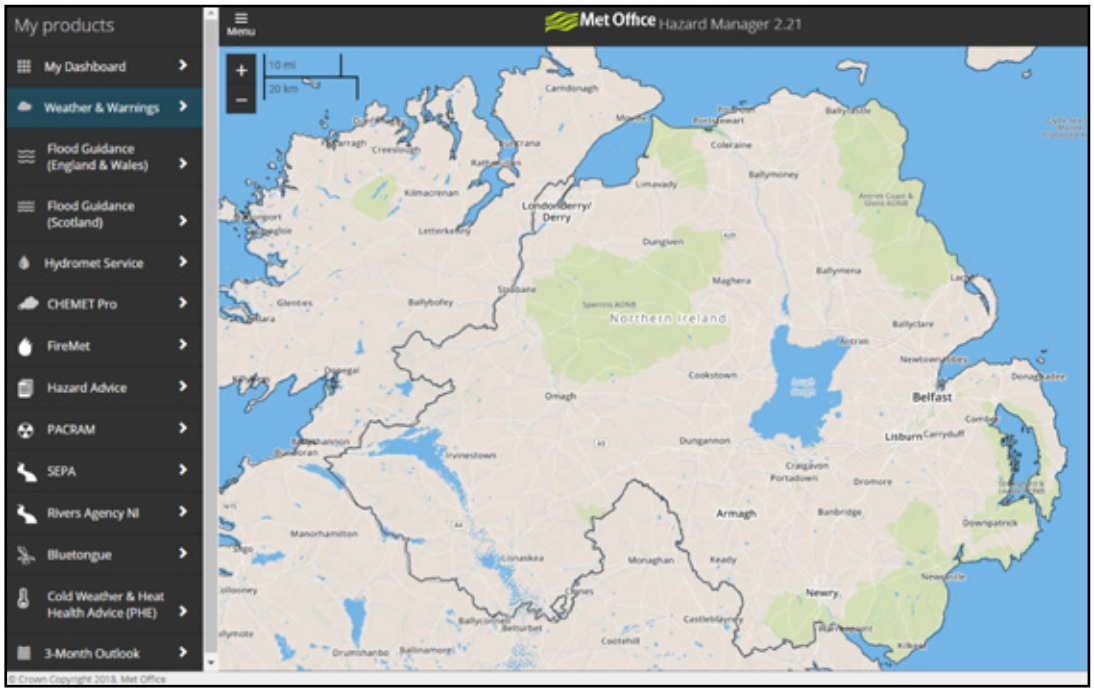

Figure 15 - Hazard Manager welcome page with the range of services listed down the left hand side.

The information available to users comprises two distinct types. First, the latest weather observations and forecasts, automatically updated, including:

- Rainfall/snowfall radar imagery
- Real-time rain gauge data
- Forecast precipitation type/intensity
- Wind observations
- Forecast wind speed/direction
- Lightning location
- All current severe weather warnings.

Second, there are the more emergency-specific services, such as the Flood Guidance Statement, FireMet, CHEMET and PACRAM. Note that some of the more specialised services such as FireMet are available only to approved users, for instance, Fire and Rescue services. When severe weather alone is the hazard, an 'event' may be activated within the 'Events' tab. Here, bespoke maps and graphical products relating to the event, such as forecast snow depth or maximum wind gusts, can be deposited. A 'useful links' tab provides connections to an ever-increasing range of weather-related sites. An additional tab takes the user to various product guides including those for CHEMET and the Flood Guidance Statement. An external link from the Met Office website takes the user to the Hazard Manager Help Centre, an alternative source of guides and training videos that explain in greater detail some of the products available.

https://www.metoffice.gov.uk/services/public-sector/hazardmanager/help-centre

Figure 16 shows an example of a rainfall radar image showing a band of rain crossing N Ireland on 22 March 2018. Figure 17 depicts those severe weather warnings in force on a day in April 2018.

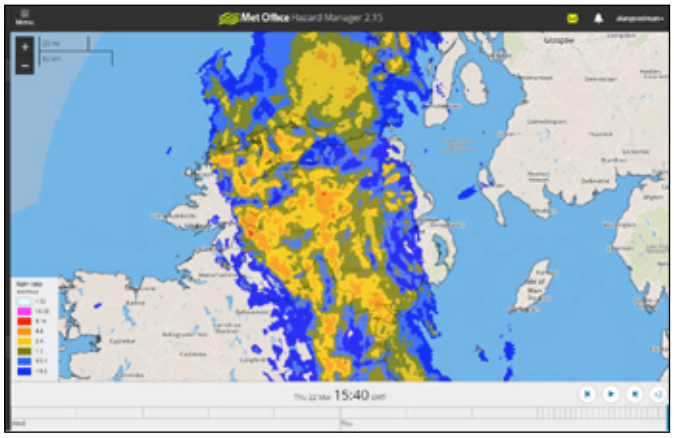

Figure 16 - Hazard Manager rainfall radar image showing an area of rain crossing Northern Ireland on 22 March 2018.

7.2 Specialised weather forecasts

During the management of an incident (particularly during the emergency and initial recovery phases) there may be a requirement for the responding agencies to receive regular, and perhaps specialised, weather forecasts from the Met Office.

For example, regular rainfall forecasts were provided to emergency responders in the aftermath of the flooding in South West England during July 2007. In the wake of the Cumbrian floods in November 2009, a daily recovery forecast service was set up which ran for a week after the flood waters had peaked. These forecasts were all provided as part of the Public Weather Service, so were designated 'free at the point of use'.

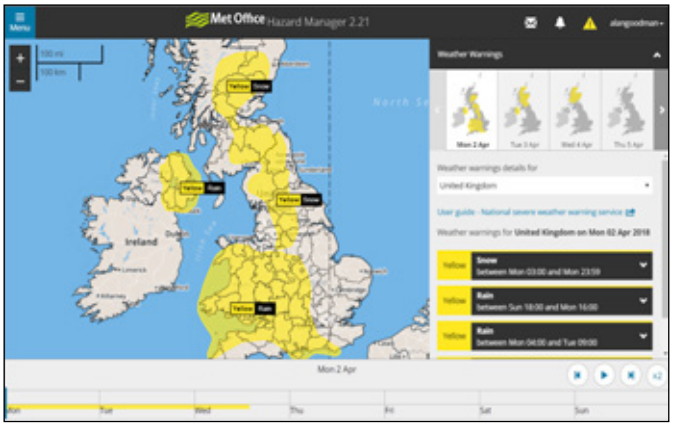

Figure 17 - Hazard Manager display of Severe weather warnings on 02 April 2018.

Another example of regular forecasts being provided for the management of an incident was when the container ship MSC Napoli was stricken off the south coast of England in January 2007. Site-specific forecasts of wind and wave conditions were supplied on a regular basis to help with the recovery operation. This type of forecast is provided as part of the Public Weather Service for the initial emergency phase, but once the incident moves on to the long-term recovery phase the costs for additional specialised forecasts must be met by the leading organisation.

7.3 Airborne support

The Met Office Civil Contingency Aircraft (MOCCA) is specifically designed for measurement of gases and aerosols in the atmosphere, as well as measurement of local meteorological conditions (e.g. wind, temperature). Commissioned as a response to the Icelandic volcanic eruption of 2010, it has a role in supporting investigations of volcanic ash around the UK and in assisting in other civil contingencies for which aircraft measurements are required.

The MOCCA – a twin-piston engine Cessna 421 – is on 24-hour standby, and can operate between 500 ft and 30,000 ft over land and sea. Its instrumentation includes a lidar, which can remotely sense the altitude of particle plumes. Data from the aircraft are sent in real time via satellite link directly to the Hazard Centre at the Met Office's headquarters in Exeter, enabling forecasters to receive immediate updates on an event.

The Met Office also jointly owns, with the Natural Environment Research Council, a BAe146 research aircraft of the Facility for Airborne Atmospheric Measurements (FAAM). The aircraft can be used to monitor particulates and pollutants in the atmosphere, as well as provide details on local meteorology (e.g. winds, temperatures).

The BAe146 is a large four-engine jet aircraft capable of carrying four tonnes of scientific payload and of operating down to 100 ft over the sea and up to 35,000 ft. It was used during the Buncefield Oil Depot fire in December 2005 and the Icelandic volcano eruption in 2010.

The FAAM is not on 24-hour standby, so its involvement in the response to a particular incident depends on its availability and the configuration of onboard instruments at any given time.

Tasking of the MOCCA and FAAM is handled through the Hazard Centre as part of the Met Office's support to incidents where Gold/Strategic Commands have been established. Following a request for assistance, the Met Office seeks to recover the costs associated with the deployment of either aircraft through the lead government authority for the incident.

Figure 18 - The FAAM BAe146 aircraft in action over the UK.

7.4 Calling on Met Office resources for Command and Control Centres or Science and Technical Advice Cells

When an incident arises in which a strategic or tactical level of command and/or a Science and Technical Advice Cell (STAC) has been established, and the weather plays a role in the management of that incident, the procedure for requesting Met Office assistance is as follows:

1. Strategic or Tactical Command contacts the Met Office Hazard Centre on 01392 447947 with a statement of the nature of the emergency and its location. However, when the incident is purely weather-related, such as with flooding, severe gales or very heavy snowfall, those Civil Contingencies Advisors within the affected areas will receive a direct request from strategic or tactical command centres to attend meetings either in person or, more usually, via teleconference.
2. The Hazard Centre can supply a general weather forecast as well as specialist services such as CHEMET, PACRAM or NAME as an initial response, with typical delivery times of between 10 and 20 minutes for CHEMET and PACRAM, and from 30 minutes to one hour for NAME.
3. In a protracted incident, Strategic or Tactical Command may also request additional resources to aid the management of that incident, such as specialist scientific advice from the Met Office's Atmospheric Dispersion and Air Quality Group (ADAQ), or even resources such as the MOCCA or FAAM research aircraft described previously.
4. The Hazard Centre will contact the ADAQ, which is on call around the clock, to discuss the incident and the request.
5. ADAQ experts at the Met Office will assess the incident in order to find the best solution for its effective management.
6. Should this solution require significant resources, such as airborne support, contact will be made with the Civil Contingencies Secretariat, via its 24-hour emergency centre, to request these resources or to mobilise resources outside Met Office control, such as military aircraft.
7. If deemed appropriate, the Hazard Centre will contact the Met Office's 24-hour Incident Management Team and/or Press Office to discuss the incident and any need for further resources that may be required to manage the situation, as judged from a Met Office perspective.

8. CONTACT DETAILS

For advice during severe weather (24 hours):

- In England and Wales - call EMARC/Hazard Centre on 01392 886095
- In Scotland and Northern Ireland - call Met Office, Aberdeen on 01224 629801

For advice during environmental emergencies e.g. Chemical, Biological, Radiological or Nuclear (24 hours):

- Anywhere in the UK - call EMARC/Hazard Centre on 01392 447947

Met Office Civil Contingencies Advisors are available in the areas shown below to discuss weather-related events, attend incident control rooms where possible, either in person or remotely, and help prepare and take part in exercises. (See Section 5 for further details).

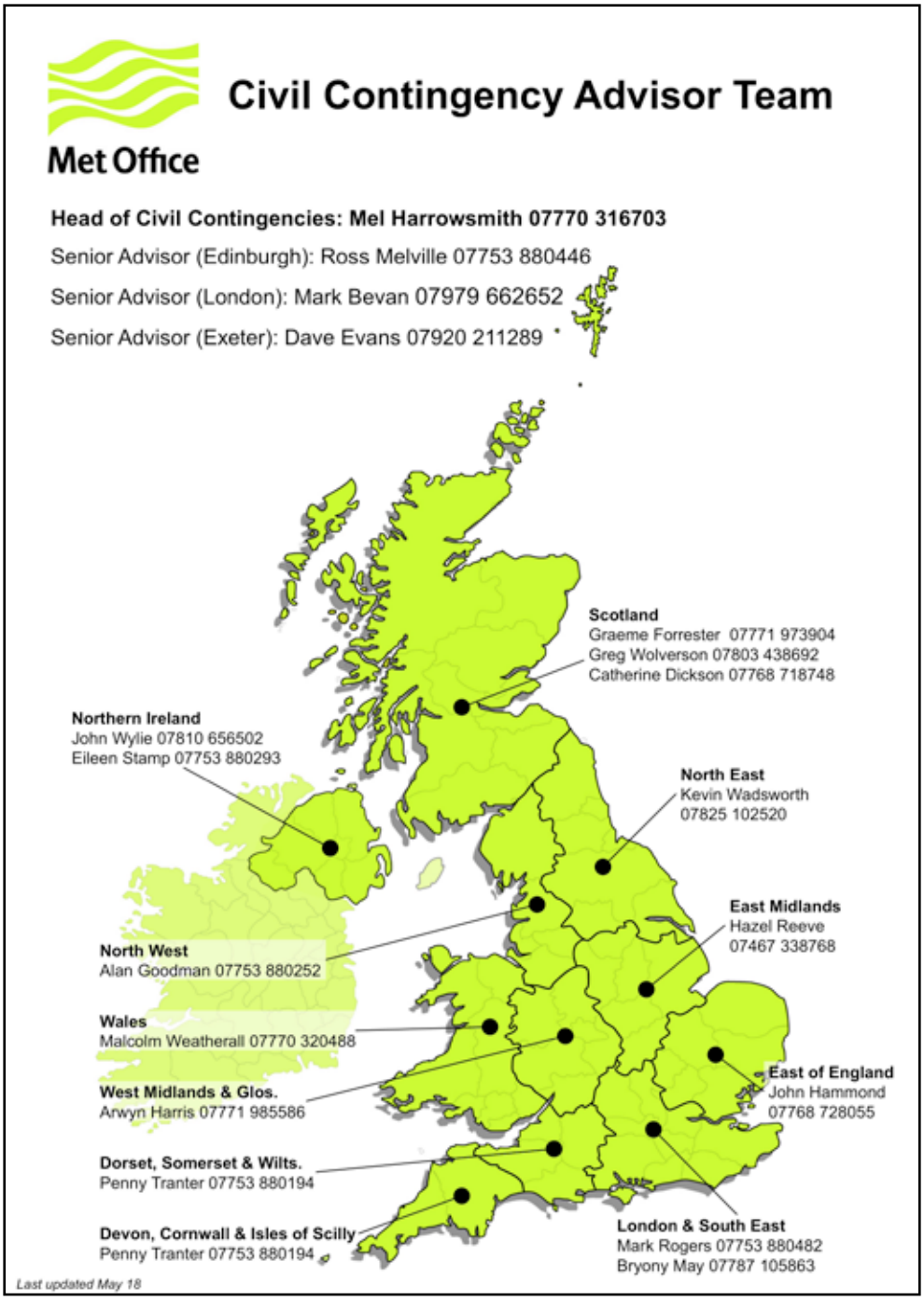

Figure 19 - Areas of responsibility for the Civil Contingencies Advisor network.

9. LIST OF ACRONYMS

ADAQ Atmospheric Dispersion and Air Quality Group	**MSC** Mediterranean Shipping Company
BGS British Geological Survey	**NAME** Numerical Atmospheric-dispersion Modelling Environment
BEIS Department for Business, Energy and Industrial Strategy	**NOAA** National Oceanic and Atmospheric Administration
CHEMET CHEmical METeorology	**NSWWS** National Severe Weather Warning Service
COBR Cabinet Office Briefing Room	**PACRAM** Procedures And Communications following Release of Radioactive Material
DEFRA Department for the Environment, Food and Rural Affairs	**PWS** Public Weather Service
DH Department of Health	**PWSCG** Public Weather Service Customer Group
EMARC Environment Monitoring and Response Centre	**RIMNET** Radioactive Incident Monitoring NETwork
FAAM Facility for Airborne Meteorological Measurements	**SEPA** Scottish Environment Protection Agency
FFC Flood Forecasting Centre	**SFFS** Scottish Flood Forecasting Service
FGS Flood Guidance Statement	**SFGS** Scottish Flood Guidance Statement
GLONASS GLObal NAvigation Satellite System	**SGoRR** Scottish Government Resilience Room
GPS Global Positioning System	**SMS** Short Message Service
ICAO International Civil Aviation Organisation	**STAC** Science and Technical Advice Cell
LRF Local Resilience Forum	**SWPC** Space Weather Prediction Centre
MCA Maritime and Coastguard Agency	**TCC** Technical Coordination Centre
MOCCA Met Office Civil Contingencies Aircraft	**VAAC** Volcanic Ash Advisory Centre
MOSWOC Met Office Space Weather Operations Centre	

10. CONVERSION TABLES

Speed

Miles per hour	10	20	30	40	50	60	70	80	90	100
Kilometres per hour	16	32	48	64	81	97	113	129	145	161
Metres per second	5	9	13	18	23	27	31	36	40	45
Knots	9	17	26	35	44	52	61	70	78	87

Beaufort Force	0	1	2	3	4	5	6
Knots	< 1	1-3	4-6	7-10	11-16	17-21	22-27

Beaufort Force	7	8	9	10	11	12
Knots	28-33	34-40	41-47	48-55	56-63	64 or more

1 knot = 0.515 metres per second = 1.85 kilometres per hour
1 mph = 0.87 knots = 1.61 kilometres per hour

Wind direction

Compass point	N	NNE	NE	ENE	E	ESE	SE	SSE
Degress	0	22.5	45	67.5	90	112.5	135	157.5

Compass point	S	SSW	SW	WSW	W	WNW	NW	NNW
Degress	180	202.5	225	247.5	270	292.5	315	337.5

Wind direction is always given as the direction the wind is blowing FROM.

Temperature

°C	–20	–15	–10	–5	0	5	10	15	20	25	30	35	40
°F	–4	5	14	23	32	41	50	59	68	77	86	95	104

APPENDIX 1

Severe Weather Impact Tables

The following table provides examples of the level of disruption that might be experienced at each of the impact levels (high, medium, low) and for each weather element (rain, snow, etc.). Note that weather assessed as having a 'very low' impact may still have some minor impacts.

	VERY LOW	LOW	MEDIUM	HIGH
Generic impact levels of **ALL SEVERE WEATHER** for emergency responder organisations	On the whole, day to day activities not affected but some localised, small scale impacts occur. A few transport routes affected.	Some short lived disruption to day to day routines in affected areas. Incidents dealt with under 'business as usual' response by emergency services. Some transport routes and travel services affected. Some journeys require longer travel times.	Injuries with danger to life. Disruption to day to day routines and activities. Short-term strain on emergency responder organisations. Transport routes and travel services affected. Longer journey times expected. Some vehicles and passengers stranded. Disruption to some utilities and services. Damage to buildings and property.	Danger to life. Prolonged disruption to day to day routines and activities. Prolonged strain on emergency responders organisations. Transport routes and travel services affected for a prolonged period. Long travel delays. Vehicles and passengers stranded for long periods. Disruption to utilities and services for a prolonged period. Extensive damage to buildings and property.
Specific impact levels associated with **WIND**	Loose debris blown around. A few transport routes affected by difficult driving conditions. Instances of spray and large waves affecting coastal routes, sea fronts and coastal communities.	Some transport routes and travel services affected. Some journeys require longer travel times. Some disruption to road, rail, air and ferry transport. Localised problems for high-sided vehicles on prone routes e.g. due to cross winds on exposed high level roads. Localised power interruptions. Coastal routes, sea fronts and coastal communities affected by spray and/or large waves.	Injuries and danger to life from flying debris. Some structural damage, such as slates dislodged from roofs. Transport routes and travel services affected. Longer journey times expected. Disruption to road, rail, air and/or ferry transport. Closure of some susceptible and key routes (e.g. some vulnerable bridges). Interruptions to power and/or other utilities and services. Casualties and danger to life from large waves/beach material being thrown onto coastal routes, sea fronts and coastal communities.	Widespread danger to life from flying debris. Widespread structural damage e.g. roofs blown off, mobile homes overturned, power lines brought down. Transport routes and travel services affected for a prolonged period. Long travel delays. Closure of main bridges, road and rail networks in many areas, and significant disruption to air and ferry transport. Widespread and prolonged disruption to power, and/or other utilities and services. Danger to life from large waves/beach material being thrown onto coastal route, sea fronts and coastal communities.

	VERY LOW	LOW	MEDIUM	HIGH
Specific impact levels associated with **RAIN**	Localised flooding of low-lying land and susceptible roads. A few transport routes affected. Road conditions affected with localised spray and some standing water.	Localised flooding of homes and businesses and susceptible roads Some transport routes and travel services affected. Some journeys require longer travel times. Road conditions affected by spray and standing water. Localised and short term disruption to utilities and services	Flooding of homes and businesses. Danger to life from fast flowing/deep water. Damage to buildings/structures. Transport routes and travel services affected. Longer journey times expected. Some road closures. Difficult road conditions due to spray and standing water. Interruption to utilities and services. Some communities temporarily inaccessible due to flooded access routes.	Widespread flooding of homes and businesses. Danger to life from fast flowing/deep water. Extensive damage to and/or collapse of buildings/structures. Transport routes and travel services disrupted for a prolonged period. Long travel delays. Widespread road closures. Dangerous driving conditions due to spray and standing water. Prolonged disruption to or loss of utilities and services. Communities become cut off for a prolonged period, perhaps several days, due to flooded access routes.
Specific impact levels associated with **SNOW**	A few transport routes affected.	Some transport routes and travel services affected. Some journeys require longer travel times.	Transport routes and travel services affected. Longer journey times expected. Some stranded vehicles and passengers, with disruption to rail, road and air services. Interruptions to power and/or other utilities and services. Some rural communities temporarily inaccessible due to deep snow or snow drifts.	Transport routes and travel services affected for a prolonged period. Long travel delays. Large numbers of stranded vehicles and passengers with widespread disruption to rail, road and air services. Widespread and prolonged interruptions to power and/or other utilities and services. Rural communities cut off for a prolonged period, perhaps several days, due to deep snow or snow drifts.

	VERY LOW	LOW	MEDIUM	HIGH
Specific impact levels associated with **ICE**.	A few transport routes affected by ice on some untreated roads, pavements and cycle paths. Limited travel disruption with difficult conditions mostly confined to a few prone routes.	Some injuries from slips and falls. Some transport routes and travel services affected with some ice on untreated roads, pavements and cycle paths, but road networks generally open. Some road traffic collisions.	Casualties with risk to life. Injuries from slips and falls Transport routes and travel services affected by widespread black ice. Some road closures and some only passable with care. Untreated pavements and cycle paths impassable. Some travel disruption with longer journey times and road traffic collisions.	Widespread risk to life. Casualties and injuries from slips and falls Transport routes and travel services affected by sudden formation of black ice across whole communities with roads pavements and cycle paths becoming instantly impassable. Widespread disruption to road, rail and air transport with frequent road traffic collisions. Widespread interruptions to power due to power line icing, leading to impacts on telecommunications.
Specific impact levels associated with **FOG**.	Limited travel disruption with difficult travel conditions mostly confined to a few prone routes. A few road traffic collisions.	Difficult driving conditions with slower journey times. Some road traffic collisions Passengers delayed with short-term closure of airports.	Difficult driving conditions with long journey times. Road traffic collisions Passengers delayed and/or stranded at airports and/or ferry terminals.	N/A

	VERY LOW	LOW	MEDIUM	HIGH
Specific impact levels associated with **THUNDERSTORMS**	A few places will have flooding, usually lasting an hour to a few hours at most. A few local transport routes may be affected with difficult driving conditions Very short-term disruption to power and/or other utilities and services in a few places.	Some flooding of homes, businesses and susceptible roads lasting several hours in places. Some damage to buildings/ structures from flooding and/or lightning. Some transport routes and travel services affected. Some journeys require longer travel times. Road conditions affected by spray and standing water and/or hail. Short-term disruption to power and/or other utilities and services in some places.	Flooding of homes and businesses. Danger to life due to sudden deep/fast flowing water. Damage to buildings/ structures from flooding and/or lightning, hail, strong winds Transport routes and travel services affected quickly by flooding. Longer journey times and cancellations. Difficult road conditions due to spray, standing water and/or hail, sudden gusty winds. Interruption to power and/or other utilities and services. Some communities temporarily inaccessible due to flooded access routes.	Widespread flooding affecting homes and businesses. Danger to life due to sudden fast flowing/deep water. Injuries from hail. Casualties and danger to life from lightning strikes. Extensive damage to buildings/ structures from flooding and/or lightning, hail, strong winds Transport routes and travel services affected by flooding for a prolonged period with long travel delays and rapidly changing/deteriorating conditions. Dangerous driving conditions due to spray, standing water and/or hail, sudden gusty winds. Prolonged disruption to or loss of power and/or other utilities and services Communities become cut off for a prolonged period, perhaps several days, due to flooded access routes or damage to road infrastructure.

	VERY LOW	LOW	MEDIUM	HIGH
Specific impact levels associated with **LIGHTNING** (where no rain impacts are forecast)	Disruption to power and/or other utilities and services in a few places. Damage to buildings/ structures from lightning strikes in a few places.	Some disruption to power and/or other utilities and services. Some damage to buildings/ structures.	Injuries with danger to life due to lightning. Interruptions to power and/or other utilities and services. Damage to buildings/ structures from lightning strikes.	Injuries with danger to life due to frequent lightning strikes. Prolonged disruption to or loss of power and/or other utilities and services over a widespread area. Extensive damage to buildings/ structures from lightning strikes over a widespread area

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