



World Meteorological Organization

GUIDELINES ON CROSS-BORDER EXCHANGE OF WARNINGS

PWS-9

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Chapter 1

INTRODUCTION

Severe weather threats are not always constrained by national boundaries. High impact weather phenomena may affect a number of neighbouring countries simultaneously or successively. While National Meteorological and Hydrological Services (NMHSs) are responsible for issuing forecasts and warnings of these phenomena for their own national territories, the advances in communication technology and increasing globalization of the media result in increased capability of the public to have access to information on severe weather events, including warnings, from neighbouring NMHSs. Unless this information is properly coordinated, their effectiveness to motivate those at risk to take appropriate action may be reduced. There is, therefore, a need to establish and maintain an effective system of cross-border exchange of warnings among NMHSs.

Basic meteorological information consisting mainly of data and products tailored for use by meteorologists, is widely exchanged and circulated internationally among NMHSs, through the Global Telecommunication System (GTS) or regional networks. The WMO 12th Congress Resolution 40 (Cg-XII) decided on WMO policy and practice for the international exchange of meteorological and related data and products, and conditions on their use.

At its Twelfth Session, the Commission for Basic Systems (CBS) recognized that although the exchange of information

exists in some regions, there was still room for improvement and expansion, especially with respect to warnings. In many areas cross-border exchange is non-existent. The Commission recommended that bilateral and/or regional cooperation be encouraged and expanded according to local requirements and that guidelines to initiate or enhance bilateral agreements on the exchange of warnings be prepared.

In response to the Commission's recommendation, these Guidelines on Cross-border Exchange of Warnings have been prepared as a deliverable by the PWS Expert Team on Warnings and Forecast Exchange, Understanding and Use, to provide guidance to Members on the implementation of cross-border warnings exchange.

Chapter 2 of this document discusses general principles regarding cross-border exchange of warnings and includes the role of the media in raising the public's expectations, focus on public safety, threshold criteria and the scope of cooperation. Chapter 3 provides examples from different parts of the world to illustrate the factors to be considered in developing a cross-border warnings exchange programme. Based on the general principles and experiences gleaned from the examples, Chapter 4 offers a number of observations and suggestions for consideration by Members who may wish to set up bilateral or regional arrangements for cross-border exchange of warnings.

Chapter 2

GENERAL PRINCIPLES

2.1 MEDIA AS A DRIVING FORCE

Meteorological impacts, sometimes affecting several countries, are often reported extensively by the media. These reports may even become available to a wide audience before the meteorological authority has issued any warnings or alerts. While being a potentially useful source of information, they raise the expectations of the general public for ever more timely warnings. In order to be able to respond to public expectation, the international meteorological community needs to use all data available to improve warnings and increase the lead-time at which they are issued. Improvements to warning services can be made by sharing information and warnings among NMHSs because this helps to widen the pool of information and the consideration of alternative forecast scenarios, leading to increased confidence in the final products.

2.2 FOCUS ON PUBLIC SAFETY

Over the last decades, for the primary objective of enhancing public safety, a well-tested mechanism has evolved to coordinate, harmonize and disseminate meteorological information concerning international waters and for major hazards affecting large coastal areas, such as tropical cyclones. Similarly, there exist well-established procedures for the exchange of aeronautical information. However, as regards the much larger land-based communities which either share a common terrestrial border or are separated by narrow stretches of water, and which are potentially affected by the same synoptic features, there is little in place in the form of formal agreements and procedures. Every day, NMHSs issue a range of public forecasts and warnings as required, be it on national or local scales, which are of interest to the media, the general public or professional meteorologists in a neighbouring country (or countries). Clearly, there is no particular need that every piece of such information should be circulated and eventually published by the adjacent NMHS. However, one example of successful exchange of information to meet the requirements of the public and the media is the WMO web-based project making forecasts and climatological information for major cities around the world available. In view of wider public access to international media and due to the increasing importance of harmonizing warnings across borders to avoid public confusion, the necessity of addressing the exchange of warnings among neighbouring countries has become clearer in recent years. These guidelines aim to provide some of the basic

considerations for establishing and maintaining successful exchange programmes.

2.3 FLEXIBLE THRESHOLD CRITERIA

The subject of threshold criteria to determine which warnings are of international significance will be considered later in these guidelines. But the basic principle remains that each hazardous phenomenon should be considered individually to determine if it is of a type likely to cross boundaries or if it is likely to generate an international response. The overriding consideration for exchange of warnings should be based on how significantly a meteorological event might impact more than one country in terms of loss of life, damage and disruption rather than stipulating the same meteorological threshold criteria for all such events.

The diversity of infrastructure resilience and natural climatological variability means that precise thresholds should be determined by neighbouring countries embarking on an exchange programme. A list of suggested hazards is included in the present guidelines with examples of threshold criteria and warning lead times. However, it should be noted that these are not prescriptive but form a basis for discussion between cooperating NMHSs.

2.4 SCOPE OF COOPERATION

The scope of cooperation between neighbouring countries goes beyond setting up an exchange mechanism in respect of selected meteorological phenomena and agreed threshold criteria. Such exchanges of warnings should be viewed as a cooperative venture specified in terms of intended recipients (between NMHSs only, or available to the public also), timeliness, frequency, content, format and delivery. Of equal importance are formal supporting agreements, regular reviewing, de-briefing, training, and exchange visits of operational personnel.

Cross-border exchanges of warnings should not be limited to relatively short-lived meteorological hazards. NMHSs are also encouraged to engage in dialogue for hazards of longer-time scale, such as hot, cold, wet or dry spells.

Even though an NMHS is regarded as the official authority for issuing warnings within its area of responsibility, the format of such information intended for cross-border exchange could be designed in such a way as to facilitate timely dissemination, understanding and response.

Chapter 3

EXAMPLES OF CROSS-BORDER EXCHANGE OF WARNINGS

To illustrate the essential aspects of cross-border exchanges, some examples of actual and planned exchange practices are given in this chapter. Such exchanges are normally confined to local warnings for reference or for harmonization purposes. The examples are by no means exhaustive, but allow a systematic approach to be developed for coordinating an effective exchange mechanism.

Examples of planning to use joint products for warning purposes by several European Members are also included. They provide a glimpse into a more user-oriented approach whereby the public will be provided with integrated warning products that span boundaries and borders of neighbouring countries. As a result, more effective mitigation actions could be taken by those at risk.

3.1 AUSTRIA

Table 1 shows examples of warnings issued by the Austrian Meteorological Service (ZAMG) for certain regions and exchanged with Hungary, Germany and Italy.

3.2 CHINA – THE PEARL RIVER ESTUARY

3.2.1 Background

Three WMO Members operate separately three meteorological services serving the communities at the head of and on both sides of the Pearl River estuary in southern China. They are the Hong Kong Observatory, Macao Meteorological and Geophysical Bureau and Guangzhou Central Meteorological Observatory.

3.2.2 Warnings in Hong Kong

To alert the public of Hong Kong to hazardous weather conditions and related phenomena, the Hong Kong Observatory

issues weather warnings. In particular, a local warning numbered signal system is activated whenever a tropical cyclone comes within about 800 km of Hong Kong. This tropical cyclone warning system utilizes ascending numbers to denote increasing threat posed by tropical cyclones. If the high wind condition is due to monsoon instead of tropical cyclone, a Strong Monsoon Signal is issued. In addition, a colour-coded rainstorm warning system is used to provide speedy and easy-to-remember alerts to the general public. The system is composed of three levels: Amber, Red and Black. Amber serves as an alert to heavy rain while Red and Black warn of major disruptions caused by heavy rain.

3.2.3 Warnings in Macao and Guangzhou

The Macao Meteorological and Geophysical Bureau and Guangzhou Central Meteorological Observatory operate similar warning systems for tropical cyclone, strong monsoon and rainstorm. Warnings issued by these centres are readily obtainable by the public via the internet and are often compared by the public with warnings issued by Hong Kong. Thus there is a need to maintain close liaison among the three neighbouring centres in warning operations especially in tricky situations.

3.2.4 Coordination and Consultation

Coordination and consultation among the centres were stepped up in 1996. The three meteorological services of Hong Kong, Guangzhou and Macao will inform one another via the GTS, supplemented by fax when warnings of tropical cyclone, strong monsoon or rainstorm are issued or cancelled. Sample messages are given in Figure 1. Warning criteria (which are the same as exchange criteria) for Hong Kong are listed in Table 2. Telephone consultation channels have also been set up for consultation on tropical cyclones operations, particularly on the assessment of the intensity category of tropical cyclones and the location and timing of the landfall of tropical cyclones nearby.

<i>Weather phenomenon</i>	<i>Criteria for issue</i>	<i>Media of dissemination</i>	<i>Exchange with other countries</i>
Flood warning	Rain > 30 mm during 72hrs, in the Austrian area of the River Danube	Fax	Hungary
Heavy thunderstorm with hail	Neighbouring area of Salzburg and Bavaria	Fax	Germany (DWD Munich)
Storm	Max wind >= 60km/h Neighbouring area of Salzburg and Bavaria	Fax	Germany (DWD Munich)
Heavy rainfall	Rain >= 30 mm	Telephone	Italy, South Tyrol

Table 1—Warnings at ZAMG

Weather Phenomenon	Criteria for issue	Media of dissemination
Rainstorm		GTS and FAX
Amber	Rainfall > 30 mm/h	
Red	Rainfall > 50 mm/h	
Black	Rainfall > 70 mm/h	
Tropical Cyclone		GTS and FAX
No. 1	A tropical cyclone centred within 800 km of Hong Kong and may later affect Hong Kong	
No. 3	Strong wind of 41–62 km/h	
No. 8	Gale or storm force wind of 63–117 km/h	
No. 9	Gale or storm force wind increasing	
No. 10	Hurricane force wind with 118 km/h	
Strong Monsoon	Winds > 40 km/h	GTS and FAX

Table 2—Warnings from Hong Kong for exchange with Guangzhou and Macao

Sample 1 (message issued by Hong Kong)	Sample 2 (message issued by Guangzhou)	Sample 3 (message issued by Macao)
WOHK84 VHHH 070200 HONG KONG RAIN-STORM RED WARNING WAS ISSUED AT 070200UTC	WOCI80 BCGZ 162140 BCGZ TROPICAL CYCLONE SIGNAL NO. 3 WAS CANCELLED IN GUANGZHOU HARBOUR AT 162130UTC	WTMU40 VMMC 160230 THE GALE SIGNAL NO.8 NW WILL BE REPLACED BY THE STORM SIGNAL NO.9 AT 160300UTC

Figure 1—Sample GTS messages on weather warnings issued by meteorological centres at Hong Kong, Macao and Guangzhou

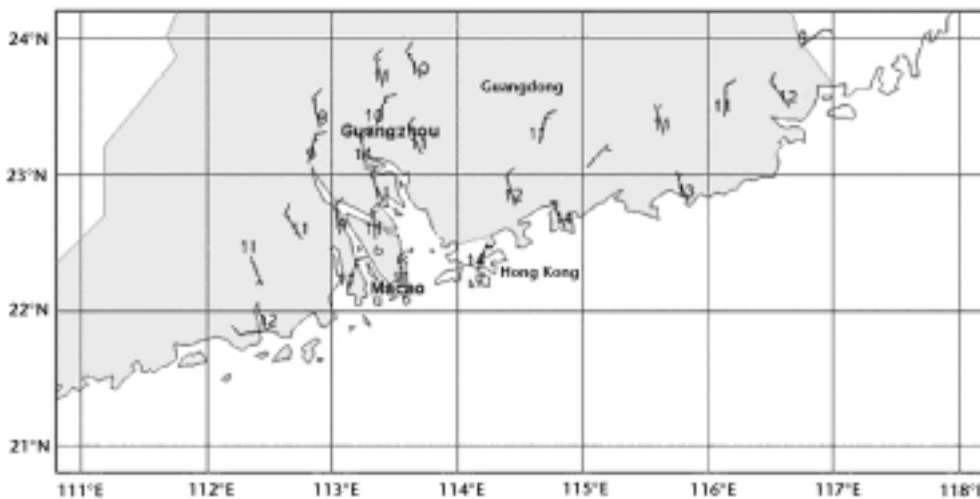


Figure 2(a)—Automatic weather station data for cross-border exchange around the Pearl River estuary



Figure 2(b)—Exchange of radar data among Guangdong Province, Macao and Hong Kong commenced in 2002. The shaded area denotes combined coverage of the weather radar.

3.2.5 Enhanced Data Exchange

To facilitate the operation of weather warning systems, arrangements are also in place for the real-time exchange of weather information among the three centres. Meteorological data including rainfall, wind and temperature recorded by automatic weather stations around Hong Kong, Macao and Guangzhou are exchanged in real-time via dedicated data lines. Figure 2(a) is a sample display. The three meteorological services started real-time exchange of radar images (PNG format) between themselves in 2002 via ISDN link or dedicated digital link using FTP. Products exchanged include both reflectivity and doppler velocity fields. Figure 2(b) shows the combined coverage of exchanged radar information in the vicinity of the Pearl River estuary. Such information contributes significantly to the smooth operation of weather forecast and weather warning systems for the region as a whole.

3.2.6 Annual Technical Conferences

Annual technical conferences are held at the three centres by rotation, where forecasters review major weather events of the past year and relevant research and development work conducted in support of forecast operations. A meeting of senior management to review the cooperative arrangements usually follows such conferences.

3.3 NORDIC COUNTRIES

The NHMSs of Finland, Iceland, Sweden and Norway have a plan to harmonize their warnings for common geographical areas and international undertakings, such as NAVTEX. As an initial step, the plan concentrated on wind warnings at sea and ice accretion on ships with a target date of autumn 2002 for deciding on common warning criteria. The area of interest is the Baltic, North Sea, parts of the northern Atlantic and the Barents Sea. Part of the process will be to make probability-based warnings of the Swedish Meteorological and Hydrological Institute (SMHI) available on the internet. The percentage probability of critical exceedance of wind speed criteria over a 6-hour period is shown in Figure 3.

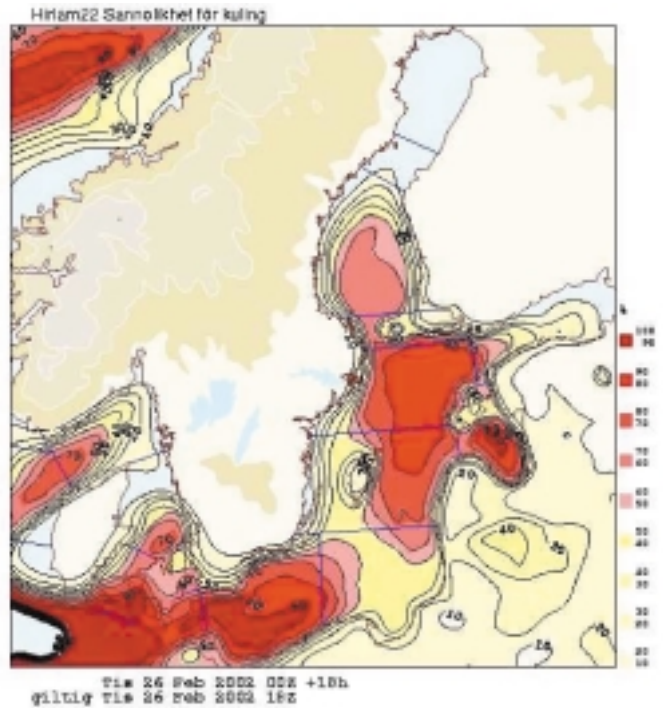


Figure 3—An example from SMHI on the percentage probability of exceeding wind speed criteria over a 6-hour period

3.4 CROSS-BORDER EXCHANGES BETWEEN GERMANY, FRANCE AND THE CZECH REPUBLIC

Bilateral agreements exist between the four regional offices of the NMHSs of France, Germany and the Czech Republic to exchange certain warnings. The exchange takes place via fax

or e-mail using standardised procedures and forms shown in Figures 4(a) and 4(b).

Expansion of bilateral exchanges of weather warnings using a similar mechanism among RAVI Members was endorsed in 2002. A pilot project will be carried out to test and develop procedures for the coordination of the


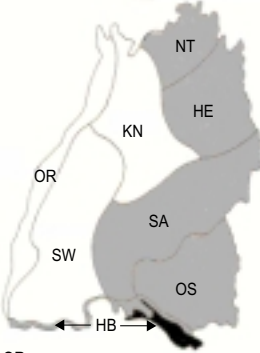
Warnformular 11/11/2003 Deutscher Wetterdienst - Regionalzentrale Stuttgart Unwetterwarnung für Baden-Württemberg / BRAM pour Ba-Wu Regionale Wetterwarnung / Alerte regionale météorologique Fax pour MétéoFrance Direction Interrégionale Nord-Est 0033388678484 - URGENT!		Absender/Expéditeur: Deutscher Wetterdienst Regionalzentrale Stuttgart Plieninger Straße 70 D-70794 Filderstadt Fon: +49 (0)711 9552-110 Fax: +49 (0)711 9552-141	
Ausgegeben am Datum - Zeit (Ortszeit) . Date-Heure de rédaction (heure locale) . Gültigkeitszeitraum (Datum - Ortszeit) . Période de validité (date - heure locale) .		Betroffene Regionen markiert Localisation des régions concernées Baden-Württemberg	
Art der regionalen Wetterwarnung Nature d'Alerte regionale	Unwetterwarnung für Baden-Württemberg Nature du tempête pour Bade-Wurtemberg		
<input type="checkbox"/> Sturmböen ≥ 34 kn (63 km/h) Rafales de vent ≥ 34 kn (63 km/h)	<input type="checkbox"/> Schwere Sturmböen ≥ 56 kn (103 km/h) Fortes rafales de vent ≥ 56 kn (103 km/h)	OR Oberrhein / Rhin supérieur (100-300m) HB Hochrhein, Bodensee (300-700m) Rhin amont, Lac de Constance	
<input type="checkbox"/> Gewitter / Orage : örtlich – verbreitet – örtlich mit Hagel isolé – généralisé – isolé avec grêle	<input type="checkbox"/> Schwergewitter mit / Orage fortes avec Sturmböen ≥ 56 kn, Hagel u. Starkregen rafales ≥ 56 kn, grêle et fortes précipit.	SW Schwarzwald / Forêt Noire (300-1500m) KN Kraichgau/Neckartal (100-600m) SA Schwäbische Alb (500-1000m)	
<input type="checkbox"/> Glätte / Glissance : örtlich gefrierender Regen – Schneeglätte isolé pluie verglaçante – neige au sol	<input type="checkbox"/> Verbreitet Glatteis durch gefrier. Regen Glissance extreme par pluie verglaçante généralisé	NT Neckar-Tauber-Ebene (150-550m) HE Hohenloher Ebene (200-550m) OS Oberschwaben (450-1000m)	
<input type="checkbox"/> Schneefall / Précip. Neigeuses : Intens. _____	<input type="checkbox"/> Schneefall / Précip. Neig. ≥ 15 cm/12h Intens. _____		
<input type="checkbox"/> Starkregen / Fortes précipit. ≥ 25mm/24h Intens. _____	<input type="checkbox"/> Dauerregen / Fortes précipit. ≥ 20mm/12h Intens. _____		
Erscheinung ankreuzen und quantifizieren oder Unzutreffendes streichen! - Cocher la case correspondante et, soit préciser la valeur prévue soit rayer les mentions inutiles!			

Figure 4(a)—The bilingual form used between the French and the German regional offices for exchange of severe weather warnings.

Český hydrometeorologický ústav Řečtinská středoevropská observatoř Plzeň Dostřova ulička 14, 30114 Plzeň, Česká republika		Tel. 00420 19 7337580 Fax: 00420 19 7237444 E-mail: meteo.stp@chmi.cz
Upozornění na nebezpečné jevy Wetterwarnung	Výstraha na extrémní jevy Unwetterwarnung	Jihozápadní Čechy Südwestlich Böhmen
Úřad pro DWD Mníchov Zu versenden an DWD München Datum a čas vyjádření (datum a čas) Ausgegeben am Datum und Zeit (Ortszeit) Období platnosti (datum a čas) Gültigkeitsbereich (Datum und Zeit)	Fax: 0049 89 25928 141 (E-mail: cz.metwchmi@dwd.de)	
<input type="checkbox"/> Nárazy větru ≥ 17 m/s Sturmstößen ≥ 34 km/h	<input type="checkbox"/> Nárazy větru ≥ 28 m/s Sturmstößen ≥ 56 km/h	
<input type="checkbox"/> Bouřky / Orvěvy křehké - řízné - křehké a bouřkové intenzivně - intenzivně na Hněpí	<input type="checkbox"/> Silné bouřky / Schwergewitter intenzivně a 28 m/s ležící s těžkým deštěm Sturmstößen ≥ 36 km/h (Hněpí - Střelce)	
<input type="checkbox"/> Náledě / Oláze křehké - řízné - křehké a silně intenzivně intenzivně přísné - Regen/Schneeglätte	<input type="checkbox"/> Ledovka / Vereisung / Oláze přísná a nebezpečná - intenzivně intenzivně přísné Regen	
<input type="checkbox"/> Sněhová / Schneefall intenzivně intenzivně	<input type="checkbox"/> Sněhová / Schneefall ≥ 25 cm / 12 h intenzivně intenzivně	
<input type="checkbox"/> Trvalý déšť / Dauerregen ≥ 25 mm / 12 h	<input type="checkbox"/> Silný déšť / Starkregen ≥ 25 mm / 6 h	
Označí kritičnost a povahu jevu, popř. referenci ke listině Einheitsmäßig und/oder durch Angabe von Unwettereffekten ausdrücken		<input type="checkbox"/> 1 - Fiederswald, Fichtengebiet <input type="checkbox"/> 2 - Karlovarsko <input type="checkbox"/> 3 - Oberpfälzer Wald <input type="checkbox"/> 4 - Český les <input type="checkbox"/> 5 - Bayerischer Wald <input type="checkbox"/> 6 - Šumava 3001200 m 3001200 m

Figure 4(b)—The bilingual form used between the German and Czech regional offices for exchange of severe weather warnings

warning activities of Members. Simple procedures, similar to the above, would be set up for bilateral exchanges between neighbouring countries taking into consideration different warning parameters and language barriers.

3.5 THE EUROPEAN MULTI-PURPOSE AWARENESS (EMMA) PROGRAMME

3.5.1 Background

Western European countries are relatively small in comparison with typical synoptic meteorological phenomena. Many important weather events like windstorms, heavy rains, coastal surges or cold spells can affect large geographical areas containing several countries simultaneously or within a very short timescale. Major recent examples are the devastating storms of 26–27th December 1999 (“Martin” and “Lothar”) which affected large parts of France, Germany and Austria. A year later heavy rain over the Alps impacted on Italy and Switzerland. In August 2002 a slow moving depression brought heavy rainfall to the UK and many parts of Europe causing widespread though sporadic flooding.

Gales may simultaneously affect several countries around the English Channel, the North Sea, the Baltic including Ireland, Great Britain, France, Belgium, the Netherlands, Germany and the Scandinavian countries.

Likewise when avalanche conditions prevail in the Alps, the threat will usually extend to several neighbouring countries. For this reason, a common scale for warnings was fine-tuned a few years ago. A corresponding education programme was also undertaken with the winter sport stations.

Considering the above, it is reasonable that the need for not only exchanging warnings of severe weather events but also for harmonizing them, has been a long standing goal for the management of many Western European NMHSs.

3.5.2 The EMMA Programme

The recent EUMETNET¹ EMMA programme illustrates essential aspects in a methodology to achieve the goal. The EMMA programme is based on the concept of meteorological awareness and its general objective is to develop a graphical information system accessible by the general public, the European forecasters and concerned authorities, for the provision of information on the potential meteorological danger over the next 24 hours. The system should complement the existing national warning systems by providing a simple and efficient way of making users aware of possible meteorological risks. It also allows an efficient method of exchanging meteorological information related to high impact weather events. The main characteristics of the system involve :

- (i) Colour coded regions related to the meteorological awareness level for the severe weather phenomena covered by the system;
- (ii) A core of severe weather phenomena to be addressed across Europe and to be displayed through a homogeneous set of pictograms, to be augmented, as necessary, by some “national” phenomena;
- (iii) Interactive access to further levels of information such as risk qualification for the identified phenomena to develop awareness;
- (iv) Flexible updating procedures taking into account individual NMHS modus operandi, geographical areas and time zones;
- (v) Implementation of the system using internet technologies.

The organization of the awareness chart production at participants’ level is built upon and complementary to existing national warning procedures. The awareness level colour code definition within EMMA is:

¹ EUMETNET is the networking organization of a number of NMHSs in Regional Association VI. It is close to the memberships of EUMETSAT and of the European Centre for Medium Range Weather Forecasts (ECMWF). But for those latter organizations, members are not NMHSs but states.



Figure 5—The Météo-France meteorological vigilance map – an illustration of graphic product available on the internet

Vigilance levels on the French vigilance chart

Green	No special vigilance required.
Yellow	Potentially dangerous and unusual meteorological phenomena have been forecast. Be very vigilant. Keep informed about meteorological conditions.
Orange	Be very vigilant; dangerous meteorological phenomena are forecast; keep informed about meteorological evolution and follow advice from authorities.
Red	An absolute vigilance is necessary; dangerous and exceptionally intense meteorological phenomena are forecast; keep regularly informed about meteorological developments and conform to the advice or orders given by authorities.

Awareness levels in EMMA

Green	No special awareness required
Yellow	Potentially dangerous, but not unusual, phenomena have been forecast. Be attentive if practising activities exposed to meteorological risks and be informed about meteorological conditions.
Orange	Potentially dangerous and unusual meteorological phenomena have been forecast. Be very vigilant. Keep informed about meteorological conditions.
Red	Dangerous and exceptionally intense meteorological phenomena have been forecast. Be extremely vigilant. Keep frequently informed about meteorological conditions.

The EMMA system is based on the “French Vigilance System” (Figure 5). It has a more generic formulation than the one used on the Météo-France vigilance chart with the intention of improving the message on the progressive response required with increasing awareness level, removing the French specific references to advice on behaviour by authorities and emphasizing awareness rather than vigilance.

3.5.3 Preconditions and Formal Arrangements

Strong cooperation has been demonstrated both at operational forecasting and senior management levels. The project history can be traced to the “Working Group of European Forecasters” in 2000 and to decisions taken by the EUMETNET Council.

The EUMETNET Council tasked a working group for assessing the requirements and the feasibility of an integrated graphical warning system. As a consequence, a workshop was organized in Toulouse in December 2001 and quickly converged on a proposal based on the “French Vigilance System”. After discussing the concept of “meteorological vigilance”, the workshop recommended that the integrated graphical warning system should complement the existing warning systems, by providing a simple and efficient way of making users aware of possible meteorological risks over the following 24 hours; and also allow an efficient method of exchanging meteorological information related to high impact weather events.

Météo-France took the initiative to organize a consortium, involving the Dutch KNMI, the UK Met Office, the German DWD and the French Civil Security Authority, which proposed the EMMA System in February 2002. Based on the recommendations of the December 2001 workshop and on the technical concepts of the EMMA proposed by the

consortium, the integrated graphical warning system described above was presented at the 15th meeting of the EUMETNET Council and was given approval to be pursued as a standard EUMETNET programme.

EMMA started in October 2002 for duration of 18 months. The main steps of the working plan are:

- Definition of the awareness presentation (T0 to T0+4 months);
- Organization of the awareness information production (T0+2 to T0+6 months);
- System implementation (T0+3 to T0+12 months);
- Demonstration, test and qualification (T0+11 to T0+17 months).

3.5.4 Presentation Levels within the EMMA System

Four levels of presentation are specified in the EMMA System.

3.5.4.1 *First Level (when entering the system, coloured maps, general information, main options)*

- Primarily a geographical map of Europe presenting all status colours (level of awareness) within participating countries, and also, if graphically feasible, for their regions, for a standard set of awareness situations selected from a base set nearly common to most participating countries. A thumbnail version (small image format) of this map will be used where necessary to refer to the map through hyperlinks.
Sub-map(s) of European regions with coloured countries and country-regions combined with pictograms as soon as a predefined national level of awareness is reached (optional in yellow, mandatory if orange or red). The pictograms present the awareness situation involved. Thumbnail versions of these maps will be used where necessary to refer to the map through hyperlinks.
- The user may choose a geographical map of Europe presenting all status colours (level of awareness) within participating countries, and also if graphically feasible for their regions, a user-defined combination of awareness situations (including those of an additional set of awareness situations less commonly covered within the participating countries).
Sub-map(s) of European regions with coloured countries and country-regions combined with pictograms as soon as a predefined national level of awareness is reached (optional in yellow, mandatory if orange or red). The pictograms present the awareness situation involved.
- Legend on colours (green, yellow, orange, red and white)
- Legend on pictograms
- General information on the EMMA System to be reached by an INFO-button:
 - General information on the EMMA System definition and content, such as remarks on the differences between the national criteria (criteria definitions are to be kept on national NMHS servers), strategy for update and validity of time horizon of maps.
 - Participating countries

- Option for black and white maps
- Option for access to the awareness information given under the form of a text table
- Printing functionalities including the choice of PDF coloured or black and white for maps and sub-maps

3.5.4.2 *Second Level (additional awareness information, critical parameters, critical time periods)*

Graphical presentation at a glance of essential awareness information, in addition to the awareness levels, together with potential impact information:

- A qualitative graphical presentation of some key critical “parameters”. Value(s) given for the critical parameter(s) (such as wind maximum mean or gust speed during the event for a wind awareness situation) specify or illustrate the potential or forecasted intensity of the weather situations for which the awareness level has been issued.
- A “critical time period” displayed as a time axis, to specify the typical period of time during which the potential or forecasted danger is the highest and justifies the awareness level for the related weather situation.
- In addition to this graphical presentation a photo image, related to each situation and critical awareness level will be presented in the background of the graph (eventually replaced by a background colour as a national option). These photo images intend to qualify the potential danger related to the specific awareness situation and to make the general public more conscious or aware of it. The use of these images to illustrate the potential danger is optional and by choice from any NMHS (see also section 3.5.5.7).

3.5.4.3 *Third Level (national documentation and information maintained on national web servers)*

National information: documentation on the national specificities for EMMA and warnings, real time information and links to or presentation of warning text files, and systematic information or access to other products if desired.

This information, which is specific to any country will be made available through the EMMA presentation system but maintained on the national servers under the responsibility of each NMHS (to prevent the need for a centralized coordination of updates on national specificities). When accessing this information the user will be linked towards the corresponding “EMMA-page(s)” on the NMHS-server(s). General specifications of content and presentation for these pages have been prepared within the EMMA programme.

3.5.4.4 *Fourth Level (password protected information for civil security authorities)*

If appropriate and needed, content and presentation of a set of password protected information for authorities will be specified in the scope of the programme and made available

on the NMHS-server(s) as part of the “EMMA-pages” related to national specificities.

The provision of this optional civil security authorities information will be solely the responsibility of the NMHS. The central EMMA System will not monitor this.

3.5.5 Detailed Presentation Specifications in EMMA

3.5.5.1 Colour Status Defining the Levels of Awareness

EMMA uses the colour status code, green-yellow-orange-red, for the identification of the level of awareness associated to countries, regions and situations, given in section 3.5.2.

A description of the consequences to be envisaged by rescue and emergency services will be provided in guidance documents on the production of the awareness information.

Each NMHS is free in assigning a colour status to awareness situations affecting its regions. Each participating country is strongly advised to develop its own decisional criteria and processes, describing in an objective way how colours will be assigned. The colour assignment shall however be consistent in the national context with the warning situations.

3.5.5.2 Regionalizing the National Map

Each participating NMHS will be allowed to divide its country into regions, for instance departments or provinces, to which awareness levels will be individually assigned. This regionalization will remain unchanged on a day to day basis and will be used for any of the weather situations covered by an awareness level.

It will be investigated during the implementation phase whether a user interface for defining the regions will be made available to each NMHS or if this definition will have to be imported at first when configuring the system.

3.5.5.3 Weather Situations Covered by Awareness Levels in EMMA

The standard set of awareness situations is :

- Wind (mean wind speed or wind gusts, or any combination)
- Rain (heavy rainfall in intensity or in cumulated amount or any combination)
- Snow/Ice (heavy snowfall, drifting snow and icing phenomena on the ground resulting from precipitation)
- Thunderstorms

The additional set of awareness situations is :

- Fog
- Temperature extremes (heat or cold waves)
- Coastal events (such as storm surge)
- Forest Fire (risk of forest fire related to meteorological conditions)
- Avalanches

The extensive number of situations that will be covered within the system does not imply that it is mandatory for each country to address all of them. Each country is free to define the situations it will address within EMMA.

Each NMHS is advised to give additional and specific national EMMA information on its own website. The EMMA user will be linked to these corresponding national web page(s) called the EMMA third level.

3.5.5.4 Symbols/Pictograms Commonly Accepted to Represent Awareness Situations

Within the first level of the system, on the (sub) map covering one country or one of its regions together with the awareness level colour, a pictogram will be displayed as soon as a predefined awareness level is reached (yellow optional, mandatory if orange or red). This pictogram will represent in a very clear way the awareness situation that is at stake and is designed to be easily recognizable by the general public.

The system should be able to present at least two pictograms at one time for each country or region on the coloured sub-map, presenting the situations associated with the highest level(s) of awareness within that country or region. Pictograms for each situation parameter and derived parameters will be developed by KNMI using also design information from Météo-France. A straightforward legend on the meaning of the pictograms will be added next to the coloured maps.

If it is graphically feasible to combine the presentation of the coloured map covering the whole of Europe, showing countries and their regions, together with the pictograms, this solution is preferred to the one described above in which separate European sub-map(s) are produced to enable or facilitate this simultaneous visualization of coloured regions and pictograms.

If awareness levels for some user requested standard or additional awareness situations are not produced routinely or if the available information does not comply with the updating time or frequency for which a commitment has been made, countries or regions may be coloured white, meaning information is not available or suspicious.

3.5.5.5 Validity of the Awareness Information within EMMA

A time horizon of 24 hours is foreseen within this EUMET-NET programme as the standard time horizon. Within the frame of allowance of this programme, investigations will be made to prolong the 24 hours time horizon up to 36 hours.

3.5.5.6 Publication of New Charts, Update Frequency of the Awareness Information, Amendments

The issuing frequency on the EMMA-server of new awareness charts covering new shifted validity periods is twice per 24 hours at fixed times, for instance at 06 UTC and 12 UTC, with a new forecast horizon until 18 UTC next day (meaning

at 06 UTC a new chart covering from 06 to 18 next day, at 12 UTC a new chart covering from 12 to 18 next day).

The NMHS will be responsible to renew or update the awareness information sent to the EMMA system at least once per 24 hours at fixed time(s), for instance at or before 06 or 12 UTC. In addition to those fixed time updates, the EMMA-system will also enable amendments of the awareness information at any time.

As soon as a country does not meet the minimum level of update that is required or if the validity horizon that is related to the graphical information within the second level of the system has expired, this country or its region(s) will be coloured “white” on the coloured map in the first level of the system, meaning suspicious information status.

It is recommended that a computer monitoring device will be developed to check the consistency of the awareness information and alert on discrepancies or omissions. This monitoring unit would send out e-mail notifications to the NMHSs concerned.

3.5.5.7 Second Level of the EMMA System

- This will provide the user with additional critical awareness information. Being a European system it is hardly possible to use text file bulletin information for this purpose.
- A graphical way of presenting all the additional awareness information will be used. Using graphs and symbols it will be clear at a glance which awareness situation is at stake, what is the critical time period and with which intensity it is expected to strike.
- To make the production of this information not too complicated for participating NMHSs, the use of a qualitative graphical presentation of critical “parameters” is suggested. Explaining or specifying the potential danger with a class-table for the intensity and a time axis to define the critical period of danger for the critical parameter is used to illustrate or qualify the event. It should be possible to make the parameters available in different units (km/hr and kts or m/s, mm/hr or inches/hr) in the intensity class table.
- In addition to this graphical presentation, an optional monochrome photo image, related to each parameter will be presented in the background of the graph. These photo images will illustrate the potential danger related to the specific awareness situation. For instance for “wind” a photo with fallen trees. The image on the photographs will be rather neutral to avoid panic. The images will present recognizable European situations so that they will be applicable for all participating countries. By presenting this additional information on the potential impact together with the graphical information on the critical parameters intensities, the general public will be made aware of the potential danger of the situation.

A participating NMHS may exclude potential impact of events in their presentation using the input user interface “Graphical presentation without impact presentation”.

Design of graphs and photos to meet the quality required for operational presentation will be worked out (by KNMI)

at a later stage during the overall project. However additional funding will probably be needed for designing these graphs and photos.

3.5.5.8 Third Level: National Specific Information

In fact the third level within EMMA is a linkage to the website of the NMHS on EMMA pages publishing specific national information such as:

- Supported awareness situations covered within EMMA (national definition, warnings that are related to)
- Thresholds or other criteria that trigger awareness levels
- Updating strategy
- Explanation of national warning systems (optional) such as:
 - Targeted users/dissemination system
 - Timeframe/time horizon in/for which different warnings are issued
 - Updating strategy
 - Link to institutional server (such as: www.knmi.nl)
 - Link to the last warning issued (www.knmi.nl/warnings/warning_text.html)
 - Link to national warning pages (www.knmi.nl/warnings)
 - Link to the password protected area for authorities (optional)
 - Any other relevant information to be identified

It is the responsibility of each NMHS to create and maintain their national information that is related to EMMA. This information is highly desirable due to its importance for the general public in defining what should be expected from the national awareness information within EMMA.

3.5.5.9 User Input Interface Specifications

General requirements :

- Countries have to designate focal points for their national input on standard and additional awareness situations and their regions to the EMMA System.
- Responsibility of focal points is of national concern only (focal points might be regional centres responsible for all situations and regions, or centres with specific national or regional responsibilities for some of the situations).
- Responsibilities may overlap at least to enable back-up procedures but organization of the input production to EMMA is of national responsibility only.

General technical specifications :

- Input to EMMA System is proposed to be in a kind of XML format to be specified.
- Inputs will be generated through the post-processing of warnings or awareness information delivered at national level and/or through web interfaces on the central EMMA web server or on the national web servers.
- To be recommended: web interfaces on web servers mirrored by each EMMA focal point, back-up interface provided on the EMMA presentation system and on mirrored web sites.

Maintenance:

- A service in charge of maintenance of the central EMMA system will have to distribute the interfaces source codes to national points of contact to be designated and the EMMA presentation system source code to points of contact of the centres mirroring the EMMA presentation system.
- Services in charge of running EMMA presentation systems will be responsible for upgrading it in due course and ensuring that the system is running properly.
- NMHSs running input interfaces will be responsible for upgrading them in due course and ensuring that they are running properly.
- NMHSs will be responsible for the maintenance of the software processing the national information to be sent by or through focal points.

3.5.5.10 Archiving

An archive that will enable NMHSs to access past awareness charts will be developed. The archive function will only be accessible for NMHSs.

3.5.5.11 Colour-blindness

The EMMA System shall also be well and easily understood by colour-blind people. As the colours that have been adopted (green-yellow-orange-red) are difficult to recognize for the colour-blind, black and white shaded versions of the awareness maps will be made available as an option, according to the geographical definitions in section 3.5.4, with different shadings to present the awareness levels that have been activated.

3.5.6 Assessment of Future Needs

The reference “French Vigilance System” was designed to improve on previous warning communications with authorities and the public. Notification time to the public of potential dangers had been reduced and improvement made in the perception of warnings. This was partly inspired from the experience gained through the procedures established with tropical cyclones-exposed countries and avalanche-prone areas. When discussing the new integrated European warning system, the participating NMHSs did recognize that an objective of combining this system with advice on behaviour and prevention information from the responsible authorities could be very useful.

Nevertheless, it was thought to be too early to set such an objective on a European scale. The development of the project is, therefore, proposed as a modular one with the first step only based on meteorological information issued by NMHSs. Further iterations will be needed to set up cooperative arrangements with the civil protection authorities in charge of public safety and/or the media.

The output presentation and dissemination are potentially compatible with the general public needs. But the proposed staged structure of the content, exchange and production methods will reflect the different audiences in participating countries.

3.6 COORDINATION OF TROPICAL CYCLONE WARNINGS BETWEEN AUSTRALIA AND OTHER METEOROLOGICAL CENTRES

The Australian Bureau of Meteorology operates a major forecasting office in the capital city of each Australian state, called a “Regional Forecast Centre” (RFC). There are seven RFCs in all. Australia also has three Tropical Cyclone Warning Centres (TCWCs) – located in Brisbane, Darwin and Perth. Darwin doubles up as a Regional Specialized Meteorological Centre (RSMC) with responsibility in tropical cyclone warnings.

There are established procedures for coordination between Australian forecast/warning centres and meteorological services in neighbouring regions, including the RSMCs in Nadi, Wellington and La Réunion.

3.6.1 Coordination with Meteorological Services in the Neighbouring Regions

The Tropical Cyclone Operational Plan for the South Pacific and Southeast Indian Ocean (WMO/TD No.292) which has been developed by the Tropical Cyclone Committee for the South Pacific and Southeast Indian Ocean sets out the responsibilities of and the relationships between the TCWCs and other meteorological authorities in the south Pacific and southeast Asia. The requirements of this plan are observed by Australian TCWCs. Australian TCWCs coordinate operationally with the following overseas meteorological services:

- (a) Isle de la Réunion, Mauritius, Indonesia and USA (Honolulu JTWC) – with the Perth TCWC;
- (b) Indonesia, USA (Honolulu JTWC), and Papua New Guinea – with the Darwin TCWC;
- (c) Papua New Guinea, USA (Honolulu JTWC), Solomon Islands, Fiji, New Caledonia and New Zealand – with the Brisbane TCWC.

International coordination arrangements are made by the Severe Weather Warning Services Programme Office (in the bureau’s head office in Melbourne) to determine appropriate communications channels and agreed schedules for information exchange. Details are then incorporated in local regional Tropical Cyclone Warning Directives.

Warning messages originated by overseas meteorological services are repeated without alteration by TCWCs and RFCs in the gale/storm/hurricane warning services for shipping provided through Australian coastal radio stations, but messages are prefixed with the name of the originating meteorological service.

3.6.2 Coordination with Honolulu Joint Typhoon Warning Centre (JTWC) and UK Meteorological Office (UKMO)

Arrangements have been made for all Australian TCWCs to provide the Central Forecast Office of UKMO, Honolulu JTWC with cyclone location, Dvorak intensity analysis, extended period track predictions, etc. In return, JTWC provides similar information from their own data sources

for cyclones that may affect the Australian area while UKMO provides numerical predictions of cyclone movement based on their global model.

Brisbane and Perth TCWCs provide the Darwin RSMC with appropriate information which is then coordinated into a bulletin and sent to Honolulu and UKMO.

For cyclones within radar range, Australian TCWCs send three-hourly radar reports directly to JTWC using the WMO RADOB code Part A (tropical cyclone). The formats of information bulletins and the RADOB code with appropriate message addresses are contained in regional Tropical Cyclone Warning Directives.

3.6.3 Coordination with New Zealand

Coordination procedures have been agreed between Australia and New Zealand for the Tasman Sea. Warnings are exchanged between the two meteorological services and major discrepancies are resolved by the telephone between the Melbourne RFC and the New Zealand Meteorological Service in Wellington.

3.6.4 Coordination with Port Moresby TCWC

The Brisbane TCWC maintains a continuous cyclone surveillance over the Papua New Guinea (PNG) Region. When a cyclone or developing cyclone threatens the PNG region, discussions are initiated with Port Moresby TCWC. Subsequent assistance is provided as required.

Port Moresby, Brisbane and Darwin TCWCs also exchange gale/storm/hurricane warnings for tropical cyclones in their respective areas of responsibility.

3.6.5 Services for the Solomon Islands

The Solomon Islands straddles the 160°E longitude border between the areas of warning responsibility of the Brisbane and Nadi TCWCs. To ensure consistency in the formatting of warnings for land areas in the Solomon Islands,

Brisbane issues all Special Advisory Messages (which are used by Solomon Islands authorities as the basis for public warnings), regardless of the position of the tropical cyclone concerned. Close liaison is maintained and all warnings are exchanged between Brisbane and Nadi TCWCs whenever cyclones are in this area and agreement is reached on position of the cyclone and other characteristics to be used in warnings.

In event of failure or partial failure of Brisbane TCWC, Nadi TCWC will take over full responsibility for Special Advisory Messages for the Solomon Islands.

3.6.6 Coordination with Indonesia

The Darwin TCWC/RSMC alerts the Jakarta meteorological office whenever a tropical cyclone within the Northern Region is expected to affect Indonesia and issues warnings to shipping (with copies to Jakarta) for the duration of the cyclone. Full details are included in the local directive.

3.6.7 Warnings near Boundaries

Whenever a tropical cyclone is within five degrees of the boundary of an area of responsibility, the other tropical cyclone warning centre sharing that boundary, receives all the gale, storm and hurricane warnings for that tropical cyclone which are issued by the tropical cyclone warning centre with prime responsibility for the area.

3.6.8 Communication in Regional Association V (RAV)

In RAV, warnings are routinely distributed via the AFTN/GTS telecommunication links. Forecasts are also distributed where a requirement exists. Most RSMCs and TCWCs have external web sites where current forecasts and warnings can be readily accessed. RSMC/TCWC forecasters often converse by telephone to develop warning strategy where a weather feature (e.g. a tropical cyclone) is close to a common border – which is generally maritime in RAV.

Chapter 4

CONSIDERATIONS IN BILATERAL OR REGIONAL EXCHANGE

Based on the general principles in Chapter 2 of these guidelines and utilizing the essential elements in the examples in Chapter 3, the following areas are highlighted for consideration in setting up bilateral or regional arrangements for cross-border exchange of warnings.

4.1 COORDINATION: BILATERAL AND/OR REGIONAL REQUIREMENTS

NMHSs may set up bilateral and/or regional coordination arrangements according to circumstances. Some severe weather phenomena tend to be localized and of short duration and would not necessitate regional coordination. But if the countries are geographically small, it may be necessary to consider regional coordination with respect to localized and short duration hazardous weather phenomena too. On the other hand, a mid-latitude large-scale phenomenon, or tropical cyclone, can easily have a widespread disastrous effect and would necessitate multilateral coordination.

Depending on geographical and climatological considerations, an NMHS can be partner to more than one regional group. It may be desirable for each regional association to designate a centre, for example a RSMC with geographical specialization, to monitor the coordination and exchange of warnings for the region and publish the relevant information from time to time.

The value of such an exchange procedure is to inform neighbours of:

- Perceived threats
- Forecast onset of severe weather
- Observed development of severe weather

When considering proposed exchanges, NMHSs should decide whether the warnings exchanged are purely for the sake of harmonization and coordination between themselves or are also to be disseminated from them to public authorities, media and general public. In the former case, the participating NMHSs would remain the sole authority for issuing warnings and additional information for their own areas of responsibility. In the latter case, the nature of the sectors receiving the information would strongly influence the form and content of the messages and would depend on special supporting arrangements involving the NMHS partners.

Unless mutually agreed otherwise, the exchange of warnings should in general be restricted to the cooperating NMHSs. Onward transmission and dissemination is the responsibility of each NMHS within its own area of responsibility, subject to the detailed conditions regarding the exchange arrangements.

4.2 HAZARD TYPES

Severe weather is defined as a weather condition, which can cause significant disruption to a country's infrastructure or

pose a threat to life. The selection of high impact weather phenomena to be exchanged in bilateral warnings should be made in terms of the general areal and temporal characteristics. If hazardous phenomena are of a local nature and of short duration, they may be of less interest for incorporation into bilateral or regional warnings. The phenomena, which can be subject to exchange, include among others:

- Extreme temperatures
- Heat waves/cold spells
- Heavy rain
- Snow/blizzard
- Severe thunderstorms (including hail, lightning, tornadoes, strong wind and flash floods)
- Wide spread sandstorm
- Conditions conducive to forest/veldt fires
- Gale force wind
- Storm surge and coastal events
- Drought
- Freezing rain
- Fog
- Avalanches
- Flooding

Consideration for exchange of information should not only be given to hazards in the relatively short term and immediate risks, but also to longer-term impacts and hazards such as prolonged hot, cold or dry spells.

4.3 TYPES OF INFORMATION FOR EXCHANGE

4.3.1 Observations and Reports

Exchange of synoptic and hourly weather observations on the GTS is routine as is the relay of several other forms of observational data (e.g. buoy reports, radiosondes, aircraft and ship reports). At the same time, a significant amount of observational information (e.g. from spotter networks, radars, automatic weather station data, wind profiler data and even regional numerical model products etc), and damage reports used in national severe weather programmes are not transmitted on the GTS because of limited communication bandwidth. It would often be helpful to the severe weather warning programmes of neighbouring countries to have access to this enhanced information through bilateral arrangements.

4.3.2 Guidance

Major centres routinely issue guidance on the expected evolution of weather systems. This guidance is often exchanged internationally (e.g. hurricane and tropical cyclone advisories). Similar guidance could be generated for other types of hazardous weather which might be of assistance to NMHSs in assessing threats to their territory.

4.3.3 Forecasts

A wide range of regularly scheduled forecasts is routinely available on the GTS. A number of NMHSs also prepare specialized products for domestic use which identify areas at risk from hazardous weather (e.g. charts outlining areas with high potential for severe convective weather). A well-coordinated system for exchange of such specialized forecasts between adjacent countries is desirable.

4.3.4 Warnings

Weather warnings are intended to alert the public in dramatic or attention-grabbing fashion and are usually issued in plain language. In some regions they are sent directly to neighbouring countries as issued and this can be an effective means of information exchange, where language differences do not pose a problem. Communication among neighbouring countries enables consistent warnings about the hazards be issued to the public and concerned organizations.

The efficient exchange of warnings of severe phenomena with the potential for cross-border impacts must clearly be a high priority component of any well-coordinated system for multi-national disaster preparedness and response.

4.4 HAZARD THRESHOLDS

The thresholds for the issue of weather warnings vary from one country and one region to another, usually for reasons of climatology and vulnerability. Thresholds and intensities for which these phenomena are considered potentially harmful should be decided by mutual agreement between the NMHSs concerned, in accordance with the warning purposes and criteria of each country.

Considering the various climatic conditions in the world, it may be possible and useful to develop regional standards as far as thresholds are concerned. Chapter 5 of the second edition of the WMO *Guide to Public Weather Services Practices* (WMO No. 834) gives many useful examples of criteria used by different countries. Table 3, which is taken from the Guide, shows the

<i>Phenomenon</i>	<i>Advisories</i>	<i>Watches</i>	<i>Warning</i>
Heavy rainfall			50mm in 24 hours
Freezing rain	Likely to cause general inconvenience		4 hours' duration
Freezing drizzle	Likely to cause general inconvenience		7 hours' duration
Heavy snowfall	Likely to cause general inconvenience		15 cm in 12 hours
Wind			Mean wind 65 km/h or gusts to 90 km/h
Blizzard			Temperature -3°C or less and visibility 1 km or less and wind of 40 km/h or more and duration 3 hours or more
Wind chill			2000 watts/sq metre
Frost			Grass minimum temperature $\leq 0^{\circ}\text{C}$; growing season only
Severe thunderstorm		Severe thunderstorm possible/probable	Thunderstorm with gusts >90 km/h; hail >15 mm diameter; rain >25 mm/h
Tornado		Tornado possible	Tornado observed or expected
Cold wave			Temperature fall within 24 hours from near normal to minimum $<-30^{\circ}\text{C}$ and maximum $<-20^{\circ}\text{C}$
Winter storm	Supervisors' discretion		When two or more criteria met for warning of rain, snow, freezing rain, blizzard, wind, cold wave, snow squall
Snow squall	Likely to cause general inconvenience		10 cm /6 hours or less
Dust storm	Visibility <1 km		Visibility near zero
Blowing snow	Sufficient to affect safety or cause concern		
Thick or extensive fog	Visibility <1 km		
High humidex	When humidex forecast >40 for 3 or more days		
Waterspout	Waterspouts reported/expected over Great Lakes		
Funnel cloud	Cold air funnel or funnel clouds expected but not a tornado		

Table 3—Representative criteria and thresholds used for warning products issued by the Canadian Atmospheric

thresholds used by the Canadian Atmospheric Environment Service for the issue of weather advisories, weather watches and warning. The Guide also demonstrates the wide variations in threshold levels for the same criteria. For example a strong wind warning may be triggered by 8 ms⁻¹ in Switzerland and 31 ms⁻¹ in the UK. Conversely 15mm of rain in 3 hours will require a warning of heavy rain in the UK but in Bulgaria same warning will be issued for 30 mm over 6 hours.

For each phenomenon, in addition to the threshold criteria, lead-time and update intervals along with acknowledgement procedures should also be established. It will also have to be decided if messages are to be exchanged only at the start and end of a risk period or at regular intervals throughout the duration of an event. All messages should be acknowledged and all messages must be cancelled when the danger has passed or no longer thought to exist. The mechanism becomes simpler and more reliable if there is a routine exchange of information including nil events.

It is practically impossible to specify warning lead-times for all events because they each have different scales of evolution in time and space. It is useful, however, to develop warning procedures that consist of initial alerts that a threat may exist. At this stage a threat may have a low probability of occurrence (say 20 per cent) but a high impact if it occurs. The purpose is to alert emergency authorities that a risk exists so that they can be put on a heightened state of awareness – even if this is just to monitor the situation more closely. A higher confidence rating (say 60 per cent) may put them into a ‘stand-by’ mode.

These initial alerts should be followed by regular updates as the timing, scale and intensity can be more accurately observed and forecast. In practice the most effective mitigating actions are usually taken from 3 to 6 hours before an event. Within the limits of current forecasting capabilities, realistic objectives for forecasting the onset of a severe weather event would be:

- 3 days for initial alerts for large-scale events
- 3 hours for details on intensity, duration and location

Table 4 shows a list of severe weather phenomena, criteria for issuing warnings and their target lead time.

4.5 MEANS OF EXCHANGE

Communication methods for the exchange of warning information may include:

- Global telecommunication system (GTS)
- Telephone

- Facsimile
- Voice mail
- Computer direct dialling
- Internet
- E-mail
- Satellite system

The essence of any warning is to give timely notice that a risk exists. It therefore follows that mechanisms for exchange of information must be as fast and reliable as possible. To achieve effectiveness and consistency, the system should be designed around the most reliable technology mutually available. Although the GTS and the internet potentially offer fast solutions, in many cases it is still advisable to consider the use of telephone and fax facilities – for sending initial messages and for direct consultation.

Longer lead-time situations can rely on communication forms such as the GTS and the internet. Reliable e-mail communication channels may also be used.

In using web sites for posting warnings automatically for exchange purpose, care should be taken to display clearing/cancellation messages at the end of the weather event. It is essential that the site has only the latest information.

In some countries greater use is being made of VSAT by national air traffic control organizations. This may be an avenue to explore for the transmission of high impact weather warnings. But the high cost of this method may inhibit its use.

Irrespective of the form of communication, acknowledgement of receipt of the message must be incorporated into the system. It is also advisable to use more than one communication medium so that the message will still be received in the event of the failure of one of the communication methods.

4.6 LANGUAGE, TERMINOLOGY, FORMAT AND CONTENT

The exchange of information in plain and simple language, or in graphic form, is preferable to that in coded messages. The language and vocabulary used must be appropriate for the country or region.

For regional exchange, the warning may be written in the language of origin and where applicable in a language, which is common to all the countries in the region. Under certain circumstances, it may be appropriate to issue the message in a third language.

Table 4—A suggested list of severe weather phenomena and some threshold criteria already in use

PHENOMENA	CRITERIA	TARGET LEAD-TIME (HRS)
Strong winds	Mean speed 20 ms ⁻¹	24
Heavy rain	25mm < 6hours	3
Heavy or drifting snow	150mm in 24 hrs	6
Severe thunderstorms	Gusts > 40 ms ⁻¹ Hail >15 mm diameter. Rain >25mm h ⁻¹	3
Rapid snowmelt	15 mm in 24hrs	12
Storm surge	1m but vary dependent on local conditions	12

Terminology should be appropriate to the country or region. The use of technical terms is best avoided. Clear, concise and simple text is most effective in conveying the desired meaning, thereby minimizing potential confusion. Ambiguity and vagueness must be avoided. Location references used must refer to well-known places.

It is advisable to reach consensus to use a standard format for exchange of warnings by NMHSs in a bilateral or regional agreement. This is to ensure that all the necessary information is conveyed to other NMHSs and to eliminate confusion. An example of such a format is given below in Table 5.

4.7 REVIEW

Maximum benefit and success of any programme of cooperation in exchange of warnings will be realized if there are regular reviews of the process and if all operational staff is adequately trained. Reviews of the process should be held at least once per year and it is highly recommended that they also take place after a significant event. Through these review meetings, shortcomings and training needs could be identified and steps could be taken to rectify them.

The review should also include the continual assessment of the following:

- User requirements;
- Means to meet those requirements;

- Ensuring that the users know how to make best use of the products and services provided by the NMHSs, and
- Assessing the accuracy and usefulness of those products and services.

The purpose of such assessment is to ensure that the exchange of warnings does serve its intended function. It will also provide the motivation to maintain continued improvement of the arrangements.

4.8 TRAINING

Joint training sessions, including workshops and drills, should be arranged for severe weather forecasters from neighbouring countries in order to familiarize them with practices and procedures in the region. This can be very beneficial for creating confidence and facilitating cross-border communication among forecasters. It is recommended that the training include topics such as:

- Interpretation and use of processed products;
- Use of conceptual models;
- The development, coordination and implementation of special indices for warnings of severe weather;
- Incorporation of local severe weather research results into operational practices;
- Improved communication skills;
- Familiarity with practices and procedures of neighbouring NMHSs.

ORIGINATOR:	
WARNING SERIAL NUMBER:	
DATE/TIME OF ISSUE (UTC):	
CONTENTS:	
TYPE OF HAZARD:	
FORECAST ELEMENTS:	
EXPECTED TIME OF ONSET:	
EXPECTED DURATION:	
AFFECTED AREA:	
MOVEMENT:	
EXPECTED IMPACT	
RECOMMENDED ACTION:	
NEXT BULLETIN:	

Table 5—An example of a standard format for exchange of warnings by NMHSs in a bilateral or regional agreement

Chapter 5

SUMMARY STRUCTURE FOR THE SETTING UP OF CROSS-BORDER EXCHANGE OF WARNINGS

