INTERNATIONAL AIRWAYS VOLCANO WATCH OPERATIONS GROUP
(IAVWOPSG)

FIFTH MEETING

Lima, Peru, 15 to 19 March 2010

Agenda Item 7: Matters related to the assessment of the need to provide information on solar radiation storms and other bio-hazards

WORLD METEOROLOGICAL ORGANIZATION (WMO) REGIONAL SPECIALIZED METEOROLOGICAL CENTERS (RSMC) FOR ENVIRONMENTAL EMERGENCY RESPONSE

(Presented by Canada and the United States)

SUMMARY
This paper provides background information on the WMO Regional Specialized Meteorological Centers’ history, operational practices and products. The RSMCs provide radiological information, upon request, to the International Atomic Energy Agency (IAEA) and to one contact point in the National Meteorological Service of each State. The relevancy and potential use of this information to Meteorological Watch Offices in writing a radioactive cloud SIGMET is discussed in a Working Paper submitted to this Meeting.

1. INTRODUCTION

1.1 Given in Annex 3 that (a) the World Meteorological Organization (WMO) Regional Specialized Meteorological Centers (RSMC) for Environmental Emergency Response provide radiological information to a single contact point in the National Meteorological Service in each State and (b) that SIGMET for radioactive cloud (RDOACT CLD) are required, we provide background information on the history, operational practice and products of the RSMC.

1.2 The WMO RSMC web site
(http://www.wmo.int/pages/prog/www/DPFSERA/EmergencyResp.html) states that:

(1 pages)
1.2.1 “WMO's Emergency Response Activities (ERA) programme involves the application of specialized atmospheric dispersion-modelling techniques to track and predict the spread of airborne hazardous substances in the event of an environmental emergency. This kind of specialized application depends directly on the operational infrastructure of the numerical weather prediction systems that are implemented and maintained at many of the global, regional or national meteorological centres within WMO's World Weather Watch system.”

1.2.2 “The ERA programme was established to assist National Meteorological and Hydrological Services, their respective national agencies and relevant international organizations to respond effectively to environmental emergencies involving large-scale dispersion of air-borne hazardous substances. “

1.2.3 “Following the Chernobyl nuclear power plant accident in 1986, the programme has focused its operational arrangements and support on nuclear facility accidents. In addition, where possible, the programme has also included emergency response to the dispersion of smoke from large fires, ash and other emissions from volcanic eruptions, and chemical releases from industrial accidents.”

1.2.4 “WMO has implemented and maintains a system of eight Regional Specialized Meteorological Centres (RSMCs) which are prepared at all times to provide highly specialized computer-based simulations that predict the long-range movement of air-borne radioactivity. These specialized centres, providing complete global coverage 24 hours a day, every day, are located in National Meteorological Centres at: Beijing (China), Exeter (United Kingdom), Melbourne (Australia), Montréal (Canada), Obninsk (Russian Federation), Tokyo (Japan), Toulouse (France), and Washington (USA).” [Note that the Exeter, Montréal, Toulouse, and Washington RSMC are co-located with VAAC.]

1.2.5 “The system also includes a telecommunication gateway at Offenbach (Germany) to provide notification and real-time information linkage between the Incident and Emergency Centre of the International Atomic Energy Agency (IAEA) and WMO. When requested, the centres will provide the specialized products within three hours to National Meteorological Centres and the IAEA.”

1.2.6 “WMO is expanding the scope and capabilities of its ERA programme to include non-nuclear environmental emergencies - the area of chemical incidents and emergencies is one under exploration and development.”

2. RSMC HISTORY

2.1 As a result of the poor communications between countries following the Chernobyl accident in the Spring of 1986, the World Meteorological Organization (WMO) was requested by the International Atomic Energy Agency (IAEA) and other international organizations to arrange for early warning messages about nuclear accidents to be transmitted over the Global Tele-communications System (GTS). In addition some WMO member countries lacking extensive forecasting capability requested that specialized pollutant transport and dispersion forecasts be provided during these emergencies.

2.2 In 1989, Regional Specialized Meteorological Centers at Toulouse, France, Bracknell, United Kingdom, and Montréal, Canada, were set up under interim arrangements between the WMO and the IAEA. Since then the Bracknell offices have moved to Exeter, U.K. and the five other RSMC given in Section 1.2.4 were established.
3. **RSMC PRACTICES**


3.1.1 “In the framework of the Convention on Early Notification of a Nuclear Accident, the International Atomic Energy Agency (IAEA) informs the WMO Secretariat and RTH Offenbach (Germany) of the status of the emergency. [As needed,] RTH Offenbach will disseminate the [notification] messages on the GTS [as a text message with WMO header] WNXX01 IAEA for global distribution.”

3.1.2 RSMCs provide products only when either the delegated authority of any country in the RSMC region of responsibility or the IAEA requests RSMC support.

3.1.3 Backup services are mutually provided by the multiple RSMC in each area of responsibility.

3.1.4 Global coverage is provided by having more than one RSMC jointly respond in their area of responsibility: WMO Regional Association (RA) I (Africa) and VI (Europe): RSMC Exeter and Toulouse; RA II (Asia): RSMC Obninsk and Tokyo; RA III (South America) and IV (North America, Central America, and the Caribbean): RSMC Montréal and Washington; and RA V (South-West Pacific): RSMC Melbourne, and, until another RSMC is created in RA V, RSMC Montréal and Washington.

![Figure 1. WMO Regions. Source: http://www.wmo.int/pages/members/](http://www.wmo.int/pages/members/)

3.2 The following are from Section 4 of WMO/TD-No. 778 (ftp://ftp.wmo.int/Documents/PublicWeb/www/era/Section4.pdf). Section 4 is included here as Appendix 2.

3.2.1 RSMC use a joint response approach. “A joint response means that the two collaborating RSMCs shall immediately inform each other of any request received; initially both should produce and send the standard set of products (charts) independently and then move rapidly towards providing fully coordinated response and services for the duration of the response. Following the initial response, the RSMCs shall develop and provide, and update as required, a “joint statement” to describe a synopsis of
the current and forecast meteorological conditions over the area of concern, and the results from the transport models, their differences and similarities and how they apply to the event.”

3.2.2 The following defaults are used when the source term parameters are unknown: “(a) uniform vertical distribution up to 500 m above the ground, (b) uniform emission rate during six hours, (c) Starting date/time: … [is the start date/time of the request], (d) total pollutant release is 1 Bq (Becquerel) over 6 hours, (e) Type of radionuclide Cs [Cesium] 137.”

4. **RSMC PRODUCTS**

4.1 The basic set of products are the following five maps: three-dimensional trajectories starting at 500, 1500 and 3000 m above the ground; time-integrated airborne concentration exposure in Bq-s m$^{-3}$ within the layer 500 m above the ground for each of the three successive 24-h forecast periods; and total deposition (wet + dry) in Bq m$^{-2}$ from the release time to the end of the dispersion model forecast (usually 72 hours).

4.2 Products are officially issued by telefax, but are also available on password-protected web sites such as from http://www.arl.noaa.gov/rsmcprod.php and http://eer.cmc.ec.gc.ca/mandats/rsmc/A-rsmc.html. Examples from the web are given in Appendix 3.

4.3 An example joint statement is given in Appendix 4.

4.4 More information on the products is given in Appendix 2 (Section 4 of WMP/TD-No. 778).

5. **MORE INFORMATION**

5.1 Information on RSMC models and specific outputs is available here: [http://www.wmo.int/pages/prog/www/DPS/WMOTDNO778/Annex4.html](http://www.wmo.int/pages/prog/www/DPS/WMOTDNO778/Annex4.html)


6. **ACTION BY THE MEETING**

6.1 The meeting is invited to note the information presented in this paper.

(Appendix I-3 to the Manual on the GDPFS (Supplement 11, 2007))

REGIONAL AND GLOBAL ARRANGEMENTS FOR THE PROVISION OF TRANSPORT MODEL PRODUCTS FOR ENVIRONMENTAL EMERGENCY RESPONSE

SUPPORT FOR NUCLEAR ENVIRONMENTAL EMERGENCY RESPONSE

NOTIFICATION OF WMO

In the framework of the Convention on Early Notification of a Nuclear Accident, the International Atomic Energy Agency (IAEA) informs the WMO Secretariat and RTH Offenbach (Germany) of the status of the emergency. If needed, the IAEA will request support from the WMO RSMCs. Beginning with a site area emergency, RTH Offenbach will disseminate the EMERCON messages on the GTS in the form of an alphanumeric bulletin in plain-text English language under the abbreviated heading WNXX01 IAEA for global distribution to the NMCs/RSMCs (see also the WMO Manual on the Global Telecommunication System, WMO-No. 386).

When the IAEA no longer requires WMO RSMC support, the IAEA will send an EMERCON termination message to the RSMCs, the WMO Secretariat and RTH Offenbach. RTH Offenbach will disseminate the EMERCON termination message on the GTS in the form of an alphanumeric bulletin in plain-text English language under the abbreviated heading WNXX01 IAEA for global distribution to the NMCs/RSMCs.

REGIONAL ARRANGEMENTS

The RSMCs designated by WMO for the provision of atmospheric transport model products for nuclear environmental emergency response shall:

1. Provide products only when either the delegated authority1 of any country in the RSMC region of responsibility or the IAEA requests RSMC support. Upon receipt of a request from the delegated authority2 or from the IAEA, the RSMC shall provide basic information to the National Meteorological Service of that country or to the IAEA, respectively. If multiple requests are received, highest priority will be given to IAEA requests.

2. Upon receipt of a first request for products related to a nuclear incident and in the absence of a prior notification by the IAEA, inform the WMO Secretariat, all designated RSMCs and the IAEA of the request.

3. For an IAEA request sent to the RSMCs to produce and distribute products, the requested RSMCs will distribute the basic products to the IAEA, and all RSMCs will distribute to the National Meteorological...
Services in the region and WMO. For a request for support from a Delegated Authority and without notification by the IAEA, basic information provided to the National Meteorological Service of the requesting country will not be disclosed to the public in that country nor distributed by RSMCs to other National Meteorological Services.

1. The person authorised by the Permanent Representative of the country to request RSMC support.

2. The RSMC products will be provided to the NMS Operational Contact Point designated by the Permanent Representative.

3. The basic information will normally be provided by the NMS to the IAEA national contact point.

4. Provide, on request, support and advice to the IAEA and WMO Secretariats in the preparation of public and media statements.

5. Determine the standard set of basic products and the method of delivery in consultation with users and the IAEA.

6. Provide product interpretation guidelines to users.

7. Provide support and technology transfer to national and regional meteorological centres that want to become designated RSMCs.

8. Make arrangements to provide backup services. These would normally be between the two designated centres in a region. Interim arrangements should be made by centres in regions with a single designated RSMC.

GLOBAL ARRANGEMENTS

Until such time as new RSMCs have been designated, it is proposed that Regional Association VI-designated RSMCs be responsible to provide services for radiological emergencies to Regional Association I; Regional Association IV-designated RSMCs be responsible to provide services to Regional Association III; while the Regional Association V-designated RSMC, in collaboration with Regional Association IV-designated RSMCs, will be responsible to provide services to Regional Association V.

In cases of radiological emergencies where coordination is required between RSMCs of different regions, the RSMCs of the region where the emergency has occurred will provide this coordination.

SUPPORT FOR NON-NUCLEAR ENVIRONMENTAL EMERGENCY RESPONSE

If support is required for response to a non-nuclear environmental emergency, related to atmospheric transport of pollutants the Permanent Representative with WMO of the affected country may direct its request for support to the operational contact point of the designated RSMC(s) for its Regional Association.

1. Due to the potentially broad range of environmental emergencies, the RSMC shall consider each request with regard to its capabilities and the suitability of its products to address the emergency requirements and will then respond accordingly.

2. The RSMC shall inform all other designated RSMCs and the WMO Secretariat of the request and the agreed actions.
APPENDIX 2

(Appendix II-7 to the Manual on the GDPFS, Supplement 11 (2007))

USERS INTERPRETATION GUIDE FOR ATMOSPHERIC TRANSPORT MODEL PRODUCTS PROVIDED BY RSMCs

Standards in the Provision of International Services by RSMCs for Nuclear Environmental Emergency Response

4.1 The Delegated Authority requests support from WMO Regional Specialized Meteorological Centres (RSMC) for atmospheric transport modelling products by using the form entitled “Environmental Emergency Response — Request for WMO RSMC Support by Delegated Authority”. The Delegated Authority then sends the completed form immediately to the RSMCs as per the regional and global arrangements and ensures receipt of the form by phone. This will initiate a joint response from the RSMCs in their region of responsibility.

The International Atomic Energy Agency (IAEA) requests support from WMO RSMCs for atmospheric transport modelling products by using the form agreed between WMO and IAEA. The IAEA then sends the completed form immediately, by fax and by e-mail (preferred), to the RSMCs as per the regional and global arrangements and ensures receipt of the form by phone. The lead RSMCs shall confirm receipt of the IAEA request by fax or e-mail (preferred) to IAEA. This will initiate a joint response from the RSMCs in their region of responsibility. The IAEA sends an information copy of its Request Form by fax or by e-mail (preferred) to RTH Offenbach. When the lead RSMCs’ products become available, the lead RSMCs shall send an announcement to the IAEA that their respective products are available and the products’ location (RSMC’s dedicated website), by fax or by e-mail (preferred).

The designated RSMCs shall implement agreed standard procedures and products by:
(a) The provision of the following standard set of basic products within two to three hours of reception of a request and according to the general rules for displaying results;
(b) The adoption of the following forecast periods for the numerical calculations;
(c) The adoption of a joint response approach;
(d) The adoption of the general rules for displaying results.

Default values to be used in response to a request for products for the unspecified source parameters

(a) Uniform vertical distribution up to 500 m above the ground;
(b) Uniform emission rate during six hours;
(c) Starting date/time: date/time specified at «START OF RELEASE» on request form or, if not available, then the «Date/Time of Request» specified at the top of the request form;

1 The adoption of default values is based on the understanding that some runs of the transport/dispersion models need to be carried out with default parameters because little or no information (except location) will be available to the RSMC at an early stage. RSMCs are, however, requested to conduct and propose subsequent model runs with more realistic parameters as they
become available (products based upon updated parameters will be provided on request only or confirmed from IAEA or a Delegated Authority). This may, for example, refer to a more precise assumption of the vertical distribution or the need to conduct a model run for the release of noble gases.

(d) Total pollutant release 1 Bq (Becquerel) over 6 hours;

(e) Type of radionuclide Cs 137.

Basic set of products

Five maps consisting of:

(a) Three-dimensional trajectories starting at 500, 1500 and 3000 m above the ground, with particle locations at 6h intervals (main synoptic hours up to the end of the dispersion model forecast);

(b) Time-integrated air borne concentrations in Bq.s m\(^{-3}\) within the layer 500 m above the ground, for each of the three forecast periods;

(c) Total deposition (wet + dry) in Bq m\(^{-2}\) from the release time to the end of the dispersion model forecast.

A joint statement that will be issued as soon as available.

Forecast periods for numerical calculations

The initial set of products will cover the period from \(T\), the start time of the release, through a forecast of 72 hours from \(t\), the start time of the current output from the operational NWP model. The first 24-hour period for integrated exposures in the dispersion model will start at the nearest synoptic time (0000 or 1200 UTC) prior to or equal to \(T\). Subsequent 24-hour integrations of the dispersion model will be made up to, but not exceeding, the synoptic time nearest to \(t+72\). If \(T\) is earlier than \(t\), the first response will use hindcasts to cover the period up to \(t\).

Joint response and joint statements

A joint response means that the two collaborating RSMCs shall immediately inform each other of any request received; initially both should produce and send the standard set of products (charts) independently and then move rapidly towards providing fully coordinated response and services for the duration of the response. Following the initial response, the RSMCs shall develop and provide, and update as required, a "joint statement" to describe a synopsis of the current and forecast meteorological conditions over the area of concern, and the results from the transport models, their differences and similarities and how they apply to the event.

4.2 General rules for displaying results

In order to make the interpretation of the maps easier, the producing centres should adopt the following guidelines:

General guidelines for all maps:
(a) Provide labelled latitude and longitude lines at 10° intervals and sufficient geographic map background (shore lines, country borders, etc.) to be able to locate precisely the trajectories and contours;

(b) Indicate the source location with a highly visible symbol (etc.);

(c) Indicate the source location in decimal degrees (latitude - N or S specified, longitude - E or W specified, plotting symbol used), date/time of release (UTC), and, the meteorological model initialization date/time (UTC);

(d) Each set of maps should be uniquely identified by at least product issue date and time (UTC). And issuing centre

(e) Previously transmitted products from the dispersion model need not be re-transmitted.

(f) Indicate with a legend if this is an exercise, requested services or an IAEA notified emergency

Specific guidelines for trajectories map:

(a) Distinguish each trajectory (500, 1500, 3000 m) with a symbol (etc.) at synoptic hours (UTC);

(b) Use solid lines (darker than map background lines) for each trajectory;

(c) Provide a time-height (m or hPa) diagramme, preferably directly below the trajectory map, to indicate vertical movement of trajectory parcels.

Specific guidelines for concentration and deposition maps:

(a) Adopt a maximum of four concentration/deposition contours corresponding to powers of 10;

(b) A legend should indicate that contours are identified as powers of 10 (i.e., \(-12 = 10^{-12}\)). If grey-shading is used between contours, the individual contours must be clearly distinguishable after facsimile transmission and a legend provided on the chart;

(c) Use solid dark lines (darker than map background lines) for each contour;

(d) Indicate the following input characteristics: (i) source assumption (height, duration, isotope, amount released); (ii) the units of time integrated concentration (Bq.s m\(^{-3}\)) or deposition (Bq m\(^{-2}\)). In addition, charts should specify: (i) "Time integrated surface to 500 m layer concentrations"; (ii) "Contour values may change from chart to chart"; and if the default source is used; (iii) "RESULTS BASED ON DEFAULT INITIAL VALUES";

(e) Indicate, if possible, the location of the maximum concentration/deposition with a symbol on the map and include a legend indicating the symbol used and maximum numerical value;

(f) Indicate the time integration starting and ending date/time (UTC). The RSMCs will normally provide the products in the ITU-T T4 format suitable for both group 3 facsimile machines and transmission on parts of the GTS. The RSMC may also make use of other appropriate technologies.
Guidance and explanations on models and specific products issued by each RSMC

4.3 Annex 4 presents information about the models and explanations on the specific products issued by each RSMC for the default release scenario.

4.4 A word of caution is needed about the interpretation of the model outputs. The default scenario is based on a hypothetical source as specified in paragraph 4.1 above. For an IAEA notified emergency, the source information may remain unknown. The users should bear these in mind when analyzing the outputs. Although the models are run from high quality NWP models, inherent uncertainties must be considered as a result of the default scenario conditions and the atmospheric conditions. The interpretation of the model outputs must be done with this in mind, given the fact that the source strength and duration are usually not known. The interpretation should be done with the help of an experienced meteorologist having a strong background in synoptic meteorology and also desirably with a background in atmospheric dispersion. For an IAEA notified emergency or when better estimates of the source are available, caution is advised as to the interpretation of the outputs. This being said, model outputs offer the best available guide in a first response situation to the question of long-range atmospheric dispersion and transport of radioactive clouds. Radiological observations should be used as soon as they become available to provide collaborative information with model outputs.
APPENDIX 3

Below and on the following pages are the cover page, a trajectory map, and 3 successive 24-h exposure maps and the 72-h deposition maps from RSMC Montréal (left) and Washington (right). These figures were available following the September 10, 2009, exercise both at https://www.ready.noaa.gov/rsmc-bin/jntrsmc.pl and http://eer.cmc.ec.gc.ca/eer-bin/jntrsmc.pl.
NOAA HYSPLIT MODEL
Deposition [Bq/m²] at ground level
Integrated from 1200 10 Sep to 1200 13 Sep 09 (UTC)
R31 Release started at 1200 10 Sep 09 (UTC)

<table>
<thead>
<tr>
<th>Source</th>
<th>50.150 N, 96.850 W</th>
</tr>
</thead>
<tbody>
<tr>
<td>0600 10 Sep 09 GFSG FORECAST INITIALIZATION</td>
<td></td>
</tr>
</tbody>
</table>

- Source: WHITEHILL, La Plata, MD 96.850 W
- Release: C=1.0
- E=1867
- S=0.0
- Rate: 0.0 hr Particles: 500
- Distribution: Uniform between 10 and 500 m AGL
- Dry Deposition Rate: 0.02 m/s
- Wet Removal (below/in-cloud): 1.0E-043
- Weather: 0800 UTC 10 Sep 2009 GFSG

Note: Continued model output may change
Note: HYSPLIT Results for CatalyticINITIAL VALUES

Response: EXC.01c, EXC.04c, EXC.07c
Example joint statement from an exercise.

**EXERCISE**
by RSMC MONTRÉAL (CA) and RSMC WASHINGTON (US)
on environmental emergency response for an incident at the
Whiteshell nuclear facility at 1200 UTC 10 September 2009

Issued: 1400 UTC 10 September 2009

________________________________________________________________________

**RADIOLOGICAL EVENT DETAILS**
Source: Whiteshell, Manitoba, Canada, nuclear facility
Location: 50.18 degrees North latitude, 96.06 degrees West longitude
I-131 Release date-time:
From: 1200 UTC 10 September 2009
To: unknown
Comments: Exercise

**METEOROLOGICAL DISCUSSION**

Surface weather:

High pressure over the NE U.S. will move little next few days while another high over BC moves east and merge with the eastern high by Sunday. Before the merger, weak low over southern SK with cold front trailing southward will move east to northeastern North Dakota by Friday morning then become stationary and more diffuse Saturday, dissipating by Sunday. Clockwise flow around the high will transport air from southern MB into eastern Canada. Showers and thunderstorms will accompany the low and cold front Thursday, weakening Friday.

Weather near 500 hPa:

An upper level trough over AB will move to the Dakotas by early Saturday then to Wyoming by Saturday. Another upper trough will develop over northern MB Thursday and move southeastward to QB by Sunday. Upper level ridging will develop in between. Average jet stream will flow from north-central Canada to James Bay region.

**METEOROLOGICAL FORECAST MODEL DETAILS**
US: GFS (Global Forecast System, 1 degree latitude grid spacing)
0600 UTC cycle, 3-h forecast intervals
CA: GEM (Global Environmental Multiscale Model, 33 km grid spacing)  
0000 UTC cycle, 3-h forecast intervals

DISPERSION MODEL PARAMETERS
US: HYSPLIT (includes dry and wet deposition)  
1.0 Bq I-131 over 6 hours, uniform between surface-500 m agl
CA: MLDP0 (includes dry and wet deposition)  
1.0 Bq I-131 over 6 hours, uniform between surface-500 m agl

TRAJECTORY AND DISPERSION RESULTS

Both models have the upper level trajectories showing transport to the east, while the lower level trajectories hover near the source for the first 24 hrs. Thereafter, the CA model shows further transport to the SSW into the north central U.S.

Concentration patterns are also similar between the two models for the first 48 hrs with transport to the SSW into the north central U.S., although the CA model shows slightly higher concentrations. Between 48 and 72 hrs more differences are found with the CA model showing higher concentrations (~2 orders of magnitude) over the U.S., whereas the US model has a maximum concentration to the north east of Whiteshell. The CA plume extends primarily to the SSW of the source covering the north central U.S., whereas the US model extends more to the WSW over south central Canada and Montana. Both models indicate an area of higher deposition to the NNE of Whiteshell with the US model ~2 orders of magnitude higher than the CA model. The CA model also shows an area of higher deposition over the Dakotas with a maximum of 1.9E-13 Bq/m2 over South Dakota.

Any model dispersion/deposition differences can be attributed to differences in the flow driving meteorological models and differences in the formulation of the dispersion models. Until updated meteorological data and sufficient radiological monitoring information become available, it is suggested that the higher comparative values of the time-integrated concentrations and total depositions presented above be considered.

Note: Trajectories represent material released from discrete levels. The limited number of trajectories displayed may be used to evaluate the general material flow beginning at each level, but should not be used to determine pollutant time-integrated concentration patterns or total deposition patterns, since these levels may not be representative of all interacting levels where pollutants are being transported, diffused, and deposited. The concentration/deposition model results and comparisons are a more appropriate guide for decision making.

— END —