RSMC Montréal Report of Activities for 2014

Executive Summary

Regional Specialized Meteorological Centre (RSMC) monthly tests comprised the primary activity during 2014. Hypothetical scenarios were run over Canada, the United States, Australia, Bulgaria, Slovakia, and Indonesia. Other activities included incremental updates and improvements to the response procedures, software, and to the joint RSMC secure web pages. The latter are the primary means of communicating transport model products to National Meteorological and Hydrological Services (NMHS), and between RSMCs. RSMC Montréal received requests - operational as well as planned - for inverse modelling support from the Provisional Technical Secretariat (PTS) of the Comprehensive Test Ban Treaty Organization (CTBTO) throughout 2014.

1. Introduction

The Canadian Meteorological Centre (Meteorological Service of Canada, Environment Canada) is designated by the World Meteorological Organisation (WMO) as the RSMC Montréal for the provision of atmospheric transport modelling (ATM) in case of an environmental emergency response. The primary regions of responsibility are WMO Regional Associations (RA) III & IV, which encompass Canada, United-States, Mexico, Central and South America. In addition to emergency response, RSMC Montréal contributes global inverse modelling support to the CTBTO verification system.

2. Operational Contact Information

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3. Responses and information on dissemination of products

i. Production of CTBTO meteorological bulletins

Work continues to transfer the production of bulletins containing meteorological data from CTBTO atmospheric monitoring stations from the Canadian Meteorological Centre (CMC) to Zentralanstalt für Meteorologie und Geodynamik (ZAMG) in Austria. These bulletins had been issued by CMC under header SNCN19 CWAO.

In order for these stations to be officially recognized internationally, the WMO requested each member-state that has CTBTO stations on its territory to assign WMO station identifiers. The transfer of production of bulletins thus requires each CTBTO station to first be assigned a WMO station identifier. Observations from those stations which have a WMO synoptic identifier are now transmitted by ZAMG under header ISAX30 LOWM in BUFR format.

iv. Dissemination of products

Transport model graphical products and joint statements are posted to secure joint web pages. When requested by the International Atomic Energy Agency (IAEA) these products are also faxed to relevant RSMCs and National Meteorological and Hydrological Services (NMHS). For examples of the graphical products, see Annex 4 of **WMO, 2014**. Throughout 2014, monitoring of RSMC mirror web pages continued in an effort to ensure that they remained congruent.

It is the practice at RSMC Montréal to transmit blank charts to all RSMC mirror websites at the start of each response, before transmitting the actual product charts once the response has begun.

In addition to the other RSMCs, the following countries' NMHSs are in our email and / or fax lists:
Antigua and Barbuda, Argentina, Bahamas, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, Guatemala, Guyana, Mexico, Netherlands Antilles and Aruba, Panama, Peru, Suriname, Trinidad and Tobago, Uruguay and Venezuela. Continual efforts are made to keep the contact list up-to-date.

v. Response to requests from CTBTO-PTS

There were a total of 14 requests from the PTS of the CTBTO in 2014, in every month except June. Many of these were related to detections in Japan, likely the result of continued emanations originating from the site of the 2011 Fukushima Daiichi Nuclear Power Plant accident.

vi. Other responses

RSMC Montréal participated in a special exercise on 3 September 2014 with the NMHS in Buenos Aires. This was the second such exercise to test procedures and product specifications for the WMO CBS Non-Nuclear Emergency Response Activities.

4. Routine operations

Monthly Test:
RSMCs Montréal, Washington and Melbourne hold a joint test on the second Thursday of every month. Following interest demonstrated by other RSMCs, the request to start the exercise is now emailed to all RSMCs. In addition, RSMC Montréal participated in quarterly tests initiated by the IAEA. The regular monthly test scheduled in May was cancelled due to IAEA having problems obtaining permission from the proposed hosting country. RSMC Montreal also ran simulations and posted results for a ConvEx-2d test, initiated by IAEA, on 25 November. The following table lists scheduled monthly and quarterly tests in 2014.

Month	Source location	Initiated by	RSMC providing joint statement
January	Davis-Bess NPP, OH, USA	Washington	Melbourne
February	Kecerovce, Slovakia	IAEA	RA I and IV RSMCs
March	Darlington NPP, Canada	Montréal	Washington
April	Lucas Heights, Australia	Melbourne	Melbourne
May	Test postponed	IAEA	-
June	Fort Calhoun NPP, NE, USA	Washington	Montréal
July	Point Lepreau, NB, Canada	Montréal	Washington
August	Fermi II NPP, MI, USA	IAEA	RA III RSMCs
September	Lucas Heights, Australia	Melbourne	Melbourne
October	Palo Verde, AZ, USA	Washington	Montréal
November	GA Siwabessy, Indonesia	IAEA	RA I and VI RSMCs
December	Point Lepreau, NB, Canada	Montréal	Washington

5. Lessons learned and significant operational or technical changes:

Upgrades to the software used to run the operational atmospheric transport and dispersion model (see section 4 of http://www.wmo.int/pages/prog/www/DPS/WMOTDNO778/Annex4.html) were implemented periodically during 2014.

6. Operational issues and challenges:

Faxing of products to NMHSs has been discontinued for monthly tests, as email has become the preferred method of communications and faxes exhibit a high failure rate. Faxes continue to be sent to RA III and IV NMHS upon request from the IAEA.

7. Other activities:

In response to Action 16 of WMO-CBS Nuclear ERA meeting of October 2013, RSMC Montreal worked to develop some examples of radioactive cloud simulations based upon realistic emissions of a major incident, to assist in the potential development aviation guidance for such incidents.

8. Summary and status of the operational atmospheric transport and dispersion models:

Current global weather conditions and forecasts are available at CMC at all times, to provide, in real time, the necessary input to the ATM, and for their evaluation and interpretation.

For forecasts, CMC operational uses the Canadian Global Environmental Multiscale (GEM) numerical weather prediction (NWP) model. Two configurations of GEM are available: regional and global. The latter, which has a uniform horizontal resolution (25 km) over the globe, is used to provide quality analyses, through the assimilation cycle, and medium term forecast guidance. The grid spacing of the regional configuration is approximately 10 km over North America. In July 2014 a new configuration of GEM, called the High Resolution Deterministic Prediction System, was implemented. This model has a resolution of 2.5 km and covers all but the northernmost areas of Canada.

i. The Modèle Lagrangien de Dispersion de Particules d'ordre zéro (MLDP0)

This is a Lagrangian particle dispersion model designed for long-range dispersion problems occurring at regional and global scales and is described in detail in D'Amours and Malo, 2004. Dispersion is simulated by calculating the trajectories of a large number of air particles (or parcels). Large scale transport is calculated as the displacement due to the NWP-resolved wind field, while discretized stochastic differential equations account for the unresolved turbulent motions. Turbulent vertical mixing is modelled with a random displacement equation based on a diffusion coefficient. Lateral (horizontal) turbulent diffusion is modelled according to a first order Langevin stochastic equation for the components of the horizontal wind that are not resolved by NWP.

MLDP0 is an off-line model and requires 3-D meteorological fields (wind, moisture, temperature and geopotential heights) from a NWP system. At RSMC Montréal these are obtained from the GEM model forecasts and analysis systems in either Global or Regional configuration.

Dry deposition is modeled using a deposition velocity. The deposition rate is calculated as a proportion of the tracer material carried by particles in a layer adjacent to the ground surface. Wet deposition will occur when a particle is presumed to be in a cloud. The tracer removal rate is proportional to the local cloud fraction.

The source term is controlled through an emission scenario module which allows different release rates of radionuclides over time. MLDP0 can be run for a large number of isotopes (Cs-137 by default) as well as for volcanic ash (D'Amours et al, 2010) or an inert gas tracer.

For volcanic eruptions, a particle size distribution can be used to model the gravitational settling effects in the trajectory calculations according to Stoke's law. The total released mass can be estimated from an empirical formula derived by Sparks *et al.*, 1997, which is a function of particle density, plume height and effective emission duration (Malo, 2007).

In MLDP0, tracer concentrations at a given time and location are calculated by averaging the residence time of the particles, during a given time period, within a given sampling volume, and weighting it according to the amount of material carried by the particles. Concentrations are expected to be estimated more accurately near the source with a Lagrangian model than with an Eulerian model.

MLDP0 operates on a polar stereographic grid and can run in both northern and southern hemispheres. The grid size and resolution define the geographical domain. More than 30 horizontal grids are now available, some of which are listed below:

- 50 km (687× 687), (477×477), (400×400) and (334×334)
- 33 km (722×722), (606×606), (505×505), (400×400) and (229×229)
- 15 km (503×503) and (251×251)
- 10 km (229×229)
- 5 km (457×457)
- 2 km (300×300)

A global configuration also exists at horizontal resolution of 1° (360×181). MLDP0 can be executed in backward (adjoint) mode. The model has been used extensively in this configuration in the context of the WMO-CTBTO cooperation. The vertical discretization is made for 25 levels in the SIGMA, ETA or HYBRID terrain following coordinates depending on the version of the GEM NWP model used.

ii. Trajectory model

This model uses winds directly from the GEM analyses and/or forecast model. The wind fields are available every hour in forecast mode and every 3 hours in diagnostic mode. Initial positions of one or more air parcels in a column are specified, and the parcels are then incrementally displaced, using time and spatial discriminations of the local three-dimensional wind field. It is assumed that air parcels preserve their identity as they are transported in the wind.

The model has been validated using back-trajectories from stations that measured concentrations of tracers from a single source (D'Amours 1998). The back-trajectories converge remarkably well towards the tracer source location. On the other hand, the lack of a boundary layer treatment and the assumption air parcel identity preservation are reflected in the results, which indicate vertical motions that are not in line with the observations.

9. Plans for 2015-2016:

- The schedule of routine monthly tests for all of 2015 has been set up in collaboration with RSMCs Washington and Melbourne. Each RSMC will select the simulated accident location and write the joint statement, on a rotating basis. Quarterly tests are also scheduled with the IAEA.
- Test and implement an upgraded version of the MLDP Lagrangian transport and dispersion model that will include zero-order, first-order, and backward-adjoint capabilties.
- Test and implement hourly meteorological fields in diagnostic and forecast modelling

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