RSMC Montréal Report of Activities for 2016

Executive Summary

Regional Specialized Meteorological Centre (RSMC) monthly tests comprised the primary activity during 2016. Different hypothetical scenarios were run over Canada, the United States, Australia, Japan, Mexico, and the Republic of South Africa. 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).

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 have 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 synoptic codes to identify the stations. The transfer of production of bulletins thus requires each CTBTO station to first be assigned a WMO synoptic 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, 2011**. Throughout 2016, 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. The charts of RSMC Montreal's own modelling products that are transmitted to the mirror websites during exercises are removed and archived 3 days after the end of each exercise.

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. Efforts are made to keep the contact list up-to-date.

v. Response to requests from CTBTO-PTS

There were 4 responses to requests from the PTS of the CTBTO in 2016: on 15 and 16 March, 3 October and 21 November.

vi. Other responses

RSMC Montreal participated in a special exercise for non-nuclear response together with NMHS Argentina on 6 and 7 January 2016. RSMC Montreal also participated in a special nuclear exercise with NMHS Argentina on 14 September 2016.

4. Routine operations

Monthly Test:

RSMCs Montréal, Washington and Melbourne hold a joint test on the second Thursday of every month. The request to start the exercise is emailed to all RSMCs. In addition, RSMC Montréal participated in quarterly tests initiated by the IAEA. The following table lists scheduled monthly and quarterly tests in 2016.

Month	**Source location**	**Initiated by**	**RSMC providing joint statement (Lead)**
January	Gentilly NPP, QC, Canada	Montréal	Washington
February	Koeberg NPP, Republic of South Africa	IAEA	(RA I and VI RSMCs)
March	Lucas Heights, Australia	Melbourne	Melbourne
April	Calvert Cliffs NPP, MD, USA	Washington	Montréal
May	Shika, Japan	IAEA	(RA II RSMC)
June	Bruce NPP, ON, Canada	Montréal	Washington
July	Lucas Heights, Australia	Melbourne	Melbourne
August	Laguna Verde, Mexico	IAEA	(RA III and RA IV)
September	Clinton NPP, IL, USA	Washington	Montréal
October	Darlington NPP, ON, Canada	Montréal	Washington
November	Lucas Heights, Australia	IAEA	RA V RSMCs (Melbourne)
December	Lucas Heights, Australia	Melbourne	Melbourne

5. Lessons learned and significant operational or technical changes:

In addition to the normal maintenance and software upgrades to the operational atmospheric transport and dispersion modelling system, a major migration of the hosting informatics system was started in 2016. However this has resulted in minimal disruptions.

6. Operational issues and challenges:

Faxing of products to NMHSs is not done for monthly tests, as faxes exhibit a high failure rate. Email has become the preferred method of communications, and faxes will only to be sent to RA III and IV NMHS upon request from the IAEA.

7. Other activities:

Testing continues with formatting of Time of Arrival charts in response to Action 18 of WMO-CBS Nuclear ERA meeting of October 2013. Some issues remain to be resolved in producing the charts in conformity with the proposed standard for the desired time intervals and colours with hatching.

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. Three configurations of GEM are available: global, regional, and high resolution. The global GEM has a uniform horizontal resolution (25 km) and is used to run the data assimilation cycle, providing analyses and medium term forecast guidance. The grid spacing of the regional configuration is approximately 10 km over North America. High resolution configurations of the GEM model operate at a resolution of 2.5 km and cover all but the northernmost areas of Canada.

i. The Modèle Lagrangien de Dispersion de Particules d'ordre n (MLDPn)

This is a Lagrangian particle dispersion model designed for dispersion problems occurring at regional and global scales and is described in detail in D'Amours and Malo, 2004, and D'Amours et al. 2015. The order "n" can be set to either 0 or 1 which controls the parametrization of vertical turbulent diffusion. 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. 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. Turbulent vertical mixing is modelled in order 0 mode with a random displacement equation based on a diffusion coefficient, while the order 1 treatment uses the Langevin equation also in the vertical.

MLDPn 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 forecast and analysis system in Global, Regional, or high resolution 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. MLDPn 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 Stokes' 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 MLDPn, 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.

MLDPn 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). MLDPn can be executed in time-backward mode. The model is used in this configuration in response to requests from the CTBTO-PTS. 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 or 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 discretizations 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 absence 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. Despite this, the back-trajectories converge remarkably well towards the tracer source location.

9. Plans for 2017-2018:

- The schedule of routine monthly tests for all of 2017 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. Tests are set for the third Tuesday of each month.

References

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