RSMC Washington report of activities for 2014

Executive Summary

RSMC Washington did not receive any requests for support for real events. Other RSMC-related activities for 2014 consisted of Region 3, 4, and 5 monthly tests, conducted for scenarios over Canada, the United States, and Australia, and four IAEA exercises with RSMC Washington and Montreal as Lead RSMCs in August. Response procedures, software, and joint RSMC secure common web pages and numerical models were improved. The joint web pages are used for communicating transport model products to National Meteorological and Hydrological Services (NMHS) and between RSMCs and IAEA.

1. Introduction

The National Oceanic and Atmospheric Administration's (NOAA) Air Resources Laboratory (ARL) together with NOAA's National Centers for Environmental Prediction (NCEP) are designated by the WMO as the Washington Regional Specialized Meteorological Centre (RSMC) for the provision of atmospheric transport model products 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.

2. Operational Contact Information

RSMC Washington
National Oceanic and Atmospheric Administration (NOAA)
National Weather Service
NCEP Center for Weather and Climate Prediction
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United States of America

Business contact: Mr Jeffery McQueen
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Operational contact (24 hours): Senior Duty Meteorologist
Tel : 1 301 683 1500
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Email : SDM@noaa.gov

3. Emergency operations

RSMC Washington did not respond to an emergency in 2014.

4. Routine operations

Monthly Test:

RSMCs Montréal, Washington, and Melbourne generally hold a joint exercise on the second Thursday of every month and invite other RSMCs to participate. In addition, RSMC Washington participated in four IAEA-initiated exercises during the year, one of which RSMC Montréal and RSMC Washington were designated as Lead RSMCs. Table 1 shows the breakdown of the details for the exercises in 2014.

Month	Source location
Jan 9	Davis-Besse, OH, USA
Feb 20	Kecerovce, Slovakia (IAEA request)
Apr 10	Lucas Heights, Australia
Jun 12	Fort Calhoun, NE, USA
Jul 10	Point Lepreau, MB, CA
Aug 21	Enrico Fermi, MI, USA (IAEA request)
Sep 11	Lucas Heights, Australia
Oct 9	Palo Verde, AZ, USA
Nov 20	Siwabessy, Indonesia (IAEA request)
Nov 25	Kozloduy, Bulgaria (IAEA request)
Dec 11	Point Lepreau, MB, CA

Table 1: RSMC Washington monthly tests for 2014

Once the model products are posted to the common web pages, an email is sent in both Spanish and English to those NMHS contact points with valid email addresses in WMO RA III and IV, the IAEA and WMO. The email contains login information to retrieve the RSMC products from the common web pages.

Common web pages:

RSMC Washington (ARL) continues to maintain and update, as needed, the common web page code. RSMC Washington is responsible for maintaining and distributing the web page code to all RSMCs and to make changes to the code based on lessons learned and RSMC technical meeting suggestions from other RSMCs. In 2014, RSMC Washington was able to post its results to the common web sites at all other RSMCs. In addition, most RSMCs regularly post their results to the RSMC Washington common web page for IAEA and Region III/IV exercises. The goal is for all RSMCs to post their products on all common web pages whenever possible.

Provision of atmospheric backtracking Modelling for CTBT Support:

The Department of State and NOAA entered into a Memorandum of Agreement for projects to make in-kind contributions to the CTBTO Preparatory Commission (PrepCom) on September 20, 2012 in accordance with the NOAA Backtracking Support to CTBTO Statement of Work of July 11, 2012. Therefore, NOAA, specifically, NWS/NCEP, agreed to become an operational center for CTBTO backtracking capabilities by utilizing the HYSPLIT dispersion model. The NWS Office of Science and Technology (NWS/OST) developed a concept of operations document that NCEP will follow for responding to a CTBTO request.

The system development is the result of dedicated efforts by NOAA/ARL to provide HYSPLIT capabilities to produce backtracking results for multiple CTBTO monitoring sites. In order to provide required information to CTBTO, a Source Receptor Sensitivity (SRS) field matrix specific to each measured radionuclide sample and sampling site is determined. These SRS fields are computed by running HYSPLIT backwards in time but with pseudo releases corresponding to the measured radionuclide at the monitoring site. The resultant backward plume provides a grid of dilution factors, which along with the SRS fields allows for a computation of an activity concentration (Bq/m^3) at any grid point. In addition, source location algorithms can be run to provide the most likely source location given the computed activity concentration and measurements. The HYSPLIT CTBTO system proposed ultimately provides CTBTO with an SRS field text file that can be used for further computation of source strength and location. The HYSPLIT CTBTO system also provides the NCEP Senior Duty Meteorologist with likely dispersion plots that are used to verify a realistic simulation (eg: compare the dispersion plume against analyzed winds in an area).

HYSPLIT dispersion for ATM backtracking response is primarily driven by the NWS/NCEP Global Forecast System (GFS) Global Data Assimilation System (GDAS). Outputs are at 1 degree horizontal resolution and 6 hour time intervals back 30 days from the present time. The RSMC-Washington CTBTO capability was demonstrated to the WMO Committee for Basic Systems (CBS) at the September 2014 meeting. The WMO/CBS and CTBTO representatives recommended implementation of the RSMC-Washington capability as it met all CTBTO requirements. The RSMC-Washington CTBTO capability was successfully implemented to NWS operations (NCEP) on September 30, 2014. One month of GDAS model output at one-degree resolution is available for the CTBTO application.

RSMC Washington participated in several CTBTO initiated requests to provide backtracking information for up to 7 radionuclide monitors from April-September, 2014. Table 1 shows the breakdown of the details for the requests during the experimental testing period.

The designation of RSMC Washington for the provision of atmospheric backtracking products was approved by CBS- Ext (2014) in Asunción, Paraguay, 8 to 12 September 2014.

Date requested	Backward calculation	Region	Responder
September 2, 2014	15 days	East Asia	NCEP/NCO successful transfer to CTBTO
July 14, 2014	15 days	East Asia	NCEP/NCO, late transfer to CTBTO
June 5, 19 2014	15 days	East Asia	NCEP/NCO hypothetical internal test
May 27, 2014	15 days	East Asia	NCEP/NCO No file transfer
May 9, 2014	15 days	East Asia	NCEP/NCO No file transfer
April 3, 15, 30, 2014	15 days	East Asia	NCEP/EMC No file transfer

Table 1: NWS/NCEP & RSMC Washington CTBTO response for April-July, 2014

5. Lessons learned from recent experiences and significant operational or technical changes:

RSMC Washington continues to experience some intermittent problems during exercises due to the fact that the common web page is hosted by ARL on a non-operational web server. It is planned that the web site will be moved to NCEP operations in 2015 and discussions on the transition are currently taking place.

During the November 20 IAEA-led exercise in Indonesia, RSMC Washington's transport and dispersion model, HYSPLIT, had a problem whereby too much pollutant was washed out very near the source giving substantially more deposition than RSMC Montreal and Melbourne. Subsequent analysis found that this was due to a combination of the wet deposition process in HYSPLIT plus the unique meteorological situation at the release location (amount of precipitation, vertical velocity). This issue will be corrected in the next release of HYSPLIT into NCEP operations, which is due in late 2015. However, if this occurs again prior to the new implementation, the Senior Duty Meteorologists have been given instructions to set the in-cloud wet deposition value to zero instead of the default.

6. Additional operational issues and challenges:

RSMC Washington continues to have difficulty with invalid email addresses for NMS contacts who receive email notices of updated model products. Guidance from WMO on the proper procedure to remove bad email addresses from our system would be helpful.

7. Summary and status of the operational atmospheric transport and dispersion models

i. The HYbrid Single-Particle Lagrangian Integrated Trajectory Model (HYSPLIT)

RSMC Washington's operational atmospheric transport and dispersion model is HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectories) model, developed at the NOAA Air Resources Laboratory. HYSPLIT is driven by meteorological forecast data from the operational Global Forecast System (GFS) model (T574, approximately 22 km, converted to 1 degree and half-degree latitude-longitude grids) and the North American Meso (NAM) Non-hydrostatic Multi-scale Model on a 12 km grid (NMM). Prior to the September 30, 2014 NWS implementation, the default meteorology was the 1 degree GFS, since then it is the half-degree GFS. Note the half-degree model output is on the native hybrid-sigma levels compared to the 1 degree pressure levels. The system is available for running on demand and can produce forecast trajectories, concentrations (or exposures) and depositions for nuclear accidents, volcanic eruptions, smoke episodes and other related atmospheric pollutant releases.

The September implementation also included upgrading to HYSPLIT ARL revision number 560 which includes updated wet deposition parameters and use of pre-computed random numbers used in the turbulence calculation.

HYSPLIT can be used for modeling atmospheric transport and dispersion of pollutants over a broad range of distances; from local to global scales. The equations used in the calculation of pollutant transport and dispersion are a hybrid between Eulerian and Lagrangian approaches. Advection and diffusion calculations are made in a Lagrangian framework using the gridded meteorological analysis and forecast fields. Air concentrations are calculated on a fixed three dimensional grid by integrating all particle masses over a pre-set averaging period. Routine calculations may consist of simple trajectories from a single source to complex emissions from several sources. Dry deposition is treated with a deposition velocity. Wet deposition is divided into two processes: a scavenging ratio for pollutants located within a cloud layer and a scavenging coefficient for pollutant removal in rain below a cloud layer. Radiological decay is also included when necessary.

8. Plans for 2015:

- The schedule of routine monthly tests for all of 2015 has been set up in collaboration with RSMCs Montréal and Melbourne.
- Four exercises in 2015 will be initiated by IAEA with the November exercise being designated "Lead" for RSMCs Washington and Montréal.
- The joint web page will be installed on an operational server run by NCEP.
- Continue to make small modifications to the common web page code as needed based on problems encountered during exercises/events and provide the changes to all RSMCs.
- RSMC/CTBTO applications continue using GFS/GDAS model output at half or one-degree though the GFS/GDAS will be upgraded (see NWP section below)

- Upgrade the HYSPLIT system at NCEP to a more recent version, including improved wet deposition.
- Implement the TCM approach in a development computer user account following NCEP operational scripting protocols for planned transfer to operations.
- Direct GRIB2 Input and Output
- Transition the static RSMC graphic web page to NCEP operations.
- Improved CTBTO SDM forecaster graphics. Currently, only coarse global graphics can be created.

9. Summary and status of the operational Numerical Weather Prediction (NWP) models

HYSPLIT dispersion for RSMC response is primarily driven by the NWS/NCEP Global Forecast System (GFS) or the North American Model (NAM). The NAM 12 km Nonhydrostatic Multiscale Meteorological Model on the B grid (NMMB; Janjic and Gall 2012) became NCEP's operational North American Mesoscale model in October 2011, replacing the previous operational model, Weather Research and Forecasting (WRF) NMM (Janjic et al., 2001). Four fixed domain nests (4 km CONUS, 6 km Alaska, 3 km Hawaii and 3 km Puerto Rico) are embedded within the NAM 12 km parent model. Unlike its predecessor, the NMMB model is formulated on the Arakawa B grid using a generalized hybrid vertical coordinate, and it can be applied at global scales. Among all the upgrades in NMMB, the most important change for dispersion predictions is the use of a more recent Land Use Land Cover (LULC) database with more expansive urban areas, based on the Moderate Resolution Imaging Spectroradiometer (MODIS) measurements for the years 2001-2005, which replaced the USGS (U.S. Geological Survey) LULC data based on the Advanced Very High Resolution Radiometer (AVHRR) measurement for the years 1992-1993. Changes in LULC can impact dispersion predictions through a variety of mechanisms, including modulation dry deposition velocities, or by modifying planetary boundary layer (PBL) height and eddy diffusivity coefficients.

In 2014, all NCEP models continue to run on the Weather and Climate Operational Supercomputer system (WCOSS). In 2014, the NAM 12 km and all nest physics were updated. Cloud microphysics were updated to better represent convective storms by advecting all cloud species separately. The ensemble Kalman filter variational data assimilation system was also implemented regionally for the first. In addition, NAM radiation is now based on the Rapid Radiative Transfer Model (RRTM) V2 that can include interactions with aerosols. WCOSS is based on the IBM iDataPlex/Intel Sandy Bridge/Linux hardware and software operation system. 10,048 processing cores with 2590 trillion bytes of storage are configured to produce about 208 trillion calculations/sec. WCOSS provides the operational and developmental platform to run HYSPLIT, GFS, NAM as well as the 16 km Short Range Ensemble Forecast, T190 Global Ensemble Forecast, hourly 13 km Rapid Refresh (RAP), 3 km High Resolution Rapid Refresh (HRRR) models and 2.5 km Real-Time Mesoscale Analysis (RTMA) and other customized weather and ocean modeling systems. The HRRR hourly analysis and forecast system (15 forecast hours) over the Continental U.S is based on the Weather Research and Forecasting (WRF) model with explicit microphysics, 2nd order closure boundary layer scheme and a multiple layer land surface model. Many fields are now output at 15 minute intervals as well.

2015 NWP plans relevant to RSMC activities:.

- Update all NAM nests to 3 km horizontal resolution with forecasts to 60 hours four times per day.
- Major upgrade to the Global Forecast System (GFS):
    - Increase horizontal resolution to 13 km
    - Move to a semi-Lagrangian dynamical core to allow longer timesteps

- Increase resolution of ensemble members used for data assimilation to T574 (around 25 km)
- Improvements to boundary layer and radiation physics
- Output high resolution grid files for public access (1/4 and ½ degree)

References

Janjic, Z. I., Gerrity Jr, J. P., & Nickovic, S. 2001. An alternative approach to nonhydrostatic modeling. *Monthly Weather Review*. 129(5), 1164-1178.

Janjic, Z., Gall, R.L. 2012. Scientific documentation of the NCEP nonhydrostatic multiscale model on the B grid (NMMB). Part 1 Dynamics. http://nldr.library.ucar.edu/repository/collections/TECH-NOTE-000-000-000-857 (full text at http://nldr.library.ucar.edu/repository/assets/technotes/TECH-NOTE-000-000-000-857.pdf)

WMO, 2012: Documentation on RSMC Support for Environmental Emergency Response. *WMO-TD/No.778*. Available online at http://www.wmo.int/pages/prog/www/DPS/WMOTDNO778/Annex4.html