RSMC Washington report of activities for 2017

Executive Summary

RSMC Washington did not receive any requests for support for real events in 2017. Other RSMC-related activities for 2017 consisted of Regions III, IV, and V monthly tests, conducted for scenarios over Canada, the United States, Brazil, and Australia, and three IAEA exercises during the year with RSMC Washington and Montreal as Lead RSMCs in February. A special exercise was conducted in November in conjunction with the National Meteorological Service of Argentina. 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 Weather Service's (NWS) 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

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National Weather Service
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United States of America

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Operational contact (24 hours): Senior Duty Meteorologist
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3. Emergency operations

RSMC Washington did not respond to an emergency in 2017.

4. Routine operations

Monthly Tests:

RSMCs Montréal, Washington, and Melbourne generally hold a joint exercise on the third Tuesday of every month and invite all other RSMCs to participate. In addition, RSMC Washington participated in three 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 2017.

Table 1: RSMC Washington monthly tests for 2017

Month	Source location
Jan 17	Angra, Brazil
Feb 21	Enrico Fermi, MI, US (IAEA request)
Mar 21	Point Lepreau, NB, CA
Apr 118	Lucas Heights, Australia
May 16	Grand Gulf, MS, US
Jun 21-22	PAKS, Hungary (IAEA request)
Jul 18	Darlington, ON, CA
Aug 15	Puspati, Malaysia (IAEA request)
Sep 19	Lucas Heights, Australia
Oct 17	Enrico Fermi, MI, US
Nov 2	Atucha, Argentina (special request)
Dec 19	Point Lepreau, NB, CA

Once the model products are posted to all 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 on its web server. RSMC Washington maintains and distributes on request 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 2017, 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.

Currently ARL operates the RSMC Washington web site, but not on a 24x7 operational basis. Products are automatically sent and posted to this ARL site when the NWS Senior Duty Meteorologist runs HYSPLIT and generates the graphics/product files on the NCEP supercomputer. ARL manually runs scripts to send the products to the other RSMCs' web sites. Other RSMCs' products are automatically posted to this ARL site. The RSMC Washington joint web page is being ported to an operational NCEP web server, however, production backlogs have slowed the transition process for implementation again in 2017. NCEP has developed the new web page, but testing the transfer of files from the NCEP to other RSMC web pages and receipt/posting of other RSMC products on the NCEP site is still being done and to date all but 2 RSMC have been able to upload their products. Sending of products by RSMC Washington to other RSMC web sites is scheduled to resume testing in 2018.

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 2018 and work on transferring products from NCEP to other RSMCs and vice versa is continuing.

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

HYSPLIT Model

RSMC Washington's operational atmospheric transport and dispersion model is the HYSPLIT (formerly called the HYbrid Single-Particle Lagrangian Integrated Trajectories) model (Draxler and Hess, 1998; Stein et al, 2015), developed at the ARL. HYSPLIT is driven by meteorological forecast data from the operational Global Forecast System (GFS) model (T1534, approximately 13 km, converted to 1 degree pressure-level and half-degree hybrid-level latitude-longitude grids) and the North American Meso (NAM) Non-hydrostatic Multi-scale Model on a 12 km parent and 3 km CONUS, Alaska and Hawaii nested grids (NMMB). Note that a half- and quarter-degree pressure-level GFS model output is also available, however it has not been configured for input to HYSPLIT. 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.

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. A scavenging coefficient is used for both in- and below-cloud removal, which gave the best results when used for the Fukushima simulations. Radiological decay can also be included, when necessary.

8. Research and Development activities:

The HYSPLIT model is a complete system for computing simple air parcel trajectories as well as complex transport, dispersion, chemical transformation, and deposition simulations. As of 2017, HYSPLIT continues to be one of the most extensively used atmospheric transport and dispersion models in the atmospheric sciences community (e.g., more than 379 citations to Stein et al 2015, Web of Science; this hot paper received enough citations from March 2016 to August 2017 to place it in the top 0.1% of papers in the academic field of Geosciences. In addition, from March 2016 to August 2017, this highly cited paper received enough citations to place it in the top 1% of the academic field of Geosciences based on a highly cited threshold for the field and publication year.).

In a recently published paper, Stein et al. (2015) present the model's historical evolution over the last 30 years from simple hand drawn back trajectories to very sophisticated computations of transport, mixing, chemical transformation, and deposition of pollutants and hazardous materials. They highlight recent applications of the HYSPLIT modelling system, including the simulation of atmospheric tracer release experiments, radionuclides, smoke originated from wild fires, volcanic ash, mercury, toxic chemicals and wind-blown dust. Among the model updates it is worth mentioning the inclusion of backward-in-time advection with dispersion to estimate footprints, time varying emissions, an embedded Global Eulerian Model (GEM), and the built-in capability to produce three different simulation ensembles.

In addition, HYSPLIT has recently been coupled inline to the Weather Research and Forecast model (WRF, Ngan et al, 2015) taking advantage of the higher temporal frequency available from the meteorological data. The model runs within the WRF architecture using the same spatial and temporal resolution and it has been tested against tracer experiments. This is a very promising approach for applications influenced by rapidly changing conditions and/or complex terrain. Further evaluation of this approach is underway.

Plans for 2018 and beyond:

There will be a HYSPLIT upgrade at NCEP, tentatively planned for April 2018. The main features relevant to RSMC are (1) use of quarter-degree instead of half-degree resolution GFS as the default meteorology, and (2) upgrade to ARL HYSPLIT revision 856 (mostly minor changes), and (3) transfer of the RSMC Washington web page from NOAA ARL to NCEP (see Section 4). Once the NCEP RSMC Washington page is operational, the HYSPLIT output in GRIB2 format will be posted to the "All Products" section of that web page. The upgrade also includes the ability to use NOAA's High Resolution Rapid Refresh (HRRR) 3 km resolution model output for near-field dispersion (not RSMC).

- The schedule of routine monthly tests for all of 2018 has been set up in collaboration with RSMCs Montréal and Melbourne.
- Four exercises in 2018 will be initiated by IAEA with the May 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 (quarter as of April 2018) or one-degree though the GFS/GDAS modeling system will be upgraded (see NWP section below)
- In 2018, test HYSPLIT with NCEP's planned replacement to the GFS, the Next Generation Global Prediction System (NGGPS) FV3-GFS model.
- In 2018, continue development of the transfer coefficient matrix (TCM) approach with a 3-hourly emissions cycle.
- A tentative 2019 implementation at NCEP will include replacing GFS with FV3-GFS, replacing the current RSMC run procedure with the TCM approach, and upgrading HYSPLIT to a more recent version.

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

The 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 Non-hydrostatic Multiscale Meteorological Model on the B grid (NMMB; Janjic and Gall, 2012) has been NCEP's operational North American Mesoscale model since October 2011. Four fixed domain nests (3 km CONUS, Alaska, Hawaii and Puerto Rico) are embedded within the NAM 12 km parent mode beginning March 2017. .

In 2016, a CRAY based supercomputer was made operational increasing the total capacity of the Weather and Climate Operational Supercomputer system (WCOSS) IBM and CRAY systems to 2.8 PFlops, 3748 Nodes, 84,512 processors and 8.124 PB of storage. WCOSS provides the operational and developmental platform to run HYSPLIT, GFS 13 km, NAM as well as the 16 km Short Range Ensemble Forecast (SREF), T574 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 (18 forecast hours) over the Continental U.S is based on the Weather Research and Forecasting (WRF) Advanced Research WRF (ARW) model with explicit microphysics, 2nd order closure boundary layer scheme and a multiple layer land surface model.

NWP plans for 2018 and beyond:

- In 2018 an experimental version of FV3-GFS will be implemented at 13 km and 64 levels for forecaster evaluation.).Transition the RSMC Washington web site to 24x7 operational NCEP web server.
- Update (2019) all NAM nests to 3 km horizontal resolution with forecasts to 60 hours four times per day.
- Update (2019) the High Resolution Ensemble Forecast (HREF) (~3 km) targeted for improving short-term severe storm prediction.

References

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