RTH/RSMC Offenbach (DWD) status report for 2018

Executive Summary

Primary activities in the year 2018 consisted of the quarterly IAEA/RTH/RSMC tests conducted for different scenarios and accident countries and of the monthly communication tests with the IAEA. In the framework of the CTBTO/WMO commitment, a number of backtracking calculations were performed on request for level-5-events. Incremental updates and improvements were made to the DWD's dispersion model software, and to the response procedures. Also the model code was further adapted to the global NWP models ICON and COSMO-D2.
The online-coupled dispersion modelling system ICON-ART substantially extends the dispersion modelling capabilities of DWD. With respect to the designation of DWD as RSMC for nuclear and non-nuclear environmental emergency response ICON-ART builds the core for the new RSMC functionalities.

1. Introduction

The RTH Offenbach is one of the 18 major Regional Telecommunication Hubs within the Main Telecommunication Network (MTN) of the Global Telecommunication System (GTS). Offenbach is also one of the currently 15 Global Information System Centres (GISC) of the WMO Information System (WIS). RTH Offenbach is the operational counterpart of the Incident and Emergency Centre (IEC) of the IAEA with respect to the distribution of the notification of an accident and additional information. In the framework of the IAEA Convention on Early Notification and Assistance RTH Offenbach has to make sure that the NHMSs are informed as fast as possible of a nuclear accident. Additionally, in the context of the CTBTO/WMO backtracking arrangements Offenbach is one of the WMO-RSMCs for atmospheric dispersion modelling/backtracking.
DWD's application to become a RSMC for nuclear and non-nuclear environmental emergency response was finally approved by WMO EC-70 in June 2018. For the dispersion modeling the new comprehensive and highly customizable online-coupled dispersion model ICON-ART is used. Main steps have been undertaken towards a full operationalization of the emergency response system based on ICON-ART. Its status, main features and applications at DWD as well as further plans are outlined in this report.

2. Operational Contact Information

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3. Standing operational procedures

According to the regional and global arrangements for the provision of transport model products in the case of a nuclear environmental emergency, the RTH Offenbach is in charge of the global dissemination of emergency messages.

In the framework of the Convention on Early Notification of nuclear accidents, the IAEA informs the WMO Secretariat and the 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 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 and RSMCs. The messages are not destined to the general public and should not be accessible on the public internet. (See also the WMO Manual on the Global Telecommunications System, WMO Publication-No. 386).

When the IAEA no longer requires WMO RSMC support, the IAEA will send an EMERCON termination message to the RSMCs, WMO Secretariat and RTH Offenbach. RTH Offenbach will also disseminate the ERMERCON termination message on the GTS under the heading WNXX01 IAEA for global distribution.

Therefore, in case of an accident occurrence and/or whether emergency meteorological support is required. RTH Offenbach will

(a) receive a message from IAEA (email/fax/USIE website),

(b) verify its content by a phone call to the IEC of the IAEA,

(c) put the EMERCON 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 and RSMCs,

(d) check that the Lead-RSMCs have received the same information (email/fax),

(e) forward the email (fax) with the notification or additional information to the Lead-RSMCs if they did not get it directly from the IAEA.

4. Programme of exercises - Regular tests

The communication between IAEA and RTH Offenbach is tested every month. According to the actual valid procedures the tests are performed each third Tuesday a month. Once every quarter RSMCs and the delivery (but not the distribution) of products are included. The GTS link can be tested at every quarterly exercise. Additionally, GTS messages are distributed in the framework of full scale tests like ConvEx-3 exercises.

5. Evaluation of exercises

In 2018 communication tests between IAEA and RTH Offenbach were conducted on a regular basis on each third Tuesday of a month.

In this period the standard exercises (and also several CONVEX tests via USIE web site) were performed, using the email (fax) and phone contacts between IAEA and RTH Offenbach. Since 2014 monthly tests consist of email communication and USIE web site information on default.

Additionally, every third month a quarterly exercise was conducted to test the communication procedures and contacts between IAEA, RSMCs and RTH Offenbach. In these exercises accident scenarios in different WMO regions were chosen and only the corresponding Lead RSMCs had to respond according to the distributed messages. The GTS link was utilized during these exercises.

The monthly and quarterly communication exercises were performed without any deviations or only minor ones from the agreed procedures.

6. Lessons learned from experience

The regular monthly communication exercises are helpful to keep the procedure in mind and to test the handling of the information. But they are very simple and no significant problems are expected to show up except perhaps short disruption of the web system or similar technical problems.

It is therefore not surprising that the major problems or deviations from the agreed procedures only happened during the quarterly tests because they were the only tests with several steps in predefined accident scenarios which also include the distribution of GTS messages.

Following a proposal of WMO experts the text of the IAEA message will be strictly adapted to the IAT2 rules.

The WNXX01 IAEA emergency messages are meant to inform the WMO, NHMSs and RSMCs. They are not destined for the general public. Therefore the dissemination conditions were modified that the messages are not accessible on the public internet.

Regarding the distribution of alarm messages the confirmation checks done by RTH Offenbach are very useful and necessary activities. They are important backup features in the emergency response communication context.

7. RTH Offenbach Backup Procedures

The German Weather Service (DWD) plans to establish backup procedures for institutions connected to RTH Offenbach. The standard backup procedure would be that all IAEA data sent to RTH Offenbach for further dissemination are sent in parallel (active backup) to a Backup RTH. It is intended to choose RTH Vienna for the Backup RTH. They will then take over the data dissemination in case of an outage of RTH Offenbach.

In 2016 this was discussed with Austria who confirmed to in principle be able to take over this responsibility. However, it was stated that Austria would need a direct RMDCN-connection with Toulouse first. Work on backup procedures was continued in 2018.

8. Participation in the WMO/CTBTO inverse dispersion modeling calculations

WMO and the Provisional Technical Secretariat (PTS) of the Comprehensive Test Ban Treaty Organization (CTBTO) cooperate according to adopted arrangements for the provision of inverse dispersion modeling by the WMO designated Centres to CTBTO. At present 10 WMO Centres (RSMCs) are active participants in these backtracking calculations. The 10 WMO Centres are asked to provide if requested inverse dispersion modeling as far back as 7 weeks and for up to 36 stations and to upload (to the CTBTO web-site) their results within 24 to 96 hours of receiving the request. RSMC Offenbach was successful in meeting these requirements. CTBTO then combines the results in various ways to generate ensemble products.

Beginning with September 2008, which was the official start of the operational phase of the CTBTO/WMO system, until end of 2018, more than 180 backtracking calculations were performed from RSMC Offenbach on request for level-5-events. In the context of the Fukushima radioactive releases (March 2011) about 100 backtracking requests were received in the following years. Since March 2015 the calculations are based on the ICON model. In the context of a National Data Centre Preparedness Exercise (NPE15) supporting backtracking calculations were also performed in that year.

9. Status of the DWD's operational atmospheric transport and dispersion model (WMO/CTBTO)

As a part of the German radioactive emergency systems IMIS/RODOS a Lagrangian Particle Dispersion Model (LPDM) is applied at the DWD. The LPDM calculates trajectories of a multitude of particles emitted from a point source using the grid-scale winds and turbulence parameters of the NWP-models and a time scale based Markov-chain formulation for the dispersion process. Concentrations are determined by counting the number and mass of particles in a freely eligible grid. Dry deposition parameterisation follows a deposition velocity concept and wet deposition is evaluated using isotope-specific scavenging coefficients. Also included is radioactive decay, a vertical mixing scheme for deep convection processes and optionally particle-size depending sedimentation coefficients. The LPDM was successfully validated using data of the ANATEX and ETEX tracer experiments.

The dispersion model is driven by the DWD's weather forecast models (ICON, ICON-EU, COSMO-D2). In case of emergency the model output will be transmitted to the national 'Integrated Measurement and Information System' (IMIS) for the surveillance of radioactivity in the environment and the real-time decision system RODOS in Germany.

The model is also a member of the multi-model backtracking ensemble of the CTBTO (Comprehensive Nuclear-Test-Ban Treaty Organization). The code was optimised for MPP computers (e.g. CRAY-XC 40, NEC-SX8/SX9, IBM P5 575) utilising MPI-based parallelisation features. The model is also implemented at MeteoSwiss based on the Swiss COSMO-version.

The NWP modelling suite of DWD consists of two models, namely the global **ico**sahedral-hexagonal **n**on-hydrostatic grid point model **ICON (**13 km, 90 layers), which replaced the GME in January 2015, including the two-way nested region **ICON-EU** (grid spacing 6.5 km, 1377 x 657 grid points, 60 layers), and the convection permitting **COSMO-D2 (replaced COSMO-DE in May 2018)**, covering Germany and its surroundings with a grid spacing of 2.2 km, 651 x 716 grid points and 65 layers.

Independent 4-dimensional data assimilation suites are performed for both NWP models, ICON and COSMO-D2. For ICON, analyses are derived for the eight analysis times 00, 03, 06, 09, 12, 15, 18 and 21 UTC based on an ensemble data assimilation using Kalman-filter techniques combined with a threedimensional variational data assimilation scheme. For COSMO-D2, the continuous data assimilation system based on the nudging approach was replaced in March 2017 by the Kilometre-scale ensemble data assimilation system (KENDA) (Schraff et. al 2016) which, as its predecessor, provides analyses at hourly intervals. Analyses and forecasts are currently run on a CRAY-XC40.

During the release phase of the Fukushima accident (March/April 2011) the DWD provided dispersion forecasts for the public mainly based on GME data. Additionally, the COSMO model (7 km grid spacing) was set up and run in an operational mode for the relevant region covering Japan and its surroundings.

In the last year incremental updates and improvements were made to the DWD's dispersion model software, and to the response procedures (e.g. for GRIB2, adaptations to the DWD global model "ICON", and to the new upcoming regional model COSMO-D2).

10. Status of the DWD atmospheric transport and dispersion model ICON-ART

The **ICON-ART** system (Rieger et al. 2015), where ART stands for 'Aerosols and Reactive Trace gases', is an extension of the operational global non-hydrostatic ICON model (Zängl et al. 2015). The ART modules developed at the Institute for Meteorology and Climate Research at the Karlsruhe Institute of Technology (KIT) are online-coupled in a tightly integrated way to the ICON model. I.e. the same routines for transport and diffusion of the gas phase and aerosol tracers are used as for the prognostic moisture quantities in NWP. The possible applications of ICON-ART range from simple tracer dispersion problems to complete aerosol-radiation and aerosol-cloud interaction studies and will soon also include the formation of secondary aerosol particles from the gas phase. ICON-ART inherits further flexibility from ICON – namely the option for multiple 2-way nesting or to use the model in a limited area mode.

The core applications at DWD are the dispersion modelling of radionuclides and other hazardous substances from point sources, volcanic ash and mineral dust.

In March 2016 a project dealing with the loss of photovoltaic power gain due to Saharan dust has started. The project is collaboration between KIT, meteocontrol GmbH – a service provider for photovoltaic power forecasts – and DWD. For example the strong Saharan dust event beginning of April 2014 was investigated in a joint effort of DWD and KIT (Rieger et. al 2017). Runs including the aerosol-radiation interaction and aerosol-cloud interaction in combination with a 2-moment cloud-microphysics scheme of the simulated dust showed a significant reduction of the short-wave radiation at the surface. This for example had a big impact on the power produced by solar energy.

The capability of ICON to employ nests for specific geographical regions might be of particular interest due to the fact that in the case of nuclear accidents the source of atmospheric contaminants is very localized. But in this respect time is a serious constraint in case of an emergency. The grid definition and external parameters for the individual nest region have to be available. In principle it is possible to start a nest region during runtime, while it is more convenient to start from available analysis and first guess fields. So in general ICON-ART will use the same grid configuration as the operational global NWP model of DWD.

The ART modules have been structured in a way to streamline further expansions and developments using the object oriented capabilities of FORTRAN 2008. Furthermore the system is highly configurable for a wide range of applications (Schröter et al. 2018) via XML configuration files. These XML files are used to specify the tracers specific to the different ATDM applications – together with their accompanying metadata and the processes to be treated respectively the process-related coefficients to be used, while in general there is no need to recompile the code.

In addition, the information about point sources and the emission scenario(s) is also given via an XML file. This concept greatly facilitates a flexible, case specific set up of the processed tracer(s) and the dispersion model itself. It is used for the application in the nuclear as well as non-nuclear section, namely to treat for example vegetation fires, chemical hazards and industrial fires.

Last but not least a new complex 2-moment aerosol module with aerosol modes for soluble, insoluble and mixed-phase particles is in its final testing stage at KIT. This among other things allows for coagulation processes, the interaction with the gas phase chemistry and the formation of secondary organic aerosol particles. For a flexible configuration of the gas phase chemistry the Kinetic Pre-processor KPP is used.
The modules for pollen forecast as well as the emission parameterization based on satellite observations and a plume-in-grid model for vegetation fires are currently implemented and have been adapted from versions which were developed for the COSMO-ART model.
These recent developments due to the inherent complexity of their application are not meant to be used in an emergency response scenario, but are tools to address basic research questions.

11. Status of the operationalization of the RSMC functionalities for nuclear and non-nuclear environmental emergency response

A working group for the operationalization of the RSMC functionalities has been established at DWD. At the moment this working group focuses on the full routine implementation of ICON-ART for nuclear environmental emergency response. The target is to declare the operational status until the next quarterly exercise in May 2019.

Base for the mandatory products are runs of DWD's trajectory model and a global 78 h run of ICON-ART at a resolution of approximately 13 km. The trajectory calculations use the output of the operational ICON NWP run on a global 0.25x0.25° lat/lon grid for the same initial time as the one used for the dispersion simulation. The 78 h forecast takes about 35 min on Cray XC40 HPC system.

So far DWD participated in all quarterly exercises for nuclear environmental emergency response since 15 May 2017. Products were either sent per E-Mail to the Chair and Co-Chair of ET-ERA for evaluation or uploaded to a test RSMC webpage at NOAA implemented by Glenn Rolph.
All exercises were valuable and either revealed shortcomings of the procedures established so far at DWD or were used to further improve the generated products. For example a number of suggestions by Anton Muscat and René Servranckx following the latest quarterly exercise in February 2019 have been taken into account in the meantime.

The emission scenario for the dispersion simulation is specified in an XML file and read in by ICON-ART. For the meteorologists on duty in the forecast centre at DWD a browser-based GUI has been developed. The form of the GUI is based on the request form for nuclear environmental emergency response defined in WMO manual on GDPFS. It provides the XML file with the emission scenario as well as additional information in order to trigger the runs for quarterly exercises, internal tests or a real emergency case.

After the model run the mandatory products are generated. The distribution of the products has still to be established. Main distribution tasks will be handled by the automatic file distribution system established at DWD. A web server for the RSMC mirror webpage based on the scripts provided by Glenn Rolph from NOAA has been set up at DWD (https://rsmc.dwd.de/).
Shortly after this report, the other RSMCs will be contacted in order to initiate the further steps for the reception and distribution of the RSMC products between the different mirror webpages. For example a set of secure FTP accounts has been created to receive other RSMC's products and transfer them to DWD's mirror webpage.

The forecasters on duty at DWD have to be further instructed about their responsibilities in case of request. So far, they are experienced in and regularly train the application of the German nuclear emergency response system.
Procedures to coordinate the actions of the RSMCs Exeter, Toulouse and Offenbach have to be established.

With respect to DWD's designation as RSMC for non-nuclear emergency response there are multiple synergies between the nuclear and non-nuclear applications to build upon. First and foremost the underlying dispersion modelling system ICON-ART and the specification of the emission scenario via an XML file are basically the same. The GUI has to be extended in order to handle the different use cases for non-nuclear emergency response. For example to provide a form which lets the user specify multiple release locations in the case of a request dealing with wildfires.
The post-processing of the model data and the product generation uses the same set of tools already established for nuclear emergency response.

12. Plans for 2019

- The schedule of tests (monthly, quarterly and others) has been set up and defined in cooperation with the IAEA.

- Continuation of the participation on WMO/CTBTO backward ensemble calculations.

- Declare as soon as possible the operational status of the ICON-ART model in the context of DWD's designation as RSMC for nuclear environmental emergency response. Coordinate this RSMC functionality with RSMCs Exeter and Toulouse.

- Carry out the necessary steps for the operationalization with respect to DWD's designation as RSMC for non-nuclear environmental emergency response. Coordinate this RSMC functionality with RSMC Toulouse.

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