WORLD METEOROLOGICAL ORGANIZATION

COMMISSION FOR BASIC SYSTEMS

MEETING OF THE CBS EXPERT TEAM ON EMERGENCY RESPONSE ACTIVITIES (ET-ERA)

Vienna, Austria, 01-05 October 2018

FINAL REPORT

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EXECUTIVE SUMMARY

The CBS Meeting of the Expert Team on Emergency Response Activities (ET-ERA) took place at the Vienna International Centre (VIC) in Vienna, Austria from 01 to 05 October 2018 under the chairmanship of Mr Anton Muscat.

The meeting was presented with information related to the relevant decisions of the Commission for Basic System (CBS-16, Guangzhou China, November 2016), the 69th Session of the Executive Council (EC-69, June 2017), a Technical Conference (TECO) and 18th Session of CBS Management Group (March 2018) and the 70th Session of the Executive Council (EC-70, June 2018).

The representatives of Regional Specialized Meteorological Centres (RSMCs) with activity specialization in nuclear ERA and RTH Offenbach presented their activities in relation to the regional and global arrangements which have been maintained in collaboration with IAEA. RSMCs for non-nuclear ERA designated at the 70th session of the Executive Council (EC-70, June 2018) also presented their activities.

The representatives of IAEA and CTBTO also presented an overview of their activities. In particular, IAEA indicated that ConvEx-3 (2017) exercise was good opportunity to test the Time of Arrival (TOA) products that are being developed by the RSMCs and expressed strong support for further development of Transfer Coefficient Matrix (TCM) method. CTBTO expressed its keen interested in the assessment of uncertainty and the use of higher resolution for global simulations. ICAO reported on the successful completion of the work of the Task Group (TG) on the *Development of Criteria to Support the Issuance of SIGMET in Case of a Release of Radioactive Material into the Atmosphere*. It was agreed that the radioactive cloud SIGMET meet the requirement by using a cylinder covering all flight levels and with a fixed radius (i.e. not time dependent) of up to 30 km.

The meeting discussed the way to improve the readiness for nuclear and non-nuclear emergency in various aspects such as further development of TOA. TCM, ensemble modelling, effectively managing RSMCs common webpages in addition to regular exercise between RSMCs, RTH Offenbach and the IAEA, and the method to efficiently alert the Members of the nuclear and non-nuclear emergencies.

The meeting reviewed and updated the lists of actions and recommendations for nuclear and non-nuclear ERA which can be found in the following Annexes:

- Annex IV: Action List for Nuclear Activities,
- Annex X: Consolidated Action List for Non-Nuclear Activities (2015 and 2018 meetings).

The meeting also noted some inconsistencies in the Manual on the Global Data-processing and Forecasting System (GDPFS, WMO-NO. 485) and proposed some amendments in Annex XI.

GENERAL SUMMARY OF THE WORK OF THE SESSION

1. OPENING

1.1 The CBS Meeting of the Expert Team on Emergency Response Activities (ET-ERA) was opened, at 09.30 on Monday, 01 October 2018, at the Vienna International Centre (VIC) by the Chair of ET-ERA, Mr Anton Muscat, followed by welcoming remarks by Mr Guenther Winkler of IAEA and Dr Xu Tang, Director of Weather and Disaster Risk Reduction Department of WMO.

1.2 Mr Muscat welcomed the team, noting existence of the team since 1993 and the number of new faces, and some missing team members (Australia and Russia). He thanked IAEA for hosting this meeting. He indicated that this was his first time chairing and noted that Mr Servranckx who was experienced in chairing this meeting would help. He then asked Mr Guenther to say a few words on behalf of IAEA.

1.3 Mr Winkler welcomed the team and expressed IAEA's pleasure of hosting the meeting in Vienna. He indicated that there were a lot of meetings in the VIC and his supervisors were all busy and could not make it to this meeting. He then shared information on logistics related to the building.

1.4 Dr Tang also welcomed the team on behalf of his Department (Weather and Disaster Risk Reduction and Services) and the Secretary General Petteri Taalas. He expressed his sincere thanks to the Department of Nuclear Safety and Security (DNSS) of IAEA for providing this excellent facility of IAEA for the meeting and a good opportunity for the team to interact with the colleagues of IAEA and CTBTO. He indicated that EC-70 adopted Strategic Plan for 2020-2023. He highlighted the Strategic Objectives 1.1 related to enhancing national multi-hazard early warning services and the Strategic Objective 2.3 related to Seamless Global Data-Processing and Forecasting System (GDPFS) in which ET-ERA will play an important role. Furthermore, he suggested that ET-ERA will need to collaborate with other WMO ERA and Environmental related services such as the marine emergency response, and warning/advisory services on Sand and Dust Storm, Vegetation Fire and Smoke Pollution and volcanic ash. The coverage of all air-borne hazards was recognized by the 17th session of the WMO Congress (Cg-17). He concluded by wishing a successful meeting to the team.

1.5 Mr Servranckx, Co-chair of ET-ERA, welcomed the team and provided some background on him, in particular that he retired from the Meteorological Service of Canada 5 years ago and that he also trained meteorologists for over 10 years. He noted that most team members are busy with their job at the office and that WMO Constituent Bodies keep adding action items with little additional time allocated. However, good work was being done as demonstrated by the service the team provided during the Fukushima NPP events. New areas such as Transfer Coefficient Matrix (TCM) are promising for the work on ERA. He also suggested that with the number of new people in this meeting, effort should be made to explain acronyms if necessary.

2. ORGANIZATION OF THE MEETING

2.1 Adoption of the agenda

The meeting adopted the agenda with a few modifications as found in Annex I.

2.2 Working arrangements

2.2.1 The meeting agreed on the organization of its work, including the working hours. All pre-session documents can be found via the Documentation Plan (INF. 1) on the WMO website at: http://www.wmo.int/pages/prog/www/DPFS/Meetings/ET-ERA_Vienna2018/DocPlan.html.

2.2.2 The list of participants is available in Annex II.

3. INTRODUCTION

3.1 Outcomes of CBS-16 (November 2016) and EC-70 (June 2018) related to ERA

Mr Harou, Chief, Data-Processing and Forecasting System (C/DPFS), recalled that since the last meeting of the ET-ERA held from30 November to 5 December 2015 in Buenos Aires (Argentina), there were a series of Constituent Bodies sessions with decisions related to ET-ERA. These sessions were: a CBS-16 Session in Guangzhou (China, November 2016); the 69th Session of the Executive Council (EC-69, June 2017), a Technical Conference (TECO) and 18th Session of CBS MG (March 2018) and the 70th Session of the Executive Council (EC-70, June 2018).

(a) CBS-16 (November 2016):
- Recommended the inclusion of Non-nuclear ERA in the Manual of GDPFS;
- Decision to apply a peer review process to the "Guidelines on Meteorological and Hydrological Aspects of Siting and Operation of Nuclear Power Plants", previously known as TN 170 "Meteorological and Hydrological Aspects of siting and operation of Nuclear Plants (WMO-No. 550)";
- The revised Manual on GDPFS (WMO-No. 485) was recommended for approval by EC-69;
- Recommended the designation of Beijing as RSMC for Atmospheric Sand and Dust Storm Forecast (ASDF).

(b) EC-69 (May 2017):
- Approved the inclusion of Non-nuclear ERA in the Manual on GDPFS;
- Approved the formal designation of RSMC-ASDF Beijing (Regional Association (RA) II);
- Approved the Manual on GDPFS for publication (published in February 2018).

(c) TECO CBS MG 18th Session (March 2018):
- CBS, normally holds an extraordinary (every two years) and a regular sessions (every 4 years). At CBS-16, there was a decision not to hold an extraordinary session and that CBS will hold only regular sessions (once every 4 years) like any other Technical Commission. Therefore, with the Congress approaching and considering that EC-70 would be the last EC before the next WMO Congress in 2018, it was decided to organize a TECO followed by a CBS MG meeting to ensure that issues are brought to EC-70 for consideration and eventually taken to Congress 18 for decision. The following Recommendations and decisions were made:
- Recommended the following designations of centres for nuclear and non-nuclear emergency response: Offenbach (Germany) for nuclear and Toulouse (France) and Offenbach for non-nuclear;
- Decision: President CBS to "contact specific PR in view to identifying appropriate resources (people) to complete the development of the TCM within the ERA programme and define procedures to be integrated into the Manual", thus addressing the request of Cg-17.

(d) EC-70 (June 2018):
- Approved the CBS recommendations listed above.

3.2 Information on the new Manual on the GDPFS (2017)

Mr Servranckx reviewed the revised Manual on GDPFS (WMO-No. 485) and highlighted the various sections related to ET-ERA. He noted that the RSMCs of SDS-WAS centres are not reporting their status to the ET-ERA which, according the Manual, is the body responsible for

checking their compliance with the requirement for designation in the Manual on GDPFS. This is related to the Activity 2.2.2.9 in the Manual.

3.3 Report of the Chair and co-Chair on nuclear and non-nuclear ERA, respectively

Nuclear

3.3.1 The Chair, Mr Muscat, recalled that the nuclear ERA programme has been in place for over 25 years. A key component of the work of the ET-ERA is to maintain real time operational response readiness and capacities, in accordance with the roles and responsibilities defined in the Manual of the GDPFS. New activities and products are also examined as ways to improve existing products and to use better delivery mechanisms.

3.3.2 The chair reported that some of the ongoing activities include:

(a) Monthly and quarterly testing between the IAEA, RTH Offenbach and the RSMCs;
(b) Testing and maintaining RSMC common Web pages;
(c) Modelling for CTBTO requests;
(d) Maintaining and updating the WMO ERA web pages;
(e) Testing potential new products, such as the ToA.

3.3.3 A major emergency response exercise – ConvEx-3 (2017) – took place in June 2017. Lead by RSMCs Toulouse and Exeter, all RSMCs participated and provided the suite of standard RSMC products to the IAEA and NMHSs in their respective areas of responsibility. Additionally, the ConvEx-3 (2017) exercise was used as a vehicle to further test the ToA products that are being developed by the RSMCs. Not all RSMCs were able to take part in the ToA test but many were. Also as part of the ConvEx-3 (2017) exercise, following a request from the IAEA, RSMCs Toulouse and Exeter directly provided to the IAEA additional (non-standard) products relating to high resolution modelling and dispersion charts for the affected area.

3.3.4 Regarding designation as a RSMC with responsibilities for nuclear ERA, during 2018 Germany expressed their interest in this and produced documentation on their capabilities against the designation criteria. After a review by the ET-ERA, CBS Management Group 18 (March 2018) recommended the designation of RSMC Offenbach. This was approved by WMO Executive Council 70 in June 2018. Congratulations to Offenbach which became the tenth RSMC with activity specialization to be designated in nuclear ERA.

3.3.5 Most recently, the concept of the TCM approach to dispersion modelling has begun to move forward significantly. Following discussions with WMO, representation was made to RSMC Washington to further develop a website that would allow results from all RSMCs to be hosted and displayed.

Non-nuclear

3.3.6 Mr Servranckx recalled that discussions on non-nuclear ERA began in the late 1990s. The growing need and interest by WMO members for non-nuclear support lead to the establishment of the Expert Team on Modelling of Atmospheric Transport for Non-Nuclear Emergency Response Activities in 2005.

3.3.7 In the years that followed, the Expert Team gradually developed the scope and concepts for non-nuclear ERA operational support. This led to a meeting of the CBS Task Team on the Development of Operational Procedures for non-Nuclear Emergency Response Activities (Melbourne, Australia, November 2012) and the development of a draft set of operational procedures, guidelines and request form for RSMC support for non-nuclear ERA.

3.3.8 Discussions at the ET-ERA meetings in 2013 (College Park, USA) and 2015 (Buenos Aires, Argentina) led to testing the draft non-nuclear ERA procedures in early 2016, and fine-tuning

the texts to be included in the Manual on the GDPFS (WMO, 2017). These were approved by CBS-16 (November 2016). CBS-16 also invited Member States to submit candidacies for the designation of new RSMCs with specialization in non-nuclear ERA.

3.3.9 Germany and France expressed their interest and produced documentation on their capabilities against the designation criteria. After a review by the ET-ERA, CBS Management Group 18 (March 2018) recommended the designation of RSMCs Offenbach and Toulouse. This was approved by WMO Executive Council 70 in June 2018. Congratulations to these two centres who become the first to be designated with activity specialization in non-nuclear ERA.

3.3.10 Mr Servranckx concluded by inviting all members of the ET-ERA to participate in the discussions at the meeting and, as importantly, to actively contribute to the follow up actions that the group will agree to. How much can be accomplished and how quickly are highly dependent on the involvement of each member of the ET-ERA.

4. NUCLEAR ERA

4.1 Review of actions from previous meeting (Buenos Aires, Argentina, 2015)

The meeting reviewed the action items from the last meeting of ET-ERA in Buenos Aires (Argentina, Dec 2015). The result of the review is attached in Annex III.

4.2 Status of operational implementation and activities of RSMCs and RTH Offenbach

4.2.1 Each centre reported on the current status of their operational implementation and activities. Their respective progress report is available on the following website: http://www.wmo.int/pages/prog/www/DPFS/Meetings/ET-ERA_Vienna2018/DocPlan.html. All actions and recommendations proposed in the meeting are listed and available in Annex IV.

4.2.2 The reports also provided the latest operational contact information as shown in Annex V.

4.3 Cooperation with other international organizations (IAEA, ICAO, CTBTO, WHO)

CTBTO

4.3.1 Mr Bourgoin provided a background on the CTBTO operation and linkages with the ET-ERA. He reported that the detection of noble gas is becoming increasingly important. CTBTO is interested in requesting Source Receptor Sensitivity (SRS) associated with significant noble gas detections (in the order of 5 to 10 per year). Currently, the agreement with WMO calls only for support for particulate detections at level 5.

4.3.2 This request requires the amendment of the MOU between WMO and CTBTO.

4.3.3 Mr Bourgoin informed the meeting that a tool using infrasound data to detect volcanic eruption called the Volcanic Information System is ready for operational testing. He wondered if the team can use this information. This issue has been of interest to ICAO for many years and the meeting felt that this issue is interesting but should rather be referred to ICAO/VAACs.

4.3.4 CTBTO would like to work in the area of assessment of uncertainty. CTBTO was looking for name(s), from each RSMC, of individuals who have a background in ensemble forecasting and who could collaborate with them.

4.3.5 CTBTO enquired about the possibility of a transition to an increased resolution of the global operational simulations. It is to be noted that CTBTO can accommodate a mix of SRS at 0.5 and 1.0 degree resolution so that not all RSMCs have to migrate at 0.5 degree at the same time.

4.3.6 CTBTO explained why only some Met obs from CTBTO sites are being disseminated through GTS. Ways to feed more CTBTO data to GTS of WMO are to be explored. Initial discussions on this subject were held with WMO and the meeting recommended continuing the discussion with WMO for the appropriate solution.

4.3.7 CTBTO was also interested in receiving real-time, 24/7 meteorological support for their On-site Inspection (OSI) activities which could last over 130 days, at time. The meeting understood CTBTO's need in this regard but expressed concerns about the workload that it represents, in light of limited resources at NMHS. The meeting suggested that CTBTO may wish to explore the possibility of funding this activity or hiring its own meteorologists to provide the service.

IAEA

4.3.8 Mr Florian Baciu of IEC and his colleague, Mr Sanjoy Mukhopadhyay, joined the meeting. Mr Baciu raised the issue of how to deal with a variety of products coming from RSMCs which are shared on the websites. Also other products are coming from different NMHSs. He needs to work with the ET-ERA to formulate a way to use these products, particularly those from NMHSs. He suggested the establishment of a working group with ET-ERA to address this issue. Major question is what the best wording is on how the NMHSs products will be used.

4.3.9 He announced that a technical meeting is planned for next year (2019) to discuss advances in Emergency Response with a topic on ATDM and the involvement of ET-ERA is important. There is a need to support/improve the display of monitoring data and to create a dense image of monitoring data around area of incident, based on the International Radiation Monitoring Information System (IRMIS). This means IRMIS would be required to display high resolution ATDM data.

4.3.10 Mr Winkler reported that since the last ET-ERA meeting in Buenos Aires in 2015, there were a series of regular exercises planned for the RSMCs and the IAEA. In addition, there have been a few ad-hoc exercises for which the IAEA had asked the RSMCs for support. The IAEA runs different type of exercises with its counterparts. Some exercises are conducted by the IAEA to test the availability of the contact points and other exercises are conducted with a specific scenario to test some of the arrangements for emergency response. In addition, the IAEA performs the regular communication test with RTH Offenbach and the quarterly RSMC exercises.

4.3.11 In 2017 the IAEA conducted 13 Exercises with its contact points, 12 Communication Tests with RTH Offenbach, 3 quarterly RSMC exercises and 3 internal Full Response Exercises and a few bilateral exercises with Member States (overall >30 exercises).

4.3.12 He also reported that the regular Communication Tests with RTH Offenbach have been conducted on the 3rd Tuesday of every month, unless there was a quarterly RSMC exercise in parallel. In this case, the actions have been performed as part of the RSMC exercise. According to IAEA records (on USIE Exercise), all tests have been performed but not in April 2017 and April 2016. Overall, their communication tests worked fine, but the majority of replies were sent to IEC7 instead of IEC23.

4.3.13 The meeting noted that for 2016 and 2017 there was an agreed schedule for the quarterly RSMC exercsie which established in the ET-ERA meeting in Buenos Aires. For 2018 the IAEA has determined the sequence by itself, and published the exercises calendar – as every year – on the USIE web-site. Two major deviations from the exercise plan happened and the two events were linked. The first deviation was the cancellation of the exercise in November 2017 since the IAEA failed to identify a host Member States which had no objection to use one of the nuclear sites as the release location. There were some messages exchanged on the issues. The IAEA took extensive actions to get Member States' commitment and consequently positive commitments were obtained for the exercise in May, which was however, not planned for the relevant region. This was overlooked by the IAEA, and this constituted the second deviation from the exercise plan.

4.3.14 He provided below the proposal for the quarterly RSMC exercises for 2019 and 2020.

(a) Feb 2019: RSMC Montreal and Washington
(b) May 2019: RSMC Melbourne
(c) Aug 2019: RSMC Exeter and Toulouse
(d) Nov 2019: RSMC Bejing, Obninsk and Tokyo

(e) Feb 2020: RSMC Exeter and Toulouse
(f) May 2020: RSMC Montreal and Washington
(g) Aug 2020: RSMC Bejing, Obninsk and Tokyo
(h) Nov 2020: RSMC Melbourne

4.3.15 He reported that the IAEA conducted the ConvEx-3 based on a scenarion at the Paks NPP in Hungary, in June 2017. Since the WMO was involved and a quarterly RSMC exercise was scheduled for the same region just a month before, it was decided to combine these two events and only ask for RSMC support for the ConvEx-3 exercise in June. In parallel this event was used to run the ToA test by most RSMCs, however, this test run was not part of the operational arrangements for the ConvEx-3 exercise.

4.3.16 He added that support for an IAEA Full Response Exercise, which are purely internal exercises, was requested off-line form RSMCs Toulouse and Exeter, which were provided before our exercises and the IEC adapted the products (the dates were changed) for use in the internal exercise.

4.3.17 The detection of Ruthenium 106 in air over parts of Europe in Octoberr 2017 and consequently lead to a request for back-tracking calculations from RSMCs in Exeter and Montreal, which provided several outputs and in different formats which allowed IAEA to present the results in an impressive way to the Senior IAEA management.

4.3.18 The meeting was informed that the Secretariats of the WMO and IAEA have worked on an revised Memorandum of Understanding and it was signed by the WMO Secretariat in September this year. At the time of the meeting, the MoU was being cleared in the IAEA Secretariat and would be signed by the Deputy Director General for Nuclear Safety and Security.

4.3.19 He concluded his presentation by a request to the staff of RTH Offenbach to use the IEC23 email address and by noting that IAEA still gets confirmations from non-lead RSMCs at times, and certain messages (confirmation of receipt of request) from one of the RSMCs are still received 9 times.

ICAO

4.3.20 In the absence of the ICAO representative, Mr Servranckx presented the paper submitted jointly by ICAO and the co-Chair. He recalled that the question around the possible use of modelling as guidance to write radioactive cloud SIGMET in a timely matter was discussed at the last ET-ERA meeting. It is part of a long-standing collaboration between IAEA, ICAO and the WMO to solve this difficult problem. The IAEA's Inter-Agency on Radiological and Nuclear Emergencies created in November 2015, at the request of WMO and ICAO, the Task Group (TG) on the *Development of Criteria to Support the Issuance of SIGMET in Case of a Release of Radioactive Material into the Atmosphere*. The Task Group's report was submitted in 2017.

4.3.21 The TG's report was presented at the ICAO Meteorology Panel's (METP) Meteorological Information and Service Development (MISD) Working Group on the Release of Radioactive Material (RRM). The MISD RRM deals specifically with the topic of radioactivity and aviation. The key points of the report are:

(a) Dose and plume projection tools are not considered suitable to define the radioactive cloud SIGMET for reasons detailed in the report;

(b) The radioactive cloud SIGMET meet the requirement by using a cylinder covering all flight levels and with a fixed radius (i.e. not time dependent) of up to 30 km*. This corresponds to IAEA emergency planning zones, but applied to aviation, and is based on very conservation assumptions:

- The radius that IAEA uses to define the “urgent protective action zone” at the surface (typically 30 km) is based on a worst-case scenario where a large amount of radioactivity is released over a 10 hr period and the corresponding predetermined estimates of the health hazard (i.e. calculated before the NPP is built, based on the characteristics of the reactor);

- The health hazard is determined from modelling calculations of the total dose (cloud shine, inhalation and ground shine) received in the first seven days after the start of the release (IAEA Safety Standards Series No. GSR Part 7) and the very conservative assumption that the most sensitive person (young child) is breathing the radioactive material directly throughout the duration of the 10-hour release.

  * This must not be interpreted to mean that radioactive material is not transported outside of the 30 km radius. Obviously, it is but from a health perspective (total dose), it is not a danger for the passengers of the aircraft.

(c) An important consequential impact of the report is that phases 2 and 3, on the use of source term estimates and ATDM to calculate airborne radioactivity concentrations and/or doses, are no longer needed in the Concept of Operations for Radioactive Material Information Services in Support of International Air Navigation. From an international civil aviation perspective, there is therefore no justification for ICAO or WMO to pursue efforts or continue to inject resources on these;

(d) There are also important consequential impacts in regard to the radioactive cloud SIGMET in Annex 3 to the Convention on International Civil Aviation.

4.3.22 The MISD-3 meeting approved these and included them in their report. Some members did not agree and indicated that they would continue with ATDM development for aviation. Paragraph 3.2.1.1 in the MISR-3 RRM report summarizes it nicely as follows: “The meeting was reminded that the MET Panel had asked for the IACRNE report and the meeting understood that the reasonable response is for the MET Panel to abide by information in the report when considering changes to ICAO’s provisions of MET information. But the meeting understood that it is within the rights of States to continue to improve modelling efforts or to close airspace (i.e., danger area) in the event of a radiation release”.

4.3.23 Following the MISD-3 RRM decisions, a proposal to always use and only use (i.e. no other option) a fixed radius cylinder for all radioactive cloud SIGMET* was accepted by the MISD-4 RRM meeting and will be submitted to the next meeting of the METP in September 2018. The meeting also decided that a major revision of the Concept of Operations for Radioactive Material Information Services in Support of International Air Navigation should be undertaken based on the decisions taken at MISD-3.

* An option to use a cylinder with fixed radius for the radioactive cloud SIGMET was added to the SIGMET template in the latest version of Annex 3 that includes Amendment 78. Note 24 of the template says: "Only for SIGMET messages for radioactive cloud. When detailed information on the release is not available, a radius of up to 30 kilometres (or 16 nautical miles) from the source may be applied; and a vertical extent from the surface (SFC) to the upper limit of the flight information region/upper flight information region (FIR/UIR) or control area (CTA) is to be applied. [Applicable 7 November 2019]".

4.3.24 The METP-4 (10-14 September 2018) meeting accepted the proposed amendment to the radioactive cloud SIGMET in Annex 3. It will be included in the draft Amendment 79 to Annex 3 applicable in November 2020.

4.3.25 In light of the above the actions 15 and 16 of the last ET-ERA meeting in 2015 were completed.

4.4 Improved product distribution / access methods

RSMC Montreal

4.4.1 Ms Biljiana Bekcic discussed the issue of using the fax to send products from RSMC Montreal to NMHS contact points. She reported that this process was fraught with errors noting that there is also a high rate of failure, exceeding 85% of fax addressees in RA III and IV. This was felt unacceptable, in view of the cost of the required web-based fax service. She indicated that in the few instances where fax transmission to addressees in RA III and IV succeeded, it was redundant. Addressees which did receive faxed notifications and black-and-white modelling products from RSMC Montreal were already receiving the same items by email or through the RSMC mirror web pages with their coloured products.

4.4.2 She noted that the issue was presented and discussed at several meetings of the ET-ERA, most recently the 2015 meeting in Buenos Aires. Recognizing RSMC Montreal experiences with fax transmission may differ from that of other RSMCs and that the Manual on the GDPFS does not specify that faxing of products by RSMCs to either IAEA or NMHS contact points is mandatory (the Manual states that email is preferred, and allows for the use of other appropriate technologies) and that, since 2012 to the present, there have been no requests that RSMC Montreal transmit products by fax, the RSMC decided that it will no longer fax notifications or products, unless faxing is specifically requested, or required due to failure of email and internet transmission systems.

4.4.3 She indicated that notifications and other items faxed to RSMC Montreal will continue to be received normally.

Modifications to the Checklist for the Verification of RSMC Common/Mirror Web pages

4.4.4 Mr Servranckx reported that after each IAEA-RSMC quarterly test, one of the lead RSMCs checks all the common/mirror web pages, fills the checklist and reports back to the ET-ERA. The problems identified are then fixed regularly by the RSMCs but a few persistent/recurring problems still need to be addressed. A modification to the checklist was proposed 1) to include the need to fix these problems as soon as possible but no later than the next quarterly test, and 2) to report back on the fixes to the ET-ERA.

4.4.5 The meeting discussed the proposal and agreed on the proposed changes to the checklist as per Annex VI.

4.5 New products and services based on user’s requirement

Update on the RSMC TCM Website Development

4.5.1 Mr Rolph presented the concept of the TCM which was developed during the Fukishima Nuclear Power Plant accident. He recalled that the problem identified during Fukushima Response included a) Initial response was with the RSMC default scenario; b) 72 hr simulation, 6 hr unit source release of 137Cs up to 500 m; c) Model was reinitialized every 6 h with new forecast data and was rerun as more information was received (source term) and d) Complexity and number of simulations exceeded some centres’ operational capability. A solution to improve modelling flexibility during next major event must be found.

4.5.2 He indicated that an approach is needed to handle changing source term without having to rerun the model each time and that model should be run from start of release through current time and then forecast into the future. In 2012, RSMC Washington developed and published the Transfer Coefficient Matrix (TCM) approach after Fukushima and was successfully demonstrated by the WMO Task Team on Meteorological Analyses for the Fukushima-Daiichi NPP Accident in their report in 2013.

4.5.3 The advantage of this approach resides in the fact that each 6hr release calculation is independent (multi-processor); Each simulation is updated to current time and then for 78 hours of forecast (no need to rerun from the initial release time); The emission rate and decay are applied in a post-processing step; it allows for quick updates given changes in emission scenarios TCM computed for non-depositing & depositing gases, and small & large depositing particles; Each species is assigned to one of these 4 “particles” in post-processing step; TCM contains the contribution from each release to each receptor location; it allows for modifying release to better match measurements and that all models use the same recommended output format. Mr Rolph’s presentation and paper are available in Annex VII for reference.

4.5.4 Mr Rolph demonstrated the capability of the TCM website and the meeting discussed various aspects of this approach and how to adopt it.

Time of Arrival (ToA)

4.5.5 Mr Aranami presented, on behalf of Mr Masami Sakamoto, the results of a joint test of the Time of Arrival (ToA) which was held in June 2017, coinciding with ConvEx-3. This activity was triggered by the Action 18 of the ET-ERA meeting, Buenos Aires, Argentina, November – December 2015. The Action was for IAEA and WMO experts to coordinate a test of ToA products. The experts were from RSMC Obninsk (Mr Kosykh), RSMC Japan (Mr Sakamoto), IAEA (Mr Winkler) and RSMC Vienna (Mr Wotawa). The experts were to a) Produce document to define and clarify details and specifications for next ToA test to ensure consistency between RSMCs products; b) Conduct new test and c) IAEA to propose threshold value for cloud boundaries.

4.5.6 Mr Sakamoto took the lead and organized practical procedures for the participants of the joint test, and issued an instruction note by the end of May 2017. Mr Aranami recalled that a) the ToA product should be used to identify when a sufficient activity concentration is reaching a point in space so that the relevant authorities can decide to start the radiation monitoring programme. He noted however that when the authorities take the above action they will likely use mobile equipment which may not be so sensitive and therefore the value should not be too low. If it is below the detection limit, they will not agree with RSMCs that the plume has arrived.

4.5.7 The results of the test were described in details in Mr Sakamoto’s document 4.5(2) of the meeting and available as Annex VIII

4.5.8 The team discussed the results and came up with a series of actions and the recommendation which can be found in Annex IV.

4.6 Capacity development and outreach

RSMC Tokyo

4.6.1 Mr Aranami, presented on behalf of Mr Sakomoto, Leader of ERA, RA II / WGWS / EG-OF, information on the Emergency Response Activities (ERA) within the Regional Association II (RA II, Asia), and introduced the result of a user survey conducted in 2016. Main objectives of the ERA in the region are to:

(a) monitor the provision of products and services by RA II GDPFS centres within the framework of the Emergency Response Activities (ERA) Programme;
(b) advise on evolving requirements for ERA operational systems and services.

4.6.2 Mr Sakamoto of Japan Meteorological Agency (JMA) was re-appointed as Leader in ERA (L-ERA) at the Twelfth Session of Regional Association II (ASIA) Management Group in Geneva, May 2017. In 2006, the RSMCs in the region (RSMCs Beijing, Obninsk, and Tokyo) agreed on the arrangement for the joint response of the Environmental Emergency Response (EER), and formed the Memorandum of the RSMCs for EER in RA II. The memorandum has been updated a) to deal with the web-based distribution of the products effectively, and b) to enhance cooperation to achieve good reachability to the registered Members. In June 2015, the 17th World Meteorological Congress (Cg-17) noted the user request survey on ATDM products in RA II. The survey was successfully conducted in 2016, and the results were presented as part of the progress report at the 16th session of Regional Association II (Asia) in Abu Dhabi, 12–16 February 2017.

4.6.3 The survey materials were reviewed by experts in ET-ERA and RA II, and officials of WMO Secretariat were also asked for their advice. The survey was administered to all 35 Members of which 29 were registered. The survey was successfully conducted with 17 Members (59%) responded to the questionnaire. Of note, 71% responded that they have specific operations using the EER service, and 82% of respondents were satisfied with the current EER service in RA II. 62% thought that the exercise frequency was appropriate (noting that a similar survey was administered in 2012). 41% respondents needed the fax service of ERR. 76% were satisfied with the common web service. As for the new products, 76% thought the Time of Arrival (ToA) is a useful addition to EER service, while 53% supported the TCM products. In conclusion, RA-II Members are very satisfied with EER.

4.6.4 The meeting noted that RSMCs in RA II continued the email / fax test to the registered members once a year. Therefore, the contact information has been confirmed three times a year. This effort maintains good reachability (95% via email or fax), and the activity also provides the opportunity of dialogue between RSMCs and the registered Members.

4.6.5 The planned actions regarding ERA include “Conveying appropriate requests from Members to the CBS Expert Team on Emergency Response Activities (ET-ERA)”, and to “provide Members with a concise guidance for the transition to the new Manual on Global Data-processing and Forecasting System (GDPFS) in particular in the area of the Environmental Emergency Response (EER)”.

4.6.6 Mr Aranami reported that some of the registered Members in the region have asked the Lead ERA to inform them of the exercise schedules beforehand, especially when WNXX01 IAEA is sent through GTS. Therefore the Lead ERA keep them informed not only on the scheduled exercises but also on unscheduled ones like Convex conducted by IAEA.

4.7 Ensemble atmospheric transport modelling

4.7.1 Mr Wotawa of the Zentralanstalt für Meteorologie und Geodynamik (ZAMG), reported on the successful two ATM challenges to predict radioxenon background levels at International Monitoring System (IMS) radionuclide stations of CTBTO in the last three years (2015 & 2016) and that a third more comprehensive exercise event is being planned for late autumn/winter 2018/2019. As for the last exercise, the runs will largely be accomplished in a unit emission/Transfer Coefficient Matrix approach. RSMCs are invited to participate in the forthcoming exercise to test their Transfer Coefficient Matrix capabilities.

4.7.2 He recalled that ZAMG has been designated by WMO as Regional Specialized Meteorological Centre (RSMC) Vienna (backtracking only) since July, 1st, 2011 and supports the CTBTO verification system with inverse atmospheric modelling activities on a global scale. In addition, ZAMG was nominated as Austria’s Provisional National Data Center (NDC-AT) by the Austrian Federal Ministry for Foreign Affairs on July, 20th, 1999, in the context of CTBTO’s verification network. Over the years there has been tight collaboration with the International Data Center (IDC) beyond day-to-day verification activities. Specifically, after the Pacific Northwest National Laboratories (PNNL, Richland/Washington, US) launched a first modelling comparison

exercise in 2015, ZAMG, together with the IDC, has developed this idea towards more comprehensive scenarios.

4.7.3 Mr Wotawa provided the following contact information for the NDC-AT

NDC-AT
Zentralanstalt für Meteorologie und Geodynamik
Hohe Warte 38
1190 Vienna
Austria

Business contact: Dr. Gerhard Wotawa
Tel : + 43 1 36026 - 2002
Fax : + 43 1 3691233
Email : gerhard.wotawa@zamg.ac.at

Operational contact: Dr. Christian Maurer
Tel : + 43 1 36026 - 2012
Email : christian.maurer@zamg.ac.at

4.7.4 The meeting was informed that the transition from merely scientific case studies to forecasting radioxenon background at selected IMS stations for the practical use in calibration and performance assessment of the verification system as described in the Comprehensive Nuclear Test-Ban Treaty (CTBT), is the goal which should be accomplished in a 3rd challenge, specifically with the emphasis on multi-model ensemble modelling. According to work done by the European Joint Research Center (JRC) in Ispra/Italy there is the possibility to train - after being corrected for redundancy - an optimal (reduced) ensemble per station if sufficient data is available. For a corresponding ensemble training period (around 2/3 of the total period) it is extremely important to involve as many above Minimum Detectable Concentration (MDC) values and as many as known sources as possible. This is the main goal of the current challenge and should be exemplified for the four selected IMS stations CAX17 (St. John's), DEX33 (Schauinsland/Freiburg), SEX63 (Stockholm) and USX75 (Charlottesville). The ultimate goal of the atmospheric transport modelling exercise is to provide an ensemble analysis of radioxenon background levels at IMS stations frequently hit by industrial emissions. Analysts at the NDCs should ideally be able to identify the source of an event and be able to associate it with known sources whenever possible as they conduct their task of screening the IMS observations for possible nuclear explosion signals.

4.7.5 The meeting noted that Xe-133 stack emission data up to hourly resolution for the time period June until November 2014 from the IRE and CRL radiopharmaceutical plants in Fleurus (Belgium) and Chalk River (Canada) is currently gathered and forms the basis of the exercise. In addition, publicly available most recent quarterly and annual global nuclear power plants emissions from 177 facilities and from around 20 research reactors distributed over the Northern hemisphere including their operating factors as well as the annual emissions from the Mallinckrodt facility (the Netherlands), the NIIAR facility (Russia) and the Karpov Institute (Russia) will be used to refine predictions. IMS station data as well as IRE and CRL emission data can be requested from CTBTO via https://www.ctbto.org/specials/vdec/. Access to these confidential data is not mandatory in order to participate in the exercise since evaluation will be performed by the scenario team (namely ZAMG and IDC). However, access to the data is needed if RSMCs just would like to test their unit emission capabilities independent from the universal output data format developed within the previous exercise. In this case RSMC runs could also not be considered in the ensemble methodologies mentioned above to be tested in the 3rd ATM Challenge. The same is true if the simulated time period per station is below three months as this is considered to be the minimum time period necessary in order to train an ensemble.

4.7.6 He informed the meeting that participants will calculate contributions to the signal at CAX17, DEX33, SEX63 and USX75 for up to 6 months (proposed time frame, but not mandatory) based on a unit emission approach for emissions of IRE and CRL and based on actual emissions

for the minor emitters. The primary reason for introducing the unit emission approach in the CTBTO context was to prevent participants, having largely access to the IMS observations, to be guided by any expectations when comparing their results with the measurements. Besides, it enables a larger group to participate in an exercise based on confidential stack emission data. Inclusion of the minor sources (reactor releases and small radiopharmaceutical facilities) is an option but not mandatory. Output will have to be delivered in a prescribed ASCII format for the four selected IMS stations for at least three months. In essence output files contain a sensitivity value per release, per collection time (24 or 12 hours depending on the measurement system) and per IMS station.

4.7.7 The plan for 2019 is to perform and evaluate the results of the 3rd ATM Challenge.

4.7.8 The discussion that followed Mr Wotawa's presentation confirmed the participation at this exercise by RSMC Exeter while the other RSMCs will provide their decision a bit later.

4.8 Review of current procedures and standards, with a view of developing proposed amendments to the Manual on the GDPFS (WMO-No. 485) as needed

4.8.1 The Chair, Mr Muscat, outlined a proposed change to the format of the request form issued by the IAEA to WMO RSMCs during an emergency. The purpose of such a change was to enhance the clarity of the information passed by IAEA to the RSMCs.

4.8.2 The Chair recalled that, in the event of an environmental emergency, involving the release of a pollutant into the atmosphere, the International Atomic Energy Agency (IAEA) can request assistance from the WMO RSMCs (Regional Specialized Meteorological Centres) with responsibility for ATDM (Atmospheric Dispersion and Transport Modelling). The request for assistance is delivered through the Environmental Emergency Response Request for WMO RSMC Support by the IAEA form. He highlighted the importance of ensuring that a request for assistance should necessarily contain a considerable amount of information that should be passed by IAEA to the RSMCs in order that dispersion models can be adequately initiated, and results of these model simulations are passed back to the IAEA and other users.

4.8.3 The current request form has been developed over a period of years, modified by the adoption of small changes that have been suggested by both the IAEA and RSMCs. As a result, it could be argued that the clarity of the information contained in the request form has, over time, been degraded. This is reflected in the fact that, on a fairly regular basis, RSMCs have been known to initiate their dispersion models with incorrect source term information as a result of misunderstanding (or misreading) the request form.

4.8.4 It is the view of some of the ET-ERA members that the information on the request form could be made clearer by adopting a more tabular approach on the form, especially when considering the source term information. In addition, a general "clean-up" of the form could be undertaken in order to address some anomalies that have arisen over the last few years, e.g. related information appearing in different sections of the form. Therefore a proposed new form was shared with the ET-ERA Members for their comments.

4.9 Status of the revision of the WMO Guidelines on Meteorological and Hydrological Aspects and Operations of Nuclear Power Plants

4.9.1 Mr Servranckx, briefed the meeting on the status of the revision of the WMO *Guidelines on Meteorological and Hydrological Aspects of Siting and Operations of Nuclear Power Plants*, previously referred to as WMO Technical Note No. 170, started in 2013 at the request by WMO Congress 16. He explained that the revision was needed because the original document was outdated (produced in 1985) and there was a desire to have a close correspondence between The Guidelines and IAEA's Specific Safety Guide No. SSG-18 (*Meteorological and Hydrological Hazards in Site Evaluation for Nuclear Installations)*, a document jointly sponsored by the IAEA and WMO.

4.9.2 He informed the meeting that the draft document was reviewed by WMO Technical Commissions and Members and most of the comments were integrated except for the one from the Commission of Hydrology which needed a bit more work. He confirmed that the Guidelines will be finalized by mid-November 2018 by the co-Chair in consultation with various experts. It will be distributed to the members of the ET-ERA once approved by the President of CBS and published on the WMO library.

4.10 Potential collaboration with new JCOMM Expert Team on Marine Emergency Response

4.10.1 The planned document to be discussed was not submitted by the JCOMM Expert Team on Marine Emergency Response (JCOMM ET-MER).

4.10.2 In the interest of understanding the requirements of ET-MER, Secretariat will check with JCOMM and MMO colleagues for the possibility of setting up a teleconference with the Co-chairs of ET-ERA to discuss areas of collaboration.

5. NON-NUCLEAR ERA

5.1 Review of actions from previous meeting (Buenos Aires, Argentina, 2015)

5.1.1 The meeting updated actions items related to the Non-nuclear ERA. The updated list of actions items is available at Annex IX. Ongoing actions were integrated with these meeting actions and available in Annex X.

5.1.2 The meeting discussed the availability of information on the contacts at NMHSs to which the RSMCs are providing service. The issue related to the European Union Policy on posting of people information on the web was discussed and as well as the RSMCs web mapping capabilities.

5.2 Status of operational implementation / activities of RSMCs

RSMC Offenbach

5.2.1 Mr Forstner reported on the application of RSMC / RTH Offenbach to become a RSMC for Non-Nuclear Environmental Emergency Response. He summarized the capabilities of the online-coupled dispersion modelling system ICON-ART used at DWD.

5.2.2 He reported that the submission of DWD's application to the WMO ET-ERA for consideration took place in Q1/2018. After valuable comments from the chair and co-chair respectively, the group and some iteration of the application document it got the approval by the Presidents of CBS and of WMO RA VI before finally being approved by WMO EC-70 in June 2018.

5.2.3 He explained that the main aspects of the non-hydrostatic atmospheric modelling framework ICON (Zängl et al. 2015) and ICON-ART (Rieger et al. 2015) and the implementation status of the system were provided in the document on DWD's application to become a RSMC for Nuclear Emergency Response.

5.2.4 The non-nuclear emergencies listed in the WMO Manual are smoke from vegetation fires, smoke from industrial fire and chemical releases not involving fire. The use cases differ in the requested forecast durations (vegetation fire: 36 h, industrial hazards: 12 h) and therefore implicitly in the envisioned regional scale for the hazard. Especially for the industrial hazards a high-resolution forecast on a limited area is to be asked for. In this respect two capabilities of ICON, respectively of the dispersion modelling system ICON-ART which inherits these capabilities, are of particular interest. The first one is the option to employ mesh refinement in form of two-way nests for specific geographical regions, e.g. among other reasons to better resolve local topographical

effects. The second one is the option to run the model in a limited area mode (LAM). It is planned at DWD to replace the current regional model COSMO-D2 with ICON-LAM on the D2 domain at a resolution of approximately 2 km in 2020. The first application of ICON-ART-LAM in Q1/2020 will be the pollen forecast on a European domain at 6.5 km resolution.

5.2.5 For both options time is a serious constraint in case of an emergency. The grid definition and external parameters for the individual nest region or limited area domain must be available. For the latter option boundary data must be provided in addition. Both options can be combined, i.e. it is possible to have nests also in the limited area model. In principle it is possible to start a nest region during runtime, but it is more convenient to start from available analysis and first guess fields. At the moment the dispersion simulations would be done using the grid configuration of the current global operational NWP at DWD, i.e. at a resolution of 13 km.

5.2.6 With the operational implementation of ICON-LAM at DWD initial and boundary data will be available at least on an hourly basis for the domain of interest. The system is highly configurable for a wide range of applications (Schröter et al. 2018) via XML files, where tracers including their specific metadata as well as emission sources can be defined, while in general there is no need to recompile the code. The emission scenario is as well specified in an XML file and read in by ICON-ART. The file consists of one or more source definitions for specific points, where the start and end time, the bottom and top height, the released substance and its source strength are specified. In addition, a vertical profile in relation to a normalized height can be specified. The formula for the profile is parsed within ICON. For the realization of areal emissions, a set of sources for the grid points covering the requested area can be specified.

5.2.7 Mr Forstner concluded his presentation with a set of questions related to the list of chemicals that should be used, the availability of international standards for example for liquid release and to the non-availability of visualization on the grid. A question around an approach to fire from industrial compound and chemical release and heat release was also put forward. Mr Rolph indicated that their model uses heat release and will share the information with Mr Forstner.

RSMC Montreal

5.2.8 Ms Bekcic recalled that RSMC Montreal was designated as an RSMC for nuclear environmental emergency response, sharing joint responsibility for RA III and RA IV with RSMC Washington. RSMC Montreal was actively involved in establishing the modelling and product standards for non-nuclear response, and has participated in all the associated non-nuclear tests and exercises.

5.2.9 The meeting was informed that the responsibility for RSMC Montreal is with the operational Environmental Emergency Response Section (EERS), within National Forecast Operations of the Canadian Centre for Meteorological and Environmental Prediction (CCMEP), in Dorval, Quebec, Canada. This operational centre runs Canada's analysis and forecast cycle with the numerical weather prediction model, GEM (Global Environmental Multiscale), assimilating data with a global Ensemble Kalman filter. Forecasts are produced using the GEM model several times daily at global, regional and high-resolution configurations. The EERS is tasked with providing atmospheric dispersion modelling guidance products in support of emergency response for environmental incidents within Canada, such as forest fires, industrial fires, chemical spills and CRBN incidents. The section also serves as the Montreal Volcanic Ash Advisory Centre (VAAC Montreal), responsible for producing transport model forecasts of volcanic ash within Canadian airspace.

5.2.10 She indicated that two types of dispersion modelling tools are used by the EERS. A simple trajectory model can be run using single particles at one or more levels, in either forward or backward model. MLCD and MLDP are off-line Lagrangian particle transport and dispersion models (D'Amours *et al* 2015), used for incidents requiring plume modelling at local and regional to global scales, respectively. These models are developed and maintained in-house and are

undergoing continual improvement. RSMC Montreal is able to perform atmospheric transport and dispersion modelling and provide products for

(a) forest, grass or peat fires,
(b) major industrial fire,
(c) chemical release not involving fire,
(d) backtracking (retro-trajectories),
(e) other incidents for which emergency response may require guidance based on atmospheric dispersion modelling.

5.2.11 She added that exercises testing the procedures and modelling have been held together with the National Weather Service of Argentina, the most recent being in January 2016. RSMC Montreal is capable of providing guidance products in support of non-nuclear response in adherence of standards outlined in the Manual of GDPFS

5.2.12 She concluded that Atmospheric dispersion modelling capabilities of RSMC Montreal satisfy requirements for non-nuclear environmental emergency response as documented in Manual of GDPFS (WMO-No. 485) and that is why RSMC Montreal confidently submitted its application for the designation of RSMC for Non-Nuclear ERA.

5.2.13 The meeting discussed the information provided by RSMC Montreal and concluded with satisfaction that it meets the requirements identified in the Manual of GDPFS and recommended the designation of RSMC Montreal for Non-Nuclear ERA.

Argentina

5.2.14 Ms Osores briefed on the action taken related to action 1 of the Nov-Dec 2015 ET-ERA meeting in Buenos Aires, Argentina, recalling that the action has to do with the Co-Chairperson, NMHS Argentina, RSMC Montreal to organize and conduct further exercises comprising simulated requests from NMHS to RSMC for assistance covering full set of non-nuclear event scenarios. She indicated that tests for grass fire, chemical incident, industrial fire and backtracking were conducted between NMHS Argentina and RSMCs Exeter and Montreal on 6 and 7 January 2016 and consisting of 4 requests as follows:

(a) Grass fire,
(b) Chemical accident,
(c) Industrial fire,
(d) Backtracking.

5.2.15 She noted that the exercise wasn't supposed to be answered on real time, but date/time of the incident had to be kept real and summarized the results, highlighting the following:

(a) Montreal: Some issues surfaced with email addresses and link provided but through smooth communication between RSMC Montreal and NMHS helped resolved the problem quickly;
(b) Exeter: Results were sent attached to an email in no real time (previously arranged;
(c) Both Centres showed technical capabilities to resolve the whole exercise. Format of the outputs were very different but accessible both for interpretation;
(d) Limitations of the request form: Language;
(e) Limitations of interpretation:
    - Date format: dd/m, mm/dd?,
    - Lack of information about backtracking in TD-778,
    - Useful information about modelling capacities of each Centre at Annex 4 of the Manual, Links to appropriate web pages, if existed, could be useful,
    - Poor resolution/definitions of base map.

5.2.16 The meeting noted the following suggestions resulting from the tests:

(a) Provide as much information as possible on the email body that aids the interpretation;
(b) For example: about source term, uncertainties, quantitative results, resolution/cycle of weather models, limitations of the forecasts, etc;
(c) Attach relevant documentation about models, guidance or any material to assist forecaster in the interpretation of products.

5.2.17 The meeting also noted the following recommendations for next steps:

(a) Establish routine exercises in order to became familiarized with outputs and products delivered;
(b) Necessary guidance in the interpretation of ERA-related products and their application
(c) Update manual WMO-TD. 778, including backtracking of non-nuclear species;
(d) Promote ERA to RA III. We need proper guidance for interpretation. She can assist on the promotion and soliciting that other NMHSs make requests to RSMCs.

RMSC Toulouse

5.2.18 Mr Lalaurette briefed the meeting on the application of RSMC Toulouse to become a RSMC for Non-Nuclear EER. He recalled that Toulouse is already a Regional Meteorological Specialized Centre for nuclear response for WMO RA I and VI (joint responsibility with RSMC Exeter). It provides meteorological support in case of national non-nuclear emergency activity, especially in case of chemical accidents:

(a) 24H/7D support with a crisis operation centre with an operational system completely integrated;
(b) A large number of routine exercises both for nuclear and non-nuclear support for French authorities (on « SEVESO » sites for example).

5.2.19 Different in-house operational Atmospheric Transport Dispersion Model (ATDM) are maintained in operational conditions:

(a) A global ATDM MOCAGE (large scale) can be coupled with global atmospheric model ARPEGE or IFS (see WMO-TD 778);
(b) A local ATDM PERLE (small scale) can be coupled with ARPEGE, IFS or AROME (not used for RSMC purposes at the moment);
(c) ATDM-EPS based MOCAGE/PEARP could also be considered in the future.

5.2.20 Mr Lalaurette shared with the meeting the planned RSMC activities for non nuclear events:

(a) Responsibility for non-nuclear activities for WMO RA I and VI as for nuclear activities;
(b) Same 24H/7D operational organization that is used for nuclear activities;
(c) Proposed activities : all of defined in Appendix A.II.2.29 of the manual on GDPFS;
    - Smoke from industrial fire,
    - Chemical releases not involving fire,
    - Smoke from forest, grass or peat fires (one point-source only at the moment, surface treatment to come later).
(d) The current mirror website for nuclear activities cannot be used.
    - As a first step, products would be disseminated to users by email
    - Requests should include contacts outside the NHMS if any
    - Other procedures would be mirrored on nuclear activities
(e) Proposal : a first exercise should be conducted by the end of 2018/ early 2019

5.2.21 The meeting noted the following operational features for non-nuclear activities:

(a) Alert reception by email from an authorized person with filled form for non-nuclear request as defined by ERA group (Appendix A.II.2.2.9e of the manual on GDPFS);

(b) Situation analysis;
(c) Use agreed default emission source parameters for essential parameters when actual source information is not available (defined in Appendix A.II.2.30);
(d) Run of the well-appropriated ATDM system;
(e) Within 2 hours from the request reception, make available a range of products to the NMHS operational contact point by e-mail or retrieval from the RSMC password protected designated website (list given in Appendix A.II.2.29);
(f) Make available on website up-to-date information on the characteristics of its atmospheric transport and dispersion modelling (ATDM) system.

5.2.22 The meeting also noted that the following planned model developments:

(a) Graphical outputs will be available for 0-200m layer "snapshot concentration charts" (instead of 0-500m for nuclear CMRS "cumulated concentration charts");
(b) 3 hourly outputs will be added to all models;
(c) RSMC will take benefit in the future from:
- the use of a regional ATDM model : PERLE system (based on FLEXPART dispersion module) to get a better resolution
- studies conducted in the frame of COPERNICUS (CAMS)

Requirements for RSMCs with Activity Specialization in Non-nuclear ERA

5.2.23 The non-nuclear ERA programme has matured considerably since the last ET-ERA meeting with the inclusion of procedures in the Manual on the GDPFS and the designation of RSMCs with that activity specialization.

5.2.24 The Manual defines requirements that the designated RSMCs have to meet. They include:
(a) Produce/maintain interpretation guidelines of products for the users (Appendix 2.2.31);
(b) Produce/maintain documentation on the characteristics of the ATDMs and NWP models that are used (Attachment 2.2.5);
(c) Demonstrate/maintain compliance (paragraphs 2.1.7 and 2.2.2.8, Table 17).

5.2.25 For (a) and (b), the Manual mentions specifically to include this information in WMO TD/No. 778.

5.2.26 For (a), the designated RSMCs have to liaise with NMSs in their WMO Regional Association(s) of responsibility, conduct exercises/tests regularly to identify and correct issues and produce annually a report of activities. In that regard, the experience acquired by NMS Argentina and the RSMCs that participated in the 2016 exercises, and that led to finalizing the non-nuclear ERA procedures in the Manual, is certainly valuable.

5.3 Review of current procedures and standards, with a view of developing proposed amendments to the *Manual on the GDPFS* (WMO-No. 485) as needed

The team reviewed the section of the Manual on GDPFS related to the Emergency Response Activities and proposed amendments to the Manual are presented in Annex XI.

5.4 Cooperation with other international organizations (ICAO, WHO)

ICAO and WHO representatives were not present

5.5 Discussion on Vegetation Fire and Smoke Pollution Warning and Advisory System (VSFP-VAS)

5.5.1 A paper submitted by Alexander Baklanov (WMO) on the Vegetation Fire and Smoke Pollution Warning and Advisory System (VSFP-VAS) was discussed. The paper described the

VSFP-VAS as a GAW research project on development, using a similar approach as the realized SDS-WAS project and alerted the ET-ERA of the possibility of this project to be harmonized in the future with GDPFS for the further operational phase.

5.5.2 The meeting noted with appreciation the information and suggested that clear requirements from the project be provided in order to assess the level of involvement of the ET-ERA.

6. ERA WEBSITE CONTENT AND STRUCTURE

6.1 The Co-Chair, Mr Servranckx recalled that with the publication of the revised Manual of GDPFS, the nuclear ERA web pages and WMO TD/NO. 778 now require more important modifications. The need to develop the web pages/WMO TD/No. 778 for non-nuclear ERA is also magnified since it is now part of the Manual and that RSMCs have been designated for this activity.

6.2 The Meeting discussed this issue and decided on the follow-up action for further development on website.

7. ANY OTHER BUSINESS (AOB)

7.1 WMO Reform

7.1.1 Mr Harou presented on the WMO planned reform highlighting the fact that the reform will see the transformation from eight technical Commissions to two. The Two new Commissions will be the Commission for Observation, Infrastructure and Information Systems (COIIS) and the Commission for Services and Applications (CSA) and will oversee the work of Standing Committees, Working Groups/Study groups. The COIIS will have 4 Standing Committees: Earth observing systems and measurement networks; Methods of observations, measurements and instrumentation; Data, products and information exchange and life cycle management, Data processing for applied Earth system modelling and prediction. The CSA, on the other hand have the following Standing Committees: Aeronautical meteorological services; Marine and oceanographic meteorological services; Agrometeorological and climatological services; Hydrological services and Public services and disaster risk reduction (noting Members' sovereignty on warnings).

7.1.2 The meeting noted that Standing Committees are expected to deal mostly with the required normative work in accordance with their Terms of Reference, and submit recommendations and suggestions on behalf of the committee to the respective commission. However, Study Groups are expert body established by and reporting to a technical commission in accordance with the general terms of reference of technical commissions, and with the specific terms of reference of the commission concerned to study an identified technical issue in order to provide guidance and asses the feasibility/necessity of development of technical regulations on the subject. The study group should be established for a fixed time period with a limited scope and clearly defined deliverables.

7.2 Visit of IAEA Incident Emergency Centre and of CTBTO

The meeting was pleased with the opportunity for a tour visit of the IAEA/IEC and CTBTO.

7.3 Support to UN Humanitarian activities

Mr Harou briefed on the status of activities related to UN Humanitarian activities. He reported that services in support of Humanitarian activities are in high demand, particularly from the UN Secretary General and his UN Operations and Crisis Centre (UNOCC).

8. CLOSURE OF THE MEETING

8.1 Mr Servranckx, Co-chair of ET-ERA, on the behalf of the Chair, thanked all the participants for their fruitful discussion and expressed his satisfaction with the outcomes of the meeting. He also thanked the IAEA for hosting the meeting and the Secretariat for the arrangements of the meeting.

8.2 The meeting was closed at 15:30 on 5 October 2018.

ANNEX I

AGENDA

PROVISIONAL AGENDA

1. OPENING OF THE MEETING

2. ORGANIZATION OF THE MEETING
- 2.1 Adoption of the agenda
- 2.2 Working arrangements

3. INTRODUCTION
- 3.1 Outcomes of CBS-16 (November 2016) and EC-70 (June 2018) related to ERA
- 3.2 Information on the new Manual on the GDPFS (2107)
- 3.3 Report of the chair and co-chair on nuclear and non-nuclear ERA, respectively

4. NUCLEAR ERA
- 4.1 Review of actions from previous meeting (Buenos Aires, Argentina, 2015)
- 4.2 Status of operational implementation / activities of RSMCs / RTH Offenbach
- 4.3 Cooperation with other international organizations (IAEA, ICAO, CTBTO, WHO)
- 4.4 Improved product distribution / access methods
- 4.5 New products and services based on user's requirements
- 4.6 Capacity development and outreach
- 4.7 Ensemble atmospheric transport modelling
- 4.8 Review of current procedures and standards, with a view of developing proposed amendments to the *Manual on the GDPFS* (WMO-No. 485) as needed
- 4.9 Status of the revision of the WMO *Guidelines on Meteorological and Hydrological Aspects and Operations of Nuclear Power Plants*
- 4.10 Potential collaboration with new JCOMM Expert Team on Marine Emergency Response

5. NON-NUCLEAR ERA
- 5.1 Review of actions from previous meeting (Buenos Aires, Argentina, 2015)
- 5.2 Status of operational implementation / activities of RSMCs
- 5.3 Review of current procedures and standards, with a view of developing proposed amendments to the *Manual on the GDPFS* (WMO-No. 485) as needed
- 5.4 Cooperation with other international organizations (ICAO, WHO)
- 5.5 Discussion on Vegetation Fire and Smoke Pollution Warning and Advisory System (VSFP-VAS)

6. ERA WEBSITE CONTENT AND STRUCTURE

7. ANY OTHER BUSINESS (AOB)
- WMO Reform
- Visit of IAEA Incident Emergency Centre and of CTBTO
- Support to UN Humanitarian activities

8. CLOSURE OF THE MEETING

ANNEX II

LIST OF PARTICIPANTS

#	Name	City & Country	Email
	PARTICIPANTS		
1	Mr Paul **SKOMOROWSKI**	Austria	p.skomorowski@zamg.ac.at
2	Mr Gerhard **WOTAWA**	Austria	gerhard.wotawa@zamg.ac.at
3	Ms Maria Soledad **OSORES**	Argentina	msosores@smn.gob.ar
4	Mr René **SERVRANCKX**	Canada	rservranckx@gmail.com
5	Ms Biljana **BEKCIC**	Canada	biljana.bekcic@canada.ca
6	Mr Zhenxin **SONG**	China	songzx@cma.gov.cn
7	Mr François **LALAURETTE**	France	francois.lalaurette@meteo.fr
8	Mr Jochen **FOERSTNER**	Germany	jochen.foerstner@dwd.de
9	Mr Kohei **ARANAMI**	Japan	aranami@met.kishou.go.jp
10	Mr Anton **MUSCAT**	UK	anton.muscat@metoffice.gov.uk
11	Mr Jeffery **MCQUEEN**	USA	Jeff.Mcqueen@noaa.gov
12	Mr Glenn D. **ROLPH**	USA	glenn.rolph@noaa.gov
13	Mr Günther **WINKLER IAEA**	Austria	G.Winkler@iaea.org
14	Ms Jolanta **KUSMIERCZYK-MICHULEC CTBTO**	Austria	Jolanta.Kusmierczyk-Michulec@ctbto.org
15	Mr Pierre **BOURGOIN CTBTO**	Austria	Pierre.BOURGOUIN@ctbto.org
16	Mr Pierrick **MIALLE CTBTO**	Austria	pierrick.mialle@ctbto.org
	STAFF		
17	Mr Xu **TANG**	Geneva	xtang@wmo.int
18	Mr Abdoulaye **HAROU**	Geneva	aharou@wmo.int
19	Ms Eunha **LIM**	Geneva	elim@wmo.int

ANNEX III

Update of Actions list from previous meeting in Buenos Aires (Argentina, 2015)

Introduction and next steps

At the Nov-Dec 2015 meeting, the ET-ERA defined actions for 2015 - 2018 (Annex III in report of the Meeting of the CBS Expert Team on Emergency Response Activities (ET-ERA), Buenos Aires, Argentina, 30 November – 4 December 2015). These actions are updated as below:

ACTION 1: RSMCS Beijing, Montreal, Tokyo and Toulouse Update to Annex 4, WMO TD-No. 778 DUE DATE: 31 March 2016
All will maintain the information regarding their respective Centres up-to-date in their mandatory annexes in the WMO Technical Note 778 on Environmental Emergency Response. The documentation should provide summary information on NWP model domains and resolution, and schedule regarding update cycles of NWP outputs that are used to feed the ATM. The WMO Secretariat will update the information on http://www.wmo.int/pages/prog/www/DPS/WMOTDNO778/Annex4.html

New action 1 that all RSMCs will update these documents annually, reviewed, by end of February each year. This will tie in with the submission of the annual RSMC reports.

ACTION 2: WMO Secretariat
Plan to migrate from fax distribution of products to e-mail/internet distribution of products
DUE DATE: ASAP
Engage WMO Regional Offices and relevant groups within Regional Associations in follow up to circular letter from WMO Secretary-General that requested all Permanent Representatives to provide confirmation or nomination of contacts for its Delegated Authority, and for its Operational NMHS Contact Point, including name, title, telephone and fax number, and only one operational e-mail address.

STATUS (SEPTEMBER 2018): RSMC Tokyo reported that a user request survey was conducted in 2016 within RA II (Asia), and a considerable number of members requested the continuation of the fax service. RSMC Obninsk has commented that they would only send products via fax in the event that usual e-mail/internet connections were not available.

WMO sent letters to NMSs but not everyone wanted to cease the use of fax. Manual of GDPFS suggests that products will be e-mailed unless specifically requested for other formats (e.g. fax). Also issue about not having any operational contact details (fax, email) for some NMSs.

WMO will continue effort to contact PR and obtain operational contact details from those NMSs whose details are not held. However, this action can be effectively deleted.

ACTION 3: All RSMCs and RTH Offenbach / DWD
Common Web-pages

i. RSMCs that have not yet done so will examine the option to include an ‘’all products’’ web link on their mirrored-web page where an archive of all modelling results will be maintained.
DUE DATE: Report back to ET-ERA by end of March 2016

STATUS (SEPTEMBER 2018): Complete. It would appear that all RSMC web pages now have the “All products” option available through their webpages (although these pages are not always accessible from every RSMC webpage).

ii. Generate GRIB2 format for existing set of standard products.
DUE DATE: Undefined.

STATUS (SEPTEMBER 2018): Responses from a few of the RSMCs (Montreal, Exeter) report that they have been unable to test or generate the GRIB2 formats for the existing RSMC products, and that there is no time line for when GRIB2 will be tested for RSMC products. Other RSMCs have indicated that they are able to generate and issue GRIB2 products, e.g. Toulouse, Washington, Beijing.

iii. A meta-data Web page and directory will be used to post non-standard / initial response products and files, including GRIB2 files.
DUE DATE: Undefined.

STATUS (SEPTEMBER 2018): No known progress on this, since it is dependent on progress of ii) above. Suggestion that this Action be deleted.

iv. RTH Offenbach / DWD will provide an example program to convert GRIB1 to GRIB2 based on GRIB_API of ECMWF.
DUE DATE: By January 2016.

STATUS (SEPTEMBER 2018): Not done. Further discussion revealed that there is no requirement for this and so the action can be deleted.

v. Explore producing basic products in geo-referenced format preferably shape files, KML or other file formats (with suitable viewer). Post on meta-data Web link.
DUE DATE: Undefined.

STATUS (SEPTEMBER 2018): RSMC Montreal report that it has the capability to generate geo-referenced model outputs. However, there has been no testing of that format specifically for RSMC products. Toulouse and Washington also providing KML/KMZ files on “All products” (or through an internal webpage that can be pushed to the user.)

vi. NMC Vienna, and RSMCs Washington and Toulouse to work on producing basic products in GRIB, GRIB-2, BUFR and post on meta-data web link and distribute the information to the all RSMCs.
DUE DATE: Undefined.

STATUS (SEPTEMBER 2018): Suggest that this action be deleted as developments elsewhere (e.g. TCM) will supersede this.

vii. Monitoring of common web pages for quarterly tests: a) beginning with February 2016 quarterly test, a systematic monitoring of all postings on all common / mirror Web pages will be performed on a rotating basis by one of the

lead RSMCs and; b) the Chair will prepare a checklist for the monitoring of all common / mirror web page for consultation with ET-ERA
DUE DATE: January 2016.

STATUS (SEPTEMBER 2018): a) Completed; the monitoring of the RSMC webpages has occurred after most (all?) RSMC quarterly tests since the beginning of 2016 and is now an established part of the RSMC response procedure. b) Completed; the Chair and co-Chair devised a checklist for the RSMC webpage checking tasks that was distributed to all RSMCs in February 2016. Since then this checklist has undergone subtle changes to improve its usability and usefulness.

Suggest a list of "scheduled tasks" (e.g. Annual status report, checking of Annex 4 TD778 and update of associated information, reference to the quarterly RSMC testing cycle, etc.) be established and this located in TD 778. Assuming that it is, this standing Action can be deleted.

ACTION 4: RSMCs Beijing, Melbourne and Toulouse
TCM for Fukushima case
DUE DATE: in 2016
Apply the TCM approach used by WMO Task Team for the Fukushima meteorological analyses. Results will be added to NOAA ARL's TT-Fukushima Website

STATUS (SEPTEMBER 2018): ????

Potential developments in the area of TCM mean that this Action can be deleted.

ACTION 5: All RSMCs; coordination by RSMC Washington , RSMC Vienna and CTBTO
Test TCM, ensemble approach and compare with measurements
DUE DATE: next meeting
ET-ERA RSMC Washington (Mr Stein) to take the lead in organizing an exercise with other RSMCs to test the TCM approach to dispersion modelling within the next two years. Consideration could be given to test varying source terms to modify the release and to combine with Ispra JRC ensemble approach in combination with measurements.

STATUS (SEPTEMBER 2018): Due to constraints on resource an exercise did not take place. However, during the Spring and Summer of 2018, RSMC Washington agreed to further develop a website (initially developed following the Fukushima accident) that could be used to incorporate TCM results from all RSMCs.

ACTION 6: Co-Chair
Revision of WMO Technical Note 170
DUE DATE: By end of January 2016
Distribute draft document to ET-ERA and request comments and feedback.

STATUS (September 2018): Completed. Report now finalised by co-Chair. This can now be deleted.

ACTION 7: Chair, Co-Chair and WMO Secretariat

Update to WMO Bulletin article on ERA
Update WMO Bulletin article on ERA (January 2006) to further promote the programme.

STATUS (SEPTEMBER 2018): Not done. Looking to combine nuclear and non-nuclear ERA bulletin. Rene to lead on this (but looking for volunteers!!). DD= not defined.

ACTION 8: IAEA and WMO SECRETARIAT
Co-operation agreement between IAEA and WMO
DUE DATE: 2016
Pursue revision of the co-operation agreement between WMO and IAEA and consider how to provide support and technical assistance to IAEA/IEC in relation to atmospheric dispersion calculations and their interpretation, as well as the provision of weather forecasts.

STATUS (SEPTEMBER 2018): An Agreement went through both organisations' legal offices – still to be signed but effectively completed – likely end of 2018. Consequently this action can be deleted.

ACTION 9: WMO Secretariat
GIS database
DUE DATE: when available
Provide a GIS database of WMO RA and States to IAEA and RSMCs.

STATUS (SEPTEMBER 2018): No such database! However, WMO can generate appropriate webpage, and associated overlay, that would provide the same information. WMO Secretariat will take a new action to do this, DD = end of October 2018. Therefore this particular action can be deleted.

ACTION 10: RTH Offenbach and RSMCs
WNXX01 IAEA messages (posting on public internet)
DUE DATE: ongoing

a) ET-ERA members to check regularly if WNXX01 IAEA messages are posted on public internet and contact NMHS to correct the situation as needed.
b) RTH Offenbach to update document on http://www.wmo.int/pages/prog/www/DPS/WMOTDNO778/Annex4.html to indicate that WNXX01 IAEA are for internal use by NMHS and are not to be posted on public web pages.
c) RTH Offenbach to contact RTH Tehran regarding transmission of WNXX01 IAEA messages.

STATUS (SEPTEMBER 2018): a) RSMC Montreal report that, at last check, there were no WNXX01 bulletins on public internet, nor multiple copies on circuit. The problem appears to have been resolved.

b) RSMC Offenbach report that the web pages were updated in March 2016.

c)RSMC Tokyo has commented that the Leader in ERA of RA-II/EG-OF needs a report on Item c) and requests that information be provided for this? In response to this, RSMC Offenbach report that a colleague of their technical infrastructure (TI) division was contacted about RTH Tehran; they subsequently contacted RTH Tehran and established that there is currently no known GTS communication problem.

c. The problem is largely resolved (i.e. no known problem). Therefore this action can be deleted.

ACTION 11: WMO Secretariat
Eliminate multiple copies of WNXX01 IAEA message on the GTS / WIS
DUE DATE: Ongoing
Report on the results from the 19 November 2015 quarterly test. Action will be closed or pursued depending on the outcome.

STATUS (SEPTEMBER 2018): WMO (Steve Foreman) had looked at this and suggested that a fix had been applied. Therefore this action can be deleted.

ACTION 12: Chair, Co-Chair, WMO Secretariat and members ET-ERA
Manual on the GDPFS
DUE DATE: Ongoing

a) That WMO's role as the technical authority for atmospheric dispersion modelling be strengthened in the revised Manual on the GDPFS.

b) Expand the text in the Manual on the GDPFS (in the global and regional arrangements) in relation to the RSMC support and advice to the WMO and the IAEA Secretariats in the preparation of public and media statements. The statements should address both weather and dispersion aspects. WMO Secretariat to coordinate with the Member State concerned and with the RSMCs, as appropriate, for preparing a consensus statement.

STATUS (SEPTEMBER 2018): a). No progress. b). Not clear what this relates to? This would be part of any service provided to the IAEA via the NMS Vienna meteorologist. Therefore, suggest that this action is deleted.

ACTION 13: IAEA (lead) and available RSMCs
Realistic source term values
DUE DATE: Ongoing
Propose new test with more realistic values for source term and contouring of outputs for specific threshold values.

STATUS (SEPTEMBER 2018): No progress so far, however, action remains on IAEA (Guenther or successor) to review the default source term and fixed contouring and to suggest a different one. DD = end of Dec 18.

ACTION 14: Members of ET-ERA and WMO Secretariat
Public information
DUE DATE: depends on availability of members

Further develop the WMO-TD. 778 on the use and interpretation of RSMC products, including examples, and guidance on how to communicate with the public (based on the IAEA publication).

STATUS (SEPTEMBER 2018): Not done. The contention is the "guidance to the public" part. For this, we could just refer to the appropriate IAEA publication (since they are the authoritative source)? Suggest re-writing the Action to only include reference to "examples". This will be included in new Action sheet and so this action can be deleted.

ACTION 15: ICAO, WMO and IAEA
Response from IACRNE Working Group
DUE DATE: Expected in 2016
Answer to Expert Team on ERA regarding the questions raised by the CG-NERA (Vienna, November 2011) on possible modelling guidance on radioactive clouds for aviation interests.

STATUS (SEPTEMBER 2018): Completed. Co-Chair to provide more information during the meeting? This action can be deleted.

ACTION 16: Co-Chair and RSMCs
Modelling guidance for radioactive clouds
DUE DATE: dependent on action 15
Continue to explore possible ways to provide modelling guidance

STATUS (SEPTEMBER 2018): Completed. Co-Chair to provide more information during the meeting? This action can be deleted.

ACTION 17: ALL RSMCs, RTH / RSMC OFFENBACH and WMO Secretariat
Annual Report
DUE DATE: REPORT FOR 2015 and 2016 BY FEBRUARY 2016 and 2017
All RSMCs and RTH Offenbach will produce and share an annual report to cover the calendar year. The report should be submitted to the Chairman of the Coordination Group by the end of February of the following year, for posting on the WMO Web-site for the ERA programme. The contents of the Annual Report shall include, but not limited to: - Introduction - Operational contact information
ET-ERA, Final Report, p. 29
- Responses and information on dissemination of products (fax, web-page access, which products were sent and time delay from point of notification) - Exercises and routine tests - Lessons learned from recent experiences - Operational issues / challenges - Summary / status of the operational atmospheric transport and dispersion model(s) - Plans for the coming year

WMO Secretariat will post the 2015 and 2016 reports on the ERA web pages: https://www.wmo.int/pages/prog/www/DPFSERA/resources.html

STATUS (SEPTEMBER 2018): **Completed.** The reports, including those for 2017, can be seen at the following link:
https://www.wmo.int/pages/prog/www/DPFSERA/resources.html

Action can be deleted since (separately) there will be an action to establish "standard" annual reports/undertakings that each RSMC will follow.

ACTION 18: RSMCs and IAEA – Coordination by experts from RSMC Obninsk (Mr Kosykh), RSMC Japan (Mr Sakamoto), IAEA (Mr Winkler) and RSMC Vienna (Mr Wotawa).
Time of arrival products
DUE DATE: 2016
'"Time of Arrival" Product Tests

1. Produce document to define and clarify details and specifications for next ToA test to ensure consistency between RSMCs products
2. Conduct new test
3. IAEA to propose threshold value for cloud boundaries.

STATUS (SEPTEMBER 2018): The concept of "Time of Arrival" products has moved on since the last meeting. Mr Kosykh has now left the ET-ERA and Mr. Sakamoto (RSMC Tokyo) has agreed to take on the lead for the Time of Arrival work. In June 2017, in association with the ConvEx-3 (2017) Exercise, a further Time of Arrival test was conducted. The results of this test will be presented under Agenda Item 4.5 at this ET-ERA meeting (Vienna 2018). RSMC Obninsk have commented that they consider it necessary to conduct a couple more exercises (in different regions) on this topic, then draw up reports on the results and hold a final discussion on this issue. Further testing required, and also clarification of what the ToA parameters should be. This to be led by RSMC Tokyo. With regards timings for this, link in with TCM discussion.

ACTION 19: Chairperson in coordination / collaboration with WMO Secretariat and RSMCs Updates to WMO TD-778 and WMO ERA web pages
DUE DATE: Depends on availability of members
Check, review and update the ERA web pages and WMO TD-778. Produce and update as needed pdf version of WMO TD-778.

STATUS (SEPTEMBER 2018): Due to restrictions on the availability of resources, this has not been undertaken. Linked to paper 6.1 (?) Decision on this is deferred.

ACTION 20: IAEA
Wish list of RSMC products and support
DUE DATE: Undefined
a) Produce a list of RSMC products and support needed by the IAEA (i.e. higher resolution, long diagnostic runs with more realistic source term, etc.) and not currently defined in the Manual on the GDPFS.
b) Examine possible data formats (GRIB2, netCDF, etc.) that would be suitable for GIS and report back to ET-ERA.

STATUS (SEPTEMBER 2018): Part a) is covered by Action 13 above and so the Action can be deleted. Part b) Is covered by numerous actions above and so the action can be deleted.

ACTION 21: IAEA, RSMCs and RTH Offenbach
Quarterly IAEA – RSMC tests

DUE DATE: Ongoing

Note: i) Quarterly tests will be held on third Tuesday of the month from now on. ii) For RAII quarterly test, the exercise will be postponed if the host state has not confirmed their participation by two weeks prior to the exercise.

Information on the planned tests for 2016 and 2017 will be published on the IAEA USIE website. GTS message will be sent with each quarterly test. Distribution of products will be done by Lead RSMCs to their region(s) of responsibility.

STATUS (SEPTEMBER 2018): Quarterly tests undertaken as per schedule, although there was some confusion concerning the lead RSMCs for the exercise conducted in May 2018. RSMC Tokyo comments that the exercise in October 2017 was cancelled on the scheduled day of the exercise.

This task will be one of those that is detailed in the to-be-written "scheduled tasks" of the RSMCs. Therefore, this action can be dropped.

ACTION 22: IAEA and RTH Offenbach
Monthly communication test
DUE DATE: Ongoing
IAEA representative to coordinate with RTH Offenbach with regards to changing monthly communication tests from Thursday to Tuesday.

STATUS (SEPTEMBER 2018): Completed. This action can be dropped.

ACTION 23: NMC VIENNA, CTBTO, WMO and Canadian Meteorological Centre (RSMC Montreal) Transmission of CTBTO meteorological data on WMO GTS
DUE DATE: Ongoing
1. NMC Vienna to continue take-over of transmission of data from Canadian Meteorological Centre to the WMO GTS.
2. WMO to provide identifiers to NMC Vienna as they become available.
3. NMC Vienna to finalize and distribute communication protocol and contact information between NMC Vienna, CTBTO, WMO and Canadian Meteorological Centre.
4. NMC Vienna will evaluate option of producing a synoptic type message at specific hours that could be used by data assimilation systems

STATUS (SEPTEMBER 2018): RSMC Montreal report that the Canadian Meteorological Centre (i.e. RSMC Montreal) is ready to relinquish transmission of the data to NMC Vienna. [From their perspective, the bottle-neck appears to be the lack of ID's for the CTBTO met stations, the assignment of which is the responsibility of individual member states. To accelerate the process, is WMO able to send "reminders" to countries that have not yet assigned synoptic ID's to their stations?]

ACTION 24: CTBTO and RSMCs
SRS fields for CTBTO
DUE DATE: Ongoing
CTBTO to provide technical requirements document to RSMC with regards to higher spatial and temporal resolutions for SRS fields. CTBTO will inform RSMCs at least three months in advance to enquire about the possibility of moving to higher resolutions.

STATUS (SEPTEMBER 2018): Further info/actions will be forthcoming from CTBTO paper on Tuesday 2nd October**.**
Regarding Action 24 of the 2015 ET-ERA meeting, transmission of CTBTO meteorological data on WMO GTS continues in two bulletins. One bulletin is sent from RSMC Montreal and the other is sent in BUFR format from RSMC Vienna. Individual member states of the CTBTO must assign a synoptic identification number to each station before its data can be encoded in BUFR format. While many countries have already done so, several have yet to complete this task.

ACTION 25: IAEA, WMO, RSMC Vienna
NMC Vienna support to IAEA during an emergency
DUE DATE: Ongoing

a) IAEA Expert (Mr Winkler) to investigate NMC Vienna access to IEC and develop consequently a paragraph in the Letter of Agreement between WMO and IAEA to address this topic.

b) Experts from WMO (Mr Harou), IAEA (Mr Winkler) and NMC Vienna (Mr Wotawa) to develop the Terms of Reference for the visiting NMC Vienna Forecaster and plan an exercise to test the arrangement.

STATUS (SEPTEMBER 2018): a). Completed – (slight changes in implementation). This part of the action can be deleted. b) Ongoing (with same personnel).

ACTION 26: RSMC Tokyo Expert
DUE DATE: Next meeting

The meeting requested that the RSMC Tokyo Expert be asked to develop and share a proposal for a test, with the intended objective to allow RSMCs to quantify the variance in output of the RSMC products that arise through differences in, e.g., the different start times of NWP used when creating the RSMC products.

STATUS (SEPTEMBER 2018): RSMC Tokyo regret to announce that there has been no progress on this action, mainly due to a heavy workload from other tasks. Ongoing for the time being. Kohei to check with Masami.

ANNEX IV

Action List for Nuclear Activities

(2018 meeting)

NO.	Type	Subject	Contents	Lead by	Due date
1	Nuclear		Secretariat to contact SDS-WAS Centres (Barcelona and Beijing) to identify a focal point to liaise with ET-ERA	Secretariat	
2	Nuclear	Security for the RSMC mirrored webpages	RSMC Washington look into security issues related to the mirrored RSMC websites.	Washington	31-Oct-18
3	Nuclear	Security for the RSMC mirrored webpages	All RSMCs to speak to their IT teams about security related to receiving files from other RSMCs for their own mirrored website. Send results to Anton who will distribute them and have a discussion on next steps.	RSMCs	31-Dec-18
4	Nuclear	Security for the RSMC mirrored webpages	RSMC Toulouse to do some background work on the problem of spam e-mails security related issues (and how this adversely affects the RSMC function	Toulouse	
5	Nuclear	Operationalization of RSMC Offenbach	The chair to formulate a plan related to the operationalization of RSMC Offenbach, with inputs from IAEA and Toulouse.	Chair	31-Jan-19
6	Nuclear	Essential information to optimized ATDM	Mr Winkler to send the list of isotopes (for modelling) to Jochen at DWD	IAEA	
7	Nuclear	Amendment of MoU between WMO and CTBTO	Secretariat to consider including noble gas services when reviewing the MoU between WMO and CTBTO.	Secretariat	
8	Nuclear	Amendment of MoU between WMO and CTBTO	CTBTO to Provide details of requirements related to SRS for noble gas to Chair. Anton then send to the rest of RSMCs for each to check if, technically, this service is possible from their perspectives.	CTBTO / Chair	31-Dec-18
9	Nuclear	Use infrasound data to detect volcanic eruption	1) Mr Servranckx to contact Raul Romero to bring this to his attention and to put him in contact with Mr Bourgouin. 2) It was also suggested that CTBTO prepare a document on this issue to table at the ICAO related meeting to be held in wellington, New Zealand.	Co-Chair / CTBTO	1) completed on 5 October 2018 2) before VAAC meeting in Nov 2018

NO.	Type	Subject	Contents	Lead by	Due date
10	Nuclear	Ensemble Prediction System (EPS)	CTBTO to share with the Chair of ET-ERA its plan related to the implementation of EPS.	CTBTO	31-Dec-18
11	Nuclear	Ensemble Prediction System (EPS)	RSMCs are to check within their respective organizations for contacts with expertise in ensemble forecasting and provide the information to CTBTO.	RSMCs	31-Mar-19
12	Nuclear	Increasing resolution of the global operational simulation	RSMCs to check whether the increase of the horizontal resolution of the SRS fields from 1.0 degree to .5 degree is possible.	RSMCs	30-Nov-18
13	Nuclear	Increasing resolution of the global operational simulation	RSMCs will migrate to higher resolution SRS data if possible.	RSMCs	30-Jun-19
14	Nuclear	International Radiation Monitoring Information System (IRMIS)	IAEA to investigate, in collaboration with RMSCs, what type of files related to RSMC products could be ingested into the IRMIS and share with RMSCs.	IAEA	28-Feb-19
15	Nuclear	WMO Country Profile Database Portal	WMO Secretariat to adapt an already-available webpage, and associated overlays, and pass to IAEA in order to show in which RA regions individual states reside.	Secretariat	31-Oct-18
16	Nuclear	TCM Website	All RSMCs to check with their team on the feasibility of implementing TCM approach and to send the result to the Co-chairs.	RSMCs	30-Nov-18
17	Nuclear	TCM Website	To organize a TCM exercise.	TBD	31-Mar-19
18	Nuclear	TCM Website	Mr Winkler to check whether IAEA could host the TCM website where RSMC TCM outputs could be made available. RSMCs are also requested to check on the appetite to host the website	IAEA / RSMCs	
19	Nuclear	TCM Website	Mr Rolph to provide basic specs of Software used to facilitate decision on hosting the website, depending on the result of the action above.	Washington	
20	Nuclear	TCM Website	Mr Winkler to assign radionuclide to various computational particles category.	IAEA	31-Mar-19
21	Nuclear	ToA	Mr Winkler to identify criteria for the ToA thresholds.	IAEA	31-Oct-18
22	Nuclear	ToA	Mr Winkler to suggest appropriate contour value for the standard RMSCs products for testing in the second quarter of 2019	IAEA	30-Jun-19
23	Nuclear	ToA	Ms Bekcic to check if RSMC Montreal could provide ToA products based on one hour average concentration	Montreal	
24	Nuclear	ToA	RSMC Tokyo to lead another ToA test, possibly, before end of	Tokyo	30-Jun-19

NO.	Type	Subject	Contents	Lead by	Due date
			June 2019		
25	Nuclear	Exercise in 2019 (3rd ATM Channelings)	RSMCs to check with their official contacts about their interest in participating in the 3rd ATM Challenge and inform Mr Wotawa by end of October 2018	RSMCs	30-Oct-18
26	Nuclear	Request form	RSMCs and IAEA to provide their comments, to the Co-chairs, on the proposed revised form available in the meeting document 4.8(1)	RSMCs	30-Nov-18
27	Nuclear	Collaboration with new JCOMM	WMO Secretariat (Mr Harou) to check with JCOMM and MMO colleagues for the possibility of setting up a teleconference with the Co-chairs of ET-ERA to determine areas of collaboration with ET-MER	Secretariat	

Recommendation List for Nuclear activities

(1-5 OCT 2018)

Remarks:
* Related with Action 21~24

NO.	Type	Subjects	Contents	Approver
1*	Nuclear	Time average of concentration value	Use one hour average concentration value	

ANNEX V

Operational Contact Information for Nuclear Emergency

Remarks:
* Based on the annual report

Country	RSMC	Type	Operational contact (24h)	Business Contact (office hours)	Updated on
Australia	Melbourne	Name	Shift Supervisor	Dr Yi Xiao	2017*
		Address	RSMC Melbourne National Operations Centre Bureau of Meteorology 700 Collins Street MELBOURNE, Victoria 3000 Australia	RSMC Melbourne National Operations Centre Bureau of Meteorology 700 Collins Street MELBOURNE, Victoria 3000 Australia	2017*
		Email	rto@bom.gov.au	SROD@bom.gov.au	2017*
		Telephone	+61 3 9669 4010	+61 3 9669 4390	2017*
		Fax	+61 3 9662 1222; +61 3 9662 1223	+61 3 9662 1222	2017*
Austria	Vienna	Name	Mr. Paul Skomorowski	Dr. Gerhard Wotawa	5 OCT 2018
		Address	RSMC Vienna (backtracking only) Zentralanstalt für Meteorologie und Geodynamik Hohe Warte 38 1190 Vienna Austria	RSMC Vienna (backtracking only) Zentralanstalt für Meteorologie und Geodynamik Hohe Warte 38 1190 Vienna Austria	5 OCT 2018
		Email	paul.skomorowski@zamg.ac.at, rsmc-vienna@zamg.ac.at, umwctbto@zamg.ac.at	gerhard.wotawa@zamg.ac.at	5 OCT 2018
		Telephone	+43 1 36026 2419	+ 43 1 36026 2002	5 OCT 2018
		Fax	+43 1 36026 74	+ 43 1 3691233	5 OCT 2018
Canada	Montreal	Name	Shift supervisor	Mr. Nils Ek	2017*
		Address	Canadian Meteorological Centre (CMC) Environment and Climate Change Canada 2121 Trans-Canada Highway DORVAL, Québec Canada H9P 1J3	Canadian Meteorological Centre (CMC) Environment and Climate Change Canada 2121 Trans-Canada Highway DORVAL, Québec Canada H9P 1J3	2017*
		Email	ec.rsmc.montreal.ec@canada.ca	Nils.Ek@canada.ca	2017*
		Telephone	Tel : 1 514 421 4635	Tel : 1 514 421 7207	2017*
		Fax	Fax : 1 514 421 4639	Fax : 1 514 421 4679	2017*
China	Beijing	Name	Shift supervisor (Li Sheng and Da Li)	Dr. Song Zhenxin	5 OCT 2018
		Address	National Meteorological Centre (NMC)China	National Meteorological Centre	5 OCT 2018

Country	RSMC	Type	Operational contact (24h)	Business Contact (office hours)	Updated on
			Meteorological Administration No.46, Zhongguancun NandajieHaidian District, BeijingChina, 100081	(NMC)China Meteorological Administration No.46, Zhongguancun NandajieHaidian District, BeijingChina, 100081	
		Email	rsmc@cma.gov.cn; shenglilily@gmail.com	songzx@cma.gov.cn	6 OCT 2018
		Telephone	86 10 5899 5818	86 10 68400477	7 OCT 2018
		Fax	86 10 6840 7469; 86 10 6217 2956	86 10 68407469	5 OCT 2018
France	Toulouse	Name	Chief Forecaster	François Lalaurette	5 OCT 2018
		Address	Météo-France Forecast Operations (DirOP) General Forecast Department (PG) 42 Av. G. Coriolis 31057 TOULOUSE CEDEX France	Météo-France Head of Forecast Operations (DirOP) 42 Av. G. Coriolis 31057 TOULOUSE CEDEX France	5 OCT 2018
		Email			5 OCT 2018
		Phone	+33 5 6107 8540 +33 5 6107 8262 +33 5 6140 4979	+33 5 6107 8000 +33 698 244 111	5 OCT 2018
		Fax	+33 5 6107 8044		5 OCT 2018
Germany	Offenbach	Name	Shift supervisor	Mr Jochen Förstner	5 OCT 2018
		Address	RTH/RSMC Offenbach Deutscher Wetterdienst (DWD) P. O. Box 10 04 65 D-63004 Offenbach a. M. Germany	RTH/RSMC Offenbach Deutscher Wetterdienst (DWD) P. O. Box 10 04 65 D-63004 Offenbach a. M. Germany	5 OCT 2018
		Email	mss.operator@dwd.de	jochen.foerstner@dwd.de	5 OCT 2018
		Telephone	+ 49 69 8062 2530	+ 49 69 8062 4947	5 OCT 2018
		Fax	+ 49 69 8062 2880	+ 49 69 8062 3721	5 OCT 2018
Japan	Tokyo	Name	Head, Office of International Affairs, Planning Division, Administration Department	Head, Office of International Affairs, Planning Division, Administration Department	2017*
		Address	Japan Meteorological Agency (JMA) 1-3-4 Otemachi, Chiyoda-ku, Tokyo 100-8122, Japan	Japan Meteorological Agency (JMA) 1-3-4 Otemachi, Chiyoda-ku, Tokyo 100-8122, Japan	2017*
		Email		iao-jma@met.kishou.go.jp	2017*
		Telephone	+81 3 3211 4966	+81 3 3211 4967	2017*
		Fax	+81 3 3212 2057	+81 3 3212 2058	2017*

Country	RSMC	Type	Operational contact (24h)	Business Contact (office hours)	Updated on
Russia	Obninsk	Name		Dr Victor Mukhalev	2017*
		Address	RSMC OBNINSK4 Pobeda street249038 OBNINSKKaluga Region Russian Federation	RSMC OBNINSK4 Pobeda street249038 OBNINSKKaluga RegionRussian Federation	2017*
		Email	rsmc@feerc.ru	mukhalyov@feerc.ru	2017*
		Telephone	+(7 484) 39 4 49 50	+(7 484) 39 7 18 08	2017*
		Fax	+(7 484) 39 4 07 04	+(7 484) 39 4 07 04	2017*
UK	Exeter	Name	EMARC (Environmental Monitoring and Response Centre	Mr Anton Muscat	5 OCT 2018
		Address	RSMC Exeter, Ops Centre, The Met Office, Fitzroy Road, Exeter, Devon. EX1 3PB. United Kingdom	RSMC Exeter, Ops Centre, The Met Office, Fitzroy Road, Exeter, Devon. EX1 3PB. United Kingdom	5 OCT 2018
		Email	emarc@metoffice.gov.uk	anton.muscat@metoffice.gov.uk	5 OCT 2018
		Telephone	+44 1392 886095	+44 1392 886033	5 OCT 2018
		Fax	+44 1392 884549	+44 1392 884549	5 OCT 2018
USA	Washington	Name	Senior Duty Meteorologist	Mr Jeffery McQueen	5 OCT 2018
		Address	National Oceanic and Atmospheric Administration (NOAA) National Weather Service NCEP Center for Weather and Climate Prediction Suite 4600, W/NP College Park, MD 20740 United States of America	National Oceanic and Atmospheric Administration (NOAA) National Weather Service NCEP Center for Weather and Climate Prediction Suite 4600, W/NP College Park, MD 20740 United States of America	5 OCT 2018
		Email	SDM@noaa.gov	jeff.mcqueen@noaa.gov	5 OCT 2018
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ANNEX VI

MODIFICATIONS PROPOSED TO THE CHECKLIST AND ACCEPTED BY THE ET-ERA

Version 3 13 September 2018
Prepared by René Servranckx and Anton Muscat

1. RSMC Web pages checklist

What? A check of all RSMC Web pages is to be done every time a quarterly test takes place (mandatory). For monthly tests, it is optional but recommended.

Who? One of the lead RSMCs

When? For quarterly tests, the initial check should be undertaken 36 to 48 hours after the reception of the IAEA request. A second (follow up) check should also be undertaken approx. 84 hours after the products are posted on any RSMC mirrored webpage to confirm that they have been successfully deleted.

How?

A) The RSMC Web pages are listed here:
http://www.wmo.int/pages/prog/www/DPFSERA/websites.htm

B) For each of the Web pages perform the checks indicated below. A table, located at the bottom of this document, can be used to record the results for each column. Those cells that are not correct can be coloured in yellow to highlight the problem to the affected RSMC. A "Comments" section is also available so that the problem can be elaborated upon if required.

1	2	3	4	5	6	7	8
RSMC TIME OF MODEL RUN (YYYYMMDDCC_HHMM)	MODEL PARAMETERS	JOINT STATEMENT	VIEW PRODUCTS	TRAJECTORIES	TIME PERIOD 1 +24 HRS	TIME PERIOD 2 +48 HRS	TIME PERIOD 3 +72 HRS

Column 1:

a. Are only the lead RSMCs showing in yellow, with all other RSMCs showing as white? If not, annotate the cell as "No" and colour the cell yellow.

b. Are the Date and time of products listed, and not older than 3 days – or – showing as "*Unavailable"* ? If not, annotate the cell as "No" and colour the cell yellow.

Column 2:

Click on "*Cover"* link. Is the information current (not older than 3 days) or showing as "*Unavailable"?* If not, annotate the cell as "No" and colour the cell yellow.

Column 3:

Click on "*Joint Statement"* link. Is the information current (not older than 3 days) or showing as "*Unavailable"?* If not, annotate the cell as "No" and colour the cell yellow.

Columns 4 to 8:

1- Click on "*Check All"* for all RSMCs and "*Request all checked products"* at the bottom of the page. This will select all products in columns 5 to 8.

2- Check that thumbnails for each RSMC are coherent with column 1 information (e.g. images of products are there for RSMCs that have posted them, whilst notification indicating ""*Unavailable*' is showing for those that didn't)

3- Click on **a few** of the thumbnails of products, other than "*Unavailable*", for each RSMC to see

- If larger size images show up correctly
- If the labelling of information and formatting on them is correct (in accordance with Appendix II-7 of the Manual on the GDPFS. Note: In the 2017 edition of the Manual on the GDPFS, that information is now in Appendix 2.2.23)

If any of the products do not conform, annotate the appropriate cell as "No" and colour the cell yellow.

Column 9:

Approximately 84 hours after the products were posted on the RSMC web pages, check that they have been successfully deleted and that "Unavailable" notices are now showing instead. If not, annotate the cell as "No" and colour the cell yellow.

C) Using the results table that you have generated, prepare a list of problems identified for each Web page. For example:

'On AA Web page:
- Column 1: Lead RSMCs not identified; Lead RSMCs incorrectly identified as BB and CC; Date / time older than 3 days for RSMC DD
- Column 2: Cover missing for RSMC EE'

'On FF Web page:
- Column 3: Old joint statement for RSMC GG; joint statement missing for lead RSMC HH
- Column 4: incorrect start time for trajectories map (column 5) or RSMC II; only thumbnail available for 48-hr total deposition map (column 7) for RSMC JJ'

D) Email findings (including the results table so that RSMCs are easily able to identify the individual problems) to ET-ERA members from RSMC Exeter, Beijing, Melbourne, Montreal, Obninsk, Tokyo, Toulouse and Washington; the WMO Secretariat, IAEA representatives as well as the Chair and co-Chair.

E) The root cause of each problem on a given web page will be identified by the host RSMC. Some problems may be corrected directly by that RSMC but most of the time, this will require coordination between two or more RSMCs. A fix will be applied before the next quarterly test in three months and each RSMC / group of RSMCs will report back to the contact list given in (D).

ANNEX VII

Update on the RSMC TCM Website Development

(Submitted by RSMC Washington)

Summary and purpose of document

This document provides background information on the development of a prototype web site to display results of the RSMC TCM modeling approach to dispersion modeling.

Reference: -

http://www.wmo.int/pages/prog/www/CBS-REPORTS/documents/Final-ReportET-ERABuenosAires2015.pdf

http://www.wmo.int/pages/prog/www/DPFSERA/Meetings/ET-ERA_BuenosAires2015/documents/Doc-4-5-2-Washington.doc

http://www.wmo.int/pages/prog/www/CBS-Reports/documents/Final-Report-ET-ERA-CollegePark2013.pdf

http://www.wmo.int/pages/prog/www/DPFSERA/Meetings/ET-ERA_College-Park2013/documents/Doc-4-5-1_RSMCWashington.doc

http://www.wmo.int/pages/prog/www/DPFSERA/Meetings/ET-ERA_College-Park2013/documents/Doc-4-5-2_RSMCWashington.doc

1. INTRODUCTION

1.1 Proposed RSMC Use of Transfer Coefficient Matrix (TCM)

In 2013 the ET-ERA was introduced to the Transfer Coefficient Matrix (TCM) at the CBS/ET-ERA meeting in College Park, MD, USA. The TCM was developed after Fukushima by RSMC Washington to allow the end user the flexibility to modify the source term and output products without having to rerun the lengthy ATM simulation again. In addition, information on applying the TCM approach in a proposed RSMC/IAEA exercise was described in 2013 and again in 2015 at the ET-ERA meeting in Buenos Aires, Argentina.

In the TCM approach, the dispersion model is run independently for a time series of segments using a unit source emission rate (1 unit/emission period) and 4 surrogate species that are dry and wet deposited as they are transported. Since the transport, dispersion, and deposition of any given species is completely independent of the actual source's emission of that species, the dispersion model needs to be run only once. The concentration or deposition at any grid cell in the domain will be the sum of the contribution from each ATM emission segment after multiplying the resulting unit concentrations by the actual emission rate for each segment. Radioactive decay can also be applied during this post-processing step.

A TCM web interface (http://www.ready.noaa.gov/ready_fdnppwmo.php) was developed as a result of the work of the WMO Task Team on Meteorological Analyses for the Fukushima-Daiichi Nuclear Power Plant Accident (http://www.wmo.int/pages/prog/www/DPFSERA/Meetings/ET-ERA_College-Park2013/documents/Doc-4-10-1.doc).
This interface allowed the user to select not only the radiological species, but also one of several estimated source terms and dispersion model simulations (CMC, JMA, NOAA, UKMET, ZAMG) used by the Task Team or an ensemble mean of several combinations of simulations. In addition, measurements taken at several locations in Japan were overlaid on the model results and statistics provided to the user.

This document updates the ET-ERA on the progress of developing a TCM web site for the RSMC/IAEA program and documents how other RSMCs can contribute their model products to the site.

2. Brief description of the TCM simulation at RSMC Washington

The TCM approach is designed to simulate a long-lived continuous release by successive, independent, 6-h unit releases of radionuclides. At RSMC Washington, the HYSPLIT ATM is used to create the TCM files. Six hours into every forecast, the HYSPLIT model computational particles are saved so that they can be used to initialize the next run's continuation of the transport and dispersion of those particles. The output particle positions are considered pseudo-analyses because they result from use of model analyses and short term forecasts (up to 6 hours). Every six hours new forecast meteorology becomes available and is called a 6-hour "cycle". When the TCM is started for the first time, there exists one dispersion model run associated with an emission and one set of output files (particles and concentration) 6 hours into the forecast. With the next cycle there are two runs of the dispersion model. One is a new emission simulation; the second is called a "zero", because there is zero (no) emission, but it is initialized with the particles that were output from the 1st cycle's run. The zero can be thought of as bringing the previous emission up to the present time. With the 3rd cycle, there are 3 runs of the dispersion model. One is a new emission simulation; the other two are zeros – one from the 1st cycle's emission, the other from the 2nd cycle's emission. And so on. In other words, every 6-hours, when the new meteorological forecast becomes available, the TCM is run with a 6-h emission beginning at the start of the meteorological forecast and the set of zeros are run to bring all the previous emissions up to the present time.

Because particles do not need to be tracked forever, at some point, with every cycle, the oldest zero is dropped, meaning those particles are no longer tracked. This results in a constant number of dispersion run executions every cycle. However, when notified of a new incident/exercise (the release location presumably being different) the TCM run must start from "scratch" with a single emission.

Lastly, with any cycle, all the dispersion runs' results can be combined, the source term and decay applied, and currently required RSMC graphics or other products created. If a revised source term becomes available, then revised products can be created using post-processing programs, without rerunning the dispersion model. This is a key feature of the system – dispersion is run once, post-processing can be easily run again as a new source terms become available.

3. Experience of running the TCM in an operational setting at RSMC Washington

The National Oceanic and Atmospheric Administration's (NOAA) Air Resources Laboratory (ARL), the research part of RSMC Washington, is running the TCM unit-source dispersion job four times per day (00, 06, 12, 18 UTC) in a development account on the NOAA National Centres for Environmental Prediction (NCEP) supercomputer, sending the output dispersion files to an ARL web server for subsequent post-processing. The operational plan is to replace the current RSMC

run at NCEP with this run, tentatively in 2019. The emission duration is currently set to 6-hourly, and concentrations/depositions[1] are 6-h averages/accumulations. Current required RSMC output products for a typical RSMC/IAEA exercise scenario are also created with each TCM run because it is assumed they will still be required when the TCM is initially implemented into operations.

For this initial WMO demonstration, ARL recommends 6-h emissions and 6-h average concentrations because of the complexity of the run, potentially high resource requirements, and the need to keep the file sizes reasonable for transmission between centres. Later, based on analysis of the exercise results and ET-ERA recommendations, a subsequent version could be made with a higher resolution (the averaging time need not be the same as the emissions duration).

With each meteorological cycle, the TCM dispersion run is composed of successive forecast segments called “f000” and “f006”. Note, the f000 segment covers the pseudo-analysis time (first 6-h of the forecast) and the f006 covers the forecast period. f000 is a 6-hour simulation from the meteorological forecast initialization time (+0[2]) to 6 hours after the forecast initialization (+6). f006 is a 78-hour simulation from +6 to the end of the forecast period (+84). For each of these two segments, there is one 6-h emission beginning at the start of the segment (+0 for f000, and +6 for f006). For example, say notification for an exercise is given at 1300 UTC, when the 06z is the current cycle. Typical release periods may be from 06-12 UTC or 12-18 UTC, which correspond to the f000 and f006 segments, respectively.

For releases other than the fixed 6-h periods of the TCM run, the release time is shifted to the nearest fixed periods. For example, with the 06z cycle of the typical exercise, if the requested release is from 13-19 UTC, in the TCM run the release will be from 12-18 UTC due to the fixed, available, release times. Clearly 1-h or 3-h emission cycles would help resolve shorter emissions, but then computer resource needs increase substantially.

For NMSs with new meteorological forecasts every 12 hours, as opposed to every 6 hours, the f006 segment described above will need to be split into a 6-hour duration f006 segment, again with f006.PARINIT output at the end as was done for f000.PARINIT, and a f012 segment with f012.PARINIT output 6-h into this period. The f012 segment will be initialized with the f006.PARINT particle positions. This is done so that releases into the near future will be able to be immediately run, rather than waiting until the next cycle. For example, with notification about 1400 UTC for a release from 12 – 18 UTC, for centres with a 06z cycle, the f006 can be used (valid from 12z through the end of the run) and for centres with a 00z cycle, the f012 segment can be used (valid from 12z through the end of the run).

[1] Further mention of “concentration” implies also deposition.

[2] Times given with a plus sign are with respect to the meteorological model initialization (cycle) time, unless otherwise stated.

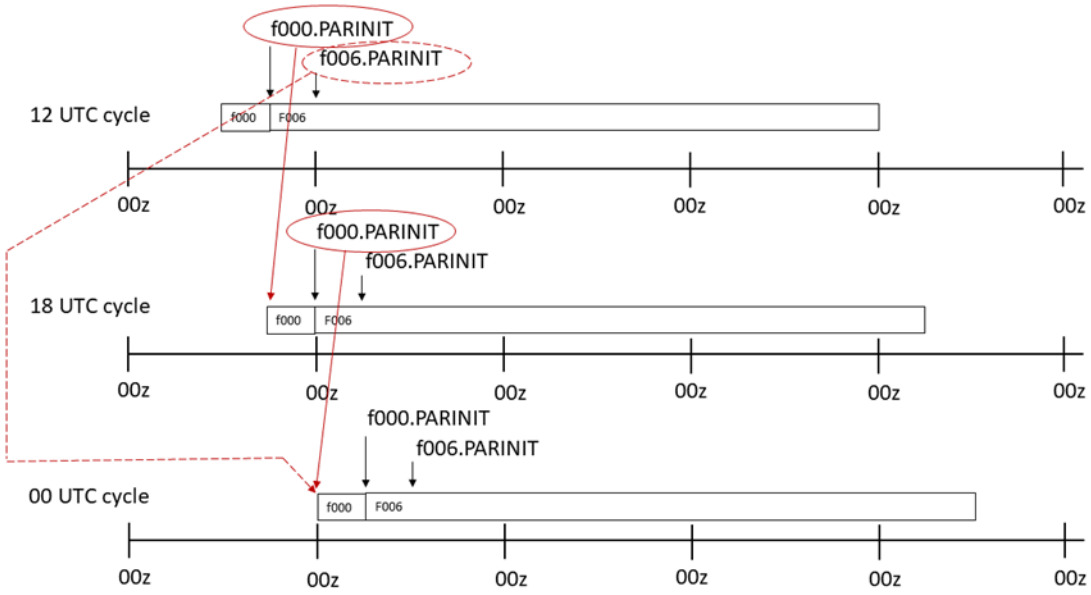

Fig. 1. Timeline showing successive 12, 18, and 00 UTC cycles. For all, at the end of the f000 segment particle positions are output and 6-hours into the f006 segment particle positions are output (depicted by black arrows). The f000 particle positions file for one cycle is used to initialize the f006 segment in the same cycle (no arrow shown) and the f000 segment of the next cycle (depicted by the red arrow and solid line). As an example of skipping the 18 UTC cycle, the f006 particle position file of the 12 UTC cycle can be used to initialize the f000 segment of the 00z cycle (red arrow and dashed line).

Output files saved on the supercomputer for a given cycle are called:
f000.PARINIT.YYYYMMDDHH
f000.cum_arch.YYYYMMDDHH
f000.zerolist.txt
f006.PARINIT.YYYYMMDDHH
f006.cum_arch.YYYYMMDDHH
f006z.zerolist.txt
f006.TG.YYYYMMDDHH

The “cum_arch” files are the cumulative archive from the start of the release through the pseudo-analysis time (f000 for 6-h cycles, f006 for 12-h cycles). The “cum_arch” files are used to create the “TG” TCM files. The “zerolist.txt” files give the dates/times of the zeroes for that cycle. Details are given in **Appendix II**.

Because input from the previous cycle is used to initialize the current cycle’s run, it is **very** important that cycles not be missed. Given how NMS numerical centres operate, it would be a rare occurrence to miss a cycle, however being able to operate through such an occurrence is prudent. One cycle can be skipped simply by starting from the model particle positions that were output from the f006 TCM segment instead of from the f000 particle position file. When multiple cycles are missed (extremely rare operational occurrence, however somewhat common for ARL’s development account because of computer maintenance), ARL runs a “catchup” script that is initialized from the last successful run, then each subsequent cycle is run to get up to the present. Further, as a development contingency, ARL downloads another set of output files, called ‘continuity’, every cycle to have a successful run that could be manually uploaded to the supercomputer, and the job re-started. These are most useful for ARL when NCEP swaps the operational (production) and backup (development) machines.

4. ATM setup and required output files

The ATM should be setup to run with four generic species (computational particles) as surrogates for the radionuclides and output in the following order (see table 1):

1. a relatively heavy (**Hpar**) particle with a large dry deposition velocity,
2. a relatively light (**Lpar**) particle with a small dry deposition velocity,
3. a depositing gas (**Dgas**) with a relatively large dry deposition velocity and wet removal, and
4. a non-depositing gas (**Ngas**) with no dry or wet removal.

The scavenging coefficients and removal rates should be the same as normally used by each RSMC in their ATM simulations, however, some suggestions for a dry deposition removal rate are provided in Table 1.

Table 1. Surrogate computational particles.

Type	Name	Wet Removal	Dry Deposition	Possible surrogate for
Particle, heavy	Hpar	Yes	Yes (0.01 m/s)	
Particle, light	Lpar	Yes	Yes (0.001 m/s)	Cs-137; I-131
Gas, depositing	Dgas	Yes	Yes (0.01 m/s)	I-131
Gas, non-depositing	Ngas	No	No	Noble gases

The output concentration/deposition grid should be a regular-spaced, latitude-longitude grid. Although multiple output levels are possible, to limit the size of the output files, it is proposed that only the data from two levels are provided: a level at height "**0**" m AGL to define the deposition, and a level at "**500**" m AGL to represent the average concentration from the ground to 500 m AGL (current RSMC protocol). The gridded output should be on a global latitude-longitude grid with 0.5 degree latitude/longitude grid spacing and each cell is centered about the latitude-longitude point. The resulting concentration grid will be 721x361 grid points centered over the prime meridian (the lower-left corner point is located at 90 degrees South, 180 degrees West). Since the file size for such a large grid can be significant, and to allow currently developed post-processing programs to be easily able to read the output files, we propose using the output format described below (an example Fortran routine to write these files will be provided to the RSMCs). File sizes will vary by ATM and the number of non-zero grid points. Output files should be named according to the start of the release time:

TG_YYYYMMDDHH, where ***YYYY*** is the 4-digit year, ***MM*** is the 2-digit month, ***DD*** is the 2 digit day and ***HH*** is the 2-digit hour (UTC) of the start of the 6 hour release period.

The concentration file format is the same used by RSMC Washington for the HYSPLIT ATM and the resulting files are compatible with the current RSMC TCM web site post-processing routines as well as numerous graphics and other output file manipulation programs. Concentration files may be written in either packed or unpacked format. Concentration file packing does not write the same information in fewer bytes, but rather writes the same information using twice as many bytes. The packed files are generally smaller because only concentration values at the non-zero grid points are written to the output file. However, this requires the grid point location to be written with the concentration data, hence the additional bytes. If most of the grid is expected to have non-zero concentrations, then the unpacked format will save space. However, for this global grid implementation, at least initially most of the grid will have zero values, and therefore the packed method is recommended. The output files should be as unformatted, big-Endian binary according to the specification in **Appendix I**.

5. Uploading of RSMC TCM files to RSMC Washington

It is recommended that the TCM files be updated by each RSMC at least every 12 hours and sent to the RSMC Washington (ARL) FTP server (ftp://arlftp.arlhq.noaa.gov/) for processing within approximately 6-12 hours after the model initialization times. The file should be placed in the same directory as the current RSMC uploads. Since each ***TG_YYYYMMDDHH*** file is modified each time the ATM is run, all (from the beginning of the simulation) of the TG files should be tarred and compressed with GNU gzip into a file with the following filename:

TCM.tar.gz.partial, where "***partial***" refers to a partially uploaded file

To avoid the server processing the ensemble mean with a partially uploaded file, the file should be renamed to ***TCM.tar.gz*** once the file is finished uploading to the server (delete any previously uploaded file first). If the server does not find this filename, any previous TCM files will be deleted (clean-up process) and the file will not be processed by the server, and therefore also not be available to the end user.

The server will periodically check for newer TCM files on the FTP server, process them, and recalculate the ensemble mean of the unit-source runs. Therefore, if an RSMC no longer wishes their results be included in the ensemble calculation, or posted to the TCM web site, they need to delete the ***TCM.tar.gz*** file from the FTP upload directory.

6. Prototype RSMC TCM web site

Similar to the web site that was setup following Fukushima, as mentioned in the introduction, an initial implementation of the RSMC TCM web-based system (https://www.ready.noaa.gov/rsmctcm/index.php) was recently developed by ARL using a series of web pages that allows the end user to select up to four radionuclides, their emission rates, their particle type, and their radioactive half-life. After entering this information the user selects a location (latitude/longitude, city name, or WMO ID) where the program will then extract the model results and produce time-series graphs and maps of concentration and deposition at that location, thereby tailoring the results to locations of interest to the user (for example where ground measurements are available or at population centres). In addition, the server routinely calculates the ensemble mean concentration/deposition of all available RSMC TCM files and produces statistical graphics based on a unit-source emission and the light particle specie. (At this time, if RSMC Washington TCM files are available, it will only use a listing of available RSMC Washington file names to calculate the ensemble of other RSMC TCM files if the same files names are available in their directories.) The ensemble mean concentration/deposition TCM files, which may be better than any one set of RSMC TCM files, are also made available to the web user to allow the same post-processing of the results with a user-entered source term and location of time series.

The time to post-process the TCM files will depend on the number and size of the TCM files and possibly the number of users on the system, hence longer duration events will take longer to process.

7. Possible limitations/considerations of the current system

Until all the RSMCs have had a chance to upload their TCM files to the new prototype web site it is difficult to predict where some bottlenecks may occur and fixes may need to be made. However, based on the testing done so far with RSMC Washington products, the following items may present a challenge in the future that may need to be addressed:

(1) Uploading of large TCM files may take too long to be useful especially for slow FTP connections and long duration events.

(2) Given (1) above, hosting the web server may need to be done by only one organization instead of residing at each RSMC. Or as an alternative, the Lead RSMC, as chosen by IAEA (one location will need to be defined per region), could be the host server for a particular event and all other RSMCs send their products to only that server.
(3) Should this RSMC TCM web site be hosted by IAEA or WMO, and if so, who will maintain the site? RSMC Washington does not have the resources to host the operational RSMC TCM web site.
(4) Timing of background ensemble calculation versus receipt of RSMC products may allow simulations with varying end times
(5) How far back in time should the TCM be able to start? For example is it possible to be notified of an event that started yesterday? 5 days ago? This has implications for the TCM "catchup" operational script.

8. Summary of recommended TCM specifications/information

(1) 6-hour emissions (duration) cycle (unit emission per emission cycle)
(2) Source uniformly distributed from the ground to 500 m above ground
(3) 6-hour average concentrations and total deposition
(4) Forecast duration is 84-h from the meteorological model initialization time (the cycle time)
(5) Particles are tracked for at most 18 days, 15 days' back plus 3 days' forecast
(6) Gridded output is on a global grid with 0.5 degree latitude/longitude grid spacing with 721x361 grid points centered over the prime meridian (90 degrees South, 180 degrees West is the lower-left corner point)
(7) Emission start date/time is the key identifier in the filenames (*TG_YYYYMMDDHH*)
(8) Incident/exercise emission beginning at the midpoint of the 6-h TCM emission are moved back to the beginning of the 6-h TCM emission (incident emission start 09z corresponds to TCM emission starting 06z).
(9) Files should be tarred and compressed and uploaded to RSMC Washington's FTP server with a unique filename (***TCM.tar.gz.partial***) and renamed to ***TCM.tar.gz*** upon completion.

9. Recommendations

Given the successful post-facto application of the TCM approach for the Fukushima incident,

- RSMC Washington will give an overview of the current developmental prototype RSMC TCM web site at the next ET-ERA meeting in Vienna.

- Other RSMCs are encouraged to create TCM files in the appropriate format and naming convention and practice uploading them to the RSMC Washington FTP site and viewing the results through the prototype RSMC TCM web site.

- Upload TCM products for an IAEA exercise during 2019 to test the process.

- Consider at least one other site (RSMC, IAEA, WMO) to host a backup prototype RSMC TCM web page during 2019 in regard to the limitations/considerations described in Section 7, and because of anticipated staffing changes at ARL. A permanent location for an operational version of the web site also needs to be defined as RSMC Washington does not have the resources to host the operational TCM web server.

- Request IAEA assign radionuclides to the Hpar, Lpar, Dgas, Ngas surrogates and provide them to RSMC Washington for inclusion in the web scripts.

10. RSMC Washington Future Work

RSMC Washington plans to complete the simulated operational development of this approach and transfer the creation of the TCM files to operations at NCEP in 2019.

RSMC Washington plans to make any needed modifications to the prototype TCM web site for any unanticipated issues that may develop once other RSMC centres have had a chance to post their products to the site and/or propose suggestions for possible alternatives.

APPENDIX I: Concentration/deposition output format

Record #1

- CHAR*4 Meteorological *MODEL* Identification
- INT*4 Meteorological file starting time (*YEAR, MONTH, DAY, HOUR, FORECAST-HOUR*)
- INT*4 *NUMBER* of starting locations
- INT*4 Concentration packing flag (0=no 1=yes)

Record #2 Loop to record: Number of starting locations

- INT*4 Release starting time (*YEAR, MONTH, DAY, HOUR*)
- REAL*4 Starting location and height (*LATITUDE, LONGITUDE, METERS*)
- INT*4 Release starting time (*MINUTES*)

Record #3

- INT*4 Number of (*LATITUDE-POINTS, LONGITUDE-POINTS*)
- REAL*4 Grid spacing (*DELTA-LATITUDE,DELTA-LONGITUDE*)
- REAL*4 Grid lower left corner (*LATITUDE, LONGITUDE*)

Record #4

- INT*4 *NUMBER* of vertical levels in concentration grid
- INT*4 *HEIGHT* of each level (meters above ground)

Record #5

- INT*4 *NUMBER* of different pollutants in grid
- CHAR*4 Identification *STRING* for each pollutant

Record #6 Loop to record: Number of output times

- INT*4 Sample start (*YEAR MONTH DAY HOUR MINUTE FORECAST*)

Record #7 Loop to record: Number of output times

- INT*4 Sample stop (*YEAR MONTH DAY HOUR MINUTE FORECAST*)

Record #8 Loop to record: Number levels, Number of pollutant types

- CHAR*4 Pollutant type identification *STRING*

- INT*4 Output *LEVEL* (meters) of this record

  No Packing (all elements)

- REAL*4 Concentration output *ARRAY*

  Packing (only non-zero elements)

  INT*4 Loop non-zero elements

- INT*2 First (I) index value
- INT*2 - Second (J) index value
- REAL*4 - Concentration at (I,J)
- … repeat the above three values; times the number of non-zero elements

Appendix II. Additional information on TCM dispersion runs

This appendix contains the following information:

- Workflow – key points and detailed example of two successive cycles
- Information on how long particles are tracked and 'dropping' the oldest runs
- Example HYSPLIT input files for those RSMCs that run HYSPLIT – CONTROL and SETUP.CFG

I. Workflow.

Key points on runs:

1. Emission duration is 6-hours, meteorology cycle is either 6- or 12-hours.
2. Segments for a given cycle –
   a. f000 segment is a 6-h run for both 6- and 12-h meteorological cycles (pseudo-analysis; short-term meteorology forecast)
   b. f006 segment is a 6-h run when the meteorological cycle is 12-h (pseudo-analysis), but covers the period from 6-h to 84-h into the forecast with a 6-h meteorology cycle. In both cases, the run is initialized with the particles from the end of the f000 segment
   c. f012 segment is only run with 12-h meteorological cycle, and covers the period from 12-h to 84-h into the forecast. It is initialized with particles from the end of the f006 segment.
   d. TG files are created in the last segment in a cycle, and sent to the TCM web server
3. For the f000 segment, the emission starts at the meteorological forecast initialization time.
4. For non-starting-from-scratch cycles, the f000 segment is initialized with particles from the previous cycle. For 6-h meteorological cycles, the initialization is from the end of the f000 segment; for 12-h cycles, the initialization is from the end of the f006 segment.
5. Concentration/Deposition files –
   a. **CG_first** has the 6-h average starting at the beginning of each segment
   b. **CG_rest** has 6-h averages for the period AFTER the file **CG_first**
6. Particle positions are output at the end time of the **CG_first** file and named **PARINIT** because they can be used to initialize a subsequent run
7. TG files contain output starting at the beginning of the emission through the end of the forecast. For periods prior to the forecast, output is from short-term forecast meteorology (pseudo-analysis).
8. **cum_arch** (cumulative archive) files are pseudo-analysis files from the beginning of the emission through 6 or 12-h into the forecast, for 6-h or 12-h meteorological cycles, respectively. This is used to create the TG files.
9. For every emission (not the zeros) the start date/time of the emission is written to text file **zerolist.txt**. This is used in subsequent segments/runs to know what zeroes to run.

10. Saved filenames include the segment identifier (e.g. f000) and emissions start time (YYYYMMDDHH).
11. Each dispersion model run is done in a unique working directory to allow for parallel processing. The name of the working directory is identified by the segment and emission start time. It is assumed cycle time and date are in the directory name and/or filename to uniquely identify files.

Here is an example for a 00 UTC cycle on 20180821, starting from scratch, assuming 12-h cycles, and a working directory named "working", with the filenames and directory structure ARL is using.

1. The f000 segment is run first (duration 6 hours) –
   A. 6-h emission starting at 2018082100
      a. Subdirectory is working/000/2018082100/
      b. 6-h average concentrations written 6-h into run (e.g. at end) to file named **CG_first**
      c. Particle positions written 6-h into run to file named **PARINIT**
      d. **CG_first** is copied to **cum_arch** (pseudo-analysis file)
      e. The start time of the emission (2018082100) is written to file **zerolist.txt**. When the f006 is run a zero will be run for the date in the file **zerolist.txt**.
   B. Save files for next segment.
      f000.PARINIT.2018082100
      f000.cum_arch.2018082100
      f000.zerolist.txt

2. The f006 segment is run next (duration 6 hours) (A and B can be run in parallel) –
   A. 6-h emission starting at 2018082106
      a. Subdirectory working/006/2018082106
      b. 6-h average concentrations written 6-h into run to file named **CG_first**
      c. Particle positions written 6-h into run to file named **PARINIT**
      d. **CG_first** is copied to **cum_arch**
      e. Copy **zerolist.txt** (f000, Sec. 1.A.e) to here. Append the start time of the emission (2018082106) to file **zerolist.txt**. When the f012 is run zeroes will be run for the dates in the file zerolist.txt.
   B. zero from emission starting at 2018082100
      a. Subdirectory working/006/2018082100
      b. Initialize with **f000.PARINIT.2018082100** (current cycle f000)
      c. 6-h average concentrations written 6-h into run to file named **CG_first**
      d. Particle positions written 6-h into run to file named **PARINIT**
      e. **CG_first** is appended[3] to **f000.cum_arch.2018082100** (current cycle f000) and named **cum_arch**
   C. Save files for next segment.
      f006.PARINIT.2018082100 (Sec. B.d)
      f006.PARINIT.2018082106 (Sec. A.c)
      f006.cum_arch.2018082100 (Sec. B.e)
      f006.cum_arch.2018082106 (Sec. A.d)
      f006.zerolist.txt (Sec. A.e)

3. The f012 segment is run last (duration 72 hours) (A, B, and C can be run in parallel) -
   A. 6-h emission starting at 2018082112
      a. Subdirectory working/012/2018082112
      b. 6-h average concentrations written 6-h into run to file name **CG_first**
      c. 6-h average concentrations written every 6 hours for the rest of the run to file named **CG_rest**
      d. Particle positions written 6-h into run to file named **PARINIT**
      e. **CG_first** is copied to **cum_arch**

[3] The HYSPLIT utility program 'conappend' can append one concentration file to another.

f. Copy **zerolist.txt** (from f006, this cycle, 2.A.e) to here. Append the start time of the emission (2018082112) to file **zerolist.txt**
g. **CG_rest** is appended to **cum_arch** and named **TG_2018080212**

B. zero from emission starting at 2018082106
a. Subdirectory working/012/2018082106
b. Initialize with **f006.PARINIT.2018082106** (current cycle f006, 2.C above)
c. 6-h average concentrations written 6-h into run to file named **CG_first**
d. 6-h average concentrations written every 6 hours for the rest of the run to file named **CG_rest**
e. Particle positions written 6-h into run to file named **PARINIT**
f. **CG_first** is appended to **f006.cum_arch.2018082106** (current cycle f006) and named **cum_arch**
g. **CG_rest** is appended to **cum_arch** and named **TG_2018082106**

C. zero from emission starting at 2018082100
a. Subdirectory working/012/2018082100
b. Initialize with **f006.PARINIT.2018082100**
c. 6-h average concentrations written 6-h into run to file named **CG_first**
d. 6-h average concentrations written every 6 hours for the rest of the run to file named CG_rest
e. Particle positions written 6-h into run to file named **PARINIT**
f. **CG_first** is appended to **f006.cum_arch.2018082100** and named **cum_arch**
g. **CG_rest** is appended to **cum_arch** and named **TG_2018082100**

D. Save files
f012.PARINIT.2018082100
f012.PARINIT.2018082106
f012.PARINIT.2018082112
f012.cum_arch.2018082100
f012.cum_arch.2018082106
f012.cum_arch.2018082112
f012.zerolist.txt
TG_2018082100
TG_2018082106
TG_2018082112

Continuing the example for the next cycle, 12 UTC on 20180821. The working directory is "working2".

1. The f000 segment is run first (duration 6 hours) (A, B, and C can be run in parallel) –
A. 6-h emission starting at 2018082112
a. Subdirectory is working2/000/2018082112/
b. 6-h average concentrations written 6-h into run to file named **CG_first**
c. Particle positions written 6-h into run to file named **PARINIT**
d. **CG_first** is copied to **cum_arch**
e. Copy previous cycle **f006.zerolist.txt** to working directory **zerolist.txt** (This has 2018210800 and 2018210806, the pseudo-archive.) Append the start time of the emission (2018082112) to file **zerolist.txt**.

B. zero from emission starting at 2018082106
a. Subdirectory working2/000/2018082106
b. Initialize with **f006.PARINIT.2018082106** (previous cycle)
c. 6-h average concentrations written 6-h into run to file named **CG_first**
d. Particle positions written 6-h into run to file named **PARINIT**
e. **CG_first** is appended to **f006.cum_arch.2018082106** (previous cycle) and named **cum_arch**

C. zero from emission starting at 2018082100
a. Subdirectory working2/000/2018082100

b. Initialize with **f006.PARINIT.2018082100** (previous cycle)
c. 6-h average concentrations written 6-h into run to file named **CG_first**
d. Particle positions written 6-h into run to file named **PARINIT**
e. **CG_first** is appended to **f006.cum_arch.2018082100** and named **cum_arch**

E. Save files
f000.PARINIT.2018082100
f000.PARINIT.2018082106
f000.PARINIT.2018082112
f000.cum_arch.2018082100
f000.cum_arch.2018082106
f000.cum_arch.2018082112
f000.zerolist.txt

2. The f006 segment is run next (duration 6 hours) -
A. 6-h emission starting at 2018082118
a. Subdirectory working2/006/2018082118
b. 6-h average concentrations written 6-h into run to file named **CG_first**
c. Particle positions written 6-h into run to file named **PARINIT**
d. **CG_first** is copied to **cum_arch**
e. Copy **zerolist.txt** (f000 this cycle, Sec. 1.A.e) to here. Append the start time of the emission (2018082118) to file **zerolist.txt**

B. zero from emission starting at 2018082112
a. Subdirectory working2/006/2018082112
b. Initialize with **f000.PARINIT.2018082112** (current cycle f000)
c. 6-h average concentrations written 6-h into run to file named **CG_first**
d. Particle positions written 6-h into run to file named **PARINIT**
e. **CG_first** is appended to **f000.cum_arch.2018082112** (current cycle f000) and named **cum_arch**

C. zero from emission starting at 2018082106
a. Subdirectory working2/006/2018082106
b. Initialize with **f000.PARINIT.2018082106** (current cycle f000)
c. 6-h average concentrations written 6-h into run to file named **CG_first**
d. Particle positions written 6-h into run to file named **PARINIT**
e. **CG_first** is appended to **f000.cum_arch.2018082106** (current cycle f000) and named **cum_arch**

D. zero from emission starting at 2018082100
a. Subdirectory working2/006/2018082100
b. Initialize with **f000.PARINIT.2018082100** (current cycle f000)
c. 6-h average concentrations written 6-h into run to file named **CG_first**
d. Particle positions written 6-h into run to file named **PARINIT**
e. **CG_first** is appended to **f000.cum_arch.2018082100** (current cycle f000) and named **cum_arch**

F. Save files for next segment.
f006.PARINIT.2018082100
f006.PARINIT.2018082106
f006.PARINIT.2018082112
f006.PARINIT.2018082118
f006.cum_arch.2018082100
f006.cum_arch.2018082106
f006.cum_arch.2018082112
f006.cum_arch.2018082118
f006.zerolist.txt

3. The f012 segment is run last (duration 72 hours) -
A. 6-h emission starting at 2018082200
a. Subdirectory working2/012/2018082200

b. 6-h average concentrations written 6-h into run to file name **CG_first**
c. 6-h average concentrations written every 6 hours for the rest of the run to file named **CG_rest**
d. Particle positions written 6-h into run to file named **PARINIT**
e. **CG_first** is copied to **cum_arch**
f. Copy **zerolist.txt** (from f006, this cycle, 2.A.e) to here. Append the start time of the emission (2018082200) to file **zerolist.txt**
g. **CG_rest** is appended to **cum_arch** and named **TG_2018082200**

B. zero from emission starting at 2018082118
a. Subdirectory working2/012/2018082118
b. Initialize with **f006.PARINIT.2018082118** (current cycle f006)
c. 6-h average concentrations written 6-h into run to file named **CG_first**
d. 6-h average concentrations written every 6 hours for the rest of the run to file named **CG_rest**
e. Particle positions written 6-h into run to file named **PARINIT**
f. **CG_first** is appended to **f006.cum_arch.2018082118** (current cycle f006) and named **cum_arch**
g. **CG_rest** is appended to **cum_arch** and named **TG_2018082118**

C. zero from emission starting at 2018082112
a. Subdirectory working2/012/2018082112
b. Initialize with **f006.PARINIT.2018082112** (current cycle f006)
c. 6-h average concentrations written 6-h into run to file named **CG_first**
d. 6-h average concentrations written every 6 hours for the rest of the run to file named **CG_rest**
e. Particle positions written 6-h into run to file named **PARINIT**
f. **CG_first** is appended to **f006.cum_arch.2018082112** (current cycle f006) and named **cum_arch**
g. **CG_rest** is appended to **cum_arch** and named **TG_2018082112**

D. zero from emission starting at 2018082106
a. Subdirectory working2/012/2018082106
b. Initialize with **f006.PARINIT.2018082106** (current cycle f006)
c. 6-h average concentrations written 6-h into run to file named **CG_first**
d. 6-h average concentrations written every 6 hours for the rest of the run to file named **CG_rest**
e. Particle positions written 6-h into run to file named PARINIT
f. **CG_first** is appended to **f006.cum_arch.2018082106** (current cycle f006) and named **cum_arch**
g. **CG_rest** is appended to **cum_arch** and named **TG_2018082106**

E. zero from emission starting at 2018082100
a. Subdirectory working2/012/2018082100
b. Initialize with **f006.PARINIT.2018082100**
c. 6-h average concentrations written 6-h into run to file named **CG_first**
d. 6-h average concentrations written every 6 hours for the rest of the run to file named CG_rest
e. Particle positions written 6-h into run to file named **PARINIT**
f. **CG_first** is appended to **f006.cum_arch.2018082100** and named **cum_arch**
g. **CG_rest** is appended to **cum_arch** and named **TG_2018082100**

G. Save files
f012.PARINIT.2018082100
f012.PARINIT.2018082106
f012.PARINIT.2018082112
f012.PARINIT.2018082118
f012.PARINIT.2018082200
f012.cum_arch.2018082100
f012.cum_arch.2018082106
f012.cum_arch.2018082112
f012.cum_arch.2018082118

f012.cum_arch.2018082200
f012.zerolist.txt
TG_2018082100
TG_2018082106
TG_2018082112
TG_2018082118
TG_2018082200

II. Particles are tracked for a given number of days (ARL defines variable num_days_back=11). In the f000 segment only, it is determined if any zeroes need to be dropped. If so, they are removed from **zerolist.txt** before the f000 is run.

III. Example HYSPLIT input file named CONTROL for an emission. The duration is 78-hours implying this is for an f006 segment, 6-h meteorological cycles.

```
18 08 24 12
2
35.74 135.99     0
35.74 135.99 500
78
0
14000.
1
/com2/hysplit/prod/hysplit.20180824/
hysplit.t06z.gfs0p5f
4
Hpar
1.0
006
00 00 00 00 00
Lpar
1.0
006
00 00 00 00 00
Dgas
1.0
006
00 00 00 00 00
Ngas
1.0
006
00 00 00 00 00
2
0.0 0.0
0.5 0.5
0.0 0.0
/working/loc1/006/2018082412/
CG_first
2
0 500
00 00 00 00 00
00 00 00 006 00
00 6 00
0.0 0.0
0.5 0.5
0.0 0.0
/working/loc1/006/2018082412/
```

```
CG_rest
2
0 500
00 00 00 006 00
00 00 00 00 00
00 6 00
4
1.0 1.0 1.0
0.01 0.0 0.0 0.0 0.0
0.0 8.0E-05 8.0E-05
0.0
0.0
1.0 1.0 1.0
0.001 0.0 0.0 0.0 0.0
0.0 8.0E-05 8.0E-05
0.0
0.0
0.0 0.0 0.0
0.01 0.0 0.0 0.0 0.0
0.08 0.0 0.0
0.0
0.0
0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0
0.0
0.0
```

IV. Example HYSPLIT input file named SETUP.CFG corresponding to the CONTROL file above.

```
&SETUP
delt = 20.0,
initd = 0,
khmax = 440,
mgmin = 200,
numpar = -1.000000e+04,
maxpar = 2.424000e+05,
maxdim = 1,
ninit = 1,
ndump = 006,
ncycl = 0,
pinpf = 'PARINIT',
poutf = 'PARINIT',
cpack = 1,
/
```

ANNEX VIII

Report on the Joint Time of Arrival Test in June 2017

(Submitted by Mr. Masami Sakamoto, RSMC Tokyo)

Summary and purpose of document

This document summerises results of the joint Time of Arrival (ToA) test in June 2017, which was coincident with ConvEx-3. This activity was in accordance with Action 18 of the ET-ERA meeting, Buenos Aires, Argentina, November – December 2015. This document is to encourage the ET-ERA members to have further discussions necessary to explore appropriate definitions of ToA.

Action Proposed

The meeting is invited to discuss the results and outcomes of the joint Time of Arrival (ToA) test. The members are encouraged to talk over the following points:

- Usages of ToA (including professional usages by radiological observers),
- Definitions of ToA (including designs of the charts, instantaneous / averaged / time-integrated concentrations, initial time, and thresholds for ToA),
- Operational measures to transmit and present ToA charts.

Reference:

- Annex-I: Instructions on the Time of Arrival test
- Annex-II: Test charts presented by the participants of the joint ToA test in June 2017.

1. Introduction

The expert team on the emergency response activities (ET-ERA) had a meeting at the Servicio Meteorológico Nacional of Argentina in Buenos Aires, from 30 November to 4 December, 2015. The meeting adopted an action item to pursue further development of the Time of Arrival (ToA) products. That is,

"ACTION 18: RSMCs and IAEA – Coordination by experts from RSMC Obninsk (Mr Kosykh), RSMC Japan (Mr Sakamoto),IAEA (Mr Winkler) and RSMC Vienna (Mr Wotawa)
Time of arrival products
DUE DATE: 2016
'Time of Arrival'' Product Tests'

1. Produce document to define and clarify details and specifications for next ToA test to ensure consistency between RSMCs products
2. Conduct new test
3. IAEA to propose threshold value for cloud boundaries."

Although Dr. Kosykh initiated a discussion to identify remaining issues in the document on the definitions of ToA charts in December 2016, there was no chance to conduct an additional joint test by the end of 2016.

In February 2017, some of the members of ET-ERA were engaged in the discussions on the large-scale exercise ConvEx-3, which was planned during 21 – 22, June, 2017. The chair of ET-ERA suggested conducting a joint ToA test using the release scenarios of ConvEx-3. Dr. Kosykh was trying to liaise with the members to restart the discussion. However, he had to move to his new position in the Roshydromet in early March, and asked the remaining members to take care of his leading work for the ToA development. The ET-ERA chair assigned Mr. Sakamoto of RSMC Tokyo to organize the ToA test in June 2017.

2. Preparations and Discussions for the Joint Test

Mr. Sakamoto took over the discussions raised by Dr. Kosykh, and asked the members for opinions and suggestions regarding the following points:

- general rules for displaying results (continuation of the document proposed by Dr. Kosykh),
- definitions of ToA (i.e. whether it is based on instantaneous or time-integrated concentration),
- time-frame of products (what should be the initial time of ToA?),
- measures to transmit and present ToA chars.

Discussions by the members had continued from March to May 2017, and the outlines of the discussions on each subject are found in this section. Mr. Sakamoto organized practical procedures for the participants of the joint test, and issued an instruction note by the end of May (see Annex-I).

2.1 Discussions on Purposes and Usages of ToA Charts

In the course of the discussions among the ET-ERA members, Mr. Winkler of the International

Atomic Energy Agency (IAEA) / the Incident and Emergency Centre (IEC) mentioned usages of the ToA charts on Friday, 21 April as follows;

"a) the ToA product should be used to identify when a sufficient activity concentration is reaching a point in space so that the relevant authorities can decide to start the radiation monitoring programme. When they do this they will likely use mobile equipment. This means that these equipment is not so sensitive and therefore the value should not be too low. Because if it is below the detection limit then, they will not agree with us that the plume has arrived.

b) the inconsistency with the exposure charts is not going to be a big problem since both charts serve a different purpose. I believe actually that on the long run, we might change the sequence of the standard products meaning once the ToA are a standard product it will be requested earlier than the exposure and deposition ones."

ET-ERA rarely had had relevant discussions to the atmospheric transport, dispersion, and deposition model (ATDM) forecast services for pre-warning for radiological monitoring programmes by then, and therefore this was a newly introduced usage.

However, reliable release amount information is seldom obtained at an early stage, while it is vital to scientifically estimate concentrations at observatories. Therefore the members have to consider and devise some appropriate definitions of ToA, because the pre-warning for the observational specialists can be a promising usage of the product.

2.2 Definitions of ToA charts

Dr. Kosykh had mainly concentrated on deciding general rules for displaying results. Namely what had been chiefly discussed through the two joint tests in 2015 were:

- each chart should cover each 24 hour time slot, and a set of ToA charts for a 72 hour forecast have 3 pages in total,
- the contour interval should be 6 hours, and second and third charts have gray areas where the plume already has arrived by the beginning of their temporal scopes,
- it is desirable to present each 6 hour time step with colored hatching; colours used in the three pages should be consistent.

Dr. Kosykh contributed to maintaining consistency in the appearances of ToA charts. While some members have proposed to adopt coloured shades instead of hatching, the graphical definitions by Dr. Kosykh were basically adopted for the test in 2017.

On the other hand, Mr. Sakamoto has been requiring discussing more technical and physical aspects of ToA since the joint tests in 2015. What he has asked the members for opinions and discussions are:

- ToA can be processed using the instantaneous or time-integrated concentrations, and these two concentrations are physically different things and therefore they have different units / dimensions. Previously Dr. Kosykh had proposed the following:

  "6. To define cloud boundary in terms of concentration value we have to use the same value as the current lowest value plotted on the other plots",

  the members needed to adopt the time-integrated ToA when the threshold of ToA

corresponded to 'the current lowest value' seen in their exposure charts.

- Previously Dr. Kosykh described

  "1.RSMCs generate three ToA plots – for periods 0-24, 25-48, 49-72 hours after release – like concentrations and depositions",

  the members needed to note that the initial times for exposure and deposition charts are not the start release time, they are the initial time of the numerical weather predictions (NWP) used for the ATDMs according to the GDPFS manual. Therefore the members had to understand more about the definition of the initial time of ToA.

Mr. Sakamoto also suggested that the members needed to decide how to handle the requests that only specify the lowest (base) release height (while the top is unspecified), because such requests were found during the joint tests in 2015.

During the discussions before the joint ToA test in 2017, Mr. Sakamoto kindly presented explanatory memos on such technical and physical issues regarding ToA, and most of the members recognized such underlying problems. Then the participants of the ToA test 2017 examined various types of definitions at the joint test (see section 3). ET-ERA needs to have further discussions 'to define and clarify details and specifications' from these aspects.

Another important point to be clearly defined is the 'threshold value for cloud boundaries'. This time the ET-ERA members also had discussions on the thresholds for both instantaneous and time-integrated ToAs. The action item of the ET-ERA meeting Buenos Aires described "3. IAEA to propose threshold value for cloud boundaries", and Mr. Sakamoto kindly presented some preliminary ATDM results in Europe to help Mr. Winkler identify appropriate threshold values. However there were no specified values this time, because of lack of considerations and understanding of ToA beforehand.

Some of the members expressed their positions regarding the thresholds, which include;

- for instantaneous ToAs: 0 [Bq /m^3] (by Dr. Wotawa),
- for time-integrated ToAs: the minimum value shown in the exposure charts at each centre (By Dr. Kosykh for the tests in 2015).

The participating members were encouraged to adopt the thresholds above, and they also were requested to clearly indicate their thresholds on each ToA chart especially when different thresholds from the ones shown above were used.

When discussing appropriate thresholds, the members need to take into consideration the fact that reliable release amount information can rarely be obtained at an early stage of an accident and/or incident. An ATDM is just a tool to scientifically predict atmospheric dispersions of a target material according to a given release scenario, and therefore there is no practical way to predict quantitative concentrations at specific locations when a reliable release amount is unavailable. It should be noted that ATDMs cannot predict whether the concentration of the target isotope does or does not reach the proposed threshold without reliable release amount information.

2.3 Measures to Transmit and Present ToA charts

ToA charts were shared among the participants by email for the joint tests in 2015, and this time again the participating members exchanged their test charts by email.

As with the joint test in 2015, there had been no pertinent discussion to the operational measures to transmit charts and present them to users for the 2017 test. Mr. Sakamoto created an experimental web system to present test charts to the participants. He provided Perl-script programs necessary to establish such a web system at RSMCs' servers. Some members were interested, however there was no participant (only except for Mr. Sakamoto) who could set up such a system at their server. Mr. Sakamoto also provided the participants with instructions on how to upload test charts to his experimental web system. The upload to the server had been voluntarily examined by the participants from Tuesday, 16 May to Thursday, 6 July 2017.

3. Results

The joint test was conducted during 21 – 23 June. The participants processed their test charts using the release scenarios of ConvEx-3. Table 1 shows the release scenarios provided by IEC at ConvEx-3. There were five request forms sent by IEC, while RSMC Melbourne and Toulouse received only three of them. Therefore two remaining release scenarios were sent to Mr. Fraser and Mr. Nicolau by other ET-ERA members, and they processed their test charts after the termination of ConvEx-3.

Table 1. Release Scenarios used in the joint test in June 2017

request	1st request	2nd request			3rd request
Isotope	not specified	^{131}I	^{90}Sr	^{137}Cs	^{131}I
start of release	2017/6/21 06:00	2017/6/21 12:00			2017/6/21 05:30
end of release	2017/6/21 12:00	2017/6/21 18:00			2017/6/22 00:00
total release quantity	1 Bq	1.38E+18 Bq	6.82E+16 Bq	9.71E+16 Bq	1.38E+18 Bq
top release height	surface	surface			none
base release height					100 m

The release site: Paks NPP, Humgary [46.574013N, 18.85362(3)E].

3.1 Participation and Issuance of the Charts

The participating ET-ERA members, who provided their charts for the joint ToA test, were (in alphabetical order of their centres' names):

- Dr. Zhenxin Song (RSMC Beijing),
- Mr. Anton Muscat (RSMC Exeter),
- Mr. Jim Fraser (RSMC Melbourne),
- Mr. Nils Ek (RSMC Montreal),
- Dr. Dmitriy Kamaev (RSMC Obninsk),
- Mr. Masami Sakamoto (RSMC Tokyo),
- Mr. Jean Nicolau (RSMC Toulouse),
- Dr. Gerhard Wotawa (RSMC Vienna).

Dr. Wotawa (and his colleague Mr. Skomorowski) voluntarily participated in the joint test, while RSMC Vienna operationally serves only the back-tracking products. On the other hand, Mr. McQueen of RSMC Washington attended just as an observer, because he (and his colleagues) was not fully equipped for the production of the ToA charts. Dr. Foerstner of RTH/RSMC Offenbach, Co-chair of ET-ERA Mr. Servranckx, and Mr. Winkler of IAEA/IEC attended as observers too.

Mr. Sakamoto kindly asked participants and confirmed what they had issued by the deadline, and many times suggested them to add and / or update the charts when necessary. They had been encouraged to process and provide as many charts as possible, and all participants successfully presented their ToA and standard charts for all scenarios.

The upload to the experimental web for the joint ToA test was only examined by two members. They are Dr. Kamaev of RSMC Obninsk and Mr. Sakamoto of RSMC Tokyo.

3.2 Test Charts by Each Participants

Test charts processed by the participating ET-ERA members are shown in Annex-II. Table 2 presents the NWP and ATDM systems used for the joint test. Note that the grid intervals for the Lagrangian ATDMs are the output intervals of estimated (instantaneous, averaged, or time-integrated) concentrations, depositions, and ToA. Lower resolution grid point values of NWP forecasts were adopted in some centres for their ATDM forecasts.

Table 2. NWP and ATDM systems used for the test in June 2017

centre	NWP system			ATDM system		
	name	grid interval	model levels	name	type	grid interval
Beijing	GRAPES GFS	25km	60	HYSPLIT4.9	Lagrangian	0.25deg
Exeter	GM (UM)	17km	70	NAME III	Lagrangian	0.5625 x 0.375 deg
Melbourne	ACCESS-G	25km	70	HYSPLIT 4.9	Lagrangian	0.25 deg
Montreal	GDPS (GEM)	25km	58	MLDP0	Lagrangian	25 km
Obninsk	GSM	75km	31	STADIUM	Lagrangian	0.5 deg
Tokyo	GSM	20km	100	[no name]	Lagrangian	0.5 deg
Toulouse	IFS cy41r2	9km	137	MOCAGE	Eulerian	0.5 deg

Table 3. Release Heights adopted by the participants

centre	1st request (surface)		2nd requests (surface)		3rd request (base: 0 m)	
	top	base	top	base	top	base
Beijing	500 m	0 m	500 m	0 m	500 m	0 m
Exeter	500 m	0 m	500 m	0 m	100 m	0 m
Melbourne	0 m		0 m		500 m	100 m
Montreal	500 m	unknown	500 m	unknown	100 m	unknown
Obninsk	10 m	0 m	500 m	0 m	500 m	100 m
Tokyo	10 m	0 m	10 m	0 m	500 m	100 m
Toulouse	500 m	0 m	500 m	0 m	100 m	0 m
Vienna	0 m	0 m	0 m	0 m	100 m	100 m

As for the release height

s, the 1st and 2nd requests required the surface release. Dr. Kamaev of RSMC Obninsk pointed out that the top and base heights used by the participants for the surface release are different. The 3rd request specified only the base height as 100 m, while the top height was not given. The release heights for this request were also different among the participants. Table 3 shows the release heights adopted by the participants, and some participants seemed to adopt wrong choices for the 3rd request. Dr. Kamaev kindly presented the ATDM results for the 1st request using the release heights: 0 – 500m AGL. His additional exposure, deposition, and the instantaneous ToA charts for the 48-72 hour after the initial are shown in Fig 1 as references. Comparisons with his original charts (with 0 – 10m AGL release) indicated that ATDM results with the different release heights for the 1st scenario resulted in the almost the same distributions by 72hours after the initial time. There are no set values for the top and base heights for the surface release and for the case in which only a base height is specified, the ET-ERA members need to have discussions and then need to have appropriate decisions in this regard.

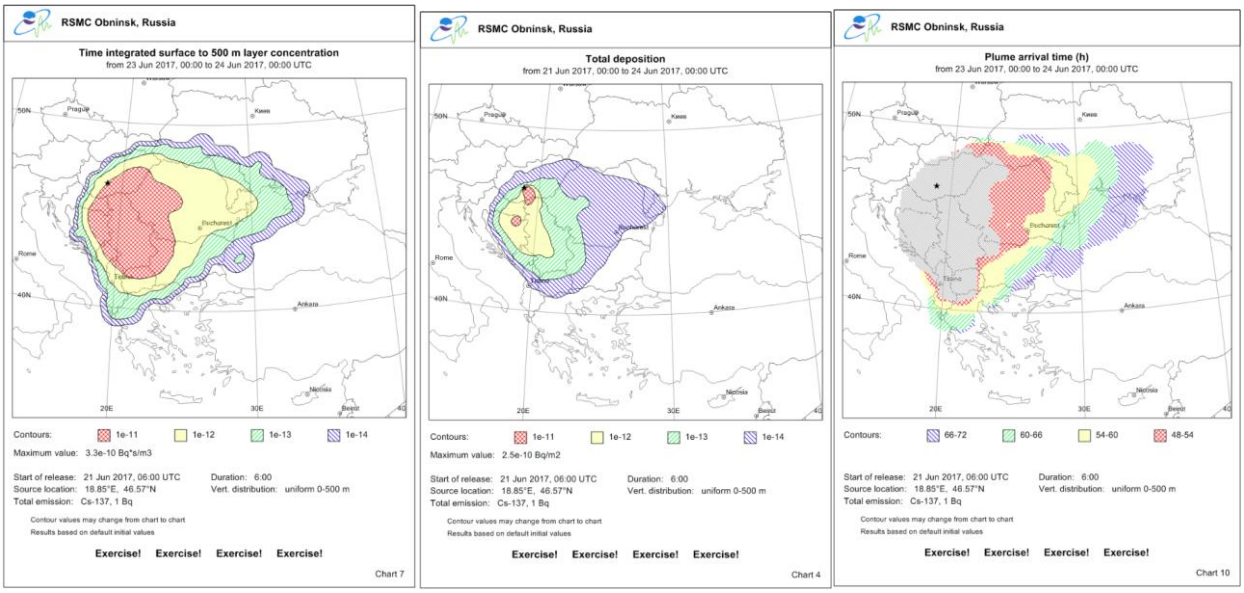

Fig 1. Exposure (left), Deposition (middle), and instantaneous ToA (right) by Dr. Kamaev using Stadium with the release height: 0 – 500m AGL for the 1st scenario (48–72 hours after the initial).

ATDM calculations for three different radiological species, which were simultaneously released from the same site, were required by the 2nd request. Because the half-lives of all three are longer than the 72 hour forecast period of ATDMs, distributed domains of exposures, depositions, and ToAs for the three isotopes were much the same for the charts submitted by most of the participants (with some exceptions).

Table 4. Production Plans of ToAs (at the end of May 2017)

centre name	Type(s) of ToA	Time-integration period
Beijing	instantaneous and time-integrated	all through (since start release)
Exeter	instantaneous and time-integrated	all through (since start release)
Melbourne	instantaneous	
Montreal	time-integrated	3 hours
Obninsk	Instantaneous	
Tokyo	Instantaneous and time-integrated	all through (since start release)
Toulouse	Instantaneous and time-integrated	
Vienna	instantaneous	

Table 4 shows the list of types of ToA the participants had planned to process before the joint test. Despite their initial intent, some members presented the 'averaged' ToA instead of the instantaneous ToA. Mr. Ek and his colleagues processed two types of ToA ('averaged and time-integrated) and this was another change from the initial plan.

As discussed above, the standard charts are processed referring the global NWP initial time. Table 5 is the list of NWP initial times the participants used to run their ATDMs. Because the ToA test was not done in an operational manner, most participants seem to have adopted latest NWP forecasts that can cover the release periods. For some centres, 12:00UTC global NWP can not be available for the 2nd requests (in their operational timeframe) because the issued time of 14:15 UTC is too early to adopt 12:00 UTC NWPs. Mr. Sakamoto adopted 06-21 00:00UTC initial NWP for the 2nd requests taking his organization's NWP production cycle into consideration. Mr. Nicolau and Mr. Deslandes adopted 12 hours older initial of ECMWF's global forecasts for the 1st and 2nd requests. It is noted that Dr. Song and Dr. Wotawa presented the standard charts referring to the start release time as the initial time of ATDMs. Mr. Sakamoto processed his ATDM charts for the 3rd request using the latest NWP forecast and the accumulation of past global analyses (means partly include a hind cast), and it seems that Dr. Wotawa presented similar results for the 3rd request.

Table 5. List of NWP Initial Time to run ATDMs (time in UTC)

	1st request	2nd request	3rd request
	issued: 06-21 06:10	issued: 06-21 14:15	issued: 06-21 18:30
centre	start release: 06-21 06:00	start release: 06-21 12:00	start release: 06-21 05:30
Beijing	06-21 06:00 (06-21 00:00)*	06-21 12:00	06-21 05:00 (06-21 00:00)*
Exeter	06-21 00:00	06-21 12:00	06-21 00:00
Melbourne	06-21 00:00	06-21 12:00	06-21 00:00
Montreal	06-21 00:00	06-21 12:00	06-21 00:00
Obninsk	06-21 00:00	06-21 12:00	06-21 00:00
Tokyo	06-21 00:00	06-21 00:00	06-21 12:00
Toulouse	06-21 00:00 (06-20 12:00)*	06-21 12:00 (06-21 00:00)*	06-21 00:00
Vienna	06-21 06:00 (06-20 00:00)*	06-21 12:00	06-21 05:30 (06-21 12:00)*

NWP initial time estimated from the integration period of the exposure charts. (MM-DD HH:MM)* are the actual NWP initial time printed on their standard charts.

Details of the charts by each participant

and comments on them are found after this. The thresholds and initial times of ToA are also the points to be checked, while they were not pre-declared. Therefore values and times printed on the charts are included in the details below.

3.2.1 Comments on the charts by Dr. Zhenxin Song (RSMC Beijing)

Dr. Song of RSMC Beijing presented the 0 deposition for Strontium 90 for the 2nd request, while other participants predicted more than 0 Bq / m^2. Depositions for Iodine 131 for the 2nd request also seem too little.

He processed both types of ToAs, and his thresholds were 0.0 Bq / m^3 for the instantaneous and 1.0E-10 Bq s / m^3 for the time-integrated ToAs for the all scenarios. The integration period for the time-integrated ones seems to start at the start release time as he initially planned. The initial times of not only ToAs but also of the standard charts seem to be set to the start release times (not to the NWP initial times).

3.2.2 Comments on the charts by Mr. Anton Muscat (RSMC Exeter)

Exposures, Depositions, and ToAs were calculated with NAME III, but the standard charts were processed by different procedures than ones RMSC Exeter uses for the operational purpose. There were more than 4 contours seen in the exposure and deposition charts, while the GDPFS manual described "adopt a maximum of four concentration/deposition contours corresponding to powers of 10". In some charts, values larger than the maximum in the legend were not colored, and look like holes. This issue has been highlighted to the appropriate teams within RSMC Exeter and a solution is expected to be rolled out in the near future.

Mr. Muscat presented 'averaged' and time-integrated ToAs, while the definition of the 'averaged' ToA was not fully explained. Thresholds used for the 'averaged' ToA were not 0 Bq / m^3, and were different depending on the release scenarios. Thresholds for the time-integrated were the minimum value shown in the exposure charts. The time-integration type was the all through, and the initial times of ToAs seem to be the NWP initial time.

3.2.3 Comments on the charts by Mr. James Fraser (RSMC Melbourne)

Mr. Fraser and his colleague Mr. Wain processed 'averaged' ToAs adding to the corresponding standard charts for all scenarios. They firstly intended to process the instantaneous ones, but they were not yet fully equipped. The threshold of their ToA was 1.0 e -18 Bq / m^3 regardless of the released amount and species. The initial times of ToAs seem to be set to the start release.

As is described earlier in this subsection, the distributed areas for ^{131}I, ^{90}Sr, and ^{137}Cs for the 2nd request resemble each other with regards to the charts submitted by most participants. However those of ToAs by Mr. Fraser and Mr. Wain look a little different. They have been trying to identify the reasons for the differences, but not yet fully understand why such differences can occur.

3.2.4 Comments on the charts by Mr. Nils Ek (RSMC Montreal)

Mr. Ek and his colleagues presented the 'averaged' and time-integrated ToAs. The threshold for the averaged ToA was 0.0 Bq / m^3, while ones for the time-integrated ToA were different values depending on the scenarios and were not the minimum values found in their exposure charts. The initial time of the ToAs was the start of release.

Total depositions presented by Mr. Ek have relatively wide spreads mainly toward east-north-east direction in comparison with his average ToAs (especially for the 2nd requests). This might occur when strong wet-scavenging including rainout happened above 500 m AGL. However there is no fixed reason for this problem so far because of lack of his resources and priority for the development in this regard.

3.2.5 Comments on the charts by Dr. Dmitriy Kamaev (RSMC Obninsk)

Dr. Kamaev and his colleagues presented the instantaneous ToAs and the standard charts for all scenarios. The threshold was found to be 0.0 Bq / m^3, because this is the recommended value in the instruction and there are no specific threshold values printed on his ToA charts. The initial time of ToA was one of the NWP forecast.

3.2.6 Comments on the charts by Mr. Masami Sakamoto (RSMC Tokyo)

Mr. Sakamoto presented the instantaneous and time-integrated ToAs for all cases. He used 1,000,000 tracer particles for each ATDM calculation, and added some revisions (which were chiefly treatments for minor species and radionuclides with short half-lives adding to the arrival time calculations) to the operational ATDM of RSMC Tokyo.

The thresholds were 0.0 Bq / m^3 for the instantaneous ToAs, and the minimum values shown in corresponding exposure charts for the time-integrated ToAs as described in the instruction book. The initial time of ToAs was one of the global NWP forecast.

3.2.7 Comments on the charts by Mr. Jean Nicolau (RSMC Toulouse)

Mr. Nicolau and his colleagues Mr. Deslandes processed both instantaneous and time-integrated ToAs for all cases. The thresholds for the instantaneous ToA were not 0.0 Bq / m^3, and they were different among the scenarios. The thresholds of the time-integrated ToAs were the minimum values shown in the corresponding exposure charts. The initial time of ToAs was the nearest synoptic time (0000 or 1200 UTC) prior to or equal to the start of release, and was not necessarily the same as the initial time of the global NWP forecast.

Mr. Nicolau and Mr. Deslandes initially adopted some nested (regional) NWP forecast to process their ToA charts. Therefore, there were some inconsistencies between their operational ATDM (exposure) charts and experimental ToA charts. Mr. Deslandes pointed out the issues, and kindly provides all the ATDM charts he reprocessed using the global NWP forecasts.

3.2.8 Comments on the charts by Dr. Gerhard Wotawa (RSMC Vienna)

Dr. Wotawa and his colleague Mr. Skomorowski processed and presented the instantaneous ToAs and the standard charts for all cases. They used 200,000 tracer particles per 24 hours for each ATDM calculation. The threshold was found to be 0.0 Bq / m^3, because there are no threshold values printed on their ToA charts. The initial time of ToA was the start

of release.

As a minor issue with their ToA charts, tiny uncovered areas are seen in some cases in the vicinity of the source, while the corresponding exposure charts don't have such. This might be related to some issues in their drawing procedures.

3.3 Considerations and Comparisons of the Charts

Since the late 1980s, WMO RSMCs for the nuclear emergency response (ERA) have been contributing to users providing ATDM results for release scenarios. The definitions of the standard set of products, which consist of 72 hour trajectory, exposures and depositions up to 24, 48, 72 hours after the initial time, are time-honoured. ET-ERA (and former CG-NERA) has been exploring useful new additions to the standard charts, and ToA is one of them.

When considering limitations of ATDM forecasts, as we commonly understand, the jet steam in the winter hemisphere can transport atmospheric mass (and tracer particles) around the zonal circle in 10 days (in the mid latitudes). This can make us confused when processing ATDM forecast for weeks and identifying the first arrival and the path of the plume. Fig 2 shows the root mean square errors (RMSEs) of 500 hPa geopotential heights of the global NWP forecasts in May 2017 (by the WMO CBS Lead Centre for Deterministic Forecast Verification: WMO-LCDNV at ECMWF[1]). The RMSEs of the global forecasts rapidly increase after 72 hours from the initial time. This might also affect the results when we process ATDM forecasts for longer than 72 hours. As is seen the fact we usually use the logarithm of 10 to present distributions of the exposures and depositions, concentrations at the ends of the plume, which we estimate with ATDMs, are almost always steep by 72 hours after the initial time. This is because the transportation by atmosphere (wind) is dominant in comparison with the dispersion and mixing processes. Considering all issues above, ToA experiments for 72 hours, which is our familiar forecast period, were appropriate starting points for us. The steep shapes of the plumes might help us identify appropriate threshold values for ToAs.

[1] http://apps.ecmwf.int/wmolcdnv/scores/mean/500_z

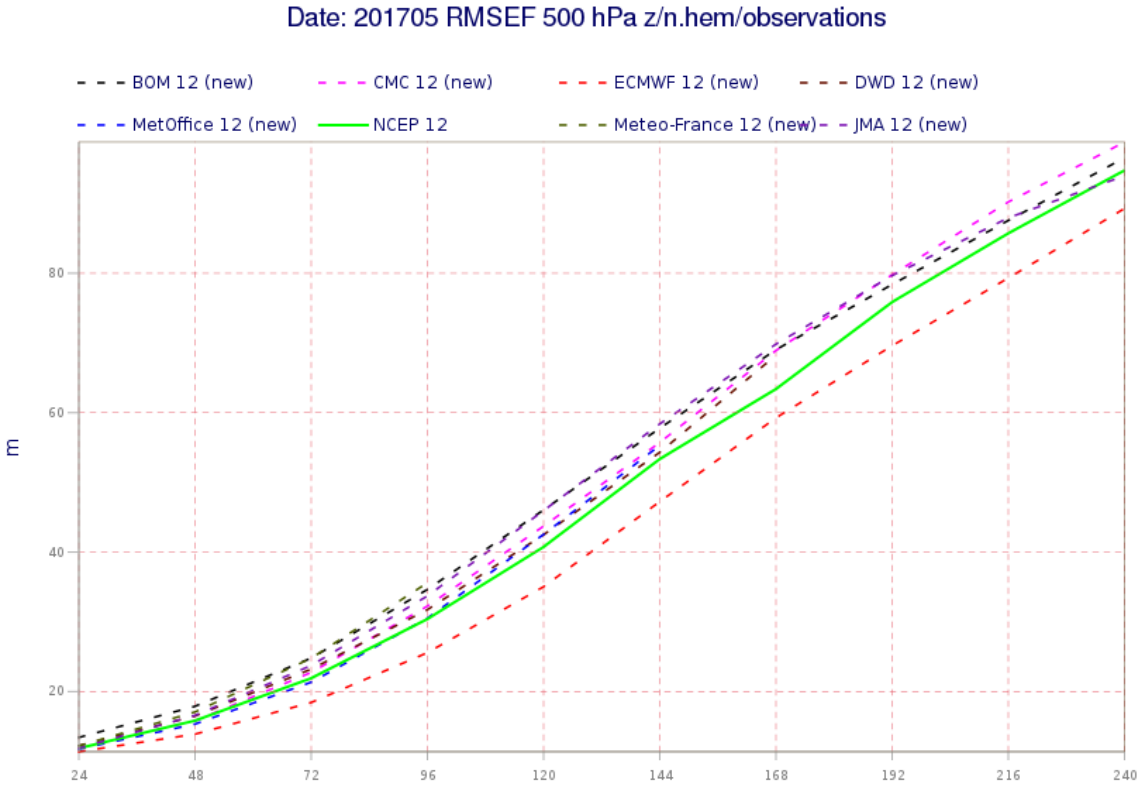

Fig 2. the root mean square errors (RMSEs) of the geopotential height at 500 hPa in the northern hemisphere of the global forecasts in May 2017 by WMO-LCDNV at ECMWF.

Basically, when exposure charts by two centres look different, ToAs by them necessarily differ from each other. Conversely speaking when members presented similar results of exposure forecasts, ToAs by them in most cases resemble one another (if there are no technical problems to estimate exposure and ToAs). As an example, Fig. 3 and 4 show exposures and instantaneous (or averaged) ToAs up to 72 hours (the 3rd time slot) for the 1st request respectively. (Please consider which charts look similar.) ToA test charts can suggest us problems of exposure and deposition charts as seen above. This is because those outputs of ATDMs are closely related to one another. This might be another benefit of examining ToA charts as a candidate product.

Fig 3 and 4 suggest that the agreement among the ATDM forecasts are not good enough to identify coverage over each specific country/state in Europe, where there are many relatively small countries / states. This may be a depressing result for some users, because such charts are not necessarily suitable to determine possibilities of arrival of the influence by the released isotopes to each specific country / state. However, when we take a closer look at the charts, we can find the following points from the charts:

- all forecasts commonly suggest the plume would move south and eastward, and the isotope released from the source would not be found in western and northern parts of Europe,
- all ATDM forecasts predict a similar extent of the influenced areas by 72 hours after the

initial time. There is no chart that suggests several times wider reachable areas in comparison with others.

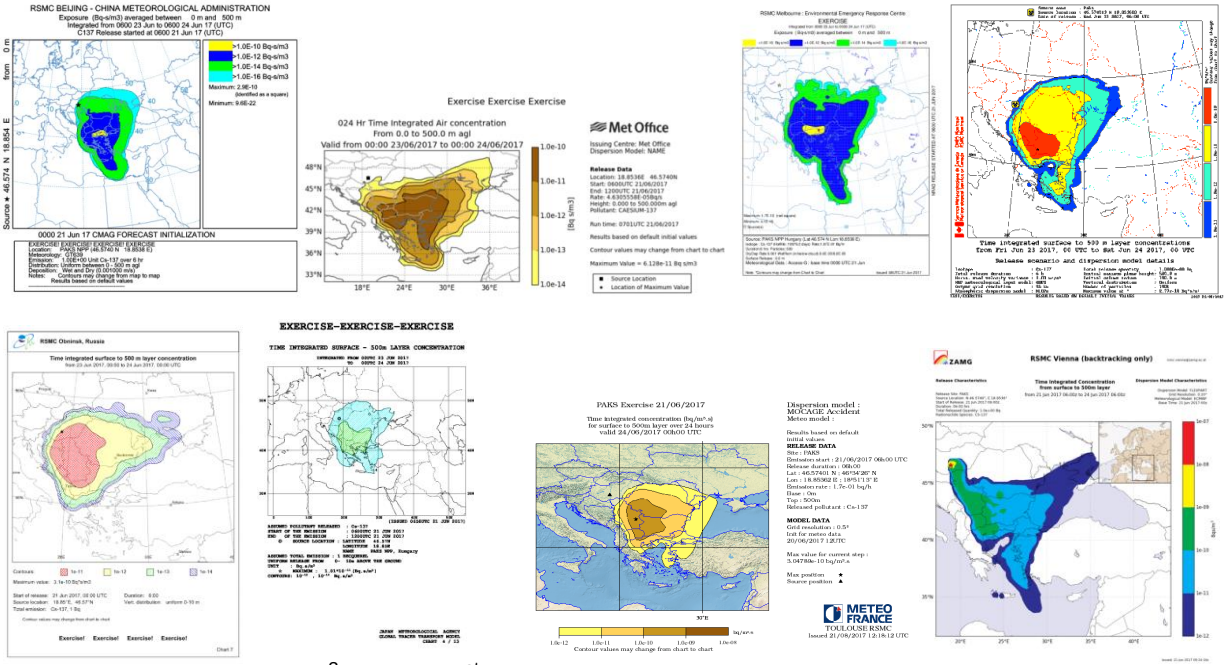

Fig 3. Exposure (Bq s/m^3) for the 1st scenario (48–72 hours after the initial) by the participants from RSMCs Beijing, Exeter, Melbourne, Montreal (upper panels), Obninsk, Tokyo, Toulouse, and Vienna (lower panels).

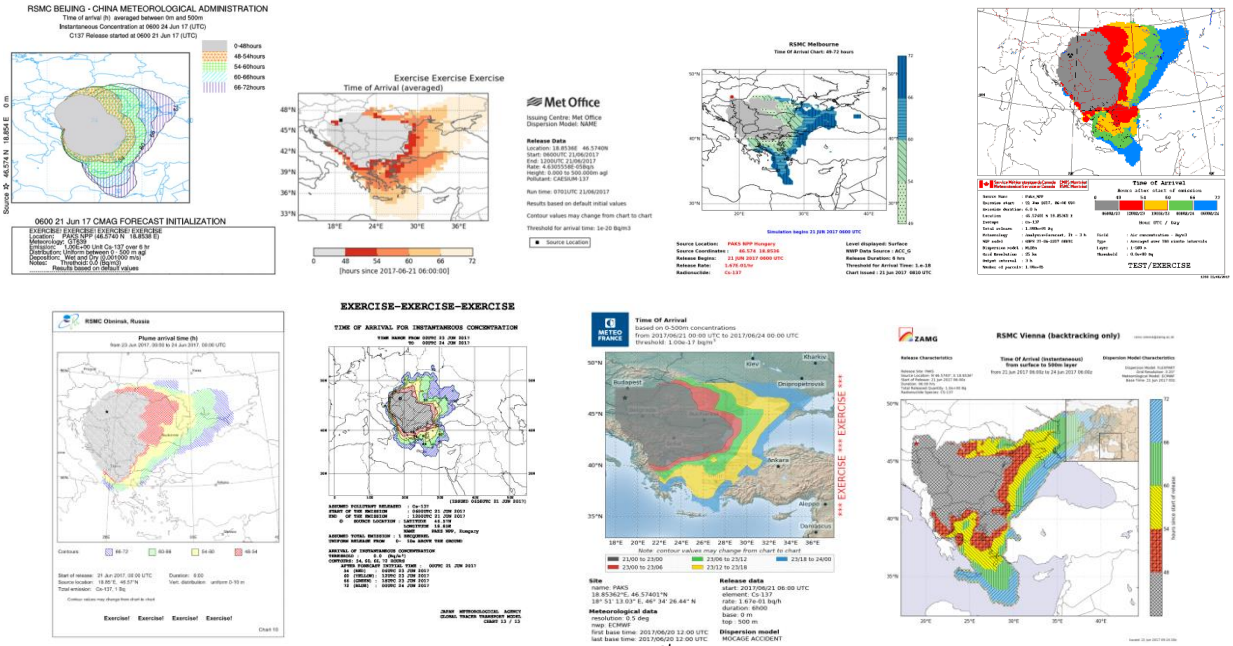

Fig 4. Instantaneous or averaged ToAs for the 1st scenario (48–72 hours after the initial) by the participants from RSMCs Beijing, Exeter, Melbourne, Montreal (upper panels), Obninsk, Tokyo, Toulouse, and Vienna (lower panels).

You might take these points for granted. But, please consider what if there was no ATDM forecast in the world. For instance, residents in Paris or London might be worrying about a

direct attack of the radionuclide plumes. People in Berlin might think that their city would be contaminated by gradual expansions of the toxic isotopes by dispersions and mixing process of atmosphere in a day or two. Such misunderstanding could have happened in the region where the accident occurs, as we experienced for the accident in Chernobyl. In a sense, the agreement of ATDMs forecasts is good enough to suggest to users where the plume won't reach in a few days. This might be useful information.

Similarly, all the forecasts commonly predict the influence would be found in very limited areas: the southeast part of WMO Regional Association (RA) VI (Europe) and the northeast end of RA-I (Africa). Therefore we can confidently predict that the influence won't be found in RA II (Asia), RA V (southwest Pacific), and RA III and IV (south, central and north America) in 72hours. Therefore, when considerable concentrations of contaminants were found in China or Japan in 48 hours after the accident, we can scientifically conclude that there should be some different source than the accident concerned. That is to say, ATDMs can tell us how far the plume can reach in a specific forecast period (usually up to about 72 hours from the initial time, because the precisions of the global NWP forecasts rapidly deteriorate after that). This might contribute to a network of radiological observatories.

As described above, we may confidently believe that ADTM forecasts can be useful, when users can understand these products appropriately (even when our forecasts don't have a perfect agreement). Actual problems might be how well users can understand the underlying issues of our ATDM forecasts and how they can make use of our products.

4. Concluding Remarks on the Joint ToA Test

The members of ET-ERA planned and conducted the joint ToA test in June 2017 using the release scenarios provided at ConvEx-3. The members had discussions on the issues:

- ✓ Usages of ToA (including professional usages by radiological observers),
- ✓ Definitions of ToA (including designs of the charts, instantaneous / averaged / time-integrated concentrations, initial time, and thresholds for ToA),
- ✓ Operational measures to transmit and present ToA charts.

ET-ERA should continue discussions to pursue practical solutions for such issues.

The ToA test was successfully done, but this time the expert form RSMC Washington did not participate in the production of ToA charts. Hopefully we would like to devise new products, for which all current RSMCs can continue their active participation. Therefore clear, practical, and achievable definitions of the ToA service are needed.

To attain such necessary definitions, the discussions the members had before the joint test were really meaningful. The discussions provided the members with an understanding of underlying technical and physical problems of the standard charts and ToAs.

The discussions on the usages of ToA were also important. Pre-warnings for radiological monitoring observers, which were suggested by Mr. Winkler, can be an ideal professional usage. There are some newly added associate members of ET-ERA from NMHS who are very familiar with the radiological monitoring[1]. We may expand this discussion to such experts to

[1] http://www.wmo.int/pages/prog/www/CBS/Lists_WorkGroups/CBS/opag%20dpfs/et-era/members

make our services more useful for the users.

I would like to highly recommend the ET-ERA members to continue their efforts to establish a new useful, practical, and achievable service of ToA. Finally, I really appreciate the active discussions and practical commitments to the joint ToA test by the ET-ERA members and their colleagues.

5. References (other than Annex)

Kosykh, Valery 2015: Status of implementation of time of arrival products. A document submitted to the meeting of the CBS expert team on emergency response activities (ET-ERA), Buenos Aires, Argentina, 30 November to 4 December 2015. http://www.wmo.int/pages/prog/www/DPFSERA/Meetings/ET-ERA_BuenosAires2015/DocPlan_000.html

WMO the CBS expert team on emergency response activities, 2015: Final Report of the meeting of the CBS expert team on emergency response activities (ET-ERA), Buenos Aires, Argentina, 30 November to 4 December 2015. http://www.wmo.int/pages/prog/www/CBS-Reports/DPFSERA-index.html

ANNEX IX

UPDATED LIST OF ACTIONS ON NON-NUCLEAR ERA (DECEMBER 2015) FOR THE ET-ERA

Area of Requirement: Development and testing of operational procedures

ACTION 1: Co-Chairperson, NMHS Argentina, RSMC Montreal
Conduct further exercises comprising simulated requests from NMHS to RSMC for assistance covering full set of non-nuclear event scenarios
DUE DATE: 1st week January 2016
Co-chairperson, the member from Argentina and RSMC Montreal to conduct a series of additional exercises covering requests for remaining non-nuclear scenarios and to report back to the Expert Team on the results of the full exercise and any further potential amendments required to the draft operational procedures, for review and comments.

STATUS (SEPTEMBER 2018): COMPLETED. Tests for grass fire, chemical incident, industrial fire and backtracking were conducted between NMHS Argentina and RSMCs Exeter and Montreal on 6 and 7 January 2016. As a result some minor changes were made to the draft non-nuclear ERA procedures that were later included in WMO, 2017. A paper about the tests is presented by NMS Argentina under agenda item 5.

ACTION 2: Co-Chairperson, All interested RSMCs (Melbourne, Exeter, Offenbach) selected NMHSs
Conduct further exercises comprising simulated requests from NMHS to RSMC for assistance covering full set of non-nuclear event scenarios
DUE DATE: Mon 4 Jan – Thu 8 January 2016
1. Co-chairperson to establish timetable for testing of scenarios with interested RSMCs

2. Co-chairperson, all interested RSMCs and selected NMHSs to conduct a series of exercises covering requests for all four non-nuclear scenarios and to report back to the Expert Team on the results of the full exercise and any further potential amendments required to the draft operational procedures, for review and comments.

STATUS (SEPTEMBER 2018): COMPLETED. No additional tests were conducted but the results of action 1 were used by the Expert Team to review and adjust the non-nuclear ERA procedures and texts that are now in WMO, 2017**.**

ACTION 3: Chairperson, Co-Chairperson, all RSMCs
5.3.3 Develop appropriate designation criteria for any organization seeking to nominate as an RSMC for non-nuclear ERA. Finalize all additions for non-nuclear ERA procedures for new Manual.
DUE DATE: March 2016

STATUS (SEPTEMBER 2018): COMPLETED. See paragraph 2.2.2.8 in WMO, 2017. Thanks to ET-ERA members that provided feedback

ACTION 4: WMO Secretariat

Submission of non-nuclear ET-ERA modifications/additions to the Manual on the GDPFS (WMO-No.485) to CBS-16 (November 2016)

STATUS (SEPTEMBER 2018): COMPLETED.

Area of Requirement: Capacity building and ERA web pages

ACTION 5: RSMCs
Share information on improving mapping products
DUE DATE: Ongoing
RSMCs to share information and techniques regarding generation of improved high-resolution mapping products for display of results.

STATUS (SEPTEMBER 2018): Information from RSMC Washington: NOAA/ARL undergoing transition of graphics python to PYTHON. MONET package under development is available to interested RSMCs. CONTINUE (develop further) RS

ACTION 6: WMO Secretariat
Assist NMHSs in the interpretation of ERA-related products and their application by publicizing aspects covered by the WMO-TD. 778
DUE DATE: As soon as the WMO-TD. 778 is updated
WMO Secretariat to send out a circular letter to WMO Members and an e-mail to the ERA contact points informing/publicizing the aspects covered by the WMO-TD. 778.

STATUS (SEPTEMBER 2018): Not done; WMO-TD. 778 has not been updated for non-nuclear ERA. NMS Argentina has offered to promote this information to NMSs in RA III once available and to assist them with making requests to RSMCs. CONTINUED

ACTION 7: TT members, RSMCs and WMO Secretariat
Advise the Secretariat on available non-nuclear ERA dispersion modelling capabilities from institutions in their RA area that can be ported to NMHSs
DUE DATE: Ongoing
TT members, RSMCs to advise; Secretariat to post it on the WMO website for ERA

STATUS (SEPTEMBER 2018): RSMC Washington provided some information. Website has not yet been developed for non-nuclear ERA. CONTINUED

- In the U.S., the Interagency Modeling Assessment and Advisory Capability (IMAAC) is an official authority to provide guidance to large chemical releases using their HPAC modeling system. See: https://www.fema.gov/imaac
- The NWS Weather Forecast Offices use a special version of HYSPLIT to respond to small and large chemical releases.
- See: http://www.nws.noaa.gov/directives/sym/pd01005018curr.pdf

ACTION 8: RSMC Offenbach
Investigate and advise on possible availability of ICON-ART web-based training modules
DUE DATE: February 2016 CONTINUED. Ask ET-ERA members to provide links and info that can be included in the non-nuclear ERA web page.

STATUS (SEPTEMBER 2018):

COMET modules are available. References to be included in 'to be developed'TD-778

ACTION 9: WMO Secretariat
Enable access to web-based training modules
DUE DATE: Ongoing
Publicize web-based training modules by inclusion of these links on the WMO-TD. 778.

STATUS (SEPTEMBER 2018): Not done; WMO-TD. 778 has not been updated for non-nuclear ERA. CONTINUED

ACTION 10: Chairperson and Co-Chairperson, ET Members
Review and update the WMO website for non-nuclear ERA, including updating the glossary
DUE DATE: Dec 2015
1. ET-ERA Chairperson and co-chairperson to coordinate and identify TT members that could contribute and establish timelines;

DUE DATE: End Dec 2015
2. TT members to check within their Services on the possibility of contributing to this task.

DUE DATE: 2017
3. TT members to review and update the WMO website for non-nuclear ERA, including updating the glossary

STATUS (SEPTEMBER 2018): Due to restrictions on the availability of resources, this has not been undertaken. CONTINUED

ACTION 11: WMO Secretariat and ET members
Promote the non-Nuclear programme via the WMO Bulletin
DUE DATE: Once the operational procedures for non-nuclear ERA are in place (2017?)
Update the WMO Bulletin article on ERA (January 2006) to further promote the programme

STATUS (SEPTEMBER 2018): Not done CONTINUED. To be done after TD-778 development (and tests – exercises).

ACTION 12: Jeff McQueen and WMO Secretariat
Capacity building in NMHSs
DUE DATE: Ongoing
Demonstrate transfer of the dispersion modelling capability to candidate NMHSs
STATUS (SEPTEMBER 2018): Information provided by Jeff: NOAA/ARL has demonstrated the transfer of dispersion modeling capabilities to the Buenos Aires, Argentina NMHSs. Ariel Stein, NOAA/ARL, continues to support transfer for any NMHS interested in HYSPLIT capability. NOAA/ARL actively develops and maintains training materials on use of HYSPLIT for a variety of applications. See: https://www.arl.noaa.gov/hysplit/hysplit-workshop/
Secretariat to promote at Training sessions
Area of Requirement: Work with International Organizations

ACTION 13: WMO Secretariat

Engage with relevant international organizations to determine requirements
DUE DATE: Ongoing
Engage with relevant international organizations to promote the usefulness of ERA products and determine requirements

STATUS (SEPTEMBER 2018): ICAO and WHO are members of the ET-ERA and are aware of the non-nuclear ERA products.

ACTION 14: WMO Secretariat
Make international organizations aware of non-nuclear ERA procedures
DUE DATE: Once the operational procedures have been established and services to Humanitarian Agencies have been developed.
Make relevant international organizations aware of the operational procedures for non-nuclear ERA

STATUS (SEPTEMBER 2018): ICAO AND WHO informed. WMO Secretariat will provide information at the meeting about humanitarian assistance support activities. DROP

ACTION 15: WMO Secretariat and Co-chairperson
Publicize outcomes of non-nuclear ERA exercise
DUE DATE: After the exercise
Share the information of the outcomes / report of the exercise, which should include an item on potential implications to other relevant international organizations.

STATUS (SEPTEMBER 2018): COMPLETED. DROP

ANNEX X

Consolidated Action List for Non-Nuclear Activities (2015 and 2018 meetings)

NO.	Type	Subject	Contents	Lead by	Due date	Proposed
1	Non-Nuclear	Contact Information (including Nuclear)	All RSMCs to provide the list of NMHSs to which they provide information and products (involves also Nuclear) and to send to the Secretariat	RSMCs	30-Nov-18	2018
2	Non-Nuclear	Contact Information (including Nuclear)	WMO Secretariat to check with Legal whether the list of NMHSs with contacts coordinates can be posted on the web (issue with European Union Policy on posting people coordinates)	Secretariat		2018
3	Non-Nuclear	Contact Information (including Nuclear)	RSMCs to exchange information on their capabilities related to web-mapping. Mr Servranckx to take the lead.	Co-Chair	30-Nov-18	2018
4	Non-Nuclear	WMO/TD No. 778 for Non-Nuclear Centres and to-be	Designated RSMCs and candidates for Non-Nuclear ERA designation to develop the documentation for the TD 778, ensuring to separate mandatory products from “other” products	Offenbach, Toulouse, Montreal	See item No. 5	2018
5	Non-Nuclear	Requirements for RSMCs designated for non-nuclear ERA: propose plan of action and timelines	The RSMCs designated for non-nuclear ERA will: 1. Produce interpretation guidelines of their products for the users** 2. Document the characteristics of their ATDMs and NWP models** 3. Conduct a few exercises/tests with other interested RSMCs 4. Conduct exercises/tests with NMSs at least every three months 5. Produce a report of activities for each year, by February of the next year*** **Details and timelines** to be defined in follow up discussions lead by the co-chair by end of November 2018. ** Annex 4 in Section 5 of WMO TD/No. 778 can serve as a model for these *** The format of the nuclear ERA annual report can be used for this. Nuclear and non-nuclear activities could also be combined in one report	Co-Chair, Offenbach, Montreal and Toulouse	30-Nov-18	2018
6	Non-Nuclear	Amendment of the Manual	WMO secretariat to take action to ensure the proposed amendments are effective in the Manual of GDPFS	Secretariat		2018
7	Non-Nuclear	ERA website structure and contents	Mr Servranckx will take the lead for the ERA website content and structure and will propose a plan to solicit contributions from ET-ERA members.	Co-chair	31-Dec-18	2015

NO.	Type	Subject	Contents	Lead by	Due date	Proposed
8	Non-Nuclear		Share information on improving mapping products - RSMCs to share information and techniques regarding generation of improved high-resolution mapping products for display of results (Action item 5 in Annex IX)	RSMCs	On-going	2015
9	Non-Nuclear		Assist NMHSs in the interpretation of ERA-related products and their application by publicizing aspects covered by the WMO-TD. 778 - WMO Secretariat to send out a circular letter to WMO Members and an e-mail to the ERA contact points informing/publicizing the aspects covered by the WMO-TD. 778 (Action item 6 in Annex IX)	Secretariat	As soon as the WMO-TD. 778 is updated	2015
10	Non-Nuclear		Advise the Secretariat on available non-nuclear ERA dispersion modelling capabilities from institutions in their RA area that can be ported to NMHSs - TT members, RSMCs to advise; Secretariat to post it on the WMO website for ERA (Action item 7 in Annex IX)	TT members, RSMCs and WMO Secretariat	On-going	2015
11	Non-Nuclear		1. Investigate and advise on possible availability of ICON-AF web-based training modules 2. Ask ET-ERA members to provide links and info that can be included in the non-nuclear ERA web page (Action item 8 in Annex IX)	Offenbach Co-Chair	2019 2019	2015
12	Non-Nuclear		Enable access to web-based training modules - Publicize web-based training modules by inclusion of these links on the WMO-TD. 778 page (Action item 9 in Annex IX)	Co-Chair	On-going	2015
13	Non-Nuclear		Promote the non-Nuclear programme via the WMO Bulletin - Update the WMO Bulletin article on ERA (January 2006) to further promote the programme (Action item 11 in Annex IX)	WMO Secretariat and ET members	2019	2015
14	Non-Nuclear		Capacity building in NMHSs - Demonstrate transfer of the dispersion modelling capability to candidate NMHSs (Action item 12 in Annex IX)	Jeff McQueen and WMO Secretariat	On-going	2015

Recommendation List for Non-nuclear activities

(1-5 OCT 2018)

Remarks:
* Related with Action No 4

NO.	Type	Subjects	Contents	Approver
1*	Non-Nuclear	Designation of RSMC Montreal for Non- nuclear	To the President of CBS to agree to the designation of RSMC Montreal for Non-Nuclear ERA and to recommend the designation to Cg-18	P/CBS

ANNEX XI

Proposed amendments to the Manual on the GDPFS (WMO-No. 485)

1. Appendix 2.2.23 (nuclear ERA; see Annex 1) in the Manual of the GDPFS covers basic products in section 1 and general rules for displaying products in section 4. For the non-nuclear ERA, the same topics are covered in appendix 2.2.29 (see Annex 2) and attachment 2.2.5 (See Annex 3).

2. The nuclear and non-nuclear texts are in fact very similar. This is not surprising given that the former were used to develop the latter. There is therefore no justification for the differences in the Manual. Another reason for reorganizing some of the texts is that attachment 2.2.5 is at the very end of the Manual and can easily go unnoticed given that the rest of the nuclear and non-nuclear texts are grouped elsewhere.

3. Appendix 2.2.28.

4. Annex 4 shows in track mode the changes proposed to the Manual. In summary, they are:
- Merged the attachment 2.2.5 to appendix 2.2.29 to make it similar to Annex 2.2.23
- Deleted attachement 2.2.5 and any reference to it
- Modified Appendix 2.2.28.

5. Comments from Yuki and Masami on additional changes:

> (1) OK, INCLUDED IN THE PROPOSAL TO AMD THE MANUAL
> Page 24 – Note just below 2.2.2.8 (CRITICAL!)
> This note (Note: This activity includes a network of regional centres and NMCs within a geographical region.) is not included in the approved document of CBS-16. So this note must be removed.

> OK, INCLUDED IN THE PROPOSAL TO AMD THE MANUAL
Page 25 Table 17
> In the caption of Table 17 and Note, “environmental” is missing after “non-nuclear”.

> VALID POINT BUT NOT CLEAR IF THIS DECISION RESTS WITH ET-ERA. NOT COVERED IN THE PROPOSAL THAT FOLLOWS
- Page 25
> The name of activity for atmospheric sand and dust storm forecasts is changed to “sandstorm and duststorm forecasts”.
> The consistency between old and new Manuals is lost. The new naming is inconsistent with the description in other publication related SDS-WAS (Sand and Dust Storm Warning Advisory and Assessment System).

> OK, INCLUDED IN THE PROPOSAL TO AMD THE MANUAL
and there is no need to include back-trajectory maps in ATTACHMENT 2.2.5 or other places any more.

6. Annex 5 shows the text in the Manual with all changes accepted.

ANNEX 1

APPENDIX 2.2.23. MANDATORY PRODUCTS AND GENERAL RULES FOR DISPLAYING PRODUCTS (NUCLEAR)

1. Basic set of products

Seven maps that shall consist of:

(a) Three-dimensional trajectories starting at 500, 1 500 and 3 000 m above the ground, with particle locations at six-hour intervals (main synoptic hours up to the end of the dispersion model forecast);

(b) Time-integrated airborne concentrations within the layer 500 m above the ground, in Bq s m^{-3} for each of the three forecast periods;

(c) Total deposition (wet + dry) in Bq m^{-2} from the release time to the end of each of the three forecast periods.

A joint statement that shall be issued as soon as available.

2. Forecast periods for numerical calculations

The initial set of products shall cover the period from T, the start time of the release, through a forecast of 72 hours from t, the start time of the current output from the operational NWP model.

The first 24-hour period for integrated exposures in the dispersion model shall start at the nearest synoptic time (0000 or 1200 UTC) prior to or equal to T. Subsequent 24-hour integrations of the dispersion model shall be made up to, but not exceeding, the synoptic time nearest to t+72.

If T is earlier than t, the first response shall use hindcasts to cover the period up to t.

3. Joint response and joint statements

A joint response means that the collaborating RSMCs shall immediately inform each other of any request received; initially they shall produce and send the basic set of products (charts) independently and then move rapidly towards providing fully coordinated response and services for the duration of the response. Following the initial response, the RSMCs shall develop and provide, and update as required, a joint statement to describe a synopsis of the current and forecast meteorological conditions over the area of concern, and the results from the ATDM, their differences and similarities and how they apply to the event.

4. General rules for displaying results

To make the interpretation of the maps easier, the Producing Centres should adopt the following guidelines:

General guidelines for all maps:

(a) Provide labelled latitude and longitude lines at 10° intervals and sufficient geographic map background (shorelines, country borders, and the like) to be able to locate precisely the trajectories and contours;

(b) Indicate the source location with a highly visible symbol (●, ▲, x, ✱, ■, etc.);

(c) Indicate the source location in decimal degrees (latitude – N or S specified; longitude – E or W specified; plotting symbol used), date and time of release (UTC); and the meteorological model initialization date and time (UTC);

(d) Each set of maps should be uniquely identified by at least product issue date and time (UTC) and issuing centre;

(e) Previously transmitted products from the dispersion model need not be retransmitted;

(f) Indicate with a legend if this is an exercise, requested services, or an IAEA-notified emergency.

Specific guidelines for trajectory maps:

(a) Distinguish each trajectory (500, 1 500, 3 000 m) with a symbol (▲,●, ■, etc.) at synoptic hours (UTC);

(b) Use solid lines (darker than map background lines) for each trajectory;

(c) Provide a time–height (m or hPa) diagram, preferably directly below the trajectory map, to indicate vertical movement of trajectory parcels.

Specific guidelines for concentration and deposition maps:

(a) Adopt a maximum of four concentration/deposition contours corresponding to powers of 10 with minimum values not less than 10^{-20} Bq s m^{-3} for time-integrated airborne concentrations and not less than 10^{-20} Bq m^{-2} for total deposition;

(b) A legend should indicate that contours are identified as powers of 10 (that is, –12 = 10^{-12}). If grey shading is used between contours, then the individual contours must be clearly distinguishable after facsimile transmission and a legend provided on the chart;

(c) Use solid dark lines (darker than map background lines) for each contour;

(d) Indicate the following input characteristics:

(i) Source assumption (height, duration, isotope, amount released);

(ii) The units of time integrated concentration (Bq s m^{-3}) or deposition (Bq m^{-2});

(e) In addition, charts should specify:

(i) "Time-integrated surface to 500-metre layer concentrations";

(ii) "Contour values may change from chart to chart";

(iii) If the default source is used, "Results based on default initial values";

(f) Indicate, if possible, the location of the maximum concentration/deposition with a symbol on the map and include a legend indicating the symbol used and the maximum numerical value;

(g) Indicate the time integration start and end date and time (UTC).

ANNEX 2

APPENDIX 2.2.29. MANDATORY LIST OF NON-NUCLEAR ENVIRONMENTAL EMERGENCY RESPONSE

The following list of mandatory non-nuclear responses shall be provided:

- Smoke from forest, grass or peat fires (default values in Appendix 2.2.30 shall be used for source parameters not provided):
  - Forecast duration 36 hours;
  - Relative concentrations from the surface to 200 m;[1]
  - Images at intervals of one, three or six hours;[2]
  - Contouring to be determined based on specifics of the event or the request;
- Smoke from industrial fire (default values for parameters not provided):
  - Forecast duration 12 hours;
  - Relative concentrations from the surface to 200 m;[1]
  - Images at intervals of one or three hours;[2]
  - Contouring to be determined based on specifics of the event or the request;
- Chemical releases not involving fire (default values for parameters not provided):
  - Forecast duration 12 hours;
  - Relative concentrations from the surface to 100 m;[1]
  - Images at intervals of one or three hours;[2]
  - Contouring to be determined based on specifics of the event or the request.

All products shall be displayed following the general rules, as listed in Attachment 2.2.5.

The RSMC shall perform a quick assessment of the products before they are issued, and shall provide a short explanatory message if any issues of concern are noted.

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[1] Absolute concentrations may be provided if an estimated or actual value of the total mass released or mass release rate is given.

[2] Additional products (for example, GIS-format files) may be provided to requesting NMHSs if possible.

ANNEX 3

ATTACHMENT 2.2.5. USER INTERPRETATION GUIDE FOR NON-NUCLEAR ATMOSPHERIC TRANSPORT AND DISPERSION MODELLING PRODUCTS PROVIDED BY REGIONAL SPECIALIZED METEOROLOGICAL CENTRES

The designated centres will make available in Documentation on RSMC Support for Environmental Emergency Response (WMO/TD-No. 778) on the WMO Emergency Response Activities website an interpretation guide for users.

General rules for displaying results:

To make the interpretation of the maps easier, the Producing Centres should adopt the following guidelines:

General guidelines for all maps:

(a) Provide labelled latitude and longitude lines at regular intervals and sufficient geographic map background (shorelines, country borders, rivers, and the like, and possibly roads and town names for localized events) to be able to locate precisely the trajectories and contours;

(b) Indicate the source location with a highly visible symbol (▲,●, ■, etc.);

(c) Indicate the source location in decimal degrees (latitude – N or S specified, longitude – E or W specified, plotting symbol used), date and time (UTC) of release, and the meteorological model initialization date and time (UTC);

(d) Each set of maps should be uniquely identified by at least product issue date and time (UTC) and issuing centre;

(e) Previously transmitted products from the dispersion model need not be retransmitted;

(f) Indicate with a legend if this is an exercise or a requested service.

Specific guidelines for concentration maps:

(a) Adopt a maximum of five concentration contours;

(b) A legend should indicate contours used on the chart;

(c) Contours may be colour filled but should be clearly distinguishable from map background lines;

(d) Indicate the following input characteristics:

  (i) Source assumption (height, duration, pollutant type, amount released);

  (ii) Units of concentration;

(e) In addition, charts should specify:

(i) "Surface to xxx-metre layer concentrations", where xxx depends on the pollutant type, and whether the default source is used;

(ii) "Results based on default initial values";

(f) Indicate, if possible, the location of the maximum concentration with a symbol on the map and include a legend indicating the symbol used and the maximum numerical value;

(g) Indicate the start and end date and time (UTC).

Specific guidelines for back-trajectory maps:

(a) Distinguish each trajectory (levels chosen will depend on the specifics of the event or the request) with a symbol (▲,●, ■, etc.) at synoptic hours (UTC);

(b) Use solid lines (darker than map background lines) for each trajectory.

Provide a time–height (m or hPa) diagram, preferably directly below the trajectory map, to indicate vertical movement of trajectory parcels.

The RSMCs will distribute their standard products to the NMHS operational contact points by email or enable retrieval by the NMHS from an RSMC password-protected designated website. Standard products in the ITU-T T.4 format suitable for group 3 facsimile machines will be maintained by exception and only if requested by the NMHS operational contact point. The RSMC may also make use of other appropriate technologies.

ANNEX 4: PROPOSED AMENDMENT TO THE MANUAL ON THE GPPFS

2.2.2.8 Non-nuclear environmental emergency response

~~*Note: This activity includes a network of regional centres and NMCs within a geographic region.*~~

Centres conducting non-nuclear ~~nuclear~~ environmental emergency response shall:

…

(d) Make available on a website up-to-date information on the characteristics of their ATDM systems (minimum information to be provided is given in HYPERLINK: Paragraph < **Appendix 2.2.31**> **) and a user interpretation guide for ATDM products. (**~~HYPERLINK: Paragraph <~~**Attachment 2.2.5**~~>~~ **).**

Note: The bodies in charge of managing the information contained in the present Manual related to non-nuclear environmental emergency response are specified in Table 17.

Table 17. WMO bodies responsible for managing information related to non-nuclear environmental emergency response

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SECTION: Chapter
Chapter title in running head: PART II. SPECIFICATIONS OF GLOBAL DATA-…

APPENDIX 2.2.28. ACTIVATION OF SUPPORT FOR NON-NUCLEAR ENVIRONMENTAL EMERGENCY RESPONSE

Environmental emergencies can be caused by a broad range of events with various temporal and spatial scales involving the release of hazardous substances into the environment. The scope of non-nuclear emergency response activities includes~~:~~ smoke from large fires, chemical releases and industrial fire/smoke. ~~emissions from volcanic eruptions (excluding those service arrangements covered by 2.2.2.10 – Volcano watch services for international air navigation) and large chemical releases.~~ Atmospheric ~~s~~Sand~~storm~~ and ~~d~~Dust ~~s~~Storm forecasts are covered under activity 2.2.2.9. Ash emitted by volcanic eruptions, relating to aviation, is covered under activity 2.2.2.10 – Volcano watch services for international air navigation.

National Meteorological and Hydrological Services may request RSMC support for releases that have the potential for large-scale (that is, mesoscale) and/or long-duration (hours to days) impacts, according to the capability of the RSMC. RSMC products are typically not applicable for shorter range incidents. RSMCs may be able to provide services for other types of incidents on a case by case basis. RSMCs will advise NMHSs if requests are not within their capabilities.

SECTION: Chapter
Chapter title in running head: PART II. SPECIFICATIONS OF GLOBAL DATA-…

APPENDIX 2.2.29. MANDATORY ~~LIST OF NON-NUCLEAR ENVIRONMENTAL EMERGENCY RESPONSE~~PRODUCTS AND GENERAL RULES FOR DISPLAYING PRODUCTS (NON-NUCLEAR)

1. The following ~~list of~~ mandatory non-nuclear ~~responses~~ products shall be provided:

- Smoke from forest, grass or peat fires (default values in HYPERLINK: Paragraph <**Appendix 2.2.30**> shall be used for source parameters not provided):
  - Forecast duration 36 hours;
  - Relative concentrations from the surface to 200 m;[1]
  - Images at intervals of one, three or six hours;[2]
  - Contouring to be determined based on specifics of the event or the request;
- Smoke from industrial fire (default values for parameters not provided):
  - Forecast duration 12 hours;
  - Relative concentrations from the surface to 200 m;[1]
  - Images at intervals of one or three hours;[2]
  - Contouring to be determined based on specifics of the event or the request;
- Chemical releases not involving fire (default values for parameters not provided):
  - Forecast duration 12 hours;
  - Relative concentrations from the surface to 100 m;[1]
  - Images at intervals of one or three hours;[2]
  - Contouring to be determined based on specifics of the event or the request.

~~All products shall be displayed following the general rules, as listed in HYPERLINK: Paragraph < **Attachment 2.2.5**>.~~

The RSMC shall perform a quick assessment of the products before they are issued, and shall **provide a short explanatory message if any issues of concern are noted.**

2. General rules for displaying results

The designated centres will make available in Documentation on RSMC Support for Environmental Emergency Response (WMO/TD-No. 778) on the WMO Emergency Response Activities website an interpretation guide for users.

To make the interpretation of the maps easier, the Producing Centres should adopt the following guidelines:

General guidelines for all maps:

(a) Provide labelled latitude and longitude lines at regular intervals and sufficient geographic map background (shorelines, country borders, rivers, and the like, and possibly roads and town names for localized events) to be able to locate precisely the trajectories and contours;

[1] Absolute concentrations may be provided if an estimated or actual value of the total mass released or mass release rate is given.
[2] Additional products (for example, GIS-format files) may be provided to requesting NMHSs if possible.

(b) Indicate the source location with a highly visible symbol (▲,●, ■, etc.);

(c) Indicate the source location in decimal degrees (latitude – N or S specified, longitude – E or W specified, plotting symbol used), date and time (UTC) of release, and the meteorological model initialization date and time (UTC);

(d) Each set of maps should be uniquely identified by at least product issue date and time (UTC) and issuing centre;

(e) Previously transmitted products from the dispersion model need not be retransmitted;

(f) Indicate with a legend if this is an exercise or a requested service.

Specific guidelines for concentration maps:

(a) Adopt a maximum of five concentration contours;

(b) A legend should indicate contours used on the chart;

(c) Contours may be colour filled but should be clearly distinguishable from map background lines;

(d) Indicate the following input characteristics:

(i) Source assumption (height, duration, pollutant type, amount released);

(ii) Units of concentration;

(e) In addition, charts should specify:

(i) "Surface to xxx-metre layer concentrations", where xxx depends on the pollutant type, and whether the default source is used;

(ii) "Results based on default initial values";

(f) Indicate, if possible, the location of the maximum concentration with a symbol on the map and include a legend indicating the symbol used and the maximum numerical value;

(g) Indicate the start and end date and time (UTC).

~~Specific guidelines for back-trajectory maps:~~

~~(a) Distinguish each trajectory (levels chosen will depend on the specifics of the event or the request) with a symbol (▲,●, ■, etc.) at synoptic hours (UTC);~~

~~(b) Use solid lines (darker than map background lines) for each trajectory.~~

~~Provide a time–height (m or hPa) diagram, preferably directly below the trajectory map, to indicate vertical movement of trajectory parcels.~~

The RSMCs will distribute their standard products to the NMHS operational contact points by email or enable retrieval by the NMHS from an RSMC password-protected designated website. Standard products in the ITU-T T.4 format suitable for group 3 facsimile machines will be maintained by exception and only if requested by the NMHS operational contact point. The RSMC may also make use of other appropriate technologies.

SECTION: Chapter
Chapter title in running head: PART II. SPECIFICATIONS OF GLOBAL DATA-…

~~ATTACHMENT 2.2.5. USER INTERPRETATION GUIDE FOR NON-NUCLEAR ATMOSPHERIC TRANSPORT AND DISPERSION MODELLING PRODUCTS PROVIDED BY REGIONAL SPECIALIZED METEOROLOGICAL CENTRES~~

~~The designated centres will make available in Documentation on RSMC Support for Environmental Emergency Response (WMO/TD-No. 778) on the WMO Emergency Response Activities website an interpretation guide for users.~~

~~General rules for displaying results:~~

~~To make the interpretation of the maps easier, the Producing Centres should adopt the following guidelines:~~

~~General guidelines for all maps:~~

~~(a) Provide labelled latitude and longitude lines at regular intervals and sufficient geographic map background (shorelines, country borders, rivers, and the like, and possibly roads and town names for localized events) to be able to locate precisely the trajectories and contours;~~

~~(b) Indicate the source location with a highly visible symbol (▲,●, ■, etc.);~~

~~(c) Indicate the source location in decimal degrees (latitude – N or S specified, longitude – E or W specified, plotting symbol used), date and time (UTC) of release, and the meteorological model initialization date and time (UTC);~~

~~(d) Each set of maps should be uniquely identified by at least product issue date and time (UTC) and issuing centre;~~

~~(e) Previously transmitted products from the dispersion model need not be retransmitted;~~

~~(f) Indicate with a legend if this is an exercise or a requested service.~~

~~Specific guidelines for concentration maps:~~

~~(a) Adopt a maximum of five concentration contours;~~

~~(b) A legend should indicate contours used on the chart;~~

~~(c) Contours may be colour filled but should be clearly distinguishable from map background lines;~~

~~(d) Indicate the following input characteristics:~~

~~(i) Source assumption (height, duration, pollutant type, amount released);~~

~~(ii) Units of concentration;~~

~~(e) In addition, charts should specify:~~

~~(i) "Surface to xxx-metre layer concentrations", where xxx depends on the pollutant type, and whether the default source is used;~~

~~(ii) "Results based on default initial values";~~

~~(f) Indicate, if possible, the location of the maximum concentration with a symbol on the map and include a legend indicating the symbol used and the maximum numerical value;~~

~~(g) Indicate the start and end date and time (UTC).~~

~~Specific guidelines for back-trajectory maps:~~

~~(a) Distinguish each trajectory (levels chosen will depend on the specifics of the event or the request) with a symbol (▲,●, ■, etc.) at synoptic hours (UTC);~~

~~(b) Use solid lines (darker than map background lines) for each trajectory.~~

~~Provide a time–height (m or hPa) diagram, preferably directly below the trajectory map, to indicate vertical movement of trajectory parcels.~~

~~The RSMCs will distribute their standard products to the NMHS operational contact points by email or enable retrieval by the NMHS from an RSMC password-protected designated website. Standard products in the ITU-T T.4 format suitable for group 3 facsimile machines will be maintained by exception and only if requested by the NMHS operational contact point. The RSMC may also make use of other appropriate technologies.~~

Change "sandstorm and duststorm" to "sand and dust storm"

1.1.2.2 The Global Data-processing and Forecasting System shall be organized as a three-tier system of activities as follows:

(b) Specialized activities:

……

– Atmospheric sand~~storm~~ and dust storm forecasts

2.2.2.9 Atmospheric sand~~storm~~ and dust storm forecasts

Centres conducting atmospheric sand~~storm~~ and dust storm forecasts shall:

(b) Prepare limited-area analyses of variables relevant to atmospheric sand~~storms~~ and dust storms;

(c) Prepare limited-area forecast fields of variables relevant to atmospheric sand~~storms~~ and dust storms;

Note: The bodies in charge of managing the information contained in the present Manual related to atmospheric sand~~storm~~ and dust storm forecasts are specified in Table 18.

Table 18. WMO bodies responsible for managing information related to atmospheric sand~~storm~~ and dust storm forecasts

* The detailed designation procedure of RSMCs with activity specialization on atmospheric sand~~storm~~ and dust storm forecasts (RSMC-ASDF) is referred to in *Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS) Science and Implementation Plan 2015–2020*, WWRP 2015-5, Geneva, WMO, 7 – Transition to operational activities: Proposed designation as regional specialized meteorological centre with specialization on atmospheric sand and dust forecasting (RSMC-ASDF).

APPENDIX 2.2.33. MANDATORY ATMOSPHERIC SAND~~STORM~~ AND DUST STORM PRODUCTS TO BE MADE AVAILABLE ON THE WMO INFORMATION SYSTEM

PART III. CURRENT DESIGNATED GLOBAL DATA-PROCESSING AND FORECASTING SYSTEM CENTRES

……..

Provision of atmospheric sand~~storm~~ and dust storm forecasts:

- RSMC-ASDF Barcelona
- RSMC-ASDF Beijing (RA II)

ANNEX 5: PROPOSED AMENDMENT TO THE MANUAL ON THE GPPFS WITH ALL CHANGED ACCEPTED

2.2.2.8 Non-nuclear environmental emergency response

Centres conducting non-nuclear environmental **emergency response shall:**

…

(d) Make available on a website up-to-date information on the characteristics of their ATDM systems (minimum information to be provided is given in HYPERLINK: Paragraph < **Appendix 2.2.31**> **) and a user interpretation guide for ATDM products.**

Note: The bodies in charge of managing the information contained in the present Manual related to non-nuclear environmental emergency response are specified in Table 17.

Table 17. WMO bodies responsible for managing information related to non-nuclear environmental emergency response

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SECTION: Chapter

Chapter title in running head: PART II. SPECIFICATIONS OF GLOBAL DATA-…

APPENDIX 2.2.28. ACTIVATION OF SUPPORT FOR NON-NUCLEAR ENVIRONMENTAL EMERGENCY RESPONSE

Environmental emergencies can be caused by a broad range of events with various temporal and spatial scales involving the release of hazardous substances into the environment. The scope of non-nuclear emergency response activities includes smoke from large fires, chemical releases and industrial fire/smoke. Atmospheric Sand and Dust Storm forecasts are covered under activity 2.2.2.9. Ash emitted by volcanic eruptions, relating to aviation, is covered under activity 2.2.2.10 – Volcano watch services for international air navigation.

National Meteorological and Hydrological Services may request RSMC support for releases that have the potential for large-scale (that is, mesoscale) and/or long-duration (hours to days) impacts, according to the capability of the RSMC. RSMC products are typically not applicable for shorter range incidents. RSMCs may be able to provide services for other types of incidents on a case by case basis. RSMCs will advise NMHSs if requests are not within their capabilities.

SECTION: Chapter

Chapter title in running head: PART II. SPECIFICATIONS OF GLOBAL DATA-…

APPENDIX 2.2.29. MANDATORY PRODUCTS AND GENERAL RULES FOR DISPLAYING PRODUCTS (NON-NUCLEAR)

1. The following mandatory non-nuclear products shall be provided:

- Smoke from forest, grass or peat fires (default values in HYPERLINK: Paragraph <**Appendix 2.2.30**> shall be used for source parameters not provided):
  - Forecast duration 36 hours;
  - Relative concentrations from the surface to 200 m;[1]
  - Images at intervals of one, three or six hours;[2]
  - Contouring to be determined based on specifics of the event or the request;
- Smoke from industrial fire (default values for parameters not provided):
  - Forecast duration 12 hours;
  - Relative concentrations from the surface to 200 m;[1]
  - Images at intervals of one or three hours;[2]
  - Contouring to be determined based on specifics of the event or the request;
- Chemical releases not involving fire (default values for parameters not provided):
  - Forecast duration 12 hours;
  - Relative concentrations from the surface to 100 m;[1]
  - Images at intervals of one or three hours;[2]
  - Contouring to be determined based on specifics of the event or the request.

The RSMC shall perform a quick assessment of the products before they are issued, and shall provide a short explanatory message if any issues of concern are noted.

2. General rules for displaying results

The designated centres will make available in Documentation on RSMC Support for Environmental Emergency Response (WMO/TD-No. 778) on the WMO Emergency Response Activities website an interpretation guide for users.

To make the interpretation of the maps easier, the Producing Centres should adopt the following guidelines:

General guidelines for all maps:

(a) Provide labelled latitude and longitude lines at regular intervals and sufficient geographic map background (shorelines, country borders, rivers, and the like, and possibly roads and town names for localized events) to be able to locate precisely the trajectories and contours;

(b) Indicate the source location with a highly visible symbol (▲,●, ■, etc.);

(c) Indicate the source location in decimal degrees (latitude – N or S specified, longitude – E or W specified, plotting symbol used), date and time (UTC) of release, and the meteorological model initialization date and time (UTC);

(d) Each set of maps should be uniquely identified by at least product issue date and time (UTC) and issuing centre;

[1] Absolute concentrations may be provided if an estimated or actual value of the total mass released or mass release rate is given.
[2] Additional products (for example, GIS-format files) may be provided to requesting NMHSs if possible.

(e) Previously transmitted products from the dispersion model need not be retransmitted;

(f) Indicate with a legend if this is an exercise or a requested service.

Specific guidelines for concentration maps:

(a) Adopt a maximum of five concentration contours;

(b) A legend should indicate contours used on the chart;

(c) Contours may be colour filled but should be clearly distinguishable from map background lines;

(d) Indicate the following input characteristics:

(i) Source assumption (height, duration, pollutant type, amount released);

(ii) Units of concentration;

(e) In addition, charts should specify:

(i) "Surface to xxx-metre layer concentrations", where xxx depends on the pollutant type, and whether the default source is used;

(ii) "Results based on default initial values";

(f) Indicate, if possible, the location of the maximum concentration with a symbol on the map and include a legend indicating the symbol used and the maximum numerical value;

(g) Indicate the start and end date and time (UTC).

The RSMCs will distribute their standard products to the NMHS operational contact points by email or enable retrieval by the NMHS from an RSMC password-protected designated website. Standard products in the ITU-T T.4 format suitable for group 3 facsimile machines will be maintained by exception and only if requested by the NMHS operational contact point. The RSMC may also make use of other appropriate technologies.

Change "sandstorm and duststorm" to "sand and dust storm"

1.1.2.2 The Global Data-processing and Forecasting System shall be organized as a three-tier system of activities as follows:

(b) Specialized activities:

……

– Atmospheric sand and dust storm forecasts

2.2.2.9 Atmospheric sand and dust storm forecasts

Centres conducting atmospheric sand and dust storm forecasts shall:

(b) Prepare limited-area analyses of variables relevant to atmospheric sand and dust storms;
(c) Prepare limited-area forecast fields of variables relevant to atmospheric sand and dust storms;

Note: The bodies in charge of managing the information contained in the present Manual related to atmospheric sand and dust storm forecasts are specified in Table 18.

Table 18. WMO bodies responsible for managing information related to atmospheric sand and dust storm forecasts

* The detailed designation procedure of RSMCs with activity specialization on atmospheric sand and dust storm forecasts (RSMC-ASDF) is referred to in *Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS) Science and Implementation Plan 2015–2020*, WWRP 2015-5, Geneva, WMO, 7 – Transition to operational activities: Proposed designation as regional specialized meteorological centre with specialization on atmospheric sand and dust forecasting (RSMC-ASDF).

APPENDIX 2.2.33. MANDATORY ATMOSPHERIC SAND AND DUST STORM PRODUCTS TO BE MADE AVAILABLE ON THE WMO INFORMATION SYSTEM

PART III. CURRENT DESIGNATED GLOBAL DATA-PROCESSING AND FORECASTING SYSTEM CENTRES

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Provision of atmospheric sand and dust storm forecasts:

- RSMC-ASDF Barcelona
- RSMC-ASDF Beijing (RA II)