WORLD METEOROLOGICAL ORGANIZATION

COMMISSION FOR BASIC SYSTEMS

MEETING OF THE CBS COORDINATION GROUP ON NUCLEAR EMERGENCY RESPONSE ACTIVITIES (NERA)

VIENNA, AUSTRIA, 31 OCTOBER – 4 NOVEMBER 2011

FINAL REPORT

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EXECUTIVE SUMMARY

The CBS Meeting on Nuclear Emergency Response Activities (CG-NERA) took place at the International Atomic Energy Agency (IAEA), in Vienna, Austria, from 31 October to 4 November 2011, under the chairmanship of Mr René Servranckx (Canada).

The representatives of National Meteorological and Hydrological Services (NMHSs), including those of Regional Specialized Meteorological Centres (RSMCs) with activity specialization in Atmospheric Transport Modelling (RSMC-ATM) and RTH Offenbach briefed the meeting on their respective responses and experiences in relation to the Fukushima Daiichi NPP accident and emergency, including the roles they played as WMO regional centres, as well as within or in support of their national nuclear emergency response organizations and operations.

The representatives of relevant international organizations (IAEA, WHO, ICAO and CTBTO) briefed the meeting on their respective roles and the relevance of meteorological information made available by WMO RSMCs in relation to their respective decision making processes during the Fukushima Daiichi NPP accident and emergency, with the view of identifying issues and possible enhancements to the present system of meteorological support.

Their full written reports are available on the WMO Web site at http://www.wmo.int/pages/prog/www/DPFSERA/Meetings/CG-NERA_Vienna2011/DocPlan.html. Based on these reports, and the lessons learnt from the Fukushima Daiichi NPP accident and emergency, the meeting identified issues, and agreed on actions and improvements to the operational procedures.

GENERAL SUMMARY OF THE WORK OF THE SESSION

1. OPENING

1.1 The CBS Meeting on Nuclear Emergency Response Activities (CG-NERA) was opened by its chairperson, Mr René Servranckx (Canada), at 09.30 hours on Monday, 31 October 2011, at the International Atomic Energy Agency (IAEA) Headquarters, in Vienna, Austria. Mr Servranckx noted that all are deeply touched and saddened by the tragic events that stuck Japan in March 2011 and the pain and suffering that resulted from the powerful earthquake, tsunami and Fukushima Daiichi NPP accident. The response to a nuclear emergency such as this one is what the members of the CG-NERA and their operational centres (IAEA/IEC, RSMCs and RTH Offenbach) have been preparing and training for since early in the 1990's. As Chairperson of the WMO/CBS/CG-NERA, he expressed his sincere thanks to all for the excellent work and response provided throughout this event and in particular, to staff at lead-RSMCs in WMO Regional Association II. A special note of appreciation was expressed to colleagues at the Japan Meteorological Agency (JMA) and RSMC Tokyo, who in the face of tragedy and adversity, continued to respond with diligence throughout the event. Mr Servranckx then introduced Mr Florian Baciu, Response System Coordinator, Incident and Emergency Centre, Department of Nuclear Safety & Security of the IAEA, to address the meeting.

1.2 Mr Baciu welcomed the participants to the meeting, to IAEA and to Vienna, on this important year due to the Fukushima Daiichi NPP accident. He noted that the longstanding good cooperation between IAEA and WMO was demonstrated during this emergency. He also noted that the arrangements between the two international organizations have been tested during regular exercises in the past and proved to be effective during the Fukushima response. He pointed out that, following the nuclear emergency in Japan, the current collaboration with relevant international organizations (e.g. IAEA, WMO, WHO, CTBTO, ICAO, etc.) can be evaluated in order to benefit from the lessons learned, and improve the system for a better response in the future. Mr Baciu informed the meeting that, following this emergency situation, the IAEA Member States have developed an Action Plan for Nuclear Safety that describes an expanded role for the IAEA and highlights the need for enhanced coordination with other international organizations, especially with WMO as new and special meteorological products may be required. He noted that IAEA was very pleased to host the meeting this year and look forward to host again such meetings in the future. Finally, Mr Baciu wished the participants a very successful meeting.

1.3 Mr Peter Chen, on behalf of the Secretary-General of the WMO, Mr Michel Jarraud, welcomed participants to the meeting and expressed appreciation to IAEA and its Director-General, Mr Yukiya Amano, and his representatives at the meeting for hosting this meeting. He also thanked Mr Guenther Winkler and Ms Ingrid Merson for making all the local arrangements. Mr Chen noted that the WMO Emergency Response Activities (ERA) programme is part of the WMO Global Data-Processing and Forecasting System. Its main goal is to assist WMO's National Meteorological Hydrological Services (NMHS), along with other relevant agencies of WMO Member countries, and in close collaboration with relevant international organizations, to assist them to respond effectively to environmental emergencies. He recalled that this ERA programme was born in the aftermath of the NPP accident at Chernobyl (April 1986). The WMO system of Regional Specialized Meteorological Centres (RSMC) designated for the "Activity Specialization for Atmospheric Transport Modelling (ATM) for environmental emergency response (EER)" was established to meet requirements that were first defined in 1993 at a CBS International Workshop on Users' Requirements for the Provision of Atmospheric Transport Model Products for Environmental Emergency Response (EER). Since then, the response system has been maintained and improved through routine exercises, few incidents, and technological advances.

1.4 Mr Chen noted that following the Fukushima Daiichi NPP accident and emergency on 11 March 2011, and at IAEA's request, WMO immediately activated its EER procedures, first with the 3 "Lead" RSMCs of the WMO Regional Association II – Asia (Beijing, Obninsk, and Tokyo, at 0930 UTC, 11 March 2011), and then all 8 designated RSMCs (at 1550 UTC, 12 March 2011). In

addition, WMO experts, from ZAMG (Austria) and MeteoSwiss (Switzerland) were dispatched to assist IAEA/IEC and WHO/emergency centre, respectively, in their response functions. Mr Chen informed that meeting that the Sixteenth World Meteorological Congress (May 2011) noted the "well-coordinated supply of useful … products by the RSMCs …", and "encouraged the continued collaboration with IAEA, PrepCom of CTBTO, ICAO, and WHO". Finally, he acknowledged the hard work and leadership of the chairperson of the CG-NERA, Mr René Servranckx (of RSMC Montréal, Canada) and wished all participants a very successful meeting.

2. ORGANIZATION OF THE MEETING

2.1 Adoption of the agenda

2.1.1 The meeting adopted the agenda, which is 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) which is posted on the WMO Web site linked to the banner for the meeting at:

http://www.wmo.int/pages/prog/www/BAS/CBS-meetings.html

2.2.2 Noting that a number of participants were new to the CG-NERA, they briefly introduced themselves, to facilitate interactions throughout the meeting. The representative from RSMC Tokyo, Mr Masami Sakamoto, on behalf of the Japan Meteorological Agency (JMA), expressed deeply gratitude to all RSMCs, especially those in Regional Association II (RSMC Beijing and RSMC Obninsk), and to the chairperson of the CG-NERA, and to WMO and IAEA Secretariats, for their support and assistance throughout the event. The list of participants is provided in Annex II.

3. INTRODUCTION / REPORT OF THE CHAIR

3.1 The chairperson provided introductory remarks regarding the work of the Coordination Group, with particular focus on the role and operational procedures of WMO in providing meteorological support to nuclear emergencies. In addition, he explained the main goals for this meeting that was focused on responses and experiences in relation to the Fukushima Daiichi NPP accident and emergency, with the view of identifying issues and possible improvements to the operational procedures. While noting the excellent work and response provided throughout this event by all the RSMCs with activity specialization on Atmospheric Transport Modelling (ATM) for Environmental Emergency Response (EER), especially the lead-RSMCs in the WMO Regional Association II (Asia), the chairperson explained that this meeting should have a frank and open discussion in order to identify the problems and develop recommendations. The meeting was informed that a WMO Report will be prepared on the WMO and its RSMCs' response, highlighting recommendations to improve the system. This report should be completed by Q1 2012. The meeting was also informed that a meeting of a Task Team on Meteorological Analyses for Fukushima Daiichi NPP accident will be held at WMO Headquarters, in Geneva, Switzerland, from 30 November to 2 December 2011.

3.2 The chairperson reviewed the progress made relative to actions from its previous meeting. The meeting agreed to continue to maintain a record of progress and to carry forward this list of actions, including adding new actions that have been identified from this meeting. This was further addressed under agenda item 8.

3.3 The meeting noted the significant progress made by all RSMCs regarding the production of SRS fields up to 7 weeks back with an occasionally more relaxed turn-around time, such as 3 to 4 days, for CTBTO. In particular, the meeting noted that RSMCs are already doing it or will be able to do it soon. Therefore, the meeting agreed that a proposed amendment to the Manual on the

GDPFS should only be developed upon confirmation that all RSMCs are producing these expanded SRS fields for CTBTO.

3.4 The meeting noted the considerable work done towards a more robust transmission of CTBTO meteorological data on the GTS. The meeting stressed the need for quality control of these data and recommended that the NMCs making use of these data for assimilation in their NWP systems provide feedback directly to CTBTO on the quality of its meteorological data.

3.5 The meeting was pleased to note that good progress has been made in the implementation of the RSMC mirrored Web sites, and in the posting of RSMCs' outputs, especially during the Fukushima event. The representative from IAEA expressed his sincerely appreciation to all RSMCs for their efforts in implementing these mirrored Web sites, and for promptly posting their products, which were very useful throughout the Fukushima event. The meeting thanked RSMC Tokyo for its ongoing work on the development of the common Web site and noted with gratitude that this work is being pursued and will soon be completed.

4. OUTCOMES OF WMO CONSTITUENT BODIES (CBS-EXT.(10), Cg-XVI)

4.1 The WMO Secretariat provided background related to outcomes of WMO Constituent Bodies, particularly focused on the 2010 extraordinary session of the Commission for Basic Systems (CBS-Ext.(10)) and the Sixteenth World Meteorological Congress (Cg-XVI), relevant to ERA. The meeting noted that CBS-Ext.(10) took place before the Fukushima Daiichi NPP accident, triggered by the Great East-Japan earthquake and Tsunami of 11 March 2011, and Cg-XVI was held after the event. Therefore there were additional issues related to ERA discussed at and requested by Cg-XVI to be addressed by CBS CG-NERA. These include:

a) the need for information on the interpretation of the prediction, and that the prediction maps should take into account the actual and accumulated emissions into the atmosphere. CBS to work with the IAEA and CTBTO to enhance the usefulness of these products.

b) based on the lessons learnt from the nuclear accident, the Secretary-General and CBS, in collaboration with other relevant technical commissions (e.g. CAeM), to take appropriate actions to review the existing procedures, taking advantage of similar activities carried out by relevant international organizations.

c) in such events (i.e. nuclear accident and volcanic ash), in the context of national disaster management practices, there are issues associated with the provision of specialized meteorological information to the general public, including proper representation of this information. CBS to review the EER procedures to strengthen these aspects in the *Manual on the GDPFS.*

d) the need to review the outdated WMO Technical Note 170, entitled: "Meteorological and Hydrological Aspects of Siting and Operations of Nuclear Power Plants". Several WMO programmes and technical commissions should be involved in updating the Technical Note; WMO Members were encouraged to consider nominating suitable experts to carry out this work.

4.2 The meeting agreed to discuss these issues under the relevant agenda items.

5. WMO RESPONSE TO THE FUKUSHIMA DAIICHI NPP ACCIDENT, TRIGGERED BY THE GREAT EAST-JAPAN EARTHQUAKE AND TSUNAMI OF 11 MARCH 2011

5.1 The representatives of National Meteorological and Hydrological Services (NMHSs), including those of Regional Specialized Meteorological Centres (RSMCs) with activity specialization in Atmospheric Transport Modelling (RSMC-ATM) and RTH Offenbach briefed the meeting on their respective responses and experiences in relation to the Fukushima Daiichi NPP accident and emergency, including the roles they played as WMO regional centres, as well as

within their national nuclear emergency response organizations and operations. Their full written reports are available on the WMO Web site at http://www.wmo.int/pages/prog/www/DPFSERA/Meetings/CG-NERA_Vienna2011/DocPlan.html. Based on these reports, and the lessons learnt from the Fukushima Daiichi NPP accident and emergency, the meeting identified issues, and agreed on actions and improvements to the operational procedures.

Provision of specialized meteorological information for the general public

5.2 The meeting recalled the request by the World Meteorological Congress, in its sixteenth session (May 2011), to the Commission for Basic Systems (CBS) to review the EER procedure to strengthen the aspects related to the provision of specialized meteorological information for the general public in the *Manual on the Global Data-Processing and Forecasting System* (GDPFS) (WMO-No. 485). The meeting noted that the current version of the *Manual* states in Appendix I-3: "RSMCs... shall provide, on request, support and advice to the IAEA and WMO Secretariats in the preparation of public and media statements". The meeting also noted that throughout the Fukushima event, the WMO Secretariat posted an excerpt of the joint statements by the lead-RSMCs on the meteorological situation on the WMO Web site; and JMA has prepared and maintained a Web page (http://www.jma.go.jp/jma/en/2011_Earthquake.html) with meteorological information for the disaster struck region (in Japanese and in English).

5.3 While recognizing that there were issues associated with public information and that there is a need for the provision of specialized meteorological information to the general public, the meeting agreed that public information is primarily the responsibility of national authorities. Noting that, within the existing arrangements, the main role of the RSMCs is to assist NMHSs within their regions, the meeting recommended that guidelines on the interpretation of the products from the RSMCs should be developed and included in the WMO/TD-No. 778. At the same time, the meeting requested RSMCs to explore the feasibility of developing a regional product(s) that could support and assist NMHSs, and the WMO and IAEA Secretariats, in the preparation of public information; and present their proposals in the next CG-NERA meeting. In addition, the meeting recommended the organization of teleconferences with the participation of all RSMCs, and WMO and IAEA Secretariats, in order to help developing a coordinated response.

5.4 The meeting discussed the possibility of distributing RSMC products to the general public, and agreed that, in accordance with the existing procedures, RSMCs are not allowed to do it, and that the dissemination of such products to the general public is entirely within of the responsibility of the national authorities.

Notification by IAEA

5.5 The meeting noted that these were issues associated with the timely issuance of the notification by IAEA (WNXX01) on the GTS, and that some NMHSs do not know what kind of actions they should perform upon receipt of this notification. The meeting recommended that documentation on the content of the WNXX01 notification, including examples, should be prepared and included in the WMO/TD-No. 778.

5.6 The meeting also recommended that IAEA issue the WNXX01 notification as early as feasible, before the event reaches the class of general emergency (e.g. for situations where there is a likelihood of an atmospheric release), in accordance with the existing procedures stated in Appendix I-3 of the *Manual on the GDPFS*. The meeting requested IAEA to send the notification to RTH Offenbach by e-mail (using fax as a back-up).

Source Term

5.7 The meeting noted that a number of RSMCs and NMCs have worked on the estimation of the source term, either by themselves or in collaboration with other national institutions within their countries. Noting that CTBTO radiological monitoring data was useful for estimating the source term, the meeting agreed to address the issue of accessibility to such data under agenda item 6.4.

5.8 The meeting recalled that the World Meteorological Congress, at its sixteenth session (May 2011), noted that the prediction maps should take into account the actual and accumulated emissions into the atmosphere, and requested CBS to work with the IAEA and CTBTO to enhance the usefulness of these products, which should assist NMHSs in fulfilling their respective national responsibilities. Therefore, the meeting requested RSMCs to explore possibilities for the determination of a realistic source term. In the same context, the meeting noted that the IAEA Member States have tasked the IAEA in the Action Plan on Nuclear Safety to provide Member States, international organizations, and the general public with timely, clear, factually correct and easily understandable information during a nuclear emergency on its potential consequences, including analysis of available information and prognosis of possible scenarios based on evidence, scientific knowledge and the capabilities of Member States. The development of default source terms falls well within this task.

5.9 The meeting recommended that, whenever possible, RSMCs should use a realistic source term instead of a unit release in their calculations. The meeting also noted that in the case a realistic source term is not available, the possibility for users of the RSMC products to scale the results (isotope specific) might be useful for example to estimate the impact of a worse case scenario or that of variations in the amount of Becquerel released. This could be done for example with an interactive / dynamic web page. An action to explore this possibility is identified in Annex III.

Requests by NMHSs, IAEA and Delegated Authorities for RSMCs' products

5.10 The meeting recalled that during the Fukushima event, a number of special/private requests were made by NMHSs and IAEA to RSMCs for atmospheric dispersion products outside of the operational agreement at the current stage, for a factual presentation of the situation. These products, namely atmospheric dispersion calculations for the local/regional range, have used sometimes higher resolution grids and / or better estimate of the source term, to produce a more detailed deposition pattern or air concentrations. In addition, the meeting noted that a number of NMHSs of neighbour countries of the accident State have also requested such products to the RSMCs within their WMO Regions. In this context, the meeting also recalled that the World Meteorological Congress, at its sixteenth session (May 2011), noted the need for information on the interpretation of the prediction, and therefore requested CBS to work with the IAEA and CTBTO to enhance the usefulness of these products, which should assist NMHSs in fulfilling their respective national responsibilities. Noting that the provision of such products by the RSMCs to NMHSs was made on a volunteer basis, and taking into account the usefulness of these products to NMHSs, the meeting encouraged all RSMCs to accommodate requests from other WMO Members whenever possible, making use of the best resolution possible.

5.11 In the same context, the meeting noted that the IAEA requests were made on ad-hoc arrangements between some RSMCs and the IEC. However, considering the tasks given to the IAEA by the Ministerial Conference (June 2011) and consequently in the Action Plan on Nuclear Safety developed by its Members States, requirements for such high resolution products were also expressed by IAEA (in support of its Member States). The meeting stressed that coordination arrangements for the operational request, production and release of such products may need to be defined. To this end, the meeting requested the RSMCs to explore the feasibility of producing such products in a more regular and systematic way. Noting that such requests can increase significantly to the workload of RSMCs and that there are resource issues associated with these requests, the meeting encouraged the WMO and IAEA Secretariats to consider convening a workshop to define users' requirements, which could be used for supporting the development of such arrangements.

5.12 The meeting discussed the possibility of distributing RSMC products to all NMHSs in their regions upon receipt a request by a Delegated Authority in a situation of a declared general emergency (i.e. IAEA's notification already issued). The meeting agreed that those RSMCs receiving these requests, can post their products on the RSMC mirrored Web sites, and can notify

all NMHSs within their regions depending of the circumstances and if the RSMC feels that it is appropriate.

New Products and Formats

5.13 The meeting noted that the Fukushima event helped to identify the need for new products, and some special users required data in GIS-compatible format, in addition to the product formats already defined in the *Manual on the GDPFS*. The meeting requested RSMCs and the IAEA to identify suitable products and formats that could be developed to meet the requirements of users. The meeting noted that both IAEA and WHO would welcome products in a geo-referenced format, preferably shape files, KML, or other file formats (with suitable viewer).

Other issues

5.14 The meeting also identified issues related to WMO-IAEA and WMO-CTBTO arrangements and products, and WMO documentation, which are reported under agenda items 6 and 7, respectively.

6. COOPERATION WITH RELEVANT INTERNATIONAL ORGANIZATIONS (IAEA, ICAO, WHO, CTBTO), INCLUDING IN RESPONSE TO THE FUKUSHIMA DAIICHI NPP ACCIDENT

6.0 The representatives of relevant international organizations (IAEA, WHO, ICAO and CTBTO) briefed the meeting on their respective roles and the relevance of meteorological information made available by WMO RSMCs in relation to their respective decision making processes during the Fukushima Daiichi NPP accident and emergency, with the view of identifying issues and possible enhancements to the present system of meteorological support. Their full written reports are available on the WMO Web site at http://www.wmo.int/pages/prog/www/DPFSERA/Meetings/CG-NERA_Vienna2011/DocPlan.html.

6.1 Cooperation with IAEA

6.1.1 The meeting recalled that the International Atomic Energy Agency (IAEA) performs regular (quarterly) exercises involving RSMCs, and that for its internal training has decided to invite RSMCs to participate by providing their products for other arranged/pre-announced tests. RSMCs agreed to participate in these IAEA training exercises and requested IAEA to inform them in advance to help with the planning (preferably one month in advance).

6.1.2 The meeting noted that IAEA has developed and taken in operation a new incident and emergency Web site (USIE Web site; https://iec.iaea.org/usie/actual/LandingPage.aspx). All RSMCs and WMO Secretariat should now have access to it. This Web site has a feature of sending a message to RTH Offenbach in an agreed format, when needed.

6.1.3 The meeting was informed of the IAEA actions in response to the Fukushima accident, focused on the WMO-IAEA operational arrangements. It noted that especially early in the event, there was some ambiguous/incomplete information in the IAEA requests for RSMCs' products, including on the provision of precise NPP coordinates and on the request for distribution of the products within their respective WMO Regions. Regarding the NPP coordinates, the IAEA has been developing an automatic system on the USIE Web site to incorporate directly this information on the template to request RSMCs' products, so that the likelihood of input errors is minimized. The meeting recommended that IAEA send its requests to RSMCs by e-mail (fax as a back-up) in a format in which the information can copied and pasted, in order to avoid transcription problems. Regarding the request for distribution of RSMCs' products within their respective WMO Regions, the meeting recommended that IAEA consider requesting regular updates for distribution to all NMHSs. This would reduce the number of requests by the national Delegated Authorities and WMO Members.

6.1.4 The meeting noted that throughout the Fukushima event, NMC Vienna (Austria), on behalf of WMO, has provided support and technical assistance to IAEA/IEC in relation to atmospheric dispersion calculations and their interpretation, as well as weather forecasts for the IAEA team in Japan. The expertise was used only for information of the staff in the IAEA/IEC, and other IAEA staff involved in the Fukushima response, but was not distributed to IAEA Member States. The representative from IAEA expressed his appreciation, on behalf of the organization, to the support provided by WMO. The meeting recommended further discussions between the two organizations in order to revise the cooperation agreement between WMO and IAEA, and include such kind of support.

6.2 Cooperation with WHO

6.2.1 The meeting noted that health is a key aspect of human security and global public health security is one of the key priorities for the World Health Organization (WHO). In the aftermath of the Fukushima accident, the risk of human exposure to radiation has received priority attention, and since then, WHO has been involved in the response to the event.

6.2.2 The meeting noted that throughout the Fukushima event, MeteoSwiss (Switzerland), on behalf of WMO, has provided support and technical assistance to WHO in relation to weather forecast and atmospheric dispersion, and on visualization and interpretation for planning appropriate public protection measures for the surrounding regions. The representative from WHO expressed her appreciation, on behalf of the organization, for the support provided by WMO. Noting that the basis for the relations between WHO and the WMO is defined by the 1952 exchange of the letters between the Secretary-General of WMO and the Director-General of the WHO, the meeting recommended further discussions between WMO and WHO on identifying the nature and the scope of the cooperation between the two agencies in the event of a nuclear emergency, in order to develop a joint Concept-of-Operations or Memorandum of Understanding between relevant departments of WMO and WHO.

6.3 Cooperation with ICAO

6.3.1 The meeting took note of the measures taken by the International Civil Aviation Organization (ICAO), under the International Atomic Energy Agency Joint Radiation Emergency Management Plan of the International Organizations, and as required by the Convention on International Civil Aviation after the earthquake of 9.0 magnitude which struck Japan's east coast, triggering a tsunami that caused the nuclear accident at the Fukushima Nuclear Power Plant. With regard to the meteorological aspects the ICAO representative informed the group that the area control centres, upon receiving information on the accidental release of radiation to the atmosphere from the IAEA via the WMO RSMCs Exeter through VAAC London, immediately informed aircraft in flight about the release and provided advice on possible alternative routes. In addition, Japan issued weather advisories relevant to the safety of aircraft and alerted pilots of hazards en route.

6.3.2 In addition, the meeting was informed that an ad-hoc task force on transport issues was established by a number of UN agencies: IAEA; International Maritime Organization; World Health Organization; World Meteorological Organization; World Tourism Organization; International Labour Organization; as well as ICAO, together with the private sector trade associations such as the International Air Transport Association which represents international aircraft operators; and Airports Council International which represents airport operators. The meeting was apprised of issues related to the task force expertise in many of its specialized fields such as meteorology, air traffic management, transport of potentially radioactive cargo and persons, airworthiness, etc. The meeting was pleased to note that, thanks to the efforts of the ad-hoc task force, the transport system remained functional and confidence of the concerned travelling public was maintained.

6.3.3 The meeting also noted that during the IAEA Conference on Safe and Secure Transport of Radioactive Materials (Vienna, Austria, October 2011) ICAO proposed the strengthening of interagency collaboration by creating an Interagency Transport Committee.

6.3.4 In a related issue, the meeting was informed, through a paper submitted by Canada, as a member of ICAO's International Airways Volcano watch Operations Group, on issues regarding the provision of information on radioactive material into the atmosphere. The meeting noted that the need for guidance related to the issuance of warnings (SIGMET messages) designed for aviation purposes was clearly identified during the Fukushima Daiichi nuclear power plant accident in March 2011. The meeting also noted that this topic was further addressed at the 6th Meeting of ICAO's International Airways Volcano Watch Operations Group (IAVWOPSG) in Dakar, Senegal, 19 to 23 September 201, where issues related to the scientific and practical aspects of radiation exposure and health impacts, led to the development of a draft concept of operations for the provision of guidance for radioactive cloud SIGMET. It identifies possible products that could be generated as guidance for the MWOs. The meeting concurred with the need for the referred guidance and products. However, due to some concerns on what the criteria for triggering the SIGMET should be (the dose criteria for the passengers' health or the contamination of the aircraft itself), the meeting was of the feeling that further work should be done first to clarify the criteria to be used to produce the guidance. In this regard the group agreed on the submission of a conjoint paper by IAEA, ICAO and WMO members to the upcoming IACRNE Meeting (Paris, 8-9 December 2011) to seek expert advice on the best criteria to be used to develop the referred guidance.

6.4 Cooperation with CTBTO

6.4.1 The meeting recalled that an important aspect of cooperation between the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) and the WMO is focussed on modelling atmospheric transport of airborne radionuclides. The joint CTBTO-WMO Level 5 Response System in atmospheric backtracking is consequently the thrust of the cooperation. The Response System provides CTBTO with the results of backtracking calculations performed by the cooperating RSMCs. These calculations are requested to support abnormal detections in the CTBTO radionuclide network; and the outputs are crucial to the process of specifying possible source regions and are made available to the CTBTO States Signatories through the IDC secure website. The meeting noted that the joint CTBTO-WMO response system for atmospheric backtracking has been in operation since 1 September 2008. It is currently, as of 28 October 2011, composed of 9 RSMCs (Beijing, Exeter, Melbourne, Montreal, Obninsk, Offenbach, Tokyo, Toulouse, and Vienna).

6.4.2 The meeting noted that in the aftermath of the release from the Fukushima NPP a considerable number of abnormal detections had been made by the CTBTO radionuclide network. In a normal operational mode all of the abnormal detections would give rise to notifications issued to the RSMCs. Bearing in mind the considerable number of those detections and after consulting the chairperson of the CG-NERA, CTBTO refrained from issuing requests for all the Fukushima related detections in order not to overburden the RSMCs with the requests. All the requests were normal with one exception (the first detection following the Fukushima release for which the time of arrival of the plume with a 2-hour precision is known). CTBTO has also been using RSMC products for post-processing.

6.4.3 The meeting noted that real time radionuclide monitoring data is of great value for RSMCs and NMCs in case of emergency. CTBTO data and bulletins could provide essential information regarding the assessment of the accident scenario. The meeting noted that a number of NMCs that host RSMCs are able to access and use the CTBTO data, in its national capacity, through the National Data Centre of the respective CTBTO Member State. However this is not possible for all NMCs hosting RSMCs. Noting that a long term solution is needed for the data access, the meeting noted that NMCs can apply to gain access to the CTBTO data through the national CTBTO authorities.

6.4.4 The meeting recommended that possibilities for WMO RSMCs with specialization in ATM backtracking to have access to data and information from CTBTO should be further explored. Providing the access to the RSMCs could help CTBTO improve the characterization of the parameters related to the CTBT verification.

7. REVIEW OF CURRENT PROCEDURES AND STANDARDS FOR EMERGENCY RESPONSE IN THE CASE OF A NUCLEAR ACCIDENT (MANUAL ON THE GDPFS), WITH THE VIEW OF DEVELOPING PROPOSED AMENDMENTS

7.1 The meeting, benefiting from the reports of the participants, reviewed the current procedures and standards as stated in the 2011 version of the *Manual on the GDPFS* (WMO-No. 485). The meeting considered developing proposed amendments to the relevant sections of Manual, for the upcoming session of the Commission for Basic System (CBS), which is planned to be held in September 2012. It agreed that at this stage, no amendments are required to the existing procedures, however it stressed that these procedures may need to be updated at a later stage based on the results of some new actions that have been identified from this meeting.

7.2 The meeting noted that the World Meteorological Congress, at its sixteenth session (May), agreed that there are fundamental changes under way in the Basic Systems and therefore adopted an extended layout for the revised *Manual on the GDPFS* in Resolution 6 (Session No. 3.1.3/2). The revised *Manual on the GDPFS* would facilitate introducing updates as frequently as required (to ensure that the content is kept up-to-date), and is being developed in accordance with quality management principles, which would ensure its sustainability as part of the WMO Quality Management Framework. The meeting noted that the CG-NERA chairperson, Mr Servranckx, has been tasked to work on the ERA aspects for the revised *Manual on the GDPFS*, and he may require the group members' assistance at a certain stage. The members of the CG-NERA agreed to assist as and if required. The meeting recommended strengthening the WMO's role as the technical authority for atmospheric dispersion modelling in the revised *Manual on the GDPFS*.

7.3 The meeting noted that there were some inconsistencies between the current procedures and standards for emergency response in the case of a nuclear accident stated in the *Manual on the GDPFS* (WMO-No. 485), and ERA procedures described in the WMO/TD-No. 778, entitled "Documentation on RSMC Support for Environmental Emergency Response". Significant work has been done to update the WMO/TD-No. 778, and the updated information was posted on the WMO web site in October 2011. However, additional work/review still needs to be done in light of the development of the revised *Manual on the GDPFS*; need to refresh/update the "Case Studies" section of the web pages; and the regular ''maintenance'' of the web pages to ensure that the information is up-to-date. In this context, the meeting requested the WMO Secretariat, in collaboration with the chairperson of the CG-NERA and the member from Japan, to ensure consistency between the two publications whenever there is an update in the ERA procedures.

8. REVIEW OF ACTIONS FROM THE PREVIOUS MEETING (BEIJING, 2010)

8.1 The meeting reviewed the actions from its previous meeting (Beijing 2010). The updated list of actions (November 2011) for the CG-NERA is found in Annex III.

9. ENSEMBLE ATMOSPHERIC TRANSPORT MODELLING

9.1 The meeting noted that for many years, possible future ensemble modelling products of RSMCs during a nuclear emergency have been discussed. The ENSEMBLE system developed by JRC provides a possible platform to host such calculations, and to present the results. The meeting recalled that at its last meeting (Beijing, May 2010), RSMC Vienna agreed to contact JRC to coordinate necessary steps for undertaking a "private" RSMC NERA session using the ENSEMBLE system. The meeting noted that JRC proposed that NMC Vienna collects the Technical contact points from each RSMC and submits it to JRC. A first exercise was envisioned to the take place in the first half of 2011, but due to the accident in Fukushima, activities of NMC Vienna in this direction were postponed.

9.2 A majority of RSMCs present agreed in principle to participate in the "private" RSMC ENSEMBLE session. The meeting agreed on the next steps for the "private" RSMC ENSEMBLE Session, as described in an Action in Annex III.

10. STATUS OF REVIEW OF WMO/TN 170 ON "METEOROLOGICAL AND HYDROLOGICAL ASPECTS OF SITING AND OPERATIONS OF NUCLEAR POWER PLANTS"

10.1 The meeting noted the successful collaboration of WMO with the IAEA on the development of a new IAEA Safety Guide, entitled: "Meteorological and Hydrological Hazards in Site Evaluation of Nuclear Installations" (IAEA/DS-No. 417), which represented an important first step to the review requested by the World Meteorological Congress, in its fifteenth session (May 2007), of the outdated WMO Technical Note 170, entitled: "Meteorological and Hydrological Aspects of Siting and Operations of Nuclear Power Plants". This Safety Guide will act as an important guide to essential subject areas where technical methods and best practices should be updated in the revision of the WMO Technical Note.

10.2 The meeting noted that only a few sections of the publication concern CBS, and several WMO programmes and technical commissions should be involved in updating the Technical Note. Following a throughout review of the relevant sections (Chapter 2, entitled Practical guidance for meteorologists in charge of the meteorological assessments and continuing services; section 2.2.4 – normal NPP operation, and 2.2.5 – NPP emergency situations), the meeting developed a proposed expanded outline for updating these sections, which it provided in Annex IV.

11. ANY OTHER BUSINESS (AOB)

11.1 There were no other issues raised during the meeting.

12. CLOSING OF THE MEETING

12.1 The CBS Meeting of the Coordination Group on Nuclear Emergency Response Activities (CG-NERA) closed at 16:30 on Friday, 4 November 2011.

ANNEX I

AGENDA

1. OPENING OF THE MEETING

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

3. INTRODUCTION / REPORT OF THE CHAIR

4. OUTCOMES OF WMO CONSTITUENT BODIES (CBS-EXT.(10), CONGRESS-16)

5. WMO RESPONSE TO THE FUKUSHIMA DAIICHI NPP ACCIDENT, TRIGGERED BY THE GREAT EAST-JAPAN EARTHQUAKE AND TSUNAMI OF 11 MARCH 2011

6. COOPERATION WITH RELEVANT INTERNATIONAL ORGANIZATIONS (IAEA, ICAO, WHO, CTBTO), INCLUDING IN RESPONSE TO THE FUKUSHIMA DAIICHI NPP ACCIDENT

7. REVIEW OF CURRENT PROCEDURES AND STANDARDS FOR EMERGENCY RESPONSE IN THE CASE OF A NUCLEAR ACCIDENT (MANUAL ON THE GDPFS), WITH THE VIEW OF DEVELOPING PROPOSED AMENDMENTS

8. REVIEW OF ACTIONS FROM THE PREVIOUS MEETING (BEIJING, 2010)

9. ENSEMBLE ATMOSPHERIC TRANSPORT MODELLING

10. STATUS OF REVIEW OF WMO/TN-No. 170 ON "METEOROLOGICAL AND HYDROLOGICAL ASPECTS OF SITING AND OPERATIONS OF NUCLEAR POWER PLANTS"

11. ANY OTHER BUSINESS (AOB)

12. CLOSURE OF THE MEETING

ANNEX II

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ANNEX III

ACTIONS FROM THE VIENNA 2011 MEETING OF THE CG-NERA

ACTION 1: ALL RSMCs, RTH Offenbach and WMO Secretariat
Updating of Annex 4, WMO TD-No. 778
DUE DATE: 1 March 2012
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.

ACTION 2: WMO Secretariat and ALL RSMCs
Implementation plan to migrate from fax distribution of products to email/internet distribution of products
DUE DATE: 30 November 2011
1. WMO, via circular letter from Secretary-General, to request 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; WMO to provide RSMCs with all replies.
DUE DATE: 1 February 2012
2. RSMCs will commence testing e-mail distribution within their respective Regions of responsibility, and contact those Members that have not replied to the circular letter; RSMCs to provide updated lists to WMO.
DUE DATE: 1 March 2012
3. WMO and RSMCs, in consultation with IAEA decide additional measures to obtain additional replies from Members; WMO to provide updated lists to RSMCs and to update all contact information on the WMO ERA Web pages.

ACTION 3: ALL RSMCs
Mirrored web-pages
ONGOING
1. RSMC Exeter to explore possibility of install the mirrored Web-site to accommodate the posting of the basic products from all 8 RSMCs. RSMC Tokyo to pursue the development of the common web page.
2. All RSMCs, where local policy permits, to include an ‘’all products’’ web link on mirrored-web page where an archive of modelling results will be maintained.
3. All RSMCs to test that the transmission of their products to the other sites is working correctly.
4. A meta-data Web page and directory will be used to post non-standard / initial response products and files, including GRIB-2 files.
5. NMC Vienna, and RSMCs Washington and Toulouse to work on producing basic products in GRIB, GRIB-2, BUFR and post on meta-data web page, and distribute the information to the all RSMCs (link to the ENSEMBLE) and report back to the group.
6. Work on producing basic products in geo-referenced format, preferably shape files, KML or other file formats (with suitable viewer).
7. Look at how to handle presentation of results in common web pages for multiple isotopes.

ACTION 4: WMO SECRETARIAT
File naming convention
ONGOING
It is necessary to define appropriate file naming conventions consistent with WMO recommended practices or standards to facilitate the exchange, accessibility and management of products. The Secretariat has investigated existing standards and will report new information as needed.

ACTION 5 (NEW): RSMC MONTREAL
Interactive web site
DUE DATE: 2012
Explore interactive / dynamic web site where RSMC results can be scaled.

ACTION 6 (NEW): IAEA and WMO SECRETARIAT
Cooperation agreement between IAEA and WMO
DUE DATE: 2012
Revise the cooperation 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.

ACTION 7 (NEW): WHO and WMO SECRETARIAT
Cooperation between WHO and WMO
DUE DATE: 2012
Discuss the nature and the scope of the cooperation between the two agencies in the event of a nuclear emergency, in order to develop a joint Concept-of-Operations or Memorandum of Understanding between relevant departments of WMO and WHO.

ACTION 8 (NEW):RTH Offenbach, NMC Hong Kong, WMO and IAEA
WNXX01 IAEA messages
DUE DATE: 1 March 2012
Document WNXX01 IAEA messages, transmission and notification procedure with examples for inclusion in WMO TD-778 and WMO ERA web pages.

ACTION 9: CG-NERA
Real-time radionuclide data and real-time radiation monitoring data
ONGOING
Real-time radionuclide data and real-time radiation monitoring data would be of great value for real-time responses, including modeling, but also for hindcast studies. It was agreed that each RSMC would investigate the possibility of accessing such monitoring data and report at the next meeting of this Group. Database for Fukushima from IAEA; vDEC from CTBTO.

ACTION 10: IAEA
NPP Coordinates and radionuclide database
ONGOING
1. Evaluate the possibility of providing an updated database with more detailed coordinates for NPP to the RSMCs.
2. Evaluate the possibility of provide an radionuclide database to the RSMCs.

ACTION 11: IAEA and WMO Secretariat
Coordination and liaison between NMHSs and the counterpart NCAs
DUE DATE: 2012
Continue work on coordination and liaison between NMHSs and the counterpart NCAs. One suggestion was to include in the next mailing of the IAEA technical operations manual information on the RSMC services and the role of the NMHS Operational Contact Point, and the list of Delegate Authorities for requesting specialized RSMC products (refer to WMO ERA and WMO TD-778 web pages). Explore the possibilities to strengthen the links through exercises.

ACTION 12 (NEW): WMO Secretariat in collaboration with CG-NERA
WMO's role as the technical authority for atmospheric dispersion modelling
DUE DATE: for inclusion in revised Manual on the GDPFS
That WMO's role as the technical authority for atmospheric dispersion modelling be strengthened in the revised *Manual on the GDPFS.*

ACTION 13: ALL
Terms of reference of NERA-CG

DUE DATE: 30 April 2012

The following Terms of Reference were adopted by CBS XIV (Dubrovnik, 25 March – 2 April 2009) for the Coordination Group on Nuclear Emergency Response Activities (ERA). The meeting recommends that they be maintained:

(a) Test and improve the collective ability of all RSMCs, the IAEA, the RTH Offenbach and NMHSs in the ERA to fulfill the operational requirements specified in global and regional arrangements, according to adopted standards and procedures.

(b) Implement and explore further improved distribution/access methods for specialized products to NMHSs, and the IAEA in collaboration with the IAEA and other relevant organizations.

(c) Collate the individual capabilities of RSMCs to produce enhanced products in support of nuclear emergencies, including ensemble techniques.

(d) Explore the operational availability of radiological monitoring data for use in the RSMC operational environment.

(e) Develop concepts of operational arrangements for atmospheric transport modelling backtracking products.

(f) Continue testing and evaluating the operational arrangements with CTBTO.

ACTION 14 (NEW): IAEA, CTBTO and RSMCs

Default /realistic source term

DUE DATE: ONGOING

Explore how to determine a default / realistic source term to help RSMCs produce guidance that is closer to reality.

ACTION 15: ALL RSMCs, RTH / RSMC OFFENBACH and WMO Secretariat

Annual Report

DUE DATE: REPORT FOR 2011 (2012) BY FEBRUARY 2012 (2013)

The meeting agreed that 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
- 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 2011 and 2012 reports on the ERA web pages: **http://www.wmo.int/pages/prog/www/DPFSERA/resources.html**

ACTION 16: RSMCs Obninsk, Montréal, Toulouse, Washington, NMC Hong Kong, WMO and IAEA. Chair will coordinate

Explore new products, including products to assist in the provision of public information and higher resolution products to fulfil the users' requirements

DUE DATE: 2012

''Time of Arrival'' Product Tests

1. Conduct a test of the experimental ''time of arrival of pollutant'' product using the parameters defined at the meeting and evaluate results.
2. Chair will consult with RSMCs about possible approaches for the ''Time of Arrival'' product beyond a few days.

ACTION 17: WMO Secretariat and RSMCs
Radar and precipitation data
ONGOING
1. Identify sources of radar and precipitation data and investigate possibility of providing information to IAEA to help diagnose ''hotspot'' regions following a nuclear accident.
2. RSMCs are invited to provide examples and links to web pages.

ACTION 18: NMC Vienna in cooperation with RSMCs and IAEA
RSMC tests with ENSEMBLE
DUE DATE: **as listed**
- By end of 2011: every interested RSMC provides technical contact information to NMC Vienna (for ENSEMBLE session).
- NMC Vienna will request a new ENSEMBLE user for each RSMC.
- NMC Vienna submits documentation and programs to RSMC technical contacts (Fortran programs to encode model output for submission to the Ensemble V5 website-regular grids).
- Q1/2012: NMC Vienna to define an exercise scenario, in cooperation with IAEA. This scenario should be based on realistic source terms of ^{137}Cs and ^{131}I instead of unit values.
- March 2012: RSMC-ENSEMBLE exercise will be conducted. For this purpose, JRC/ENSEMBLE needs to generate a "source-file" including a random key, which will be sent to the RSMCs.
- RSMCs to send back results to the ENSEMBLE platform, using the predefined format. The exercise will not be conducted in near real time (RSMCs can respond within 2-3 weeks).
- Q2/2012: RSMC Vienna will draft a report regarding the ENSEMBLE RSMC exercise.
- Q3/2012: Participating RSMCs and NERA group to comment on the report.

ACTION 19: Chairperson in coordination / collaboration with RSMC Tokyo and others and WMO Secretariat
Updates to WMO TD-778 and WMO ERA web pages
DUE DATE: 2012
Check, review and update the ERA web pages and WMO TD-778 (including Action 8 on WNXX). Produce and update as needed pdf version of WMO TD-778. Develop guidelines on the interpretation of the RSMC products to assist with provision of public information (link to action 16).

ACTION 20: RSMC Toulouse
Updates to WMO TD-778 and WMO ERA web pages
ONGOING
RSMC Toulouse will request and lead a group of members to maintain, update and further develop the ''WEB LINKS'', ''CASE STUDIES'' and ''WEBSITE LINKS to RSMCs and International Organizations".

ACTION 21: IAEA and WMO Secretariat
Users' requirements meeting
DUE DATE: 2012
Consider the possibility of organizing a users' meeting regarding requirements in 2nd half of 2012.

ACTION 22: CTBTO PTS
Reference material on CTBTO Web page
ONGOING
Maintain reference material on the Web page regarding the CTBTO – WMO response system.

ACTION 23 (NEW): IAEA IN CONSULTATION WITH RSMCs
Quarterly tests for 2013
DUE DATE: 1 June 2012
Define the schedule for quarterly tests for 2013.

ACTION 24: ALL (except CTBTO)
Quarterly tests
ONGOING
February 2012: RSMCs Exeter and Toulouse
May 2012: RSMCs Beijing, Obninsk and Tokyo
August 2012: RSMCs Washington and Montreal
November 2012: RSMC Melbourne
Information on the planned tests for 2012 and 2013 will be published on the IAEA USIE Web site. GTS message will be sent with each quarterly test. Distribution of products will be done by Lead RSMCs to their region(s) of responsibility. Coordination conference call between RSMCs and IAEA to be considered. IAEA to propose technical means of doing this.

ACTION 25 (NEW): NMC VIENNA, CTBTO, WMO and Canadian Meteorological Centre (RSMC Montreal)
Transmission of CTBTO meteorological data on WMO GTS
ONGOING
1. Pursue plans to make the transmission of CTBTO meteorological data to NMC Vienna more robust.
2. NMC Vienna to pursue gradual take-over of transmission of data from Canadian Meteorological Centre to WMO GTS. Transmission from NMC Vienna will begin after a few WMO station identifiers have been obtained.
3. NMC Vienna to inform Canadian Meteorological Centre as new transmissions are added, so that they can be discontinued at CMC.
4. WMO to provide identifiers to NMC Vienna as they become available.

ACTION 26: CTBTO and RSMCs
SRS fields for CTBTO
DUE DATE: 2012
CTBTO will make a formal request to the WMO Secretariat for SRS fields at finer resolution. RSMCs to investigate and inform CTBTO through the WMO Secretariat on the feasibility of performing computations of the SRS fields with the enhanced resolution of 0.5° x 0.5°.

ANNEX IV

WMO/TN-No. 170 – PROPOSED EXTENDED OUTLINE FOR UPDATING SECTIONS 2.2.4 AND 2.2.5

Considering Atmospheric Dispersion for Nuclear Power Plant Siting and Operations

Abstract: The atmospheric planetary boundary layer (PBL) height and winds and temperature in the boundary layer are critical weather components that drive dispersion decision support tools to assess contaminant concentration at a particular location. Therefore, accurate assessment of complex boundary layer processes at finer scales should improve a nuclear power plant operator's ability to assess the effects of a potential toxic release. Three dimensional dispersion models coupled with high resolution meteorological model can now be used to provide improved estimate of the temporal and spatial structure of the PBL and a plume dispersion assessment forecast models to protect life and property.

1. Introduction

The atmospheric planetary boundary layer (PBL) height and winds and temperature in the boundary layer are critical weather components that drive dispersion decision support tools to assess contaminant concentration at a particular location. Numerous studies have shown model concentrations to be very sensitive to boundary layer information. For example, Hanna (1984) showed that doubling the PBL height led to a reduction in plume concentrations by a factor of two. Therefore, small errors in boundary layer heights can lead to large errors in plume concentration forecasts.

Therefore, accurate assessment of complex boundary layer processes at finer scales should improve a nuclear power plant operator's ability to assess the effects of a potential toxic release. The goal of this paper is to provide recommendations on improving an emergency manager's assessment and response to a potential release of toxic materials form a nuclear power plant to the atmosphere. New methods are now available to better capture important atmospheric boundary layer processes that influence the toxic plume dispersion are summarized. The following recommendations are made to improve these assessments:

- Basic weather and atmospheric turbulence monitoring to capture atmospheric planetary boundary layer processes derived from surface and upper level instruments.

- Integrating these observations into a retrospective or Real Time Mesoscale weather Analysis (RTMA) around the site through recent downscaling technologies (described in section XX). A planetary boundary layer (PBL) analysis can be created by ingesting on-site or nearby surface mesonets and upper level ACARS, profiler or lidar measurements through dynamic or statistical downscaling. Adequate meteorological analyses may also be obtained through the regional NMC who may already run higher horizontal resolution (~ 4km) weather analysis and forecast models. Typically high resolution vertical resolution (50-100 m) meteorological fields are also desired to accurately resolve boundary layer information.

- Outputting important meteorological parameters from the analysis including:
  - Surface and boundary layer winds, temperature, moisture, pressure
  - Mixed layer depth
  - Precipitation

  Also useful would be:
  - Cloud fraction, base and heights.
  - Surface momentum, heat and moisture fluxes
  - Estimates of mixed layer turbulence (e.g: turbulent kinetic energy, energy dissipation rates…) and stability.
  -
- Regular verification of basic meteorological downscaled predictions would be performed to determine strength and weaknesses of the modeling system that could be conveyed to the model developer or modeling center where the predictions were performed.

- Utilizing these analyses and forecasts to drive an Atmospheric Transport and Diffusion Model (ATM) to produce surface estimates of realistic toxic concentrations if source term estimates are know. Otherwise relative concentration factors (X/Q) would be produced to help emergency managers identify areas conducive for weak dispersion (stable atmospheric conditions) that would be particularly vulnerable to high toxic pollutant concentrations if a release did occur.

- Using the emergency response dispersion capability for power plant siting evaluations by conducting an assessment of areas vulnerable to higher concentrations from atmospheric dispersion processes. Guidelines for producing a dispersion assessment are suggested in section XX.

2. Background

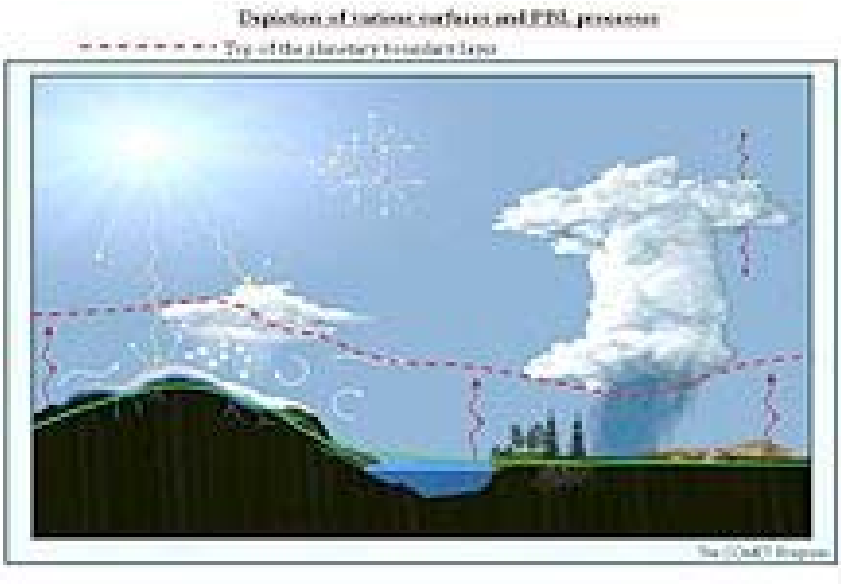
2.1. Previous reports on assessing dispersion for site planning or operations

- TN 170:
  - Assessment of flow characteristic when evaluating NPP Siting.
  - What and how to respond After a release has occurred.
  -
- IAEA Doc 3-2
  - The atmosphere is a major exposure pathway by which radioactive materials that are either routinely discharged under authorization or accidentally released from a nuclear power plant could be dispersed in the environment and transported to locations where they may reach the public.
  - The evaluation of the transport in the atmosphere of radioactive materials discharged from a nuclear power plant under normal operational or accidental conditions is a requirement of design and licensing (Ref. [2], para. 503). A meteorological investigation should be carried out to evaluate regional and site

specific meteorological parameters. These data should be collected from appropriate elevations above ground in order to obtain realistic dispersion parameters.
  - Contamination in the air, on the ground and in water over short and long time periods should be described in the atmospheric dispersion models, with account taken of diffusion conditions in the region. Orographic elevations having significant slopes should be considered in the models.
  - The type and extent of acquired and stored meteorological data should allow for reliable statistical analyses to determine the distribution of radiation exposures.
  - The effects and consequences for the public and the environment of short term or long term radioactive discharges should be assessed on the basis of meteorological information and site specific conditions relating to land and water uses, population distribution, infrastructure in the vicinity of the site and relevant radiological parameters.
  - A detailed meteorological investigation should be carried out in the region. The calculations of the dispersion and concentrations of radioactive materials should show whether the radiological consequences of routine discharges and potential accidental releases of radioactive materials into the atmosphere are acceptable. The results of these calculations may be used to establish authorized limits for radioactive discharges from the plant into the atmosphere (see Ref. [5]).
  - The results of the meteorological investigation should be used to confirm the suitability of a site; to provide a baseline for site evaluation; to determine whether local meteorological characteristics have altered since the site evaluation was made and before operation of the plant commences; to select appropriate dispersion models for the site; to establish limits for radioactive discharges into the atmosphere; to establish limits for design performance (for example, containment leak rates and control room habitability); and to assist in demonstrating the feasibility of an emergency plan.

- IAEA Doc. 417 : Most of the focus are on Meteorological and Hydrological Events that may trigger a release.
  - No consideration of likelihoods of population centers being affected after a release by typical flow patterns.
  - Mention of the need for a warning system after a release (Chap. 9)
    - The warning system should be used in connection with forecasting models since the time period that would be necessary for operator actions to put the installation into a safe status may necessitate acting on the basis of extrapolations of trends in phenomena without waiting for the actual occurrence of the hazardous event.

2.2. local-scale meteorological processes that influence atmospheric dispersion



2.1.1 Mountain-Valley winds
2.1.2 Sea and ake breeze
2.1.3 Urban Heat Island

3. Methods for creating a representative atmospheric dispersion analysis and forecast system.

3.1. Prototype Dispersion Analysis and Forecast System

Recognizing the amount of effort needed to develop a thoroughly tested and validated dispersion analysis and forecasting system, this document recommends a range of capabilities.

Configuration of the U.S. NWS boundary layer analysis system is illustrated below. The RTMA is executed at high resolution (5 km) for the CONUS. Time continuous 3-D distributions of boundary layer) products, calibrated by measurements, are linked to the operational systems.

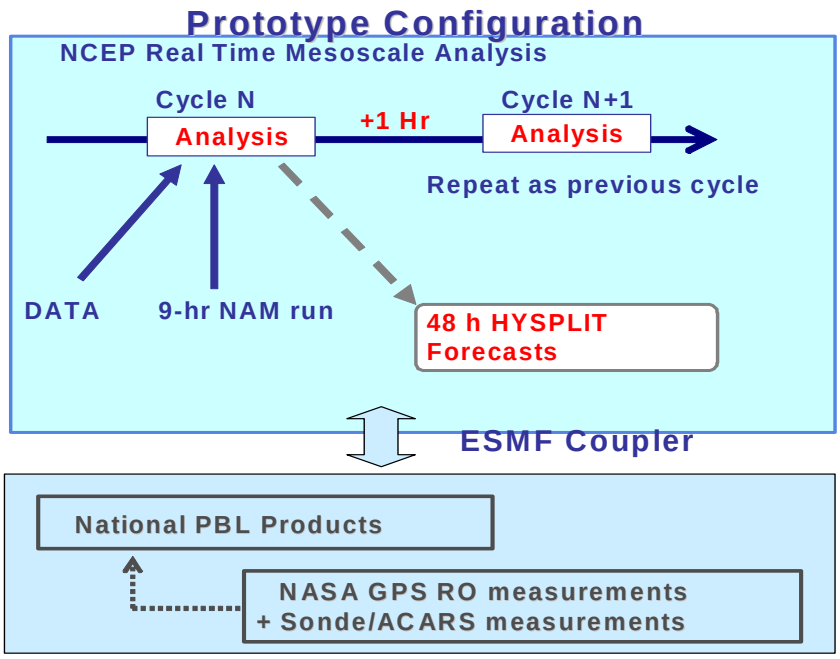


Figure 1. Overview of prototype configuration for RTMA boundary layer analyses using GPS RO and other profile measurements. The analysis can be used to drive NOAA's plume dispersion forecast tool, HYSPLIT.

4. Data collection for an atmospheric boundary layer observation network

4.1. Surface mesonets and mult-level towers

4.2. Nearby Radiosondes and Aircraft profiles

4.3. On-site or nearby boundary layer profilers, sodars and rass data

4.4. Nearby Lidar Measurements

Lidar data such as the NASA Micro-Pulse Lidar Network (MPLNET) (*Welton et al*., 2001) Micro-Pulse Lidar (MPL) systems are designed to measure aerosol and cloud vertical structure continuously, day and night, over long time periods required to contribute to climate change studies and provide ground validation for models and satellite sensors in the NASA Earth Observing System (EOS). Figure 7 shows locations of MPLNET sites and various field campaigns, and planned and proposed future sites. The MPLNET website, http://mplnet.gsfc.nasa.gov, provides up-to-date information on the project and access to data products.

Figure XX shows an example of Level 1 lidar profiles from the MPLNET site at NASA Goddard Space Flight Center in Maryland on May 3, 2001. Sunrise occurs around 13:00 UTC, and PBL growth during morning into afternoon is visible in the figure. Aerosol layers in the free troposphere are visible during the previous night, and the PBL eventually reaches high enough to entrain the material in the afternoon. Entrainment of transported material by the local PBL is directly impact surface concentration measurements. MPLNET collect data continuously, day and night.

5. Creating a Mesoscale Analysis

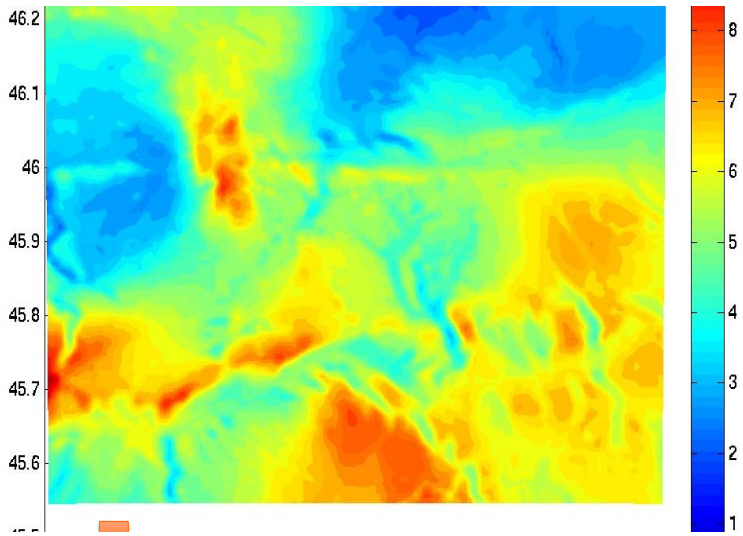
A region's NMC may produce high resolution analysis and prediction system that can be leverage to to capture local-scale flows around an NPP. Otherwise, several downscaling techniques may be employed from diagnostic statistical techniques to running a mesoscale numerical analysis and prediction systems. Observations collected in section 3 would be used to produce these retrospective or real-time analyses.

5.1. Diagnostic Mass Consistent Wind field Analyses.

- Surface winds are interpolated to a regular grid
- Inverse distance-squared weighting (Goodin et al. 1979)
- Inverse elevation difference weighting (Palomino and Martin 1995)
- Upper-level wind data are interpolated to the three-dimensional grid
- Topographic effects, slope winds and blocking are parameterized (e.g.: CALMET).
- The three-dimensional wind fields are adjusted to ensure the conservation of mass (Moussiopoulos and Flassak 1986; Brocchini et al. 1995)

5.1.1. Examples (CALMET)

- Uses coarse-grid input of meteorological fields, and makes adjustments to wind field based on coarse versus fine-grid terrain and land use fields
- Forces flow to be terrain-parallel, modulated by stability
- Requires along-terrain flow where Froude number < 1
- Removes the consequent 3D divergence with an iterative procedure
- Makes adjustments for underlying roughness using similarity theory



CALMET downscaled winds (550 m resolution)over the central PA valley

5.2. Combined Physical and Statistical Downscaling (A. Jacobs, KNMI)

- Based on a simple model of the Planetary Boundary-Layer and on high-resolution surface roughness information.
- The PBL model consists of two layers:
  - the Ekman layer
  - the surface layer
- Roughness lengths determined by averaging geographical variations in surface roughness over the upstream area of the airflow.
- The resulting high-resolution roughness lengths are wind direction dependent**.**

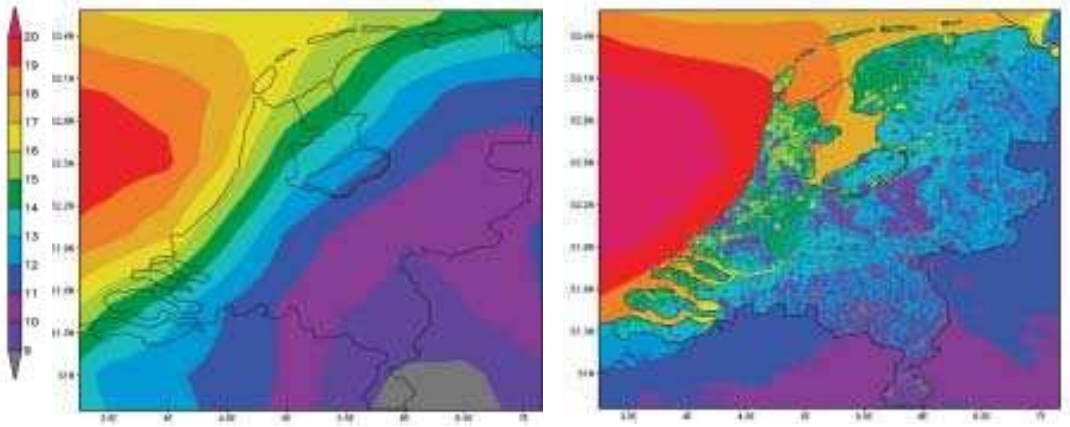
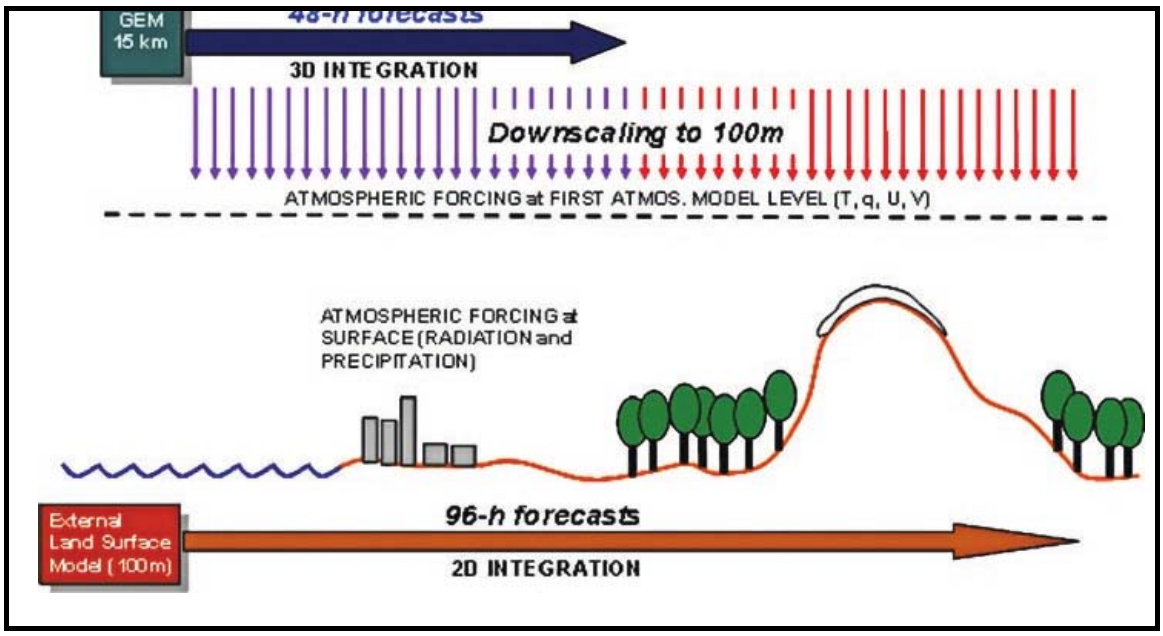


Figure 3 (left) shows a 10m wind field forecast [ms^{-1}] of HIRLAM-11km; (right) shows the downscaled wind speed field (1km resolution) following the combined physical/statistical approach. Outside the Netherlands no roughness information is available and local wind speeds over land should be ignored.

5.3. Uncoupled high resolution land surface model (Canada)

- External high- resolution prognostic surface model driven from regional model
- Interactions between Surface, Biosphere, and Atmosphere (ISBA) land surface scheme integrated on a 100-m grid (140 km × 180 km)
- Define local land characteristics.
  - microscale topo- graphic information from the Shuttle Radar Topography Mission Digital Elevation Model (SRTM-DEM).
  - GlobCover global data- base at 300 m and several Canadian databases.

- Down-scale driving atmospheric forcing (i.e. temperature, humidity, winds, surface pressure, downwelling shortwave and longwave radiation, *and precipitation)*
  - height difference between the high-resolution (100 m) grid and the low-resolution atmospheric forcing grid,
  - assume a constant lapse rate of 0.0060 K m−1 to adjust to high res. elevation
  - downscale surface pressure and temperature.
  - downscale low-level air humidity, by assuming conservation of relative humidity, and to possibly change precipitation phase
- Initial conditions of surface variables (e.g., snow surface temperature, snow depth, etc.) from the 24-h external microscale forecast of the previous day.



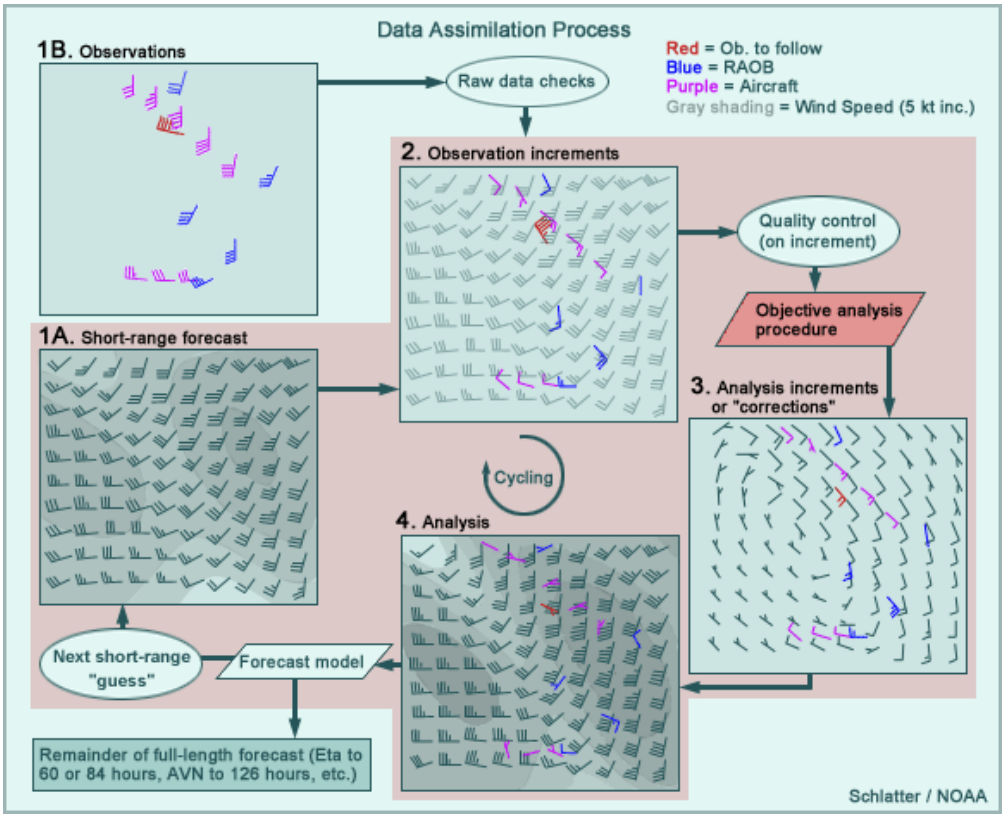
5.4. Variational Assimilation (RTMA)

Two components of the Real-Time Mesoscale Analysis (RTMA) run in the NCEP production suite on the NOAA Central Computer System (CCS). These two components of the RTMA system are developed and supported by the Environmental Modeling Center (EMC) and operated and managed by NCEP Central Operations (NCO). RTMA products were introduced on the National Weather Service's Advanced Weather Information Processing System (AWIPS) in 2006.

The RTMA suite of analyses comes from three sources with two running at NCEP. An Effective Cloud Amount (ECA) is produced from GOES data at and by NOAA/NESDIS. An hourly analysis of gage observations and radar estimates of precipitation accumulation over the contiguous United States (CONUS) is produced at NCEP and is called the Stage II National Precipitation Analysis. For the RTMA, this analysis is converted and interpolated to the 5 km NWS National Digital Forecast Database (NDFD grid) used by all NWS Forecast offices to produce gridded forecast products

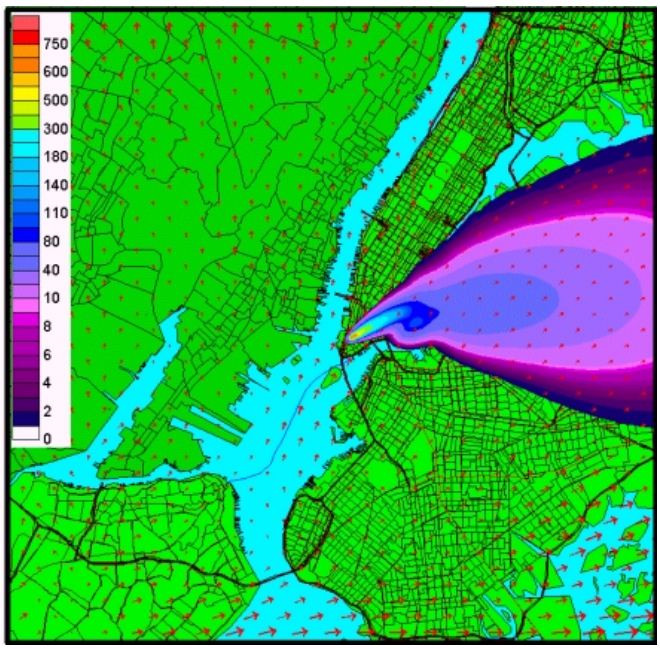
The primary RTMA system component, is based on a 2-dimensional application of EMC's unified 3-dimensional variational analysis system called Grid-point Statistical Interpolation (GSI). The GSI runs in both the North American Mesoscale (NAM & NDAS) and Global Forecast System (GFS & GDAS). Using a first-guess obtained by downscaling a 1-hour Rapid Update Cycle (RUC) forecast from 13- to 5-km, the RTMA performs an analysis of all surface observations (surface-synoptic, metar, mesonet, ship, buoy etc) of temperature and dew point at 2 m and wind at 10 m. In addition, estimates of analysis uncertainty for each variable are also produced. Reducing the assimilation process to two dimensions enables the development of high resolution analysis in real-time for various forecaster applications. A high horizontal resolution analysis is essential for dispersion and air quality applications which are very sensitive to fine scale boundary layer

processes driven by fine scale orography such as land-sea breezes, flows in complex terrain and urban heat island effects.



6. Dispersion models for creating concentration analyses and forecasts

These high resolution meteorological analysis would then be used in an atmospheric dispersion model to account for atmospheric turbulence and stability for relatively turbulent, convective or unstable and conditions where less turbulence and a more stable atmosphere exists. Atmospheric stability can have a large effect on the predicted or analyzed plume footprint or concentration amount. Under unstable conditions, for example, a dispersing gas will mix rapidly with the air around it. The plume cloud will extend less far downwind than it would under more stable conditions, because the pollutant would more be diluted faster.



Several types of dispersion models are used as part of the WMO EER RSMC capability.

As a result of the poor communications between countries following the Chernobyl accident in the Spring of 1986, the World Meteorological Organization (WMO) was asked by the International Atomic Energy Agency (IAEA) and other international organizations to arrange for early warning messages about nuclear accidents to be transmitted over the Global Tele-communications System (GTS). In addition some WMO member countries lacking extensive forecasting capability requested that specialized pollutant transport and dispersion forecasts be provided during these emergencies.

In 1989, Regional Specialized Meteorological Centers at Toulouse (Meteo-France), Bracknell and Montreal were set up under interim arrangements between the WMO and the IAEA. Under these arrangements Meteo-France was to provide global coverage (with Bracknell as the backup center) until each WMO region had at least two RSMCs for transport model products.

6.1. RSMC-Washington Dispersion Model Capability

The HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) model is the newest version of a complete system for computing simple air parcel trajectories to complex dispersion and deposition simulations. It is the primary NOAA decision support tool for plume dispersion and RSMC support. The dispersion of a pollutant is calculated by assuming either puff or particle dispersion. In the puff model, puffs expand until they exceed the size of the meteorological grid cell (either horizontally or vertically) and then split into several new puffs, each with it's share of the pollutant mass. In the particle model, a fixed number of initial particles are advected about the model domain by the mean wind field and a turbulent component. The model's default configuration assumes a puff distribution in the horizontal and particle dispersion in the vertical direction. In this way, the greater accuracy of the vertical dispersion parameterization of the particle model is combined with the advantage of having an ever expanding number of particles represent the pollutant distribution.

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6.2. RSMC-Toulouse

6.3. RSMC-Canada

6.4. RSMC-Austria

6.5. RSMC-Offenbach

6.6. RSMC-Obninsk

6.7. …

7. Creating a Dispersion Climatology for assessing Power Plant release impacts

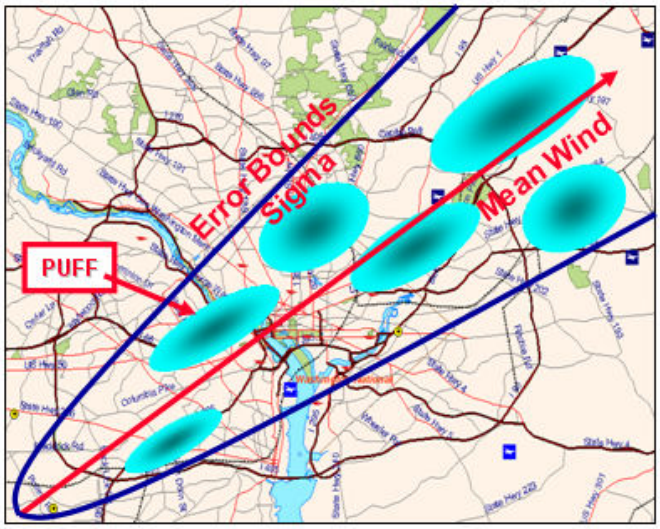
7.1. Dispersion model analysis guidelines

7.1.1. Annual simulations

7.1.2. Create gridded summary statistics.

7.1.2.1. Mean, Variance, probability of threshold exceedance

Probabilistic Calculations



7.1.2.2. Clustering to represent different scenarios

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