

# WMO Nuclear Emergency Response Activities in the framework of the Joint Plan

Current status and lessons learned from Fukushima

Dr. Gerhard Wotawa, Head of Division Data,  
Methods and Modelling, ZAMG  
WMO Representative (Member of ET-ERA)

Presentation at IAEA's International Experts' Meeting,  
Vienna, Austria, 17-21 February 2015



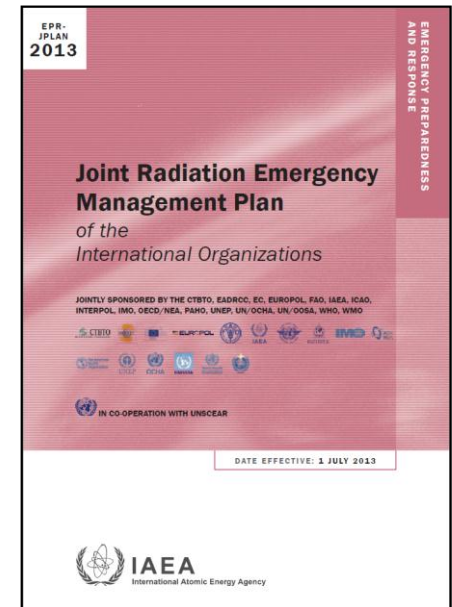
**ZAMG**  
Zentralanstalt für  
Meteorologie und  
Geodynamik

# Outline

- WMO involvement in the Joint Plan
- Nuclear ERA: Structure and Responsibilities
- The Fukushima lessons
  - High-resolution modelling products
  - Ensemble products
  - Dealing with unspecified source terms
- Summary and conclusions

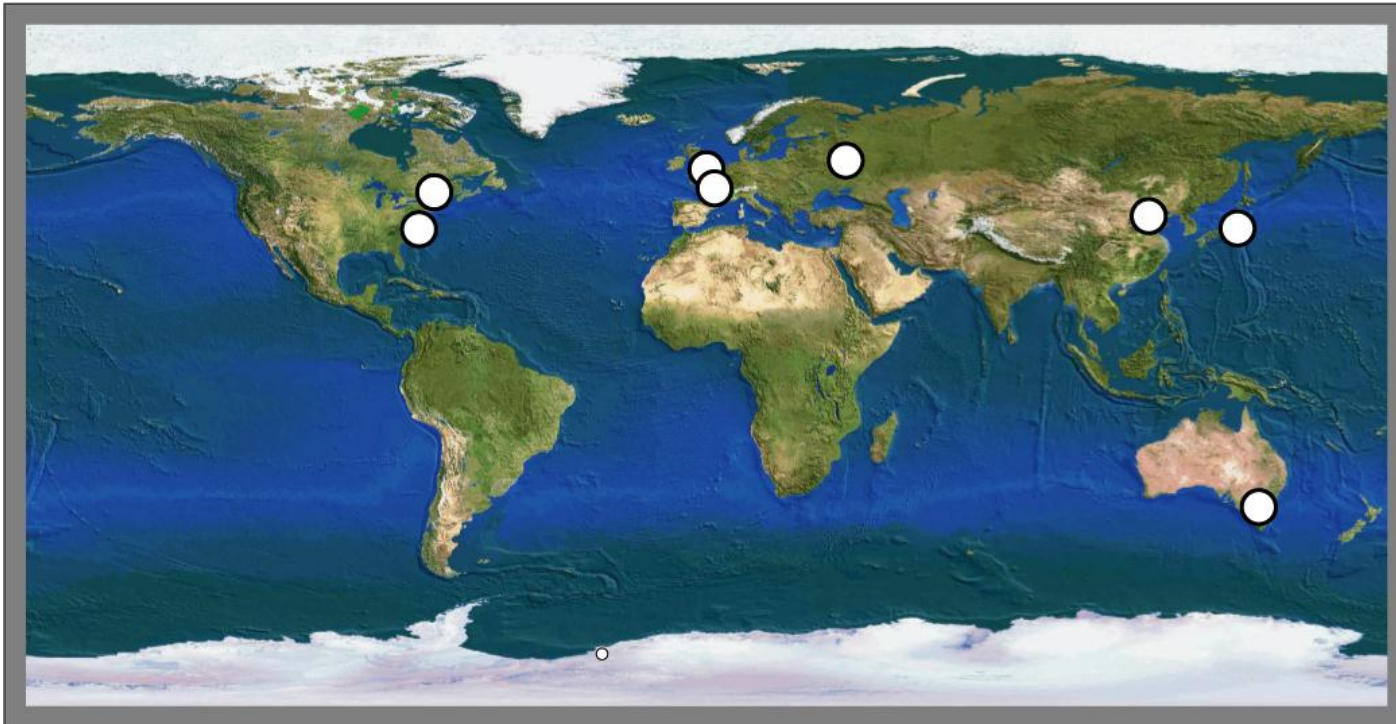
## WMO has the following tasks under the Joint Plan :

- Provision of meteorological information, including wind and precipitation
- Atmospheric transport and dispersion predictions
- Retransmission of information to all NMHSs
  - Information distributed to authorities/government agencies in each state by NMHS according to national arrangements



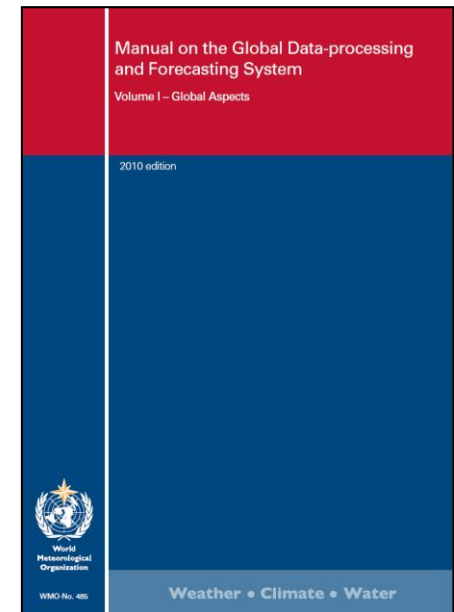
# Nuclear ERA: Structure and Responsibilities

- Atmospheric transport and dispersion predictions are performed by 8 Regional Specialized Meteorological Centers (RSMCs) with activity specialization in Atmospheric Transport Modelling designated by WMO (Montreal, Washington, Exeter, Toulouse, Obninsk, Beijing, Tokyo and Melbourne)



# Nuclear ERA: Structure and Responsibilities (2)

- Operational procedures are defined in the Manual on the Global Data Processing and Forecasting System (GDPFS)
- Operational procedures are revised and coordination is performed by the WMO/CBS Expert Team on Emergency Response Activities (ERA-ET)
- Standard products are delivered by the “lead RSMC” designated



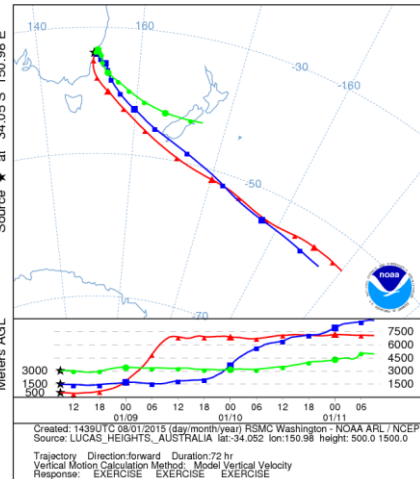
# RSMC Standard Products

RSMC standard products include trajectories and exposure/deposition for

24/48/72 hours

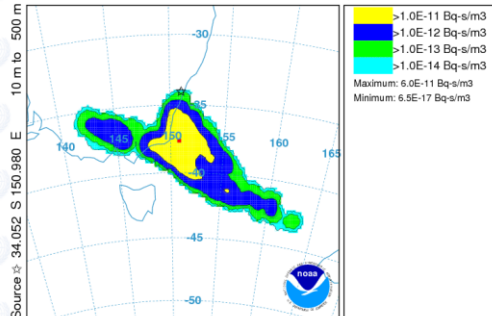
## Product from RSMC Washington

NOAA HYSPLIT MODEL  
Forward trajectories starting at 0900 UTC 08 Jan 15  
06 UTC 08 Jan GFSG Forecast Initialization



## Product from RSMC Washington

NOAA HYSPLIT MODEL  
Exposure (Bq-s/m3) averaged between 0 m and 500 m  
Integrated from 0000 10 Jan to 0000 11 Jan 15 (UTC)  
C137 Release started at 0900 08 Jan 15 (UTC)



Created: 1438UTC 08/01/2015 (day/month/year) RSMC Washington - NOAA ARL / NCEP  
Source: LUCAS\_HEIGHTS\_AUSTRALIA lat:-34.052 lon:150.98 hgt:10 to 500 m  
Release ID: C137 Rate: 0.166966666666667 Bq/hr Duration: 6.0 hr Particles: 50  
Distribution: Uniform between 10 and 500 m AGL  
Dry Deposition: Yes Wet Removal: No  
Meteorology: 0600 UTC 08 Jan 2015 GFS  
Note: Contour values may change from chart to chart  
Response: EXERCISE EXERCISE EXERCISE

## REGIONAL SPECIALIZED METEOROLOGICAL CENTER (RSMC)

### TRANSPORT MODEL PRODUCTS

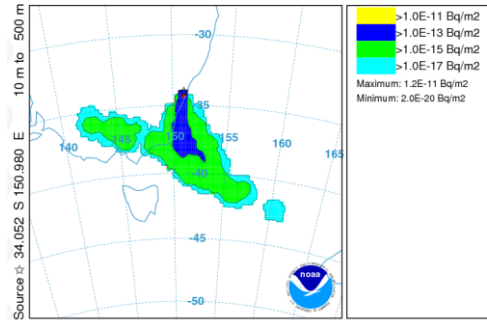
The following are current (as of the date indicated in the table) operational RSMC products as established by the World Meteorological Organization (WMO) for the provision of transport model products for environmental emergency response. To view a product click on the text link or click on one or more checkboxes and then click on the Request checked boxes button at the bottom of the form. Details on the model products can be found in WMO/TD-No. 778. The lead RSMCs are highlighted in yellow shading. To ensure the latest update, refresh/reload your browser.

For all (current and past) model results, click on the link titled "All Products" in the first column of each RSMC.  
"No archive" is displayed if no additional products are available.

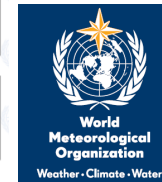
RSMC TIME OF MODEL RUN (YYYYMMDDCC HHMM)	MODEL PARAMETERS	JOINT STATEMENT	VIEW PRODUCTS	TRAJECTORIES	TIME PERIOD 1 <24 HRS	TIME PERIOD 2 <48 HRS	TIME PERIOD 3 <72 HRS
Washington 2015010805_1439	Cover (Postscript)	Region III/IV	<input type="checkbox"/> Check All <input type="checkbox"/> Uncheck All	<input type="checkbox"/> Trajectories (traj.txt)	<input type="checkbox"/> Exposure <input type="checkbox"/> Exposure	<input type="checkbox"/> Exposure <input type="checkbox"/> Exposure	<input type="checkbox"/> Exposure <input type="checkbox"/> Exposure
All Products					<input type="checkbox"/> Deposition <input type="checkbox"/> Deposition	<input type="checkbox"/> Deposition <input type="checkbox"/> Deposition	<input type="checkbox"/> Deposition <input type="checkbox"/> Deposition
Montreal 2015010800_1442	Cover (Postscript)	Region III/IV	<input type="checkbox"/> Check All <input type="checkbox"/> Uncheck All	<input type="checkbox"/> Trajectories (traj.txt)	<input type="checkbox"/> Exposure <input type="checkbox"/> Exposure	<input type="checkbox"/> Exposure <input type="checkbox"/> Exposure	<input type="checkbox"/> Exposure <input type="checkbox"/> Exposure
All Products					<input type="checkbox"/> Deposition <input type="checkbox"/> Deposition	<input type="checkbox"/> Deposition <input type="checkbox"/> Deposition	<input type="checkbox"/> Deposition <input type="checkbox"/> Deposition
Melbourne 2015010806_1244	Cover (Postscript)	Region V	<input type="checkbox"/> Check All <input type="checkbox"/> Uncheck All	<input type="checkbox"/> Trajectories (traj.txt)	<input type="checkbox"/> Exposure <input type="checkbox"/> Exposure	<input type="checkbox"/> Exposure <input type="checkbox"/> Exposure	<input type="checkbox"/> Exposure <input type="checkbox"/> Exposure
No archive					<input type="checkbox"/> Deposition <input type="checkbox"/> Deposition	<input type="checkbox"/> Deposition <input type="checkbox"/> Deposition	<input type="checkbox"/> Deposition <input type="checkbox"/> Deposition
Esler Unavailable	Cover (Postscript)	Region I/VI	<input type="checkbox"/> Check All <input type="checkbox"/> Uncheck All	<input type="checkbox"/> Trajectories (traj.txt)	<input type="checkbox"/> Exposure <input type="checkbox"/> Exposure	<input type="checkbox"/> Exposure <input type="checkbox"/> Exposure	<input type="checkbox"/> Exposure <input type="checkbox"/> Exposure
No archive					<input type="checkbox"/> Deposition <input type="checkbox"/> Deposition	<input type="checkbox"/> Deposition <input type="checkbox"/> Deposition	<input type="checkbox"/> Deposition <input type="checkbox"/> Deposition
Toulouse Unavailable	Cover (Postscript)	Region I/VI	<input type="checkbox"/> Check All <input type="checkbox"/> Uncheck All	<input type="checkbox"/> Trajectories (traj.txt)	<input type="checkbox"/> Exposure <input type="checkbox"/> Exposure	<input type="checkbox"/> Exposure <input type="checkbox"/> Exposure	<input type="checkbox"/> Exposure <input type="checkbox"/> Exposure
No archive					<input type="checkbox"/> Deposition <input type="checkbox"/> Deposition	<input type="checkbox"/> Deposition <input type="checkbox"/> Deposition	<input type="checkbox"/> Deposition <input type="checkbox"/> Deposition

## Product from RSMC Washington

NOAA HYSPLIT MODEL  
Deposition (Bq/m2) at ground-level  
Integrated from 0000 08 Jan to 0000 11 Jan 15 (UTC)  
C137 Release started at 0900 08 Jan 15 (UTC)

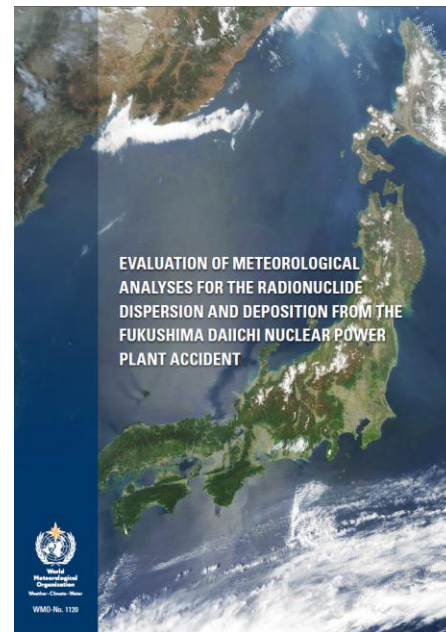


Created: 1438UTC 08/01/2015 (day/month/year) RSMC Washington - NOAA ARL / NCEP  
Source: LUCAS\_HEIGHTS\_AUSTRALIA lat:-34.052 lon:150.98 hgt:10 to 500 m  
Release ID: C137 Rate: 0.166966666666667 Bq/hr Duration: 6.0 hr Particles: 50  
Distribution: Uniform between 10 and 500 m AGL  
Dry Deposition: Yes Wet Removal: No  
Meteorology: 0600 UTC 08 Jan 2015 GFS  
Note: Contour values may change from chart to chart  
Response: EXERCISE EXERCISE EXERCISE



# Fukushima Lessons

- After Fukushima, the WMO SG set up a small Task Team (TT) to support UNSCEAR dose assessments
- Its mission was to examine how using met. analyses and introducing additional observational data might improve ATDM calculations



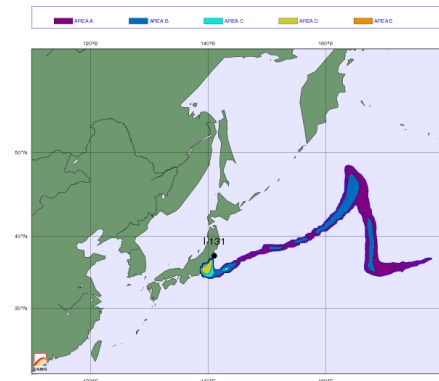
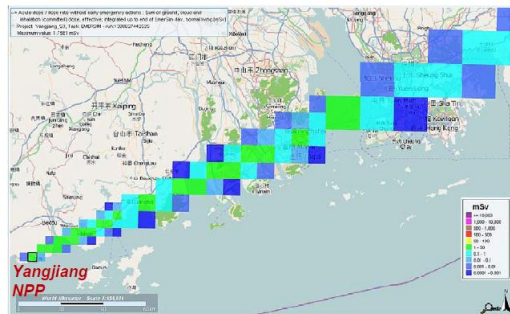
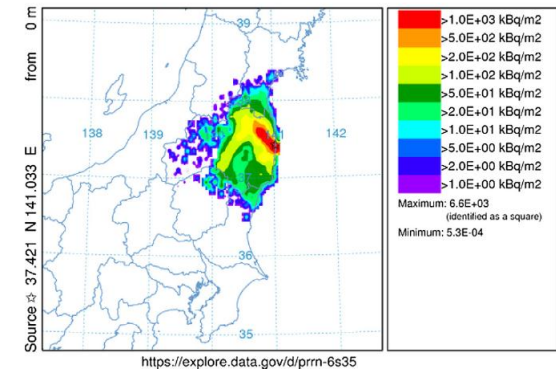
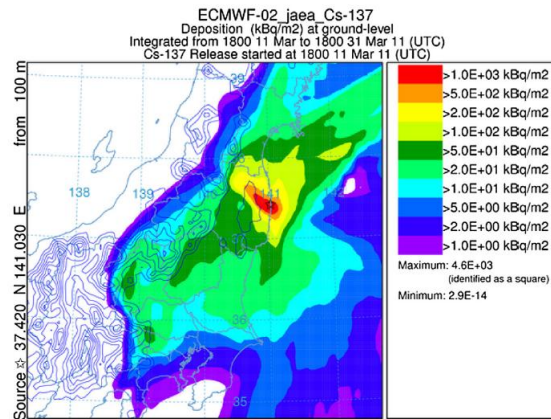
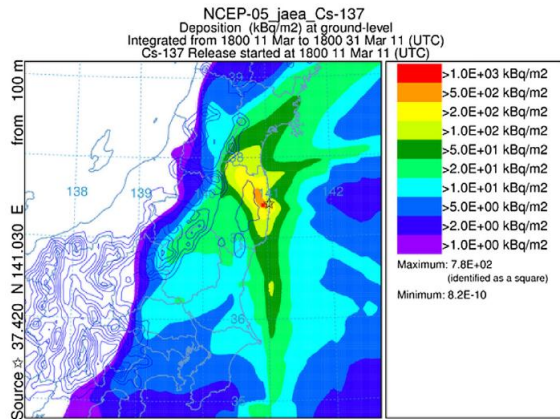
# Nuclear ERA products: Possibilities of improvement

- **High-resolution ATDM products:** better resolved terrain and precipitation features, improved deployment of sampling and monitoring devices
- **Ensemble ATDM products:** better account for ATDM uncertainty
- **Methods to deal with unspecified source terms:** possibility to deal with situations evolving with time
- **Estimate/constrain source terms of key radionuclides:** assure consistency between emission estimates and monitoring results



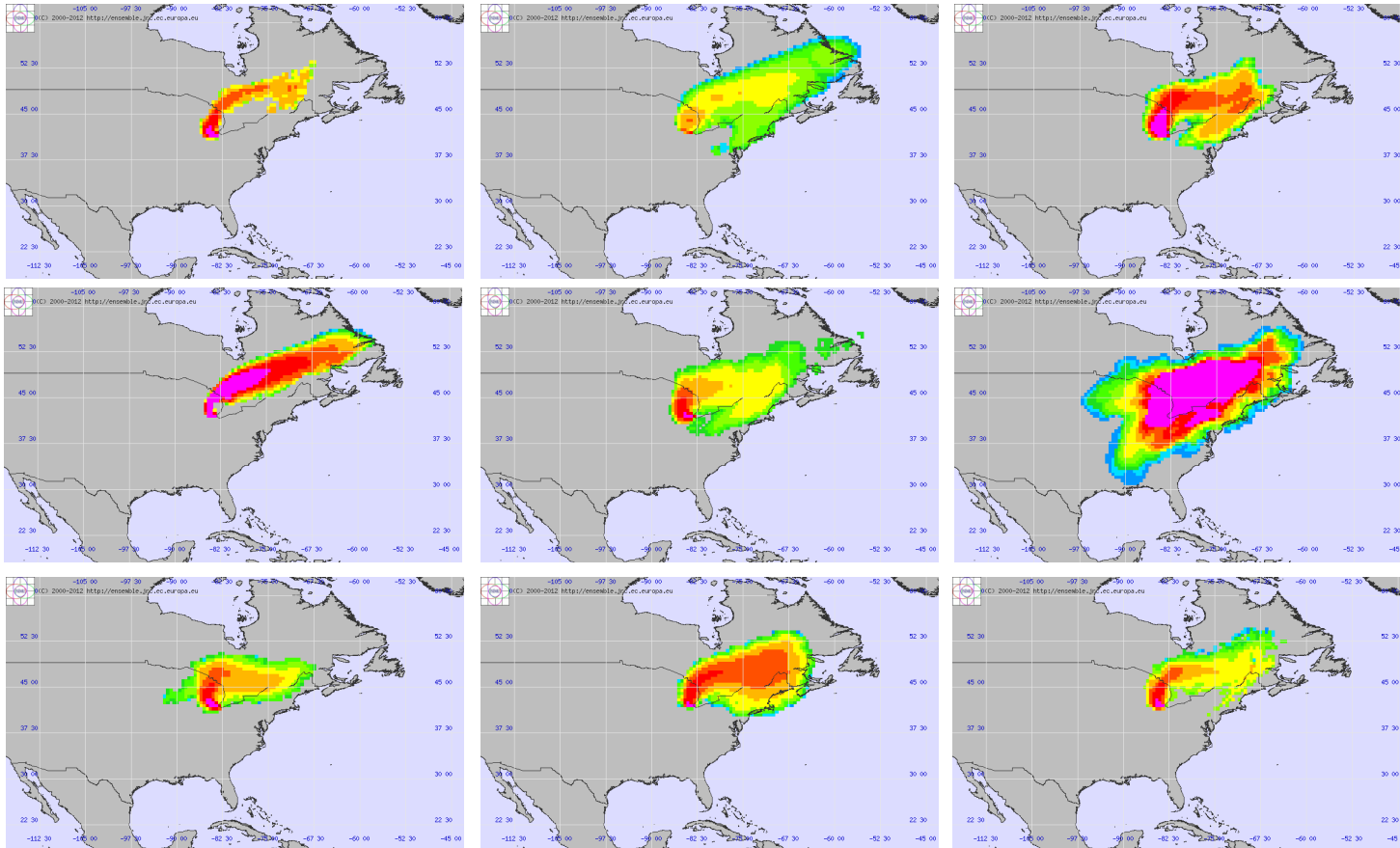
# High-resolution products

- **High-resolution ATDM products** are needed to better coordinate data sampling/measurement activities
- A **seamless transition between local and regional scale** ensures that predictions are consistent



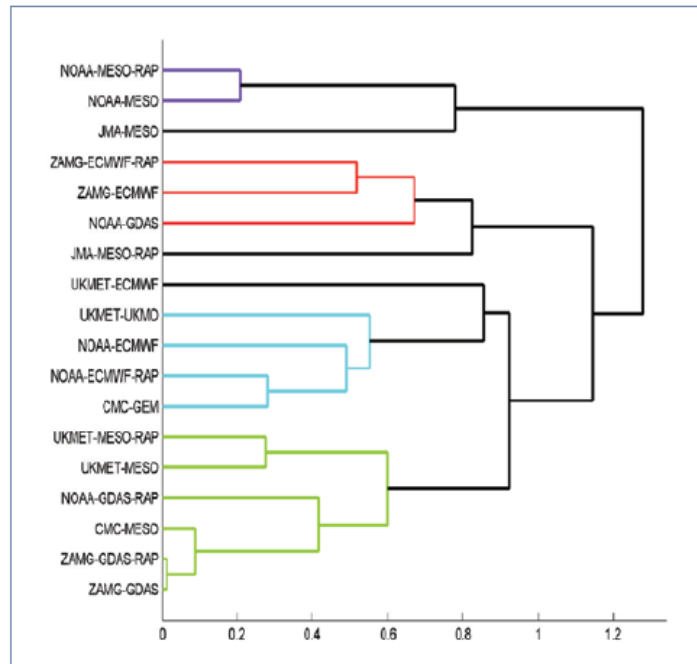
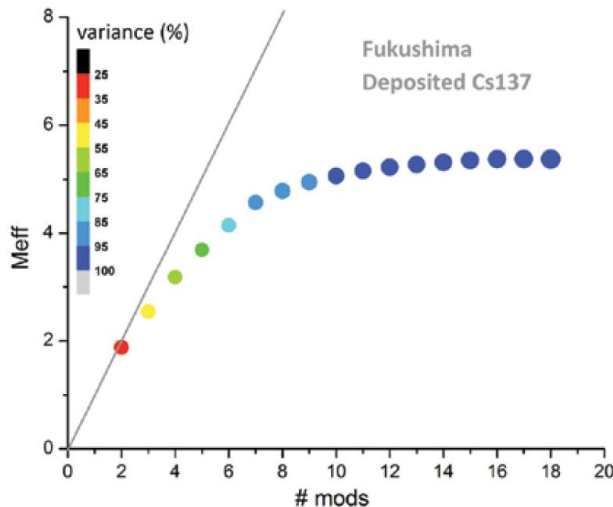
# Ensemble products

- Ensemble products show uncertainties of ATDM simulations



# Ensemble products (2)

- Ensemble modeling does not mean to run a large number of different models
- **State of the art ensemble analysis** helps to limit number of members, better assess contribution of individual models (case dependent)



# Dealing with unspecified/variable emissions

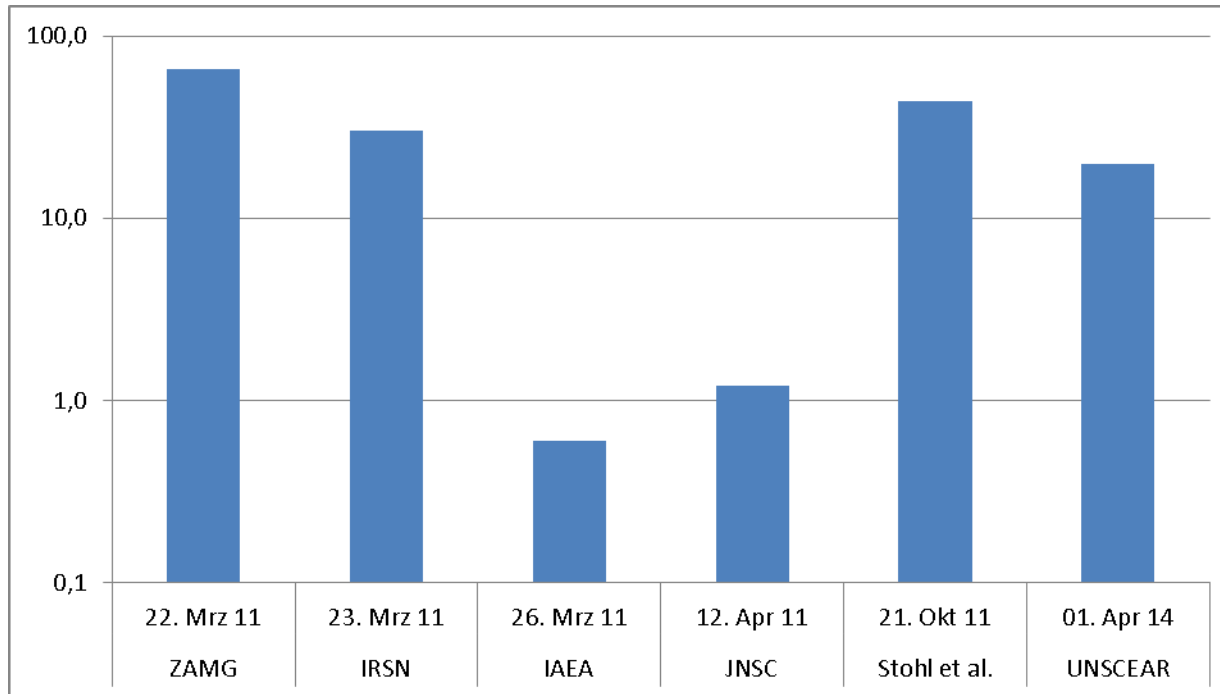
- **WMO/RSMC standard runs** – unit emissions for 24/48/72 hours – are not useful in case emissions are highly variable
- **WMO Fukushima TT used alternative approach** – perform consecutive unit emission runs – e.g. every 3 hours – throughout the accident period (called Transfer Coefficient Matrix – TCM; or Source Receptor Matrix - SRM)
- By **multiplying the unit emission runs with** – estimated or assumed – **emissions** for the – e.g. 3 hour – time period, or by keeping the unit emissions, either standard products or customized add-on products are possible depending on how scenario evolves

# Estimating emissions

- TCM/SRM method allows to **estimate emissions** of selected key nuclides based on measurements
- **Emission factors** for the unit runs **are varied** under certain constraints to **best describe measurement scenario**
- **Estimates** can be **done** by the center(s) calculating the TCM/SRM fields, but also **by any other entity that has access** to the TCM/SRM results (allows for de-centralization)
- TCM/SRM method also useful for planning of deployment of sampling/measurement devices

# Estimating emissions (2)

- Order-of-magnitude emission estimates are possible also with very few measurements (example:  $^{137}\text{Cs}$  source estimates after Fukushima)



# Conclusions

- After Chernobyl, an **international system** was built up to provide meteorological/ATDM assistance to states affected by a nuclear accident and emergency
- During Fukushima, **designated RSMCs did exactly what they were supposed to do** in accordance with existing arrangements in the Manual on the GDPFS
- **WMO and its various Centers provided crucial input** to emergency response during the Fukushima case, and situation assessment in the aftermath (e.g. UNSCEAR report to UN GA)

## Conclusions (2)

- There is a need for IAEA and WMO to **review existing arrangements** in light of the lessons learned and points discussed in this presentation
- Lessons learned can be incorporated, step by step, in the existing frameworks, assuring seamless reception by IAEA and states parties
- Technical concepts for improvements are ready