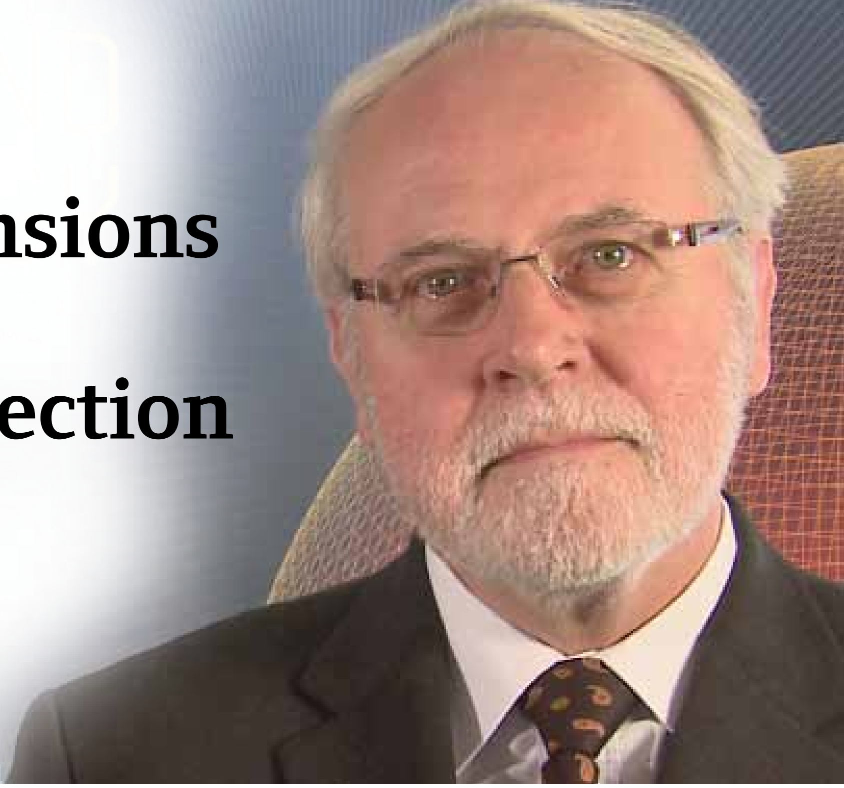
The global dimensions of atmospheric radioactivity detection

Experience and conclusions after the Fukushima Daiichi nuclear power plant accident



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There are good reasons why data from the International Monitoring System (IMS) network could significantly improve the basic understanding of the global transportation and mixing of radionuclides in the atmosphere and contribute to the mitigation of the radiological consequences during a large-scale nuclear accident. This is one important result of many analyses of the accident at the Fukushima Daiichi nuclear power plant published six months after the release of radionuclides from the plant in March 2011. An understanding of the time and spatial variations of airborne concentration levels can provide the basic data for further assessments of deposition mapping of those radionuclides onto soil or plants, their transfer to foodstuffs and finally, dose estimates to humans. Additionally, the detailed knowledge of activity levels offers a unique opportunity to test and enhance modelling of all sorts, thus providing worthwhile information for scientists in various fields.

The IMS monitoring data and International Data Centre (IDC) analyses were shared continuously with 120 Member States and close to 1,200 authorized users through the IDC's secure website. Bearing in mind the objectives and purpose of the Treaty's verification system – i.e. monitoring the globe for signs of nuclear explosions – as well as the need to assist in a severe humanitarian disaster situation, the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) responded positively to requests from Member States and to Yukiya Amano, Director-General of the International Atomic Energy Agency (IAEA) by providing the IAEA with access to the data and data products relevant to the Fukushima accident. The CTBTO also cooperated with other pertinent international organizations such as the World Meteorological Organization (WMO), the World Health Organization (WHO) and the United Nations Office for Disarmament Affairs (UNODA), to help mitigate the consequences of this nuclear disaster.

The request to share this important data from the CTBTO directly with a number of relevant international organizations was formulated early on during the accident and the CTBTO reacted swiftly and in a timely manner to this request. There is great hope now that – similar to the contribution of IMS seismic and hydroacoustic data to tsunami warning efforts – IMS radionuclide data as well as atmospheric transport modelling (ATM) predictions can be shared in the future not only with governments and their institutions around the world but also with scientific committees like the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), and the wider research community as well as with the general public. This is good news – not only for science. In the medium to longer term, such an agreement will raise the professional profile of the CTBTO, enhance public confidence in the developments of the organization, and provide new opportunities for the CTBTO to initiate and further develop professional partnerships with many more international and scientific organizations.

WHAT CONTRIBUTIONS CAN THE CTBTO MAKE?

The CTBTO's radionuclide monitoring network comprises a total of 80 stations; 63 were operational in March 2011 and able to detect airborne radioactivity attached to particulates in the air worldwide. When complete, 40 of the 80 stations will operate systems that detect radionuclides of the noble gas xenon – a chemical element that normally occurs as a gas and is only produced by a nuclear reaction. It is measured to detect clandestine underground nuclear explosions. The "stress test" of the radionuclide network in March and April 2011, when the radionuclide releases from the Fukushima Daiichi

Operators verifying the installation of the detector system at radionuclide station RN38, Takasaki, Japan.

nuclear power plant were detected by 41 particulate stations and a further 19 stations designed to detect noble gases, demonstrated high standards of operational capabilities and resilience in a remarkable fashion.

Initial detections of radioactive materials were made on 15 March[1] at the IMS station at Takasaki in Japan, which is around 200 km away from the accident site. Key radionuclides needed for radiological protection estimates (iodine-131 and caesium-137 – see table on page 32) were detected continuously and reported to the IDC in Vienna. The early detection of niobium-95 and ruthenium-103 was a timely indicator of a meltdown inside one or more of the reactors at Fukushima. Nine days after the accident, the radioactive cloud had crossed Northern America. Three days after that, when a station in Iceland picked up radioactive materials, it was clear that the cloud had reached Europe. By day 15, traces from the accident in Fukushima were detectable all across the northern hemisphere. Based on these atmospheric data, reliable estimates of dose levels for populations outside Japan could be made with a high level of confidence.

The CTBTO contributed to the better understanding of the situation outside Japan by predicting the global dispersion of radioactive material based on its ATM tool. Forward ATM predictions proved to be 95 percent correct and the radionuclides mostly reached the stations within hours of the time predicted. This "precision" was very reassuring to the public; it contributed to trust and public confidence in recommendations issued by authorities dealing with public health.

By 13 April, radioactivity had spread to the southern hemisphere of the Asia-Pacific region and had been detected at stations located in Australia, Fiji, Malaysia and Papua New Guinea.

[1] Due to contamination caused by the high levels of isotopes, measurements before 16 March 2011 could not be analyzed.

DEALING WITH THE IMMENSE PUBLIC DEMAND FOR REAL-TIME INFORMATION IN AN EMERGENCY SITUATION

Immediately after news of the accident became available, TV and radio stations released details of the developments in almost real-time and created immense public demand for timely information about possible consequences. Major concerns about

ATMOSPHERIC TRANSPORT MODELLING

Atmospheric Transport Modelling (ATM) is an advanced computer-based technology for the calculation of the travel path of a given radionuclide, using meteorological data. This calculation can be performed in two ways:

1. **As backtracking ATM, which identifies the area from which a radionuclide may have been released, calculated from the location where it was observed.**
2. **As forward ATM, which predicts where radionuclides may travel from their known point of release.**

the health status in populations even at great distances from Japan, e.g. in Europe, resulted in reactions such as panic buying of iodine tablets. The Federal Office for Radiation Protection (BfS) tried to cope with this situation in Germany by answering the huge number and variety of questions in a timely manner by means of various electronic media. The BfS website was widely used for this purpose; it registered an increase in the "normal" daily hits from some 30.000 to over a million during the first week of the crisis. The electronic media were not only used by German citizens but also by Germans worldwide.

BfS operates one IMS radionuclide station, RN 33 in Schauinsland/ Freiburg. From the very beginning of the accident, BfS had access to all IDC data, bulletins and analyses. As a result of the immense public interest in reliable information during the initial days and weeks after the accident, a national decision was taken to release analyses based on IMS data. IMS radionuclide data were also published regularly on the BfS website together with results from national monitoring stations that have detection capabilities comparable with the IMS stations. The public response to this transparency measure was very positive. Based on this experience, I hope that there will be mechanisms available at the international level in the future that lay down the conditions for sharing IMS radionuclide data directly with those organizations responsible for public health prevention and radiation protection measures. Mechanisms of this kind should clearly identify the roles and responsibilities of the partners involved. The CTBTO would be responsible for providing the following, in a timely fashion:

- A comprehensive picture of the global spread of relevant airborne radionuclides based on the daily data of quality-assured analyses from the IMS radionuclide stations.
- State-of-the art predictions of the radioactive material by using its ATM calculations.

National and international organizations involved in radiation protection and public health would be responsible for the interpretation of the radionuclide data in terms of radiation risk, prevention measures, and public protection recommendations.

SHARING CTBTO RADIONUCLIDE DATA WITH THE WIDER SCIENTIFIC COMMUNITY

The sharing of CTBTO data with the IAEA and other international organizations at the beginning of the Fukushima disaster was a very good first step but in the longer term this is not enough to reach an optimum solution which satisfies all demands.

For example, the Fukushima data set could help meteorologists and climate researchers to further develop their models and to better understand how air circulates nearer to the surface. One specific aspect is a better understanding of the observation of the fast transport of radionuclides to the southern hemisphere. Questions of this nature can best be answered by sharing the radionuclide data with the wider scientific community through WMO or other scientific institutions. Interactive work of this kind could in turn result in significant improvements of the location capabilities of the verification system, which is an issue where improvements are highly welcome.

Another aspect of data sharing is the regular evaluation of the levels of exposure from all sources of ionizing radiation and the associated health and environmental effects by UNSCEAR (www.unscear.org) with the aim of identifying longer-term global trends. The first two substantive reports submitted to the General Assembly in 1958 and 1962, presented comprehensive evaluations of the state of knowledge about the levels of ionizing radiation to which human beings were exposed and of the

Radionuclide station RN38, Takasaki, Japan

possible effects of such exposures. Those reports laid the scientific grounds on which the Partial Test Ban Treaty on the prohibition of nuclear weapon testing in the atmosphere was negotiated and signed in 1963.

UNSCEAR would like to use the unique data set from the IMS radionuclide network for its work. Taking into account the common roots and the mutual interests of UNSCEAR and the CTBTO, it would be more than desirable if an agreement for data sharing between CTBTO and UNSCEAR could be established in the near future.

BIOGRAPHICAL NOTE

WOLFGANG WEISS
is a physicist by profession. During the CTBT negotiations in Geneva from 1994 to 1996, he supported the German Government as scientific adviser. He established the International Monitoring System radionuclide station RN 33 in Germany and conducted an international assessment of noble gas techniques. He has been responsible for all questions related to radiation protection and health in Germany at the German Federal Office for Radiation Protection since 2000. Dr Weiss is also the current Chairman of UNSCEAR.