VERIFICATION SCIENCE

The Fukushima disaster, the importance of CTBTO data and the need for an open data and information policy

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Certain events in life make such an impression that you'll always remember where you were and what you were doing at that very moment. On 11 September 2001, I was at a meeting dealing with cooperation between the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) and the World Meteorological Organization (WMO) in Washington, DC, USA. Despite the disaster that struck while I was there, the meeting paved the way for successful cooperation between the two organizations, which has continued for over a decade (for further reading about WMO-CTBTO cooperation in addition to articles in this issue, please see *Spectrum* 11, pages 24 to 27, and *Spectrum* 12, pages 26 to 28).

On 11 March 2011, I was travelling to the inaugural meeting of the International Network of Engineers and Scientists against Proliferation, in Darmstadt, Germany. While I was on the bus from Frankfurt airport, I heard about the devastating earthquake that had struck Japan that day. At the meeting, news about the serious situation at the Japanese nuclear power plants, especially Fukushima Daiichi, spread quickly. It soon became clear that this was going to be an extremely serious accident.

Back in Vienna at the Central Institute for Meteorology and Geodynamics (ZAMG), the model to simulate the spread of radiation had been set up before the first images of the first explosion at the Fukushima power plant were transmitted across the globe on the morning of 12 March at 07:30 CET.

During the Fukushima accident, ZAMG played a number of roles. Firstly, it operates the Austrian National Data Centre and thus has full access to data, bulletins and data analyses from the CTBTO. Secondly, in our national emergency support role, we provided data, information and assessments to our national authorities and also to Austrian Airlines regarding the safety of flights to Tokyo, Japan. At the international level, ZAMG represented the WMO at the Incident and Emergency Centre of the International Atomic Energy Agency (IAEA) and at CTBTO briefings in Vienna.

SIMULATING THE DIRECTION OF THE RADIOACTIVE PLUME

One major component of ZAMG's work was to calculate the predicted direction of the radioactive cloud released during the accident. We did this through Atmospheric Transport Modelling (ATM) calculations, which international organizations such as the IAEA also requested from us.

ZAMG employed a model for its simulations similar to the one applied by the CTBTO. For our simulations, we used input from the European Centre for Medium-Range Weather Forecasts (ECMWF) in Reading, UK. We made calculations of the most important radionuclides that had been released into the atmosphere after the Chernobyl disaster in 1986: iodine 131(^{131}I) and caesium 137(^{137}Cs) - see page 32 in *Spectrum* for brief explanation.

Using its own modelling in combination with CTBTO radionuclide data, ZAMG was able to describe and report on the spread of radionuclides from the damaged power plant through the hemisphere. The ZAMG model simulated with a high degree of accuracy the direction of the radioactive plume across the Pacific Ocean to the west coast of the United States, across the United States, eventually reaching Europe a few days later. On 22 March, ZAMG was the first institute worldwide to make estimates of the source terms (the release levels of radioactive substances) available to the public.

The first estimates by ZAMG were based on data from the CTBTO's International Monitoring System (IMS) station at Takasaki, Japan, on 16 March (due to contamination caused by the high levels of isotopes, measurements before this could not be analyzed). The second estimates were made using data from the IMS station in Sacramento, California. The data showed that there were very high emissions of ^{131}I and ^{137}Cs during the first few days of the accident. These emissions must have been released by the damaged reactor as early as 12 March, which is much earlier than initially reported by the nuclear power plant operators – otherwise the early detections in California could not be explained.

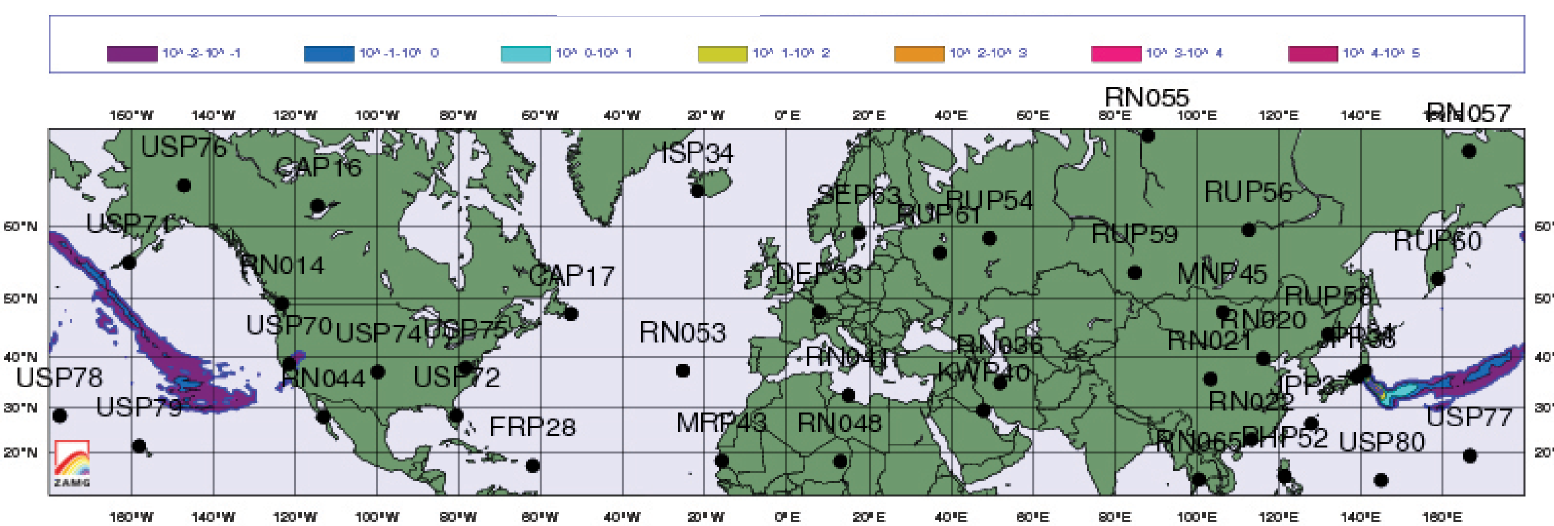
Our first source estimates of ^{131}I and ^{137}Cs amounted to 4 10^{17} and 4 10^{16} Becquerel (the number of radioactive decays per second) respectively during the first few days after the Fukushima accident. To put this into perspective, this ^{137}Cs release is probably in the same order of magnitude as the releases during the nuclear bombings in Hiroshima and Nagasaki in 1945, but less than the Chernobyl release in 1986. Afterwards, releases decreased significantly.

Similar emission estimates were provided by the *Institut de Radioprotection et de Sûreté Nucléaire* (INRS) in France on 23 March and by the Japanese authorities on 12 April.

A SWIFTER RESPONSE TO NUCLEAR ACCIDENTS

Compared with the situation after the Chernobyl accident, the technical capabilities for modelling the spread of radiation are very advanced. This has greatly increased the chances of responding to a nuclear accident in a timely, effective and accurate manner.

In full accordance with the position of the Austrian authorities regarding transparency and openness, ZAMG shared all information and model results with the public through its website. The ZAMG assessments included available information from the CTBTO that was also relevant. The daily volume of downloads amounted to a few terabytes – 1,024 gigabytes – with the largest number of users who accessed ZAMG's website based in Japan followed by the United States, and users from Austria only in third place. Our IT department managed the dramatic increase in traffic to our website well. At no time did the information that was made available create a panic situation, nor did it cause any international outrage or other complications. We strongly believe that in today's world, it is not the availability but rather the absence of data and information that can be perceived as disturbing and troublesome, and that our approach was the right one.



Low levels of radioactivity from Japan reached the U.S. West Coast on 17 March. The image shows the position of the radioactive cloud on 18 March 2011 at 00 UTC. The radioactivity was measured at IMS station USP70, Sacramento, California, on the same day as predicted by the ZAMG model.

SOME OF THE KEY RADIONUCLIDES

CAESIUM-134 (^{134}Cs)
has a half-life of 2.1 years. Only a small amount of ^{134}Cs is produced by nuclear weapon testing but it accumulates in nuclear reactors. It can therefore be used to distinguish between releases from nuclear weapon testing and nuclear power plants.

CAESIUM-137 (^{137}Cs)
has a half-life of 30.1 years. This is the most common radioactive form of caesium and is produced by nuclear fission. ^{137}Cs is one of the major radionuclides in spent nuclear fuel and radioactive wastes associated with the operation of nuclear reactors and fuel reprocessing plants. Large amounts of ^{137}Cs and other radioactive isotopes were released into the environment by atmospheric nuclear weapon tests between 1945 and 1980. ^{137}Cs did not occur in nature before nuclear weapon testing began.

IODINE-131 (^{131}I)
has a half-life of 8.0 days. ^{131}I is a radioactive isotope released into the environment mostly in gaseous form as a result of the atmospheric testing of nuclear weapons and accidents that have occurred at nuclear power plants (e.g. the Chernobyl nuclear power plant in 1986 and the Fukushima power plant in March 2011). It was a significant contributor to the effects on human health from atmospheric nuclear weapon testing and from the Chernobyl disaster.

CTBTO DATA PROVED TO BE OF GREAT VALUE

Considering the usefulness, reliability and relevance of the CTBTO radionuclide data, it is very important to have access to the data in the future during accident scenarios. Without the data, many conclusions in the beginning would not have been possible. I believe that, in the aftermath of the events, the cooperation between CTBTO and the International Atomic Energy Agency (IAEA) needs to be further strengthened, as well as the cooperation between CTBTO and WMO. This future cooperation should build on existing roles, responsibilities and technical competencies, and would certainly create added value for the whole international community. The conventions regulating the notification as well as the assistance after a nuclear incident were created after the Chernobyl accident. The events in Fukushima 25 years later are providing a unique opportunity to review these conventions, to check their effectiveness, and to include the most important lessons learned.

A UNIQUE VERIFICATION SYSTEM

Finally, I would like to mention that the major lesson I learned from Fukushima was actually a non-technical one. In a crisis situation in the world of the 21st century, it is evidently not enough to stick to mandates and to fulfil duties. Everybody is expected to do everything that is possible, as quickly as possible. This is true for national as well as international organizations. In this sense, I think that together, the technical staff of national organizations like ZAMG as well as CTBTO staff can be proud of what was achieved, based to a remarkable degree on the invaluable data collected by a unique international verification system.

BIOGRAPHICAL NOTE

GERHARD WOTAWA
is the Coordinator of the Group on Earth Observation/Global Earth Observation System of Systems at the Central Institute for Meteorology and Geodynamics (ZAMG). He was responsible for managing the ZAMG's response during recent crisis situations such as the Eyjafjallajokull volcanic eruption in 2010 and the Fukushima accident. Prior to this, Dr Wotawa worked as an Atmospheric Sciences Officer at the International Data Centre at the CTBTO from 2000 to 2009.

Trinidad and Tobago's long standing support continued from page 10

in the Caribbean, including the Seismic Research Centre in Trinidad and Tobago, should an earthquake occur or trigger a tsunami that may affect the Caribbean. In light of the fact that the PTWC utilizes the CTBTO monitoring data, Trinidad and Tobago is already a potential recipient of this invaluable technology.

The indispensable contribution of the CTBTO monitoring system to global safety and security was never more fully demonstrated than during the devastating 9.0 magnitude, tsunami-generating earthquake which struck Japan in March 2011. The data from the CTBTO monitoring stations were among the fastest and most accurate, which allowed Japanese authorities to issue tsunami warnings within a few minutes, thereby allowing many people to escape to higher grounds. The CTBTO data also allowed for early tsunami warnings to Japan's neighbours, as well as to the wider Pacific region.

THE WAY FORWARD

The global community of States deserves commendation for its unified efforts to mitigate the effects of armed conflict. Having been bestowed with the privilege and honour of a leadership position, my role is to encourage my fellow leaders, particularly women leaders, to join me in placing emphasis on strategic frameworks and mandates for implementing and measuring changes in the lives of men and women in conflict-affected territories.

It is my firm belief that States can definitely strengthen the prospects for sustainable peace by including a gender lens in the approach to peace-building efforts, through equal involvement of women and men in policy formation, accountability, post conflict and humanitarian planning.

I remain deeply committed to these causes.