Global radiation monitoring in the wake of the Fukushima disaster

BY KIRSTEN HAUPT AND THOMAS MÜTZELBURG

Since the double disaster of the 9.0 magnitude earthquake and tsunami that affected hundreds of thousands of people and seriously damaged the Fukushima Daiichi power plant in Japan on 11 March 2011, minute traces of radioactive emissions from Fukushima have spread across the entire globe. By mid-April, most of the radionuclide stations of the International Monitoring System (IMS) had detected radioactive particles and noble gases from the Fukushima accident. The IMS is a global network that will comprise 337 facilities when complete. Sixty-three of the 80 planned IMS radionuclide stations are already operational and able to detect airborne radioactivity.

SPREADING ACROSS THE ENTIRE GLOBE

The first analysis results of the monitoring data became available a few days after the accident. A clear picture quickly emerged. Initial detections of radioactive materials were made on 12 March at the Takasaki monitoring station in Japan, just 300 km away from the troubled power plant. The dispersion of the radioactive isotopes could then be followed to eastern Russia on 14 March and to the west coast of the United States two days later.

Nine days after the accident, the radioactive cloud had crossed Northern America. Three days later, 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. For the first four weeks, the radioactive materials remained confined to the northern hemisphere, with the equator initially acting as a dividing line between the northern and southern air masses. 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.

Fukushima Daiichi power plant: a regional dispersion simulation (Austrian Meteorological Service ZAMG)

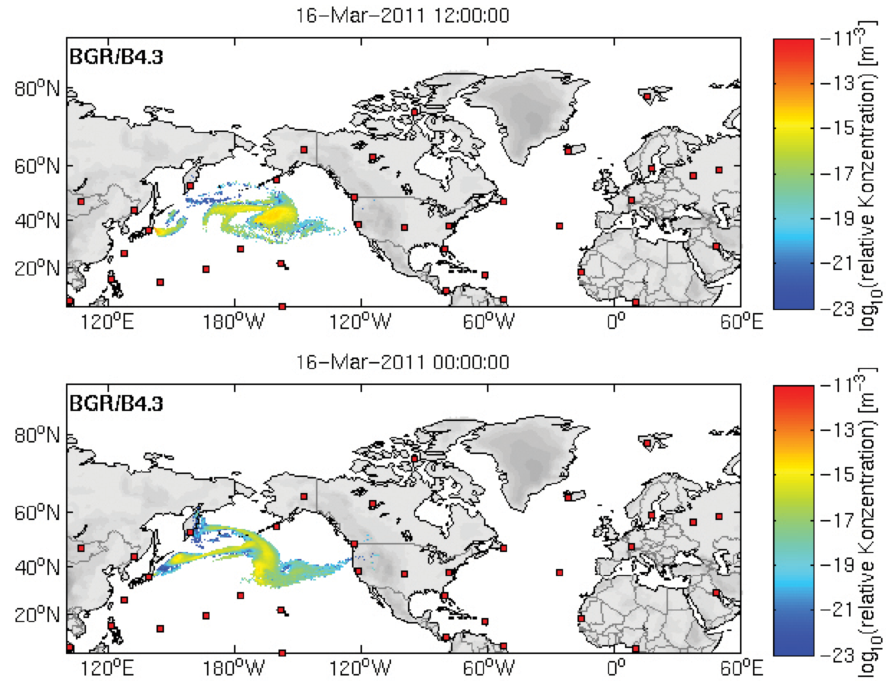
UNPARALLELED SENSITIVITY

The monitoring system of the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) can detect a range of radioactive isotopes, among them iodine-131 and caesium-137. Looking at the ratios between the various radioactive isotopes enables the source of the emission to be identified. In the case of the current readings, findings clearly indicate radionuclide releases from a damaged nuclear power plant, which is consistent with the recent accident at Fukushima in Japan. By 13 April, the average level of radioactivity picked up by the stations worldwide continued to decline, which is also due to the relatively short half-lives of iodine-131 (8 days) and xenon-133 (5.2 days).

The CTBTO's radionuclide stations are designed to register minuscule amounts of radioactive particles and noble gases – down to a number of a few atoms. The system's sensitivity is second-to-none – it can detect a concentration of 0.1 g of radioactive xenon evenly distributed within the entire atmosphere of the Earth. A rooftop detector at the CTBTO's headquarters in Vienna still catches traces of emissions from the 1986 Chernobyl disaster.

BENEFITS FOR DISASTER MITIGATION EFFORTS

The IMS is being built to ensure compliance with the Comprehensive Nuclear-Test-Ban Treaty (CTBT), which bans all nuclear explosions. CTBTO monitoring data and technologies, however, offer a host of additional benefits, particularly in relation to disaster mitigation. One of these benefits is already in place – the contribution of data to tsunami warning efforts. In 2006, Member States mandated the CTBTO to provide seismic and hydroacoustic monitoring data to a number of tsunami warning centres in the Indo-Pacific region. Data were also made available to Japan when it was hit by the massive earthquake on 11 March. Tragically, tens of thousands of people were killed by the tsunami; but many were saved due to the rapid alerts. According to Japanese authorities, CTBTO data helped them to issue tsunami warnings within a few minutes, thus allowing many people to escape to higher ground. CTBTO data also helped other countries in the region, such as Australia, Indonesia, Malaysia, the Philippines and the United States, to issue timely tsunami warnings, even though the wave turned out to have lost its devastating power by the time it had reached these countries' shores.



Simulation of dispersion of radioactivity. Courtesy of the German Federal Institute for Geosciences and Natural Resources

ENHANCED COOPERATION WITH OTHER INTERNATIONAL ORGANIZATIONS

Following an initiative by United Nations Secretary-General Ban Ki-moon, relevant international organizations agreed on 25 March 2011 to enhance cooperation to help mitigate the consequences of the nuclear disaster in Japan. These organizations include the CTBTO, the International Atomic Energy Agency (IAEA), the World Meteorological Organization (WMO), the UN Development Programme (UNDP), the World Health Organization (WHO) and the UN Office for Disarmament Affairs (UNODA).

The CTBTO contributes to this effort by providing information on the detection of radioactive isotopes from its worldwide monitoring network. The CTBTO can also assist in predicting the global dispersion of radioactive material by using its atmospheric transport modelling (ATM) tool, which has been developed in cooperation with the WMO. This method allows for the calculation of the dispersion of a given radionuclide emission, using meteorological data. This calculation can be performed as back tracking in order to identify the area where a radionuclide may have been released, calculated from the station where it was observed. In the case of Fukushima, where the point of release was known, the CTBTO applied forward ATM to predict where radionuclides would travel in the future.

Although the emissions were initially based on estimates only, they proved to be 95 percent correct as the radionuclides mostly reached the stations within hours of the time predicted. With information made available later by the IAEA on the release level of radioactive substances at the Fukushima power plant – the so-called source term – the CTBTO has been able to quantify and refine its global dispersion predictions.

RADIOACTIVITY OUTSIDE OF JAPAN BELOW HARMFUL LEVELS

The present event has understandably given rise to concerns about manmade radiation. In particular, atmospheric nuclear testing in the 1950s and 1960s caused widespread fallout, resulting in radiation-related diseases and deaths and rendering vast areas uninhabitable to this day. These nuclear tests had the most direct impact on the immediate region. The danger from fallout decreases with distance, as radioactive particles are dispersed into the atmosphere or washed out through precipitation. A number of radioactive isotopes also have a limited half-life of a few days or weeks, which reduces the overall radioactivity with time. Other radioactive substances though, such as plutonium, linger for thousands of years. The locations where over 1,500 underground nuclear tests were carried out worldwide are highly contaminated and have had to be completely fenced off to limit the danger to humans.

The cumulative effects of the nuclear explosions resulted in much higher levels of radioactivity than were observed after the Chernobyl disaster. Radioactive isotopes could be traced in the baby teeth of children born even at great distances from the test sites in these decades. By comparison, the levels detected at stations outside Japan up until May 2011 have been far below levels that could cause harm to humans and the environment. The levels are comparable to natural background radiation, such as cosmic radiation and radiation from the environment on Earth, and are lower than those from manmade sources, such as medical applications or nuclear power plants (under normal operations) or isotope production facilities.

BIOGRAPHICAL NOTES

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