Potential civil and scientific applications

IMS data on natural radionuclides released for WMO Programmes

By Dieter C. Schiessl

The International Monitoring System uses seismic, hydroacoustic, infrasound and radionuclide technologies to monitor compliance with the Comprehensive Nuclear-Test-Ban Treaty. These technologies, together with the data and the products of the International Data Centre, have potential civil and scientific applications which may benefit States and the scientific community.

DAILY CHANGE OF FILTER IN THE AIR SAMPLER AT RN51, NEW HANOVER, PAPUA NEW GUINEA

The Preparatory Commission for the CTBTO and the World Meteorological Organization (WMO) recognized soon after the establishment of the CTBTO that active collaboration would be beneficial for both organizations in fulfilling their missions and meeting their goals. To formalize and strengthen mutual cooperation and consultation, WMO and CTBTO signed a working agreement in mid-2003.

Within the framework of that agreement, several key activities have been implemented or are being pursued which have benefited or would benefit from civil and scientific applications of International Monitoring System (IMS) data and from methodologies, technical advice and services provided to the CTBTO by forecast centres and the Secretariat of WMO. These include in particular:

- CTBTO provides meteorological parameters, which were measured at selected IMS sites, to WMO;
- WMO provides specific meteorological forecast models and products to CTBTO to support calculations of backtracking of detected radionuclides (see CTBTO Spectrum 2, July 2003);
- studies to assess the application of IMS infrasound data to detect explosive volcanic eruptions for improved early warning to civil aviation against ash plumes (see CTBTO Spectrum 3, December 2003); and
- CTBTO provides IMS natural radionuclide measurements to WMO to strengthen the Global Atmosphere Watch (GAW) programme.

AIR INLET OF AUTOMATIC RADIONUCLIDE STATION, RN34, REYKJAVIK, ICELAND

This article illustrates the use and the benefit that could be gained by the GAW from additional routine measurements of natural radionuclides. The GAW is a global programme for systematic monitoring of the chemical composition of the atmosphere, related environmental analyses and assessments, and development of a predictive modeling capability on global, regional and urban scales. Within the GAW, the collected data are made available to international GAW data centres. The international community of environmental scientists accesses the archives to support research on atmospheric dynamic processes, pollutants and on the cycles of natural radionuclides originating from continental soils and from cosmogenic production.

A relative thin network of stations exists under the GAW network that measures natural radionuclides. Such measurements, including those of radon-222 (^{222}Rn), radon-220 (^{220}Rn) , lead-212 (^{212}Pb), lead-210 (^{210}Pb), beryllium-7 (^{7}Be), beryllium-10 (^{10}Be) and carbon-14 monoxide (^{14}CO), are essential to monitor atmospheric composition and air quality, to examine a variety of atmospheric processes and to validate global chemical transport models.

For example, evaluations of atmospheric chemical transport models rely in part on accurate estimates of the ^{222}Rn source term. Due to lack of reliable and representative measurements, our knowledge of the magnitude and the distribution of ^{222}Rn flux to the atmosphere over the earth's surface is still rather insufficient. Mapping the variation of ^{222}Rn flux over

MANUAL STATION AIR SAMPLER AT RN29, RÉUNION, FRANCE

the earth's surface requires supplementary information on a number of factors, such as type, temperature and moisture of the soil, as they control the release of ^{222}Rn gas to the atmosphere. Suitable global datasets are needed to predict ^{222}Rn emissions which are generated by the decay of ^{226}Ra. However, global information on ^{226}Ra in the soil is incomplete and observations of vertical profiles of ^{222}Rn concentrations are sparse. Due to the short half-lives of the ^{222}Rn offspring and the current sampling and counting practices at IMS stations, the CTBT system does not provide data on ^{222}Rn. This could be rectified, but would imply some extra costs and efforts.

While ^{210}Pb and ^{7}Be concentrations on the surface are measured routinely at the GAW stations by weekly cumulative filtration and subsequent gamma counting, very few measurements exist to assess the trans-continental transport of these radionuclides. Radionuclides, such as ^{210}Pb, ^{7}Be and ^{10}Be, which condense on particle surfaces, provide tests of aerosols physical processes including wet and dry deposition. In the last decade, substantial progress has been made in the field of numerical simulation of cosmogenic nuclide production rates. The rates as functions of altitude, latitude, solar and geomagnetic field intensity are available. With the advent of new particle flux measurements, the quality of numerical models can be tested.

Techniques of measuring radionuclides need to be standardized and harmonized, observations need to be collected and archived with information on uncertainty and, finally, research to generate even better source functions is needed.

Much still remains to be done to understand better the complex air chemistry processes. Researchers and operational environmental monitoring experts hope to gain substantive new knowledge from additional routine observations provided by IMS monitoring stations. In order to be useful, these observations need to be carried out on a truly world-wide scale and the station density of the final IMS network is really helpful in this context. It is now important that CTBTO and WMO intensify their cooperation in setting up the necessary data management functions to facilitate access to IMS data by the GAW data centres. ■

HIGH-PURITY GERMANIUM DETECTOR IN ITS LEAD SHIELD WITH AN INNER COPPER LINING

Biographical note

Dieter C. Schiessl is the Director of the World Weather Watch Department in the World Meteorological Organisation (WMO) since 2002. He studied Nuclear Physics at the Universities of Munich and Erlangen in Germany. After more than 15 years in the German Military Geo-Information Service, he joined WMO in 1989. From 1992 to 2002 he served as Director for Basic Systems, coordinating various WMO programmes related to the global meteorological infrastructure. In his current position he is responsible for the coordination of the operational collaboration, standards and procedures for observations, weather forecasting and information exchange of the National Meteorological Services of the WMO Members. ■

Potential civil and scientific applications

Tsunamis and the International Monitoring System

It often takes a tragedy to focus minds on disaster prevention and preparedness. Following the tsunami generated by the massive earthquake off Sumatra on 26 December 2004, the Provisional Technical Secretariat (PTS) received various enquiries from interested parties: Could we help to warn of such a disaster in the future, especially in the Indian Ocean region? The PTS was invited to participate in international meetings held under the auspices of UNESCO and the International Oceanographic Commission, which were considering the extension of existing tsunami warning systems into the Indian Ocean region. On 4 March 2005, the 24th session of the Preparatory Commission tasked the PTS to begin exploring its capability with National Authorities and with international tsunami warning organizations recognized by UNESCO. This task was renewed in November 2005 at the Commission's 25th Session.

For the analysts in the International Data Centre (IDC), the Sumatra earthquake of 26 December 2004 posed a very different problem. A large earthquake generates many aftershocks large and small, and many thousands were recorded by the International Monitoring System (IMS) during the following weeks. The sheer number of aftershocks created an unprecedented workload for analysts, and the Reviewed Event Bulletin for 26 December contained some ten times the average number of events. The issuance of Reviewed Event Bulletins for some days following 27 December had to be postponed.

Technically, the PTS could offer a number of special contributions to a tsunami warning effort. One would be the provision of data in near-real time from IMS seismological stations in remote regions where no other suitable stations exist; this is particularly relevant for the stations of the IMS auxiliary seismic network. Moreover, the Global Communications Infrastructure allows data to be transmitted immediately and continuously from the remotest of stations with high reliability.

TSUNAMI HITTING THE COAST OF PHUKET, THAILAND, 26 DECEMBER 2004

A further PTS contribution might be in the rapid location of the largest earthquakes. To this end, a 'proof of concept' has been conducted to demonstrate that, with minor reconfiguration of existing software, the IDC can produce location estimates of some large earthquakes within 20 minutes of their occurrence. Many IMS seismic stations consist of multiple sensors arranged in an 'array'. Seismic arrays are better for locating earthquakes, and the PTS can use this advantage when computing rapid location estimates – something not normally possible for disaster agencies.

Since the Commission's decision of 4 March 2005, the PTS has begun forwarding continuous data from selected seismological and hydroacoustic stations of the IMS on a test basis to the Northwest Pacific Tsunami Information Centre in Tokyo, Japan, and to the Pacific Tsunami Warning Centre in Hawaii, United States of America. Presentations at the 25th session of Working Group B by experts from international tsunami warning organizations, and from representatives of national institutes, concluded that data from the IMS were potentially of high value for tsunami warning purposes, partly because data are often transmitted faster and with higher reliability from station to warning organization. This gave encouragement that IMS data could contribute in a very practical way to tsunami warning efforts. The forwarding of data from the IDC in Vienna on a test basis to international tsunami warning organizations is continuing, and will be discussed further at the 26th Session of Working Group B in February 2006. ■