Potential civil and scientific applications

The importance of IMS data for global climate change research

by Professor Dr Helga Kromp-Kolb

Climate research deals with the analysis and projection of weather patterns over long periods of time. While the CTBTO Preparatory Commission is building the International Monitoring System (IMS) to monitor the earth for signs of a nuclear explosion, data from its 337 IMS facilities could also be of relevance for climate and climate change research, if made available to the scientific community. This is particularly true for the 60 station-infrasound network and the 80 station-radionuclide network, which are the only global monitoring networks of their kind.

Former US Vice-President Al Gore's highly recommended movie on global warming, "An Inconvenient Truth", pays tribute to Roger Revelle and Charles David Keeling, pioneers in monitoring the atmosphere for carbon dioxide at the Mauna Loa Observatory in Hawaii. In the mid-1960s, observations had only been carried out for about half a decade when Roger Revelle warned his students – Al Gore among them – that climate change would be the result of the observed change in the composition of the atmosphere (Fig.1).

This example demonstrates a number of important points. Our understanding of global climate is based on observations. Data collected in remote areas can give a clearer picture than data influenced by nearby disturbances. Some of the observed variables, like temperature or precipitation, are obvious climate indicators and are being monitored with the explicit purpose of climate (or weather) research. Others, initially not monitored for climate research, can prove extremely helpful in understanding the global atmospheric system. Unless trends are very strong, a period of a few years or even decades of observation will not be a proof of systematic climate change. Observed changes can, however, stimulate creative people to come up with interesting thoughts and hypotheses, as in the case of the CO^2-concentrations measured on Mauna Loa.

Several of these points demonstrate the relevance of IMS data. Although the worldwide national meteorological services operate a network of some 5000 ground stations, more than 600 upper air sounding stations, thousands of climate stations, as well as satellites, they were built primarily to serve national monitoring interests. The IMS network, however, was built to ensure global monitoring. Therefore, the IMS includes remote and inaccessible sites, whereas the vast majority of meteorological monitoring stations are situated in populated areas. Thus, IMS data can help to fill geographical gaps and IMS stations in remote locations could support additional meteorological monitoring efforts.

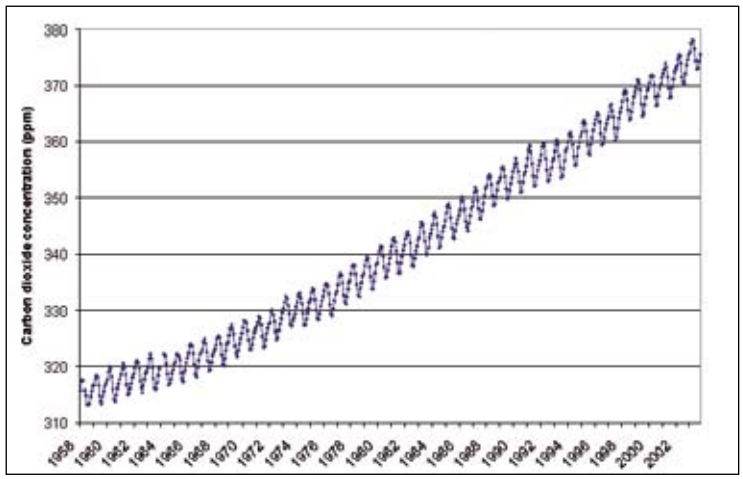

FIGURE 1: ATMOSPHERIC CO^2 CONCENTRATIONS (PPMV) DERIVED FROM AIR SAMPLES COLLECTED AT MAUNA LOA OBSERVATORY, HAWAII, STARTING 1958. ANNUAL CYCLES REFLECT THE INCREASED CARBON DIOXIDE INTAKE BY PLANTS IN THE SUMMER.

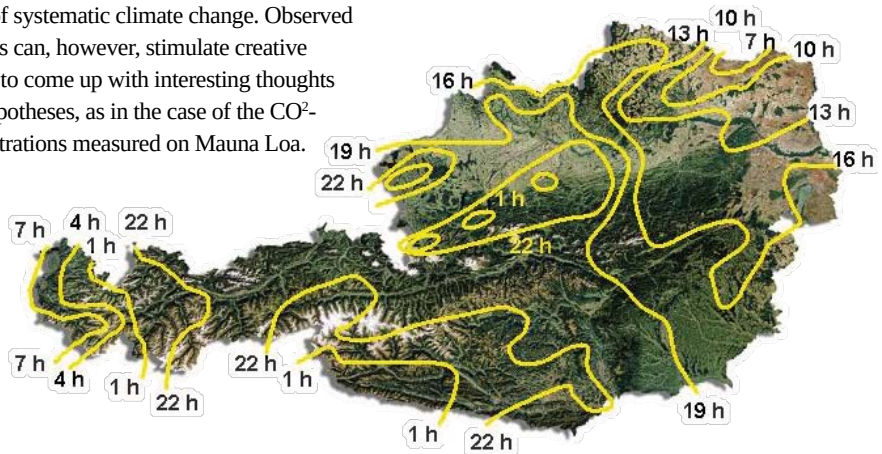

FIGURE 2: FIRST ARRIVAL OF THE RADIOACTIVE CLOUD IN AUSTRIA, FOLLOWING THE CATASTROPHE AT THE CHERNOBYL NUCLEAR POWER PLANT IN APRIL 1986. THE CLOUD ARRIVED AT THE NORTH EASTERN BORDER OF AUSTRIA ON APRIL 29TH AT 7 GMT IN THE MORNING AND REACHED THE WESTERN BORDER ABOUT 24 HOURS LATER. THE DATA SET GATHERED BY THE 336 ONLINE STATIONS OF THE AUSTRIAN EARLY WARNING SYSTEM THAT MONITORED THE GAMMA DOSES, CONTINUES TO SERVE METEOROLOGISTS IN VALIDATING ATMOSPHERIC TRANSPORT MODELS IN COMPLEX TERRAIN. [SOURCE: KOLB 1986]

Mauna Loa data and others clearly demonstrate the value of data from remote sites.

It might be felt that IMS data are of little value for climate research, as they are only available for a few years and many climate processes can only be understood by looking at observations over long time periods. However, some processes such as volcanic eruptions and the ensuing cooling can be documented within a few years. In some cases, even shorter time scales, in the order of days or hours, can enhance the understanding of processes or evaluate different hypotheses. For example, the ban on aviation in the United States following the 9/11 attacks proved to be a valuable full scale experiment to analyze the influence of aircraft exhaust emissions (so-called 'contrails') on solar radiation. Another example are the measurements tracing the first arrival of the Chernobyl radioactive cloud in Austria (Fig. 2) or its propagation over Europe. These data sets continue to be used to test dispersion models. There are also some processes that elude systematic and direct monitoring due to the long time scales involved, such as the

100 000 year ice-age cycles. These can only be reconstructed based on indicators of a different nature such as the composition of air trapped in ice cores. Coupled with modern monitoring results, however, these records show the dramatic man-made impact on the composition of the atmosphere (Fig 3). Thus, even now, IMS data could be helpful in climate research.

In addition, IMS stations focus on parameters not monitored by meteorological networks, such as infrasound and radionuclides. These data are collected for IMS purposes, but contain additional information of no immediate use to the Preparatory Commission. A range of meteorological events can emit infrasound, such as severe storm systems, air and ocean waves, meteorites entering the atmosphere, auroras, volcano eruptions and earthquakes. What is considered a 'disturbance' or 'noise' in the data when monitoring Treaty compliance, may be of relevance to the climate science community. Thus, IMS data could become an important archive for the research of the atmosphere, severe storm systems, mountain waves, etc. – phenomena that can undergo significant changes as a consequence of climate change.

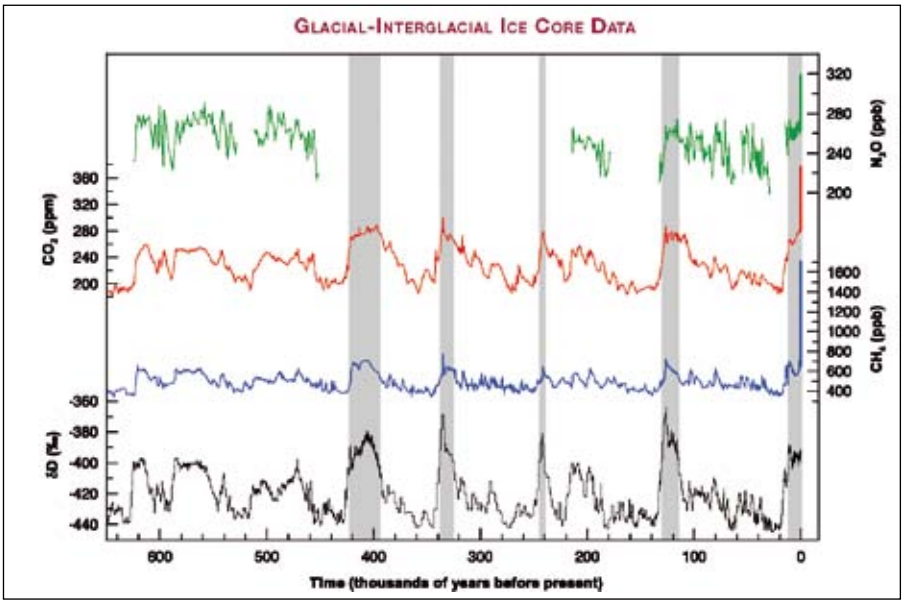

FIGURE 3: CARBON DIOXIDE CONCENTRATIONS IN THE ATMOSPHERE OVER THE LAST 600 000 YEARS, AS RECONSTRUCTED FROM THE AIR BUBBLES ENCLOSED IN ICE CORES. THE DRAMATIC INCREASE IN CONCENTRATION AS A RESULT OF BURNING OF FOSSIL FUELS DURING THE LAST 200 YEARS IS CONFIRMED BY THE MONITORING DATA OF THE MAUNA LOA OBSERVATORY. [SOURCE: IPCC 2007, FOURTH ASSESSMENT REPORT WGI, TS]

FILM POSTER OF AL GORE'S "AN INCONVENIENT TRUTH"

Natural radionuclide data also registered by the monitoring system can be used to validate and calibrate weather prediction and climate models. Very likely, IMS data sets will reveal useful and unexpected information, once they become available to the scientific community.

In his film, Al Gore shows how data on the thickness and extent of the Arctic ice cap, collected over the years, facilitated United States military submarine movements. When declassified, the data revealed a startling record of climate change. The extent and thickness of the Arctic ice cap had diminished by 40% since the 1970s. Although other data and models had shown that the effects of global warming were especially severe in higher latitudes of the northern hemisphere, it was the extent of ice melting in the Arctic and in Greenland that came as one of the biggest surprises to climate researchers. The arctic ice data were originally not released due to national security considerations.

Today it has become clear that it is the processes behind the data – not their release – that could threaten national security. Due to the melting of significant parts of the Greenland ice sheet, the sea level could rise considerably faster and higher than originally expected and cause flooding in densely populated coastal areas around the world. Millions of people would lose their homes. The ensuing global refugee crisis would further destabilize a world in which climate change already contributes to a widening of the gap between rich and poor.

Scientists need all available information to help society cope with the challenges associated with climate change. Here the CTBTO Preparatory Commission and IMS data can make a valuable contribution. ■

Biographical note

Dr Helga Kromp-Kolb is Professor at the University of Natural Resources and Applied Life Sciences in Vienna. Her research focuses on environmental meteorology, especially air pollution dispersion and climate change. She is a member of a number of scientific boards, as well as advisory committees to the Austrian Government. ■