Oceanographic research to predict global climate change

The Japan Agency for Marine-Earth Science and Technology (JAMSTEC) is involved in a wide range of basic marine-related research, including observation and projection of the earth's environment, inner earth dynamics research and study of marine life in extreme environments. To support its environmental monitoring, JAMSTEC has developed a miniaturized observation device to measure carbon dioxide (CO_2) in seawater, relying on Tecan's Cavro® XCalibur Pump for accurate automated pipetting.

Dr Yoshiyuki Nakano with the drifting buoy, alongside JAMSTEC's TRITON buoy, a larger, anchored observation device.

JAMSTEC's main objective is to collect and disseminate information that helps to understand changes in the earth's environment, upon which the oceans have a big influence. Data are being collected by various methods and made publicly available for use in research and industry, as well as to help the planning and implementation of international environmental monitoring programs. JAMSTEC also develops basic technology for oceanic research, including data processing technology.

For environmental monitoring, JAMSTEC uses research ships and buoys to measure seawater variables such as temperature, salinity and chemistry. Since 2005, funded by the Ministry of Education, Culture, Sports, Science and Technology, scientists at JAMSTEC's Mutsu Institute for Oceanography (MIO) in Aomori, Japan, have been developing a drifting buoy device for automatic measurement of CO_2 in seawater. "It is almost certain that CO_2 released by human activity is the cause of global warming," explained Dr Yoshiyuki Nakano, Research Scientist at MIO. "It is necessary to continue monitoring CO_2 concentrations in order to predict future climate change. Although atmospheric CO_2 is being measured in various locations, there are very few observations being made at sea – which represents 70 % of the earth's surface – mainly because of difficult access, and because securing a source of electricity for the measuring instruments also presents problems. *In situ* seawater CO_2 sensors are being developed in several countries, but all have issues with size or cost, and none are in widespread use."

"An important design goal was to make the CO_2 sensor small and light, so it was necessary to have a compact pump. The Cavro XCalibur Pump was chosen for this reason, because the pump also offered high

Oceanographic research vessel MIRAI (Japanese for 'future'), which is being used for oceanographic surveys. One of its missions is to deploy observation buoys.

accuracy, was capable of maintenance-free operation for long periods, and a broad volume selection range."

Dr Nakano continued: "Our buoy weighs about 15 kg, light enough to be lifted by one person. It makes a measurement once a week and the results are sent to the laboratory via satellite. The device calculates the CO_2 concentration in seawater, using the acidic nature of CO_2 dissolved in water. Within the buoy, the CO_2 in seawater passes through a gas-permeable membrane into a sample cell containing a pH indicator solution, which is analyzed by spectrophotometry. To help miniaturization, the capacity of this cell is less than 1 ml, and all connecting parts and tubes are very thin. Pure water and concentrated indicator need to be freshly mixed for each measurement because diluted indicator is quickly bleached by UV rays from the sun. Appropriate amounts of indicator and water are accurately aspirated using two Cavro XCalibur Pumps and mixed, before being put into the sample cell. The volumes of indicator and water used are critical; without sufficient accuracy, the final concentration of the pH indicator can be too concentrated or too dilute for reliable results, but the Cavro XCalibur Pump allows us to achieve exactly the concentration we aim for. The pump's broad selectable volume range is important because the concentration of indicator to use has been determined empirically, and the pump allows us to choose the exact concentration we want."

"In May 2008, we placed our first drifting buoy in Canada's Sea of Labrador and, in January, the second in the Antarctic Sea," said Dr Nakano. "We have just deployed another three in March 2009, this time in the western north Pacific Ocean. Once we have enough data, the information will be used for various research; JAMSTEC has its own program of computer-aided simulation research for future climate prediction, but the data will also be made generally available worldwide to be used by other scientists too. Our work has only just started so the data are still of limited practical use but, in the future, I expect that it will be used by institutes like the Intergovernmental Panel on Climate Change (IPCC), an organization that has received the 2007 Nobel Peace Prize for its work towards securing neutral, objective information related to climate change," concluded Dr Nakano.

TRITON buoy *in situ*.