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Tracking down the greenhouse gases methane & Co: IOW heads a method standardization expedition

On October 15, 2016, an international research team under the lead of the Leibniz Institute for Baltic Sea Research Warnemünde (IOW) heads out on the research vessel ELISABETH MANN BORGESE for a one-week cruise on the Baltic Sea. The goal of the 12 scientists from Germany, China, the UK, and the USA is to prepare the road for measuring the marine emissions of the greenhouse gases methane and nitrous oxide worldwide with highly precise and comparable methods. Therefore six measuring systems will participate in an onboard intercalibration campaign and the results will be communicated as recommendations to the Scientific Committee for Oceanic Research (SCOR).

After carbon dioxide, methane and nitrous oxide, also called laughing gas, are the most important natural greenhouse gases. Their anthropogenic increase in the atmosphere contributes about 25 % to the current global warming. Therefore, the question of how much of both gases is emitted when and where, is very important for any calculations of future climate scenarios. While the oceans constitute a sink for CO_2, which has been documented extensively by worldwide seasonal maps, they are a source for methane and laughing gas. However, there are many knowledge gaps regarding marine sources of these two gases and the amount that actually reaches the atmosphere. One important reason for this is that most emissions come from coastal and shelf regions. The marine ecosystems in these regions differ so much from each other that a few individual measurements cannot be extrapolated to characterise larger areas. Furthermore, until recently, there was no precise instrumentation available that was suitable to conduct massive measuring campaigns.

“This has changed fundamentally during the past five years,” explains Prof. Gregor Rehder, marine chemist at IOW and the expedition’s chief scientist. “Despite much lower concentration in the surface waters, the development of laser-based detectors has made it possible to measure methane and laughing gas as precisely and highly resolved in space and time as CO_2,” he continues. The high precision and measuring speed of the new systems are crucial prerequisites to take measurements while the ship is moving, which makes them especially suitable to be employed not only during research cruises but also on so called “Voluntary Observing Ships” (for instance freighters and large ferries) to continually collect data from the surface waters along their routes. This would create a much denser and therefore much more conclusive data network then the information generated by comparatively short and few research expeditions. “These new measuring techniques clear the road to increase our knowledge about methane and nitrous oxide in big leaps,” comments Gregor Rehder.

Reaching the ambitious goal of global emission records for these two greenhouse gases, however, is only possible as a joint effort of numerous scientists and a growing number of working groups. It is therefore imperative that all data used to derive worldwide budgets and to calibrate modelling are comparable and without methodological bias. This necessitates careful intercalibration of all methods and measuring devices. An international working group of the Scientific Committee for Oceanic Research (SCOR), which belongs to the International Council for Science ICSU, has set themselves the task to achieve this method harmonisation and the coming expedition of ELISABETH MANN BORGESE, with a special emphasis on continuous measurements in marine surface waters, is part of its activities.

"Intercalibration is an old but prevalent issue in marine research," says Prof. Hermann Bange of the GEOMAR Helmholtz Centre for Ocean Research Kiel, one of the two chairs of the SCOR working group. "Usually we achieve this by simply splitting a sample and sending the subsets to different labs to compare the measurement results. To compare continuous measurements is not so easy, because all systems need to be present simultaneously in the same measuring area – this means on the same vessel – and huge amounts of water are needed to provide all of them with enough to run simultaneously," Bange explains. For this purpose, six different systems for measuring methane and nitrous oxide as well as an especially customised seawater pumping system are currently being installed on the ELISABETH MANN BORGESE. "This is a tricky challenge: Not only do we have to find ways to bring 50 litres of seawater per minute into the on-board labs while the ship is moving, we also have to find ways to get them out after the measurements are done," chief scientist Gregor Rehder sums up one of the core problems.

After the cruise is completed and the data are evaluated, the results will be summarized by the SCOR working group as methodological recommendations for scientific working groups worldwide that have a focus on the continuous measurement of methane and nitrous oxide in marine environments.

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