3. Cruise report

05.06.-11.06.2017

In the third week of the cruise *MSM-64* we finished the work at Goban Spur at the eastern edge of the Atlantic Ocean. On Monday, 05.06.2017, we installed the *EB-3/2* mooring at 4400 m water depth in very variable wind conditions and rainy weather. As the mooring *EB-1/2*, which was installed on the previous day, mooring *EB-3/2* is equipped with various sensors which measure the flow strength and direction, the temperature and the salinity at different depths. These measurements are used to investigate water masses, which originate in the subtropics and flow north along the eastern boundary. The North Atlantic can be roughly divided into two gigantic water gyres. The subpolar gyre, located between Greenland, North America and Europe, distributes counter-clockwise large amounts of cold and fresh waters, whose origin can be found in the high northern latitudes. Further south the subtropical gyre causes warm and saline water from the subtropics to flow to the north. The Gulf Stream as part of the subtropical gyre and its northern continuation, the so-called North Atlantic Current, import these water masses from the subtropics far into the Nordic Seas and beyond. The highly branched North Atlantic Current forms the transition zone between the subpolar and subtropical regimes. Various studies have already pointed out long-term changes in the water composition of the East Atlantic. These changes can be attributed to a growth and shrinkage in the spatial extent of the subpolar gyre. When it extends further to the east, there is an increased inflow of subpolar water into the eastern Atlantic. However, when it shrinks and shifts to the west, there remains more space for the inflow of saline subtropical water from the south. These fluctuations can be related to changes in the atmospheric state and thus the strengthening and weakening of the westerly winds over the Atlantic, expressed by the North Atlantic Oscillation Index (NAO). Our 47°/48°N section, which we follow from Europe to Newfoundland, crosses this transition zone, in which water masses from the western Atlantic with subpolar character encounter water masses from the south with subtropical character. The data collected during *MSM-64*, together with the moorings to be recovered in 2018, will show whether the Atlantic water, which eventually flows into the North Sea with its increased salinity, ultimately originates directly from the subtropics and takes this eastern route or originates in the western Atlantic.

After we had also finished the hydrographic program at the eastern boundary, we followed the 47°/ 48°N section westwards into the deep West European basin. Here, last year, we had installed three inverted echo-sounders equipped with pressure sensors, so-called PIES. In analogy to a conventional echo-sounder, these devices send sound signals from the sea floor to the surface. There they are reflected and received by the PIES after some time again. The PIES now measures the travel time for such a signal. Since the sound velocity in the ocean is very high with approx. 1500 m/s, this takes only a few milliseconds. The exact speed of sound in the ocean mostly depends on the temperature and the salinity. We use this dependency to convert the travel time measurements of the different PIES into time series of temperature and salinity in the ocean. From this information and the spatial differences between two PIES positions, the volume transports in the interior of the North Atlantic can again be reconstructed.

During this week, we reached the positions of the three PIES BP-32, BP-33 and BP-34 installed in the deep eastern Atlantic. Using an underwater microphone, a so-called hydrophone, we contacted the devices acoustically, thus transmitting the recorded data, recovering the devices thereafter and replacing them with devices we have brought for this purpose. The acoustic work requires acceptable conditions of the sea state. If there are too many air bubbles in the water due to wind and waves, or if the ship cannot be held in position at low speed, there is noise in the water, which results in gaps in the acoustic data recording. The wind and weather conditions were largely acceptable for data transmission. The first two instruments were then recovered during two consecutive nights, as the dark night provided the greatest chance of seeing the flashing signal of a device that had ascended to the surface. We have been successful in all three cases, have recovered all the devices and then equipped the positions again with new devices, but our work had to be interrupted starting on Friday afternoon. Then, a fierce storm system crossed our path and brought our work to a halt in the short term. On Saturday evening, we were able to continue the work and also reinstalled the last PIES in the eastern Atlantic. Since then we are on the way to the western Atlantic, where we will continue our work.

On behalf of all cruise participants

Dagmar Kieke

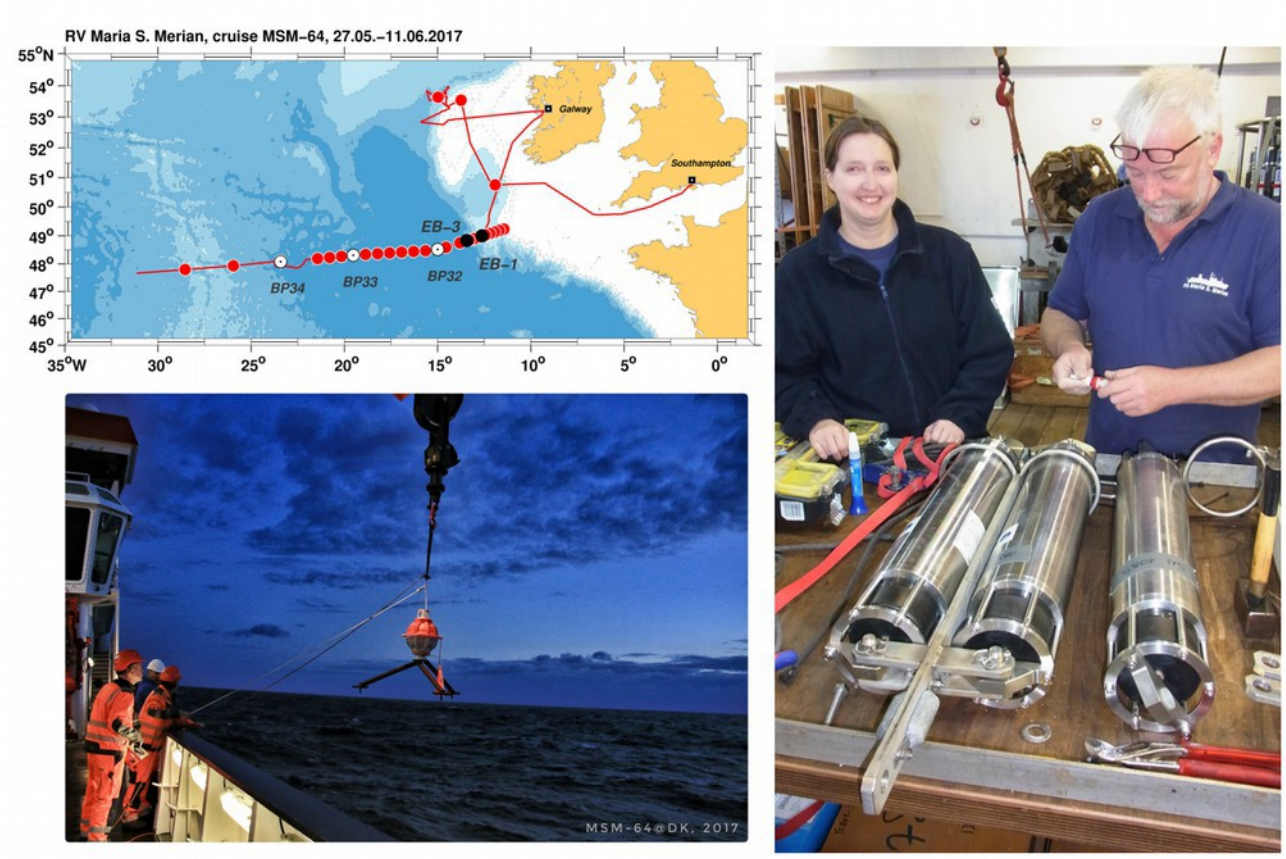

Fig. 1: Present track of cruise MSM- 64 during 27 May to 11 June 2017 (top), preparation of mooring devices (right) and deployment of a bottom- mounted inverted echo-sounder (PES BP-32, bottom).