5th Weekly Report SO284, Emden-Emden

Jul. 26 - Aug. 1, 2021

During our fifth week we completed the meridional section along the 35°W meridian and at the same time arrived in the intertropical convergence zone, the core area of the meteorological measurements (see Fig. 1). The first station of the 35°W section was at the shelf edge at the Northeast Brazilian corner at about 350 m water depth. The section crosses the North Brazil Undercurrent (NBUC) and different branches of the Deep Western Boundary Current that are topographically guided by several ridges and seamount chains. One week ago, we finished the zonal section along about 5°S. The analysis of the data is ongoing. So far, all the instruments used at the section worked extremely well. For the CTD system, we only had to exchange one CTD oxygen and one fluorescence sensor. The latter one, we could borrow from the ship's backup CTD system. The section at 5°S was measured with 13 CTD stations and continuously with a thermosalinograph and shipboard ADCPs (acoustic Doppler current profiler). The shipboard velocity measurements typically reach down to 1200 m. They are combined with the lowered ADCP measurements at the CTD station to obtain full-depth velocity sections (Fig. 2). Temperature along the section can be compared with the mean distribution from previous measurements and show interesting signals of increased and decreased temperatures in the upper ocean. Near 4000m we see a substantial decrease in temperature that is associated with an anomalous northward flow of Antarctic Bottom Water.

Fig. 1: Heavy precipitating storm in the intertropical convergence zone (Photo Ronny Engelmann)

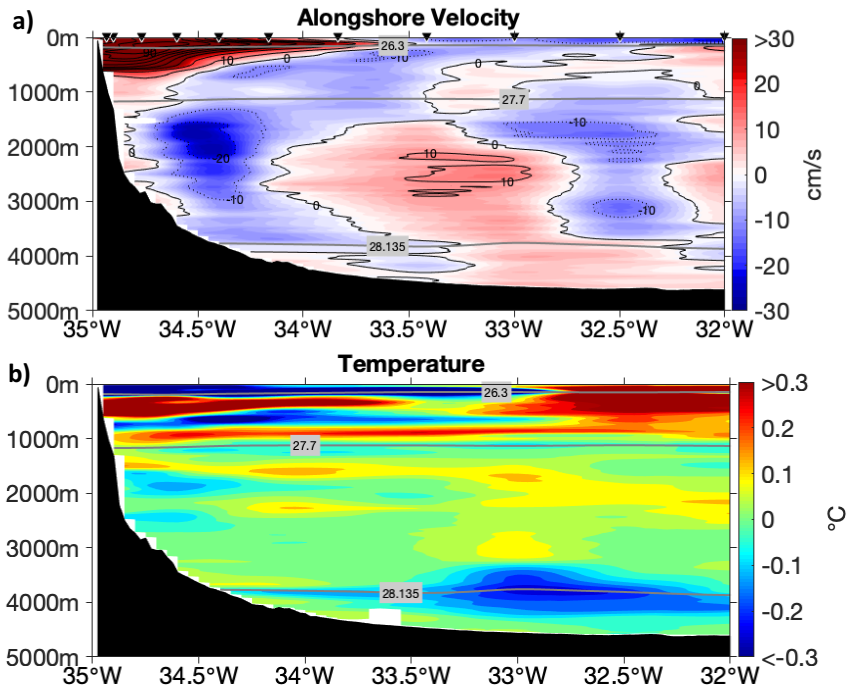

Fig. 2: Section measured with the CTD/LADCP system and the shipboard ADCPs along about 5°S. Temperature shown is the temperature anomaly with respect to the mean of previous measurements (Fig. Florian Schütte).

The mooring work that was finished also during the last week was extremely successful with all instruments working well with only some minor data loss due to empty batteries near the end of the mooring period. The calibration of the instruments is still ongoing. Here we can show the velocity timeseries measured by a moored ADCP in the core of the NBUC and by a single-point Aquadopp current meter in the core of the Deep Western Boundary Current.

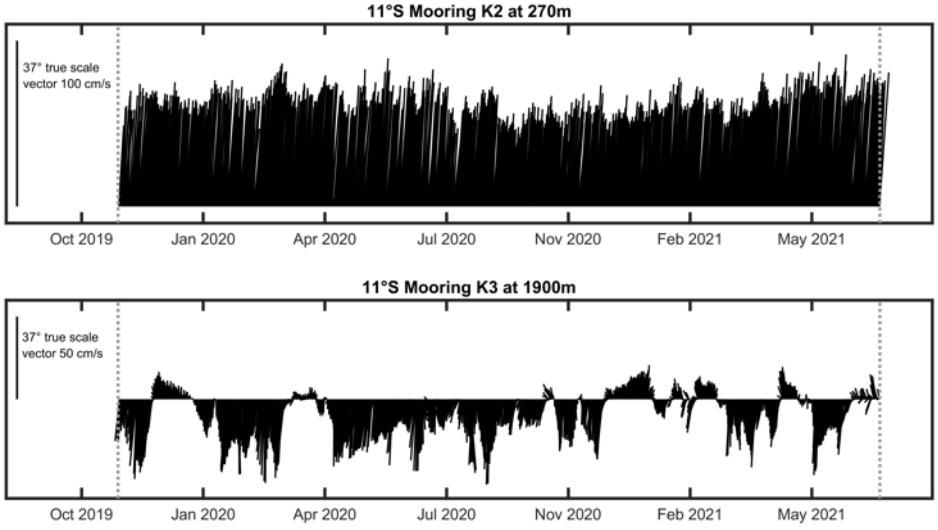

Fig. 3: Velocity time series from the 11°S western boundary current mooring array. Upper plot shows northward flow in the core of the North Brazil Undercurrent at mooring K2 at 270m depth, lower plot shows the highly variable Deep Western Boundary Current at mooring K3 at 1900m depth (Fig. Anna Christina Hans).

With the end of the 35°W section, we are now back in one of the key meteorological regions: the intertropical convergence zone (ITCZ). The ITCZ marks not only the region where the northerly and southerly trade winds meet, but also the region where the air rises on average. However, the air in the ITCZ does not rise continuously within the entire ITCZ, but the rise is limited to the tropical storms within it. These storms are very impressive as they can easily reach heights of up to 15 kilometers and often produce a lot of rain (see Fig. 1 for an example). While the particularly warm and humid air in the ITCZ provides ideal conditions for heavy precipitating storms, these storms usually need a trigger to form. For example, a storm can be triggered by the so-called "cold pool" of a previous storm. Cold pools form when rain evaporates, cooling the surrounding air. Since cold air is denser than warm air, this process can make the air so heavy that it sinks. When this cold and heavy air hits the earth's surface, it spreads out horizontally, causing a sudden drop in temperature and a sudden increase in wind speed - a phenomenon that most readers may have experienced during the approach of a thunderstorm. We measured such a cold pool, which was characterized by a drop in temperature of 3.5°C and an increase in wind speed of almost 10 m/s, when we entered the ITCZ on 30 July (see Fig. 4). If a cold pool spreads, it can lift the surrounding air, which can lead to the formation of new clouds. Looking closely at Fig. 4, one can even see a small ring of clouds near the location of our research vessel, marking the region where new clouds form at the edge of the detected cold pool. The measurement of cold pools is a central goal of this campaign, as recent studies indicate that the repeated formation of new clouds at cold pool edges helps to determine how far north and south tropical storms can travel and thus influences the width of the ITCZ.

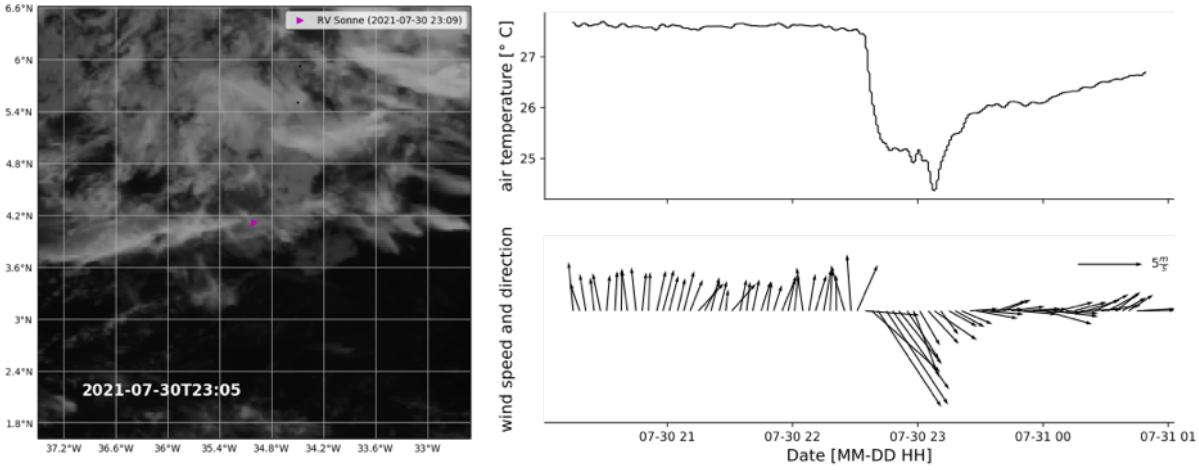

Fig. 4: Cold pool event detected at the edge of the Intertropical Convergence Zone (satellite image from GOES-16)

Although we are very busy with our science program, we are enjoying our life on board and feel that time is passing very quickly. This week we even had the opportunity to take a small boat trip around the RV Sonne and see our current home from a new

perspective. We would like to thank the crew very much for organizing this little excursion.

Greetings from the tropics in the name of the cruise participants of SO284,

Peter Brandt, GEOMAR Helmholtz Centre for Ocean Research Kiel and
Julia Windmiller, Max-Planck-Institut für Meteorologie, Hamburg