Lowered Acoustic Doppler Current Profiler (LADCP) data were collected on all stations (84-186). For all profiles a dual head system was used consisting of a downlooker and an uplooker. All profiles were sent daily to A. Thurnherr for shore-based processing and QC. Preliminary processing for horizontal velocity was also performed onboard using the LDEO_IX software (www.ldeo.columbia.edu/LADCP). Figs. 1 and 2 show the zonal and meridional velocity components, respectively, including the profiles from cruise leg 1 (I08S). [Due to instrument problems no LADCP data were collected on leg-1 stations 14-27 and, in addition, the data quality of horizontal velocities on stations 28-59 were low.] The upper panels show the upper ocean down to 800m using data from the ship-board ADCP (SADCP) because the data are continuous; the lower panels show the horizontal velocities from the LADCP.

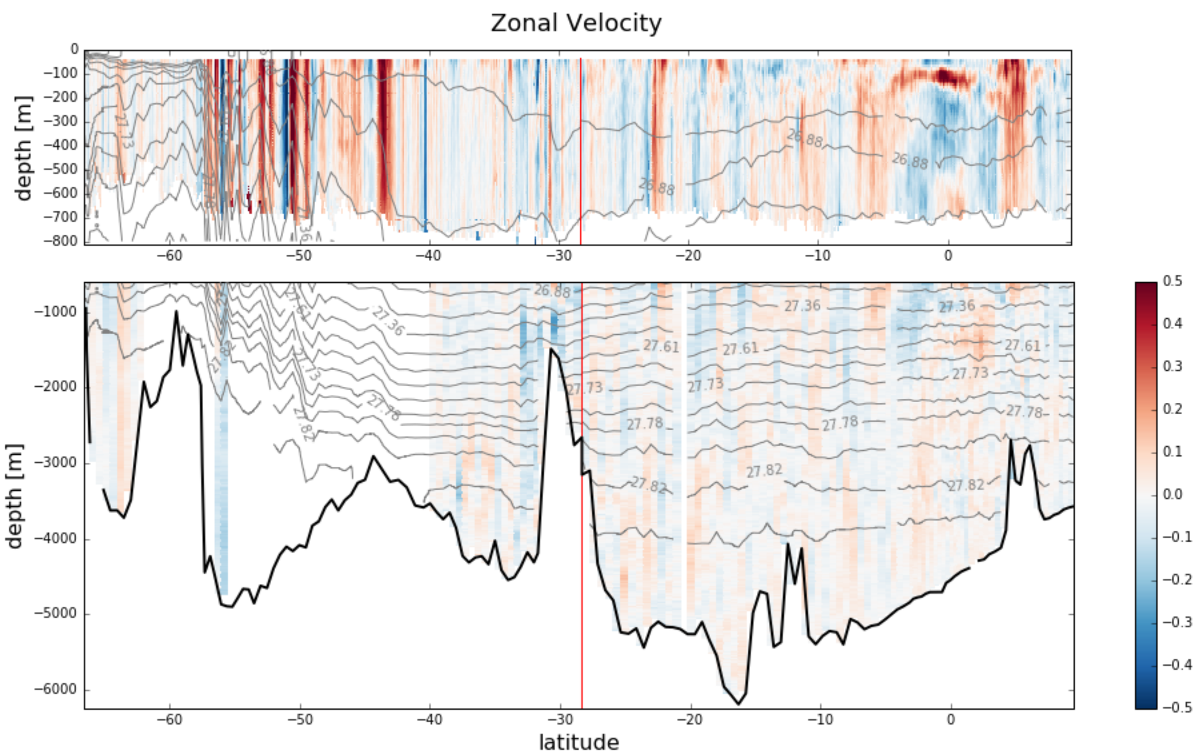

Figure 1. Zonal velocity [m/s] acquired from the LADCP (upper panel SADCP, lower panel LADCP). The potential density contours (grey solid lines), topography (black solid line) and the intersection of the two cruise legs (red solid line) are shown. Due to instrument problems and data quality issues, LADCP data are masked out on stations 14-59.

The figures clearly show strong horizontal velocities in the Antarctic Circumpolar Current (ACC) (~45-57S) and in the zonal equatorial undercurrent region near the Equator. Additionally there are strong currents around the Broken Plateau (30S). Based on satellite data, the Broken Plateau coincides with the southern edge of a wedge of high surface eddy kinetic energy (EKE) apparently emanating from the western coast of Australia (e.g. Jia et al., 2011). Regions with high vertical kinetic energy (VKE) derived from our LADCP data (Fig. 3) do not seem to propagate southern of the Broken Plateau consistent with the results by Jia et al., (2011). The west coast of Australia is an upwelling zone, which results in baroclinically unstable conditions, making it potentially the source for the high EKE emanating from the Australian coast. Menezes et al. (2014) also emphasize three separate eastward “jets” near the surface in the Wharton Sea and the SADCP velocities near the surface seem quite consistent with this inference. Based on solely the data from the present cruise, we cannot determine whether the northwestward flow along the southern flank of the Broken Plateau is part of the mean circulation or a transitory feature.

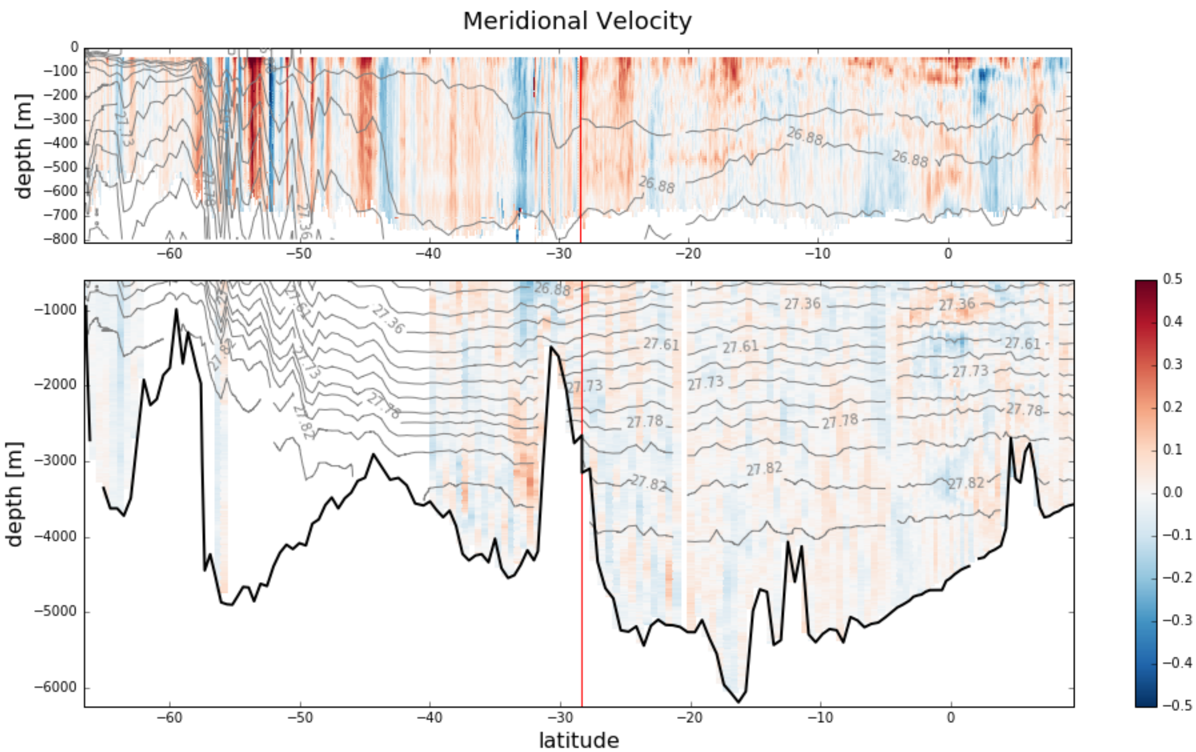

Figure 2. Meridional velocity [m/s] acquired from the ADCP (upper panel SADCP, lower panel LADCP). The potential density contours (grey solid lines), topography (black solid line) and the intersection of the two cruise legs (red solid line) are shown. Due to instrument problems and data quality issues, LADCP data are masked out on stations 14-59.

The vertical shear of the horizontal velocity, buoyancy frequency and the local Richardson number for the upper 300m are shown in Fig. 4 and 5. The buoyancy frequency was derived using temperature and salinity data from the CTD and the Thermodynamic Equation of Seawater - 2010 (TEOS-10: https://github.com/TEOS-10/python-gsw) package. The Richardson number was defined as:

$$Ri \equiv \frac{N^2}{(du/dz)^2 + (dv/dz)^2}$$

and the vertical resolution of the Richardson number was restricted by the SADCP data with vertical scales of 10m. The Richardson number is an indicator of how susceptible the water column is to shear instability. It is interesting that we see low values right around the equator, due to the large vertical shear of horizontal velocities. The ACC region also has low values due to small buoyancy frequency. We also show the mixed-layer depth (MLD) which was derived as the depth at which the potential density exceeded by 0.1 kg/m^3 from the surface value following Fernández-Castro et al., (2014). As expected the MLD is deep in the ACC region, agreeing quite well with the MLD provided by Dong et al., (2006), and shallows up towards the equator.

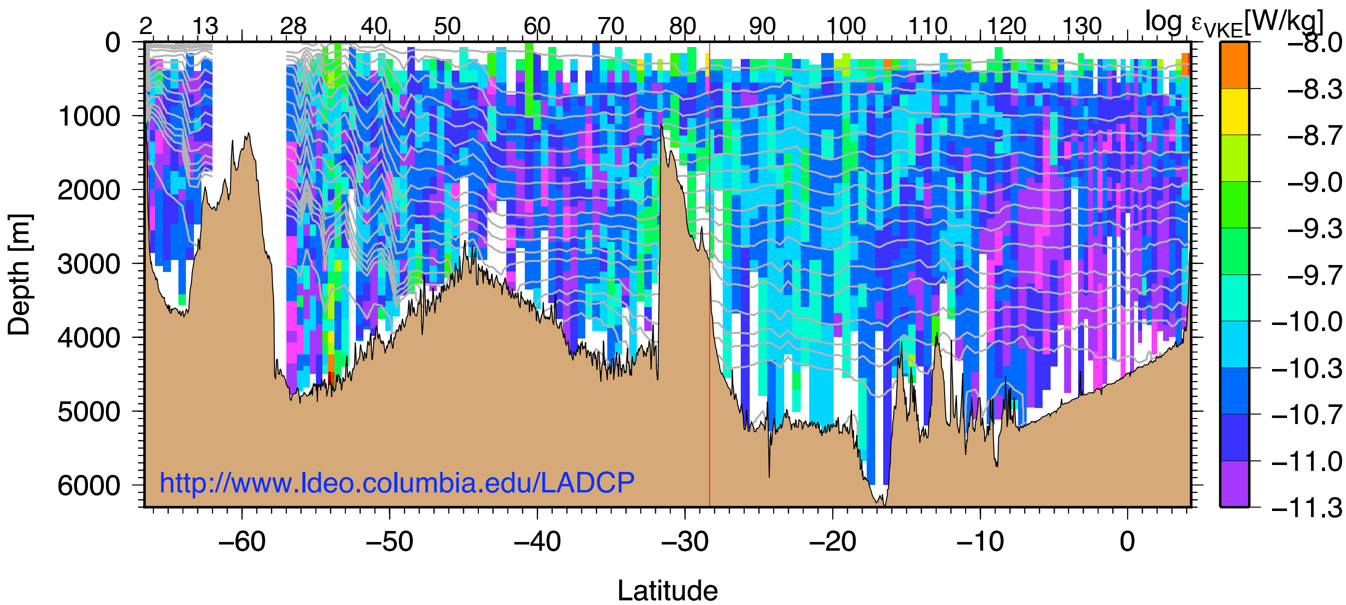

Figure 3. LADCP-derived turbulence levels (W/kg) from vertical velocity measurements, using a novel finestructure parameterization method (Thurnherr et al., GRL 2015), which yields unbiased results at latitudes of 10 degrees and higher but overestimates turbulence levels close to the equator. Grey contours show equally spaced neutral surfaces. The red vertical line separates the two cruise legs.

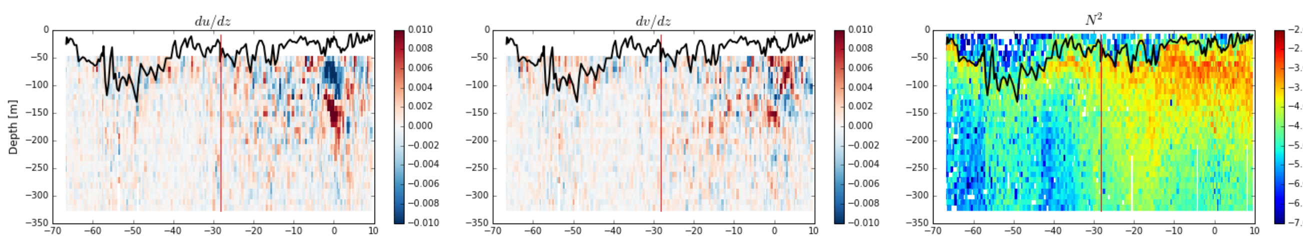

Figure 4. Vertical shear of the zonal velocity (left), meridional velocity (middle) from the SADCP and buoyancy frequency in $\log_{10}$ scale from CTD (right). The black line shows the MLD and the red vertical line separates the two cruise legs. The top 40 meters of velocity has been masked out due to low data quality.

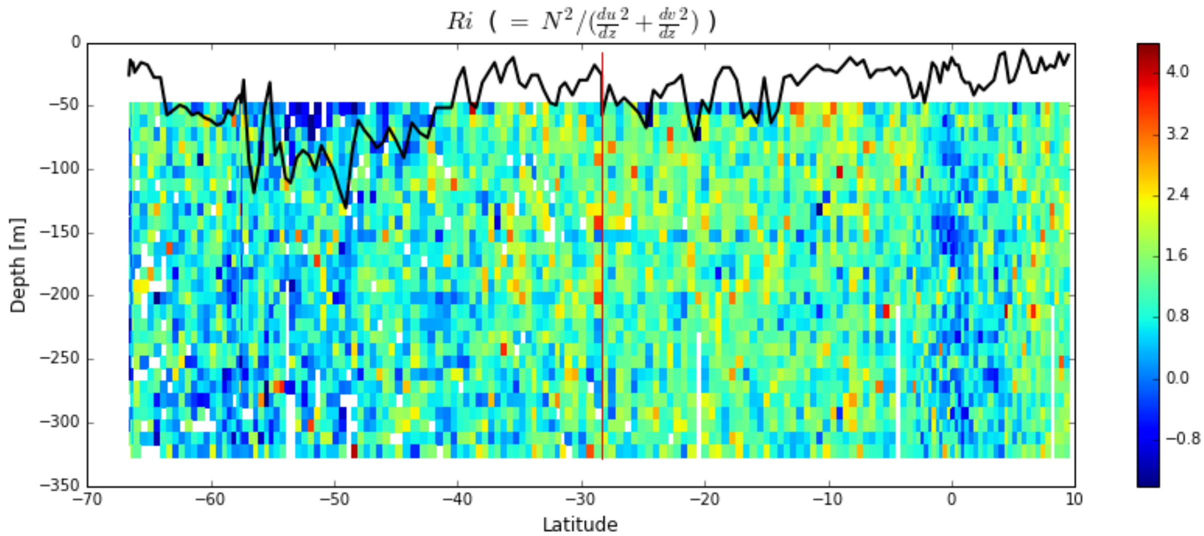

Figure 5. Richardson number in $\log_{10}$ scale. The black line shows the MLD and the red vertical line separates the two cruise legs. The top 40 meters has been masked out due to low quality of velocity data.

Post-cruise processing and additional QC will be conducted at LDEO. At that point it will be determined which profiles are of sufficient quality for inclusion in the final CLIVAR ADCP archives.

References

Dong S., J. Sprintall, and L. Talley. Souther Ocean mixed-layer depth from ARGO float profiles. *Journal of Geophys. Res.: Oceans*. **113(C6)** (2008): 2156—2202

Fernández-Castro B., B. Mouriño-Carballido, V. Benítez-Barrios, P. Couchiño, E. Fraile-Nuez, R. Graña, M. Piedeleu, and A. Rodríguez-Santana. Microstructure turbulence and diffusivity parameterization in the tropical and subtropical Atlantic, Pacific and Indian Oceans during the Malaspina 2010 expedition. ***Deep-Sea Res. I*** (*Accepted for publication*).

Jia F., L. Wu, and B. Qiu. Seasonal Modulation of Eddy Kinetic Energy and Its Formation Mechanism in the Southeast Indian Ocean. *Journal of Phys. Ocean*. **41.4** (2011): 657—665.

McDougall T., and P. Barker. Getting started with TEOS-10 and the Gibbs Seawater (GSW) Oceanographic Toolbox. *SCOR/IAPSO*. **WG127** (2011): 28

Menzenes V., H. Phillips, A. Schiller, B. Nathaniel, Dominigues C., and M. Vianna. South Indian Countercurrent and associated fronts. *Journal of Geophys. Res.* **119.10** (2014): 6763--6791.

Thurnherr A., L. St. Laurent, K. Richards, J. Toole, E. Kunze, and A. Ruiz Angulo. Vertical kinetic energy and turbulent dissipation in the ocean. *Geophys. Res. Lett*. **42** (2015): 794--807