Thermocline Variabilty in the Eastern Pacific Warm Pool

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ABSTRACT

While there is a direct relationship between the thermocline topography and the geostrophic current system (e.g. ridging associated with the North Equatorial Current and North Equatorial Counter Current), the relationship between thermocline topography and sea surface temperature (SST) is more subtle. The thermocline in the northeastern tropical Pacific has a zonally oriented trough-ridge-trough structure that terminates in a bowl and dome system offshore of Costa Rica. The trough-ridge-trough structure is caused by the reduction in the trade winds in the Inter-tropical Convergence Zone (ITCZ). The dome/bowl system is formed by the wind stress curl patterns resulting from Central American Cordillera gap winds interacting with the ITCZ. The thermocline bowl is in the heart of the North East Pacific Warm Pool, while SST above the Costa Rican dome is anomalously cool. In contrast, beneath the ITCZ the thermocline ridge brings cold water near to the surface; yet this region is considered the thermal equator and has some of the warmest surface waters on the globe. The EPIC enhanced TAO moorings along 95W lie in the path of the Tehuantepec wind jet, along the western edge of the Costa Rica Dome, and on the migratory path of the ITCZ. In this preliminary study, 95W mooring data are examined in conjunction with satellite wind, sea surface height, rain, and SST data to identify the structure and evolution of the thermocline topography, in relation to the ITCZ and gap winds.

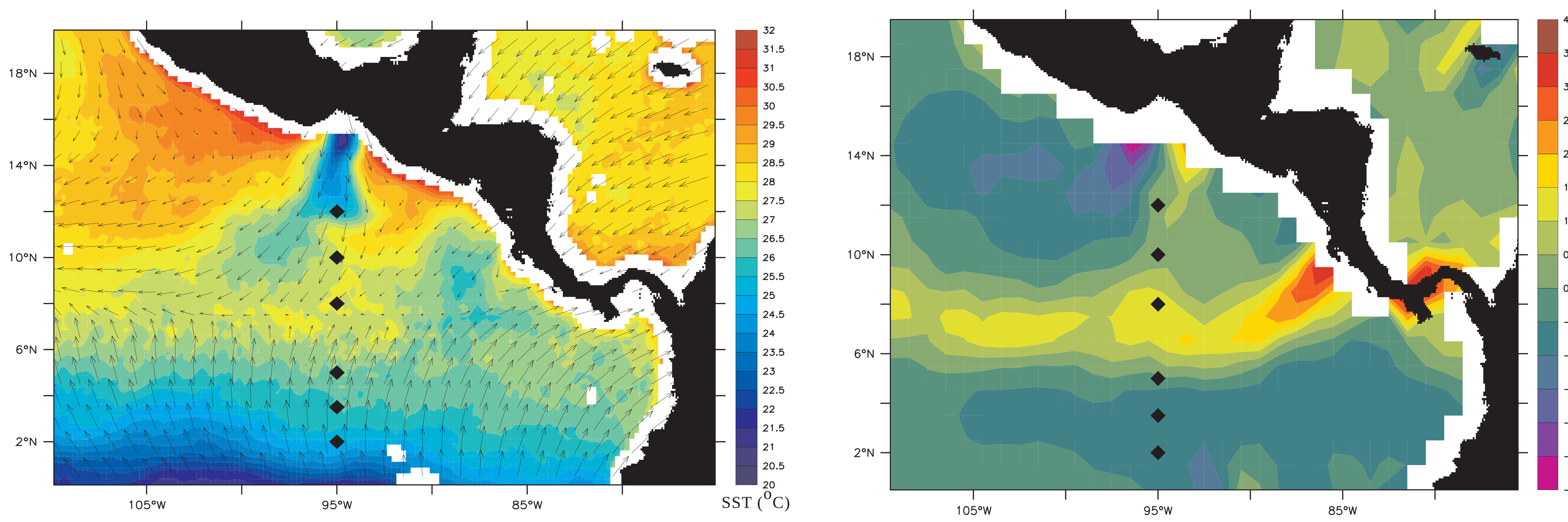

Figure 1. TAO/EPIC moorings along 95W shown in relation to November 2001 TMI SST and QuikSCAT wind fields (left) and in relation to QuikSCAT wind stress curl (right).

The 95W moorings lie directly in the path of the Tehuantepec wind jet. The moorings are also influenced by the positive wind stress curl reaching west from the Gulf of Papagayo.

The effect of the wind forcing can be seen on the sea surface height (SSH) fields shown in figure 2. SSH contours can be interpreted as streamlines of surface current flow.

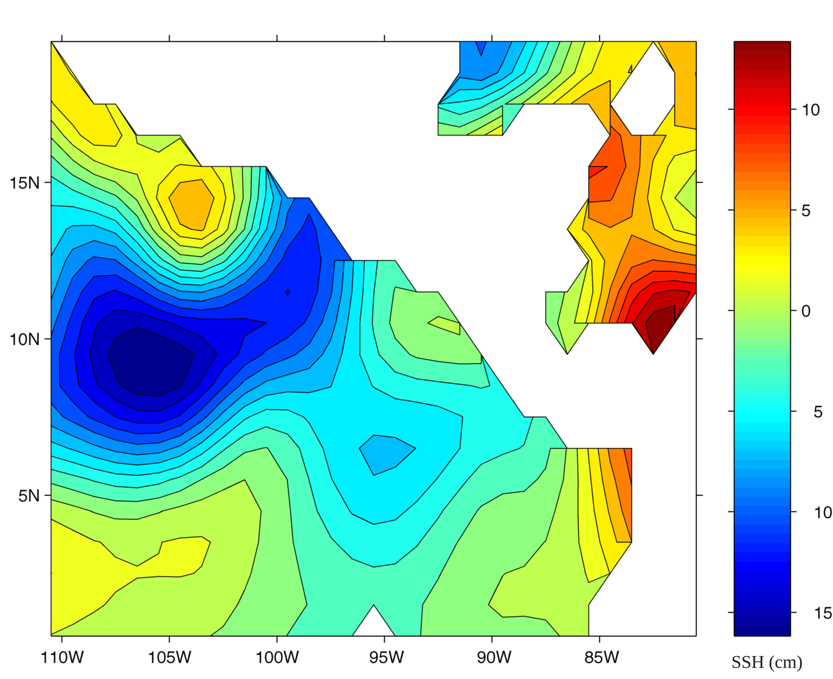

Figure 2. November 2001 TOPEX/POSEIDON SSH

SSH variations tend to be reflected in thermocline depth variations of opposite sign. Thus the Costa Rica Dome's positive thermocline anomalies generally correspond to negative SSH anomalies, while the Tehuantepec Bowl tends to have positive SSH anomalies.

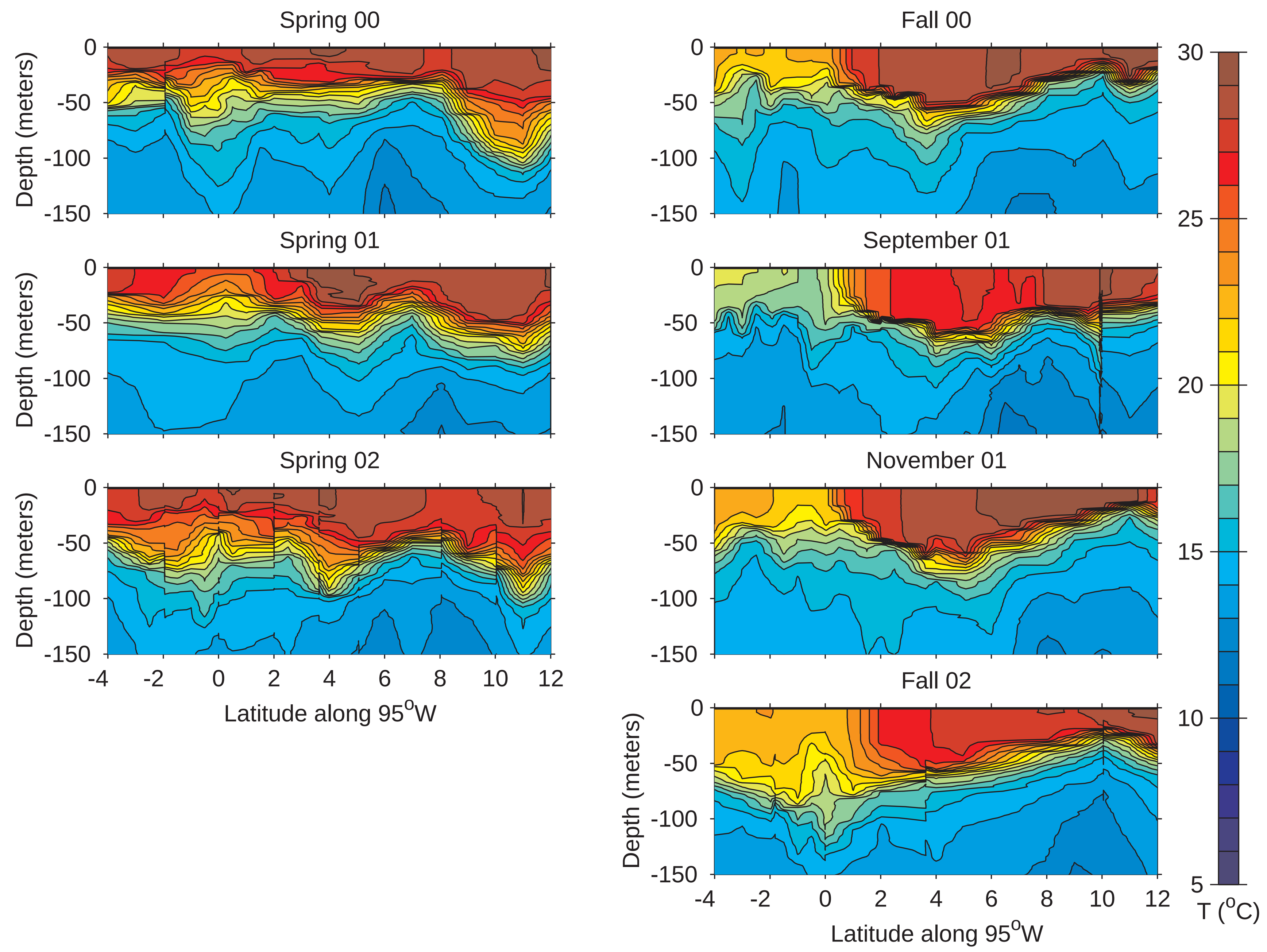

Figure 3. CTD temperature sections from the EPIC 2001 cruise (September 2001) and from the biannual TAO maintenance cruises.

The fall/spring variations in the trough-ridge-trough thermocline structure correspond to the seasonal march of the ITCZ, which modulates the wind stress curl patterns.

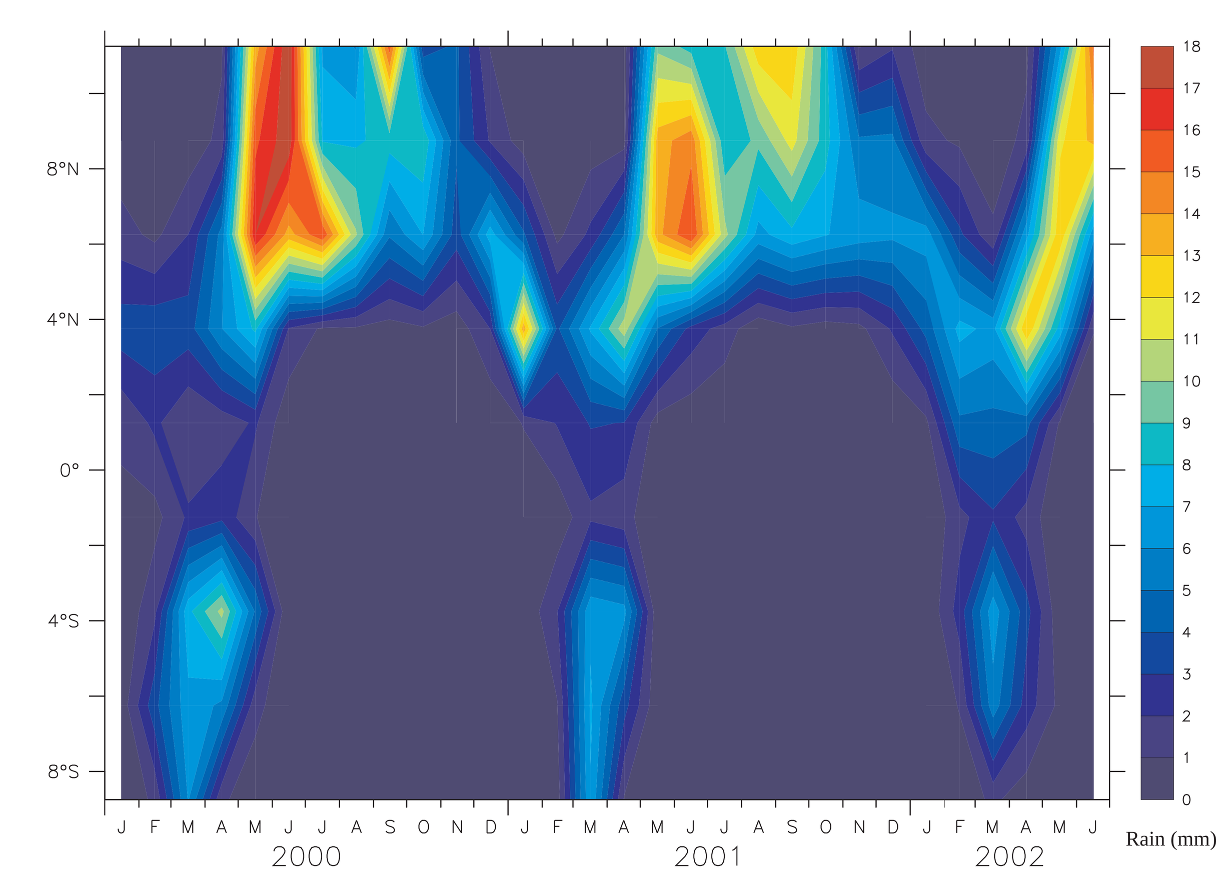

Figure 4. The annual march of the ITCZ along 95W, as seen from Xie and Arkin integrated monthly rainfall.

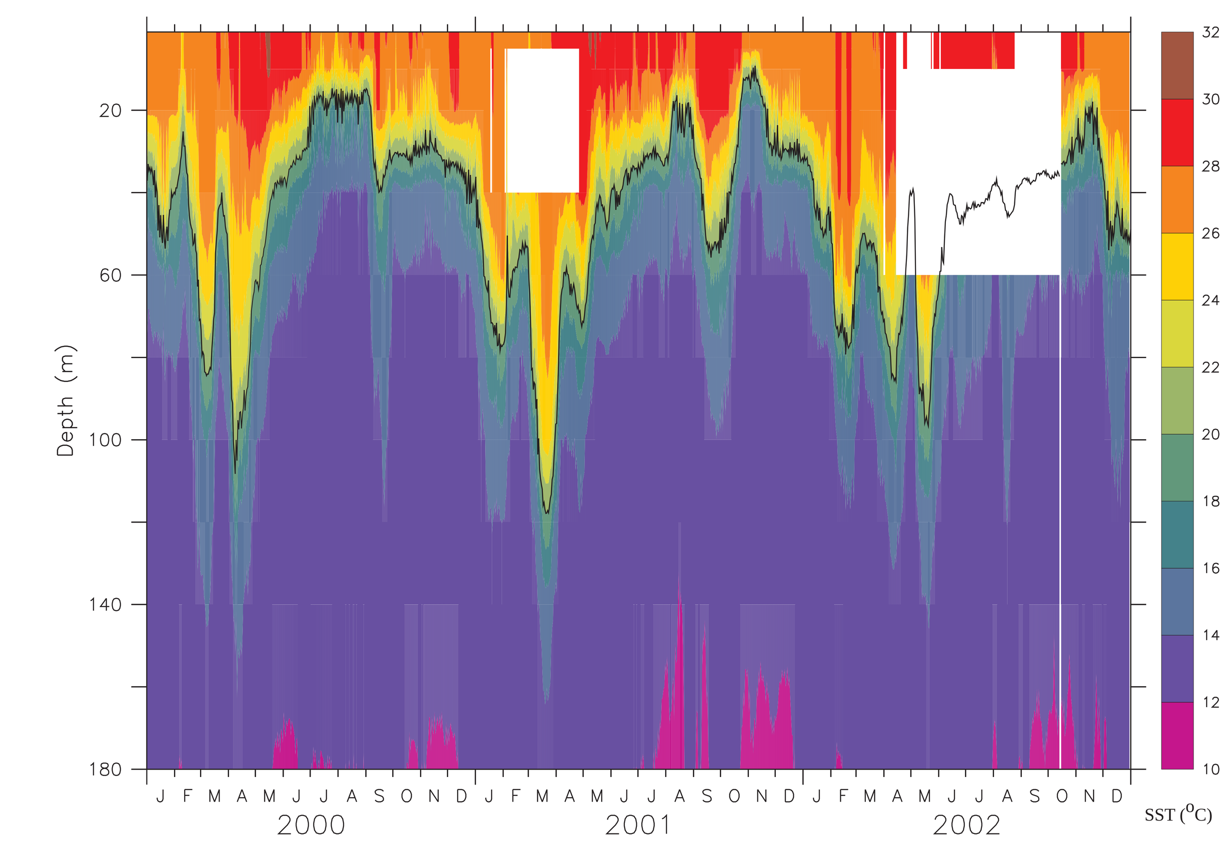

Figure 5. Temperature timeseries from the TAO/EPIC mooring at 10N, 95W. The 20°C isotherm is shown in black.

The annual cycle in thermocline depth at 10N (fig 5) corresponds to Rossby waves (fig 6) forced by changes in the wind stress curl (e.g. fig 1).

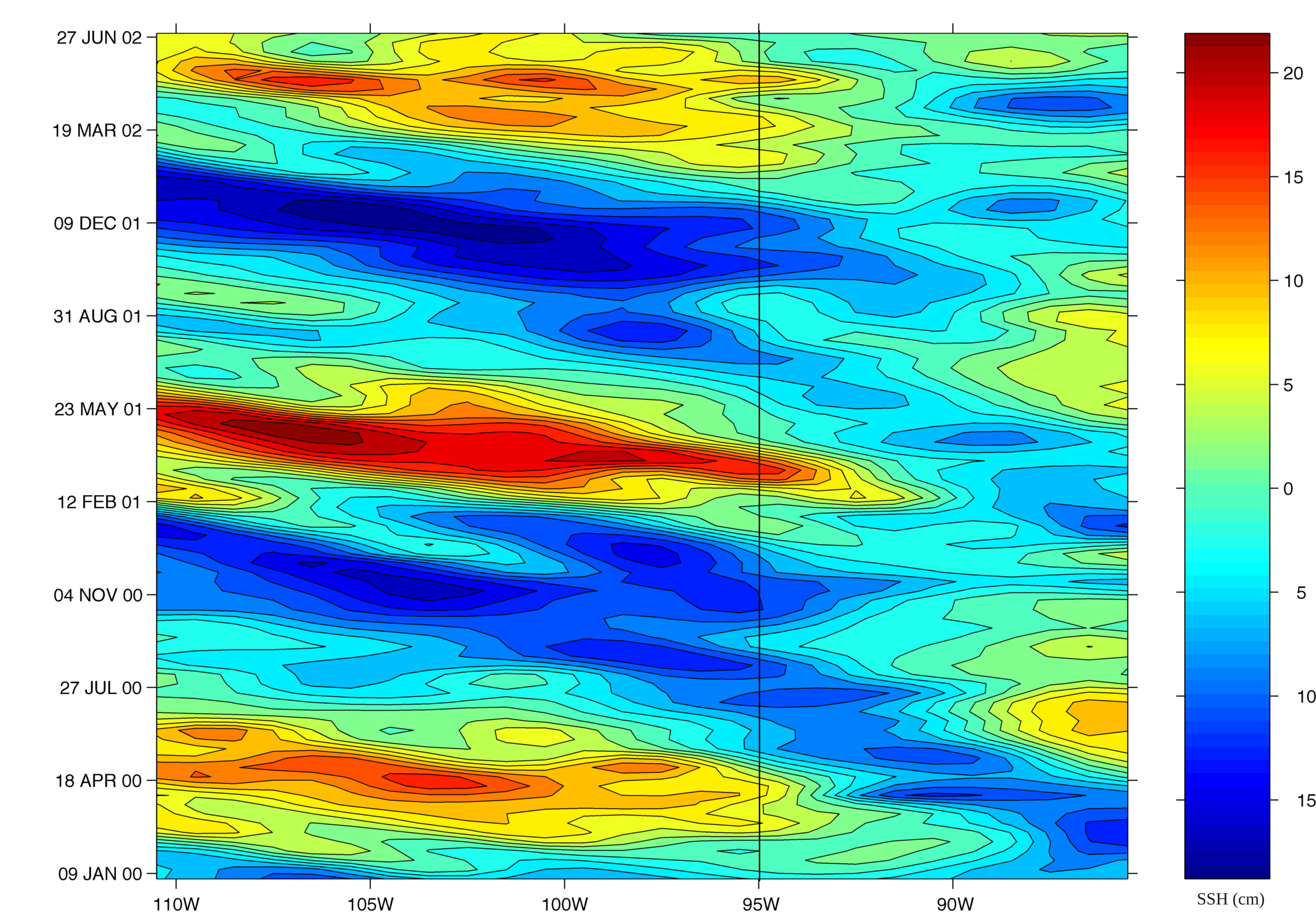

Figure 6. Rossby waves can be seen in the time-longitude section plot of TOPEX/POSEIDON SSH at 9.5N.

Further investigation will include the use of satellite and other data products to identify the Costa Rica Dome's formation and movement, and its influence on the thermocline. Ultimately this study will also involve analysis of the ITCZ freshwater input, regional heat budget, surface buoyancy fluxes and their influence on the coupled ocean-atmosphere circulation patterns.