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Wave activity flux and kinetic energy analysis applied to a cut-off low event in the Southern South America

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Cut-off lows (COLs) affect the South American region with a mean frequency of 17 episodes per year and they develop more frequently off the subtropical coast of Chile, in a region between 30o-45oS and 68o-80oW. Several COL episodes are associated to significant weather events in the extratropical Andes region and La Plata basin as, heavy rains, hail snowfalls, strong winds. To further understand the physical processes explaining both the development and stationary characteristics of the COLs that occur in the vicinity of the west coast of South America, we performed the analysis of the kinetic energy (Ke) equation, during the life cycle of a COL that developed between March 25 and April 2, 2007. We also analyzed the wave activity fluxes, as well as the large-scale circulation conditions during March 2007, to better understand the mean conditions in which the COL were embedded. That particular COL develops when an upper level trough traveling in a westerly wave train extended over the southeastern South Pacific Ocean, deepens. During the cut-off and mature stages, the COL becomes a quasi-stationary circulation pattern off the central coast of Chile for more than four days. Results show that Ke advection by both the mean flow (AKM), and by the eddies (AKP), as well as the divergence of the geopotential flux term (DFG), dominate throughout the COL life cycle. During the COL initial stage, the maximum displacement of Ke to the east is dominated by AKM, while AKP led to an extension of the energy center to the northeast and an energy increase at the northern portion of the trough. In this stage DFG contribute considerably to Ke dispersion from the extratropical regions to the place where the COL develops. During the COL mature stage, a balance is observed between mainly the dominant terms (AKM, AKP, DFG) keeping stationary the Ke center at the region where the low is segregated. DFG is important in the formation of a new Ke center on the COL eastern side and tends to cancel AKP. Along the COL life-cycle, the barotropic term contribution is always secondary while the conversion baroclinic term is almost negligible. At the end of the cut-off stage, AKM decreases extensively in the COL region but dominates at higher latitudes, promoting the eastward displacement of the extratropical waves, and thus the COL isolation. The analysis of wave activity flux and eddy stream function shows that the wave packets in which the COL is embedded, have their source in the southern Australia, eight days before the COL's segregation. Energy spreads from that source region through a Rossby wave train that remains stationary during the following days in the South Pacific region at around 50 ∞S. The analysis of OLR anomalies indicates no tropical influence in the formation of the COL system. In addition, during March 2007, a 3-wave pattern is observed at high latitudes, which seems to have an important role in providing the mean-state conditions favorable for the maintenance of the stationary large scale atmospheric pattern in which COL developed.