

Review of “Deepening mechanisms of cut-off lows in the Southern Hemisphere and the role of jet streams: insights from eddy kinetic energy analysis” by Pinheiro et. al.

Suggested outcome: Major Revisions

Scientific significance: Good

Scientific quality: Good

Presentation quality: Good

This work creates a climatology of cut-off low depth over the Southern Hemisphere and studies the vertical extent and mechanisms that lead to deep cut-offs from an energetics perspective.

General comments:

This study considers the depth of COLs in the southern hemisphere and, by using an energetics perspective, aims to understand the processes at play. The authors have made some progress since the first iteration of the manuscript. The authors tend to simply display the resulting calculations and, in my view, there is still a lack of explanation and detail as to how the processes unfold and why which would increase the impact of their work. As the aim of this work is to understand these processes, I think the authors should try to expand their analysis to highlight the processes at play.

Major comments:

1. There seems to be a lack of dynamical explanations given to explain the observations highlighted by the calculations done. For example, there is an increase in deep COLs with a strengthening in the polar front jet. Can you explain this using the energetics framework used in this work? There is a hypothesis that eddy feedbacks between the surface and the upper-levels. What does this do and how is related to the development of a deep COL versus a shallow COL from an energetics perspective? More detail needs to be added into the discussion and interpretation of the results, particularly associated to how COLs deepen (or not) in the energetics framework chosen, since this is the focus of this work.
2. There seems to be a link between depth and intensity of COLs (ie. Deep COLs are generally strong). Yet, the authors state that jets affect depth and intensity of COLs differently (eg. L245). Are the four categories defined in this work interdependent? If so, should they be looked at separately and how why do the different jets impact deepening and intensity differently?

Specific comments:

- L98: “if mean separation” – missing “the”?
- L110: what are the reasons for the choice of extension level (400hPa for shallow; 800hPa for deep).
- L112-113: where is the track is intensity metric calculated? Is it the most intense value in the track? Or mean? Be specific.
- L127-128: Do you just mean monthly means? The sentence is hard to understand.
- L132: “jet streams exhibit relatively small seasonal variations” – is this true of the subtropical jet in the southern hemisphere? The subtropical jet is barely visible in the mean in summer for example (ie. Fig 3).
- L145: Missing “”?
- L162: Do you mean Section 2.3?
- L166: Deep and strong COLs show similar frequencies and distributions – it may be useful to provide some statistics of the various combinations. Are most strong COLs also deep?
- L184-185: RWB occurs in regions of weak climatological zonal flow and RWB is also associated with the development of COLs. The authors further state in L193-194) that COLs occur in regions

of weakened westlies. However, in the authors results the find that deep COLs occur most frequently during polar jet stream increases during transitions seasons and mention that this is consistent with previous RWB work. Could you clarify this alignment and elaborate?

- L213 and L218: “anticyclonic vorticity” – do you mean anticyclonic barotropic shear?
- L285: “poleward jet shifts to the east” – I do not really see this occurring in your figures. Could you be more specific? Maybe plotting the jets on some of these timelags may help.
- L290: How do we see momentum transfer from the jet into the COL from your results?
- L293: “stationary nature of Rossby waves” – surely we are talking about transient Rossby waves here and not stationary waves?
- Section 3.5: The residual is presumed here to be mostly connected with diabatic processes. This is of course a reasonable assumption. However, is it possible that some of the residual is generated by frictional processes associated with deep COLs? Do the residuals on different surfaces reveal anything here?