

## Diabatic jet streak intensification during serial cyclone clustering: the North Atlantic case of February 2022 Egusphere-2025-4871

This paper aims to determine if diabatic heating is a pathway for jet streak intensification during an extratropical cyclone clustering event involving cyclones Dudley and Eunice. The authors perform a novel jet-streak centred analysis to quantify the temperature tendencies occurring either side of the jet axis and attribute tendencies to either diabatic or adiabatic processes. They also perform a sensitivity study varying the latent heating to establish a mechanism by which diabatic processes influence the jet streak intensification. Overall, the paper was enjoyable to read, and the results are clearly presented although some of the figures could benefit from improved colour bars. However, I feel that the authors have set the problem up as a bit of a false dichotomy, i.e. the intensification of the jet is either latent heating or double-sided Rossby wave breaking. The results suggest that both are playing a role. Diabatic processes enhance the jet streak in the initial intensification phase, but the second intensification prior to the genesis of cyclone Eunice appears to be more strongly influenced by adiabatic processes. I feel that focusing on only one phase of the jet streak is not telling the whole picture.

### General comments

1. Lines 142-145: The experimental design is described here in 4 sentences. It would be nice if more details were given here to explain the motivation behind this design. For example, could you introduce this approach generally saying something like 'Jet streak intensification is partly driven by diabatic heating associated with convection and cloud microphysics, but also strongly influenced by dynamical temperature changes associated with advection and vertical motion)' and then explain your partitioning? I also think it would be a good idea here to explicitly say that Rossby wave breaking would influence the jet through the dynamical temperature tendencies. Finally, there is a caveat to be noted that although Rossby wave breaking itself is dynamical, it interacts strongly with diabatic processes. Latent heating in warm conveyor belts can amplify upper-level ridges which can lead to Rossby wave breaking. Once RWB occurs, the dominant temperature tendencies near the tropopause are usually advection and adiabatic processes not diabatic processes. So Diabatic heating may initiate or precondition RWB and explain why dynamical heating dominates after the diabatic heating.
2. Line 190-197: One major conclusion from the paper is that RWB does not significantly intensify the jet. To justify this conclusion, a more rigorous quantitative analysis is required than is presented in this paragraph. By how much is the jet streak intensified between T+60-T+90h and how does this compare to the strengthening between T+15-T+45h when diabatic processes dominate? I also wonder if there is some value in thinking about the jet intensification relative to local climatology. Priestley et al. (2020) in their lagged composites of jet speed show 250hPa wind speed anomalies. Given the jet streak propagates from a region of high climatological jet speed to one of lower climatological jet speed, does this help understand in some part the relatively small intensification in the later period in which dynamical processes dominate and help reconcile the apparent contradiction with the Priestley conclusions?
3. Line 312: The authors focus their analysis on the initial intensification period'. I understand that this is T+0-T+60h when cyclone Dudley is developing and crossing the upper-level jet. I was left wondering what happened when Eunice developed and reached maturity. Is the same pattern of diabatic heating, followed by adiabatic heating occur or something else?
4. Lines 348-351: The conclusion that diabatic heating drives jet streak intensification is too simplistic. It drives the jet streak intensification in the first phase of the jet streak lifecycle. Similarly, the conclusion that Rossby wave breaking is secondary only applies to the first phase of the jet streak lifecycle. There is evidence of double sided Rossby wave breaking in all the simulations at T+60h. Following the RWB the jet intensifies, and the adiabatic heating dominates. This suggests that the intensification of the jet after T+60 may be dominated by RWB, I think.
5. Line 71: If your research question is 'What is the relative role of latent heat release in jet streak intensification' then you need to quantify how much of the intensification is due to

latent heating compared to other processes. In several places, noted in the comments below, quantitative comparison was missing. It should be straightforward to include some more quantitative statements to support the subjective statements.

### Specific comments

6. Line 13:  $L_v$  is not defined.
7. Line 17: Remove 'more' as weaker is already a comparative adjective.
8. Line 23: Why 'often referred to'? Are there alternative words used to describe this kind of cyclone clustering?
9. Line 51: What are 'instantaneous jets'? Is this terminology used to differentiate from time-averaged winds that might constitute the jet stream? If so, how do they differ from jet streaks?
10. Lines 87-89: Here the authors start by stating the structure of the paper, but then they state their results/conclusions. If this paragraph is to introduce the structure of the paper, then it shouldn't include results/conclusions.
11. Figure 1a-c: This figure uses a rainbow colour bar which has been shown to be problematic for several reasons including common red-green colour blindness and non-perceptual uniformity. Please use an alternative.
12. Figure 1d-f: Why was a divergent colour bar used for this field which is positive everywhere? Also, why is equivalent potential temperature shown in °C but potential temperature is shown in K?
13. Line 106 and 181: I wonder if you could make some reference here to the respective wavelength of the planetary-scale Rossby wave in which the jet streak is embedded and the synoptic-scale Rossby wave constituting the cyclone Dudley and their respective phase velocities. This might help readers understand how the cyclone can 'propagate through the jet streak'. Also, on line 181 the authors calculate the propagation speed of the jet streak. Is this consistent with the estimated phase velocity?
14. Line 109: How can the jet 'remain' fragmented when this is the first time in your analysis?
15. Line 117: What is 'robust' moisture flux? I was confused by this word.
16. Line 120: The authors claim that the moisture flux sustains baroclinicity. Although they go on to show this, there is no evidence at this point in the paper to support this statement.
17. Line 129: What makes this case an 'extraordinary jet streak lifecycle'. There is no climatology presented in the paper, so it is difficult to judge how rare this jet streak is. In fact, if it were rare, it might imply that the results of the case study may not be applicable to other jet streak intensifications.
18. Line 139: Repetition,  $0.5xL_v$  and  $50\%L_v$  are not both needed.
19. Figure 2: There are lots of black lines on this figure (jet axis, perpendicular cross sections, coastlines). Have you experimented with different colours to make the figures clearer? Also, I don't see a black dot in figure 2.
20. Line 182 and elsewhere: What is a 'jet pulse'? Is this the same as a jet streak or are the authors referring to some temporally varying aspect of the jet streak magnitude?
21. Line 185 and elsewhere: the authors refer to a time when Dudley and Eunice 'start to influence the jet structure'. How is this time defined and what happens? This phase of the jet streak lifecycle is not shown in the paper I believe.
22. Line 232 and elsewhere: Instead of a slight increase, could the authors be quantitative? It is up to the reader to determine if the increase slight or not.
23. Line 265: How much weaker is 'substantially weaker', can the authors be quantitative here?
24. Figure 7 and 11a,b: I could not differentiate the colours representing 0.25-1.25 d-1 or 1.5-2 day-1 eady growth rate. This may be my printer, but please could another colour bar be used which has better differentiation be considered?
25. Line 328: What is extreme about this jet streak? The authors do not provide evidence to show that it is particularly unusual.

### Typos

1. Figure 1 caption: 'Februafwry' should be February.
2. Figure 5 caption: 'ar' should be are.