

## **Review comments** **egusphere-2024-2978 (WCD)**

**Title:** Environments and lifting mechanisms of cold-frontal convective cells during the warm-season in Germany

**Authors:** Pacey et al.

**Recommendation:** minor revisions

### **General**

By using automated front detection and convective cell tracking data, this study analyzes the environmental conditions and lifting mechanisms influencing convection near cold fronts in warm seasons in Germany. Results show that pre-surface-frontal cells tend to form in areas with the highest surface dew points and CAPE. Other front-relative regions also support cell formation, though with lower CAPE and dew points compared to non-cell regions. Mid-level humidity helps distinguish post-frontal cell locations from non-cell regions. Pre-surface-frontal cells experience strong large-scale lifting at 850 hPa and 700 hPa, with high convective inhibition. Significant large-scale lifting also appears post-frontal, especially at 500 hPa. Additionally, less sunshine was observed before cell initiation compared to non-cell regions, suggesting that solar heating may not drive most cold-frontal cell initiation.

This study provides a valuable analysis of the atmospheric conditions that influence convection near cold fronts. I find the subject interesting and well within the scope of WCD. It is well written, has a clear structure, and good illustrations. However, I have a couple of minor concerns which can maybe be solved with more explanations. I expand on some of these concerns below and outline additional minor/technical comments.

### **Specific comments**

- The authors study the warm-season in Germany, but only convection related to frontal zones. I assume that a large part of convection occurs in situations with weak synoptic forcing as well. Can the authors comment on the overall relevance of frontal convection in Germany? Moreover, several field experiments were carried out to better understand convection initiation in Germany. At least some of those with their main findings should be cited.
- Some general information about convection initiation is given in the introduction. However, the multiple effects of mountains or land-surface heterogeneities are not mentioned. I recommend enlarging that section with these points, particularly the role of low-level convergence zones.
- One aspect I may have missed in the manuscript is the fact that even if CAPE values are lower in post-frontal regions, the atmosphere is often unstable due to the advection of colder air at higher levels. Warming by solar radiation is then often sufficient to initiate convection in large areas.
- I am a bit concerned about the fact that pre-surface-frontal cells form in environ-

ments with the highest CAPE AND strongest CIN. High CAPE values usually occur at low altitudes of the LFC which also often is associated with smaller values of CIN. Please comment on this.

- The authors detect and track convective cells based on radar data from the DWD. Radar-derived precipitation adjusted to surface observations is also available from the DWD on the same domain. I wonder why this data set is not used for precipitation? Precipitation and in particular convective precipitation is certainly not best represented in the ERA5 data set.
- Why do you need a smoothing of  $\theta_e$  and why 30 times?
- P6: You state that cold fronts reach the southern parts of Germany less frequently. Is this related to the more complex terrain there?
- P6, L162: You state that wind shear affects convective initiation. Wind shear, however, is not a trigger mechanism, it is decisive for the evolution and organisation of the initiated convection. I suggest to write that it affects convection and not convective initiation.
- As for convective precipitation, I doubt that the vertical velocity in the ERA5 data set is really representative for deep convection. Please comment.
- What are the implications for forecasting convective storms near frontal zones? Are there any ways to improve numerical models with these findings?

### Technical comments

- P3, L85: Paramter → Parameter
- Line breaks occur between numbers and their units throughout the entire manuscript (e.g. P4, L117-118). Please correct that everywhere.
- P6, L151: ...bin at at the current...
- P6, L165: A full list... are **is** shown...
- P6, L177: The quasi-geostrophic forcing for ascending and descending motion can be **measured** using the Q-vector convergence... I think "measured" is not the best word here as this is not a measurement. Maybe "expressed" or "described" are better options.
- P10, L286: This result highlights the importance of upper-level forcing **particularly** on the development of convective cells **particularly** at the 700 hPa front and also post-700-frontal. Please rephrase.
- P14, L408: 16 C → 16°C
- P17, Fig. 2 caption: celcius → Celsius
- P20, Fig. 7 caption: Postive → Positive
- P29, L509: 1. ~~auf~~, edn.