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Beyond Warm and Cold: An Objective Classification for Maritime Mid-Latitude Fronts

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The distinction between warm and cold fronts is one of the essential building blocks for our understanding of mid-latitude dynamics. The distinction is well founded in conceptual models describing the life cycle of extratropical cyclones, but has also proved helpful in a wealth of other contexts. However, in these conceptual models there exists a third front type, occluded and bent-back fronts, respectively, that is independent of the distinction between warm and cold. To accommodate for those, as well as to better capture differences between individual cold and warm fronts, we introduce a comprehensive and more detailed classification of mid-latitude maritime fronts.

To this end, we objectively detect three-dimensional front objects in the ERA-Interim data set, and classify them using an EOF analysis. In addition to the distinction between warm and cold fronts, the EOF analysis exposes several further dimensions of variability between front objects: (a) front intensity, (b) surface fluxes and (c) intensity of the associated conveyor belts. These additional dimensions of variability are robust, because they consistently make up the dominating patterns of variability between fronts in a large number of locations in the Atlantic, Pacific and Indian oceans. We also demonstrate the dynamical significance of the additional dimensions by lagged composites that illustrate the different temporal evolution for the different front types. Finally, we show that the additional front types can be redefined based on simple parameter thresholds, such that our results can easily be applied to other contexts without repeating the EOF analysis.