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How do fronts of differing types arise?

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This study is based on a recently proposed detailed front type classification. In addition to the well-known distinction between warm and cold fronts, this classification also takes into account (a) front intensity, (b) surface fluxes, and (c) intensity of the associated conveyor belts to distinguish between many additional front types. While these additional distinctions appear physically meaningful, the dynamical processes leading to these differences remain unclear.

We investigate the dynamical differences between fronts of different types using the Bergen Dynamic Model (Bedymo) to simulate the dry hydrostatic evolution of fronts in the cross-frontal plane. In this model, frontogenesis is forced by basic-state deformational (but non-divergent) flow which compresses the initial temperature gradient in the cross-frontal direction. Despite its very idealised character, this model setup can generate fronts covering all types of the proposed front type classification. We achieve this variety by (a) introducing a basic-state vertical wind shear to vary front intensity, (b) adjusting the initial surface pressure distribution to vary the character of the conveyor belts associated with the front and (c) introducing a surface sensible heat flux. We analyse the differences in the dynamical evolution of these differing front types up to their respective frontal collapse, comparing amongst others the cross-frontal Sawyer-Eliassen circulation.

Finally, we remark on the difficulties and potential ways to represent the well-established difference between warm and cold fronts in this idealised modelling framework excluding boundary layer and moist processes. We suggest that the distinction might be best represented by varying the background static stability to create varying frontal slopes.