A Simple Parcel Theory Model of Downdrafts in Convective Clouds

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Taste of Research 2021

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Abstract

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Acknowledgements

The author is most grateful to his supervisor, Prof. Steven Sherwood, for his patient guidance and mentorship during the ten-week research project whose outcomes are documented in this report. The author also thanks the members of Prof. Sherwood's research group at the UNSW Climate Change Research Centre for some useful suggestions and feedback.

The author would also like to thank the UNSW School of Physics for offering the Taste of Research program under which this project was conducted, and in particular the program coordinator, A. Prof. Sarah Martell. The program has proved to be a very valuable and enjoyable learning opportunity.

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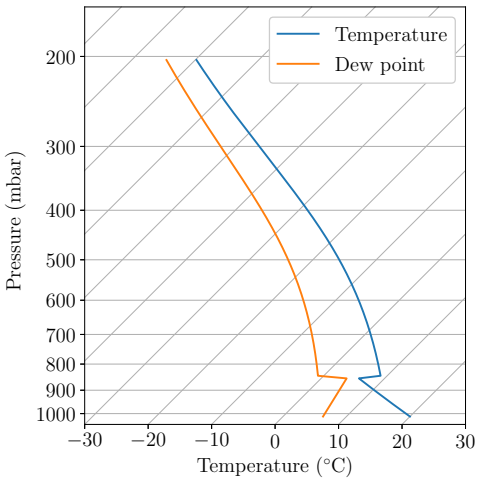

Figure 1: Skew T-log p plot of the idealised atmospheric sounding used in Section 4.1.

4.2 The impact of entrainment

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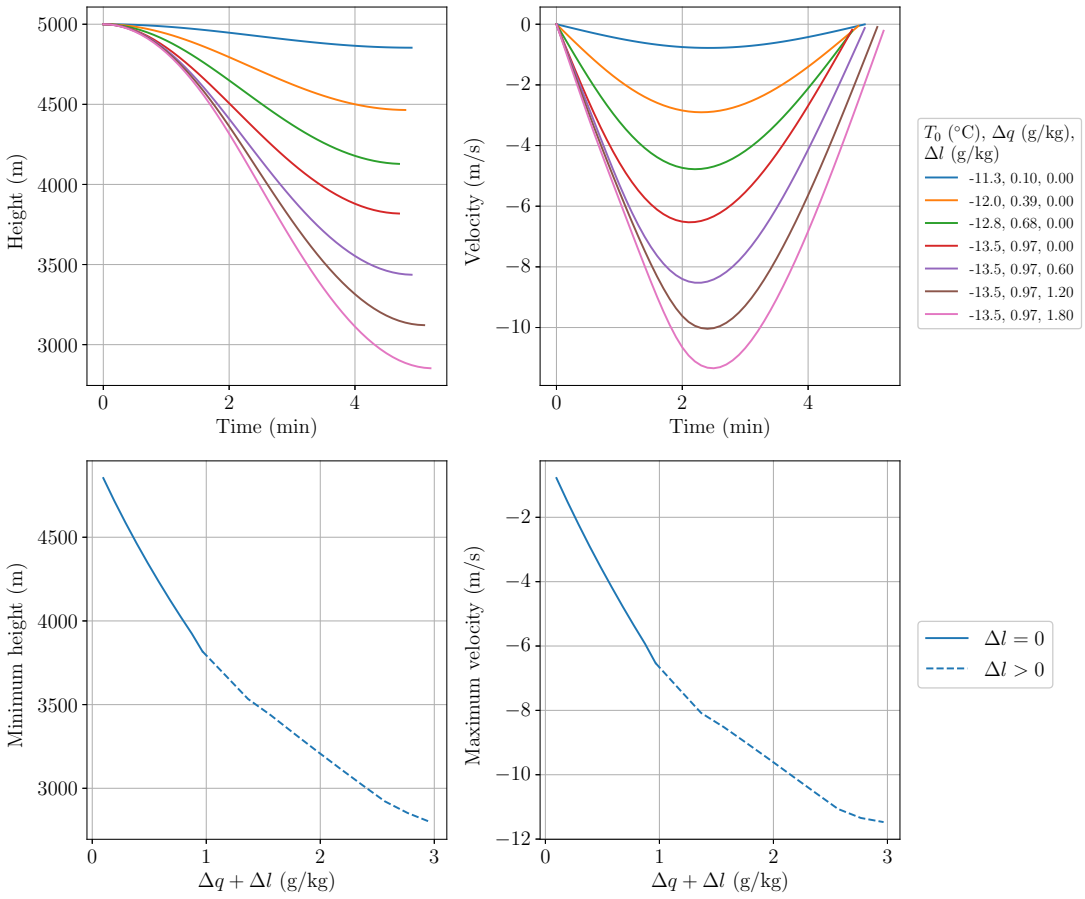

Figure 2: Properties of a downdraft parcel originating at height 5 km in an idealised atmospheric sounding with 50% relative humidity in the upper atmosphere and a fixed entrainment rate of $1\,\mathrm{km}^{-1}$. Top row: height (left) and velocity (right) as functions of time, for selected initial conditions. Bottom row: minimum height reached (left) and maximum downward velocity (right) as functions of the total amount of water initially added to the parcel (specific humidity change due to evaporation Δq plus additional liquid water per unit parcel mass Δl).

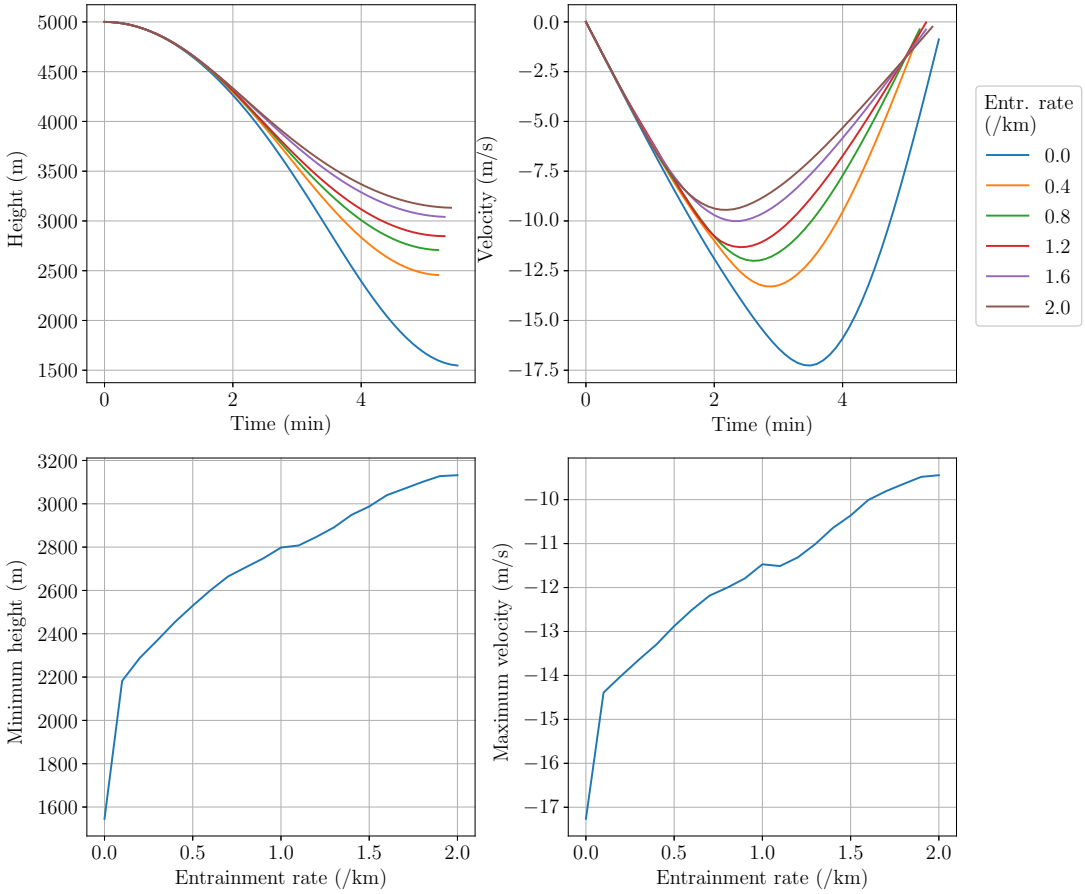

Figure 3: Properties of a downdraft parcel originating at height 5 km in an idealised atmospheric sounding with 50% relative humidity in the upper atmosphere. The initial conditions are fixed: an environmental parcel is brought to saturation by evaporation of liquid water, and $2\,\mathrm{g\,kg^{-1}}$ liquid water is additionally suspended in the parcel. Top row: height and velocity over time for selected entrainment rates. Bottom row: minimum height reached and maximum velocity as functions of entrainment rate.

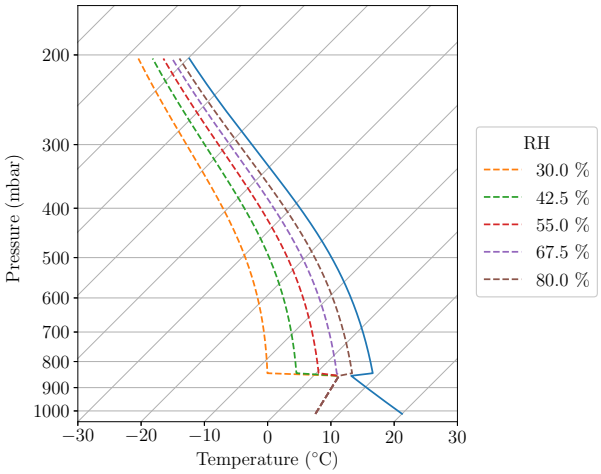

Figure 4: Skew T-log p plot of some selected idealised atmospheric soundings used in Section 4.3. The dashed lines on the left are the dewpoint profiles for the different soundings, and the solid blue line on the right is the common temperature profile.

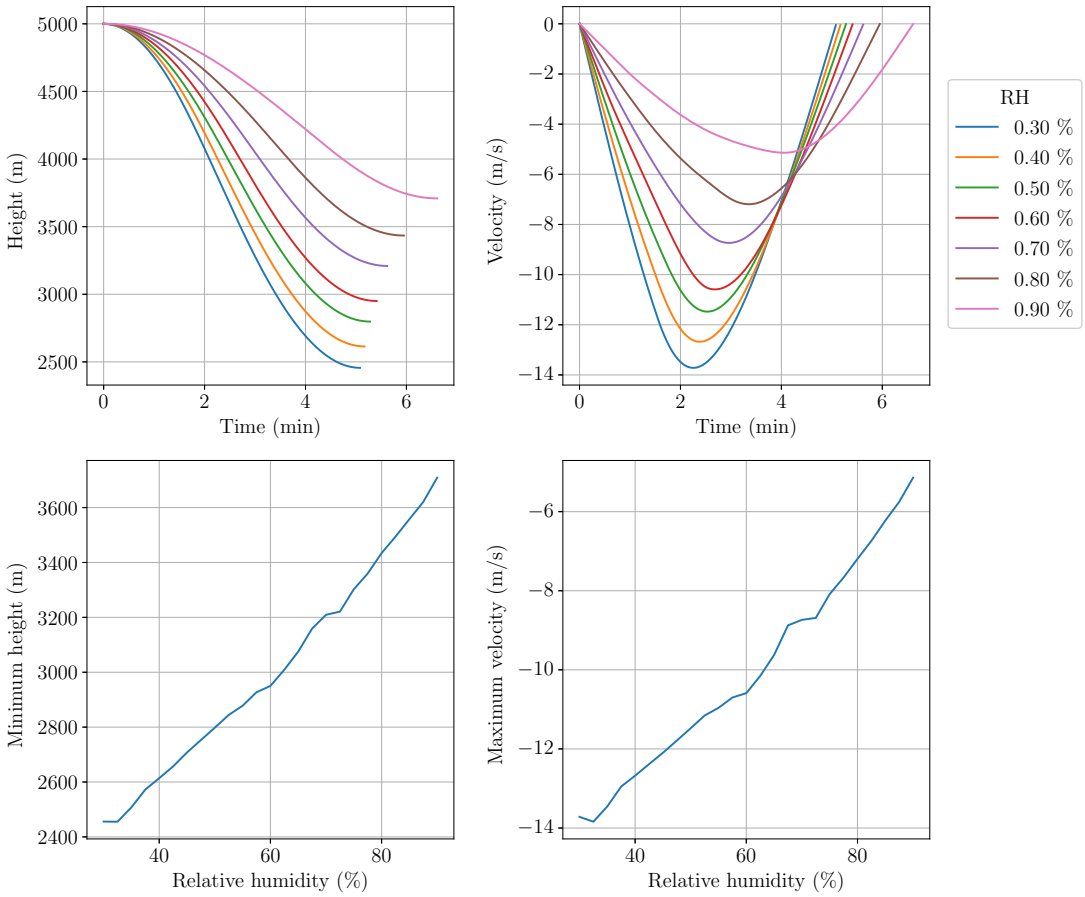

Figure 5: Properties of a downdraft parcel originating at height 5 km in idealised atmospheric soundings whose upper atmosphere relative humidities vary between 30% and 90%. The initial conditions are generated by bringing an environmental parcel to saturation by evaporation of liquid water (note that the resulting temperatures differ since more humid environmental parcels are closer to their wet bulb temperatures), and $2\,\mathrm{g\,kg^{-1}}$ liquid water is additionally suspended in the parcel. Top row: height and velocity of the parcel over time for selected soundings. Bottom row: minimum height reached and maximum downward velocity as functions of relative humidity in the upper atmosphere.

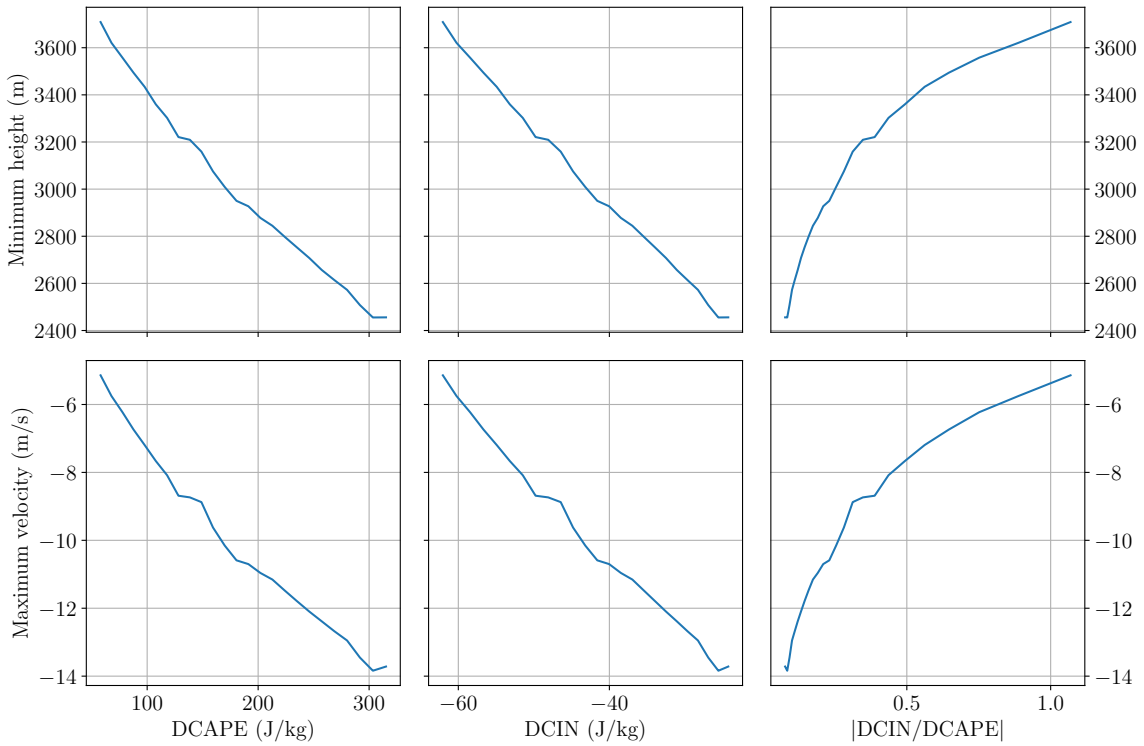

Figure 6: Plots of the minimum height (top row) and maximum downward velocity (bottom row) reached by the parcel of Figure 5 as functions of the downdraft convective available potential energy (DCAPE, left column), downdraft convective inhibition (DCIN, centre column) and the ratio |DCIN/DCAPE| (right column).