

# Declaration of authorship

The candidate confirms that the work submitted is her own and that appropriate credit has been given where reference has been made to the work of others.

This copy has been supplied on the understanding that it is copyright material and that no quotation from the thesis may be published without proper acknowledgement.

The right of Anne Barber to be identified as Author of this work has been asserted by her in accordance with the Copyright, Designs and Patents Act 1988.

© 2020 The University of Leeds and Anne Barber

To my dear Grandad, Noel Broadberry, for inspiring and encouraging me to pursue a career in Atmospheric Science.

# Acknowledgements

I would like to thank my brilliant supervisors - Professor Alan Blyth, Drs. Steven Böing, Andrew Ross and Alison Stirling - for their expertise and guidance over the last four years. Alan, thank you for the Big Picture chats, the cups of coffee and your constant, infectious enthusiasm. Andrew, thank you for your patient explanations of difficult mathematical concepts, and for helping me navigate the rocky emotional road of a PhD. Alison, I am grateful that you involved me (a fledgling scientist!) in Paracon from the beginning, and showed me how my small contribution to research could fit into the wider, exciting task of building a new parametrisation. Finally, Steef, I want to extend my biggest thanks to you: for being there every step of the way, pushing me to achieve my best and, of course, always being available for ‘quick chats’ that inevitably turned into hour long discussions over tea.

As is the case with every research student, I had a lot of additional help along the way. I’d like to thank Dr Leif Denby for always lending a friendly ear and a critical eye (in a good way!). Thanks to Richard Rigby, Drs. Adrian Hill and Chris Dearden, without whose help I would possibly have never run a single model simulation. Cheers also to my lovely office mates - Sam C, Sam H, Craig, Dean and Beth - who let me bounce ideas off them, and whisked me away for coffee and a chat when things got too much.

Finally, on a personal note, thank you to the excellent Haddon Road girls - Josie, Sarah, Laura, Lau and Anya. Meeting you all made the process of compiling and writing a thesis a lot less painful and a lot more Tea, Cake and Good Times. I hope soon, in a post-Covid world, we can all meet again and celebrate in a proper fashion. Special obligatory shout-out to our house guinea pigs, Hagrid (RIP buddy) and Merlin, for always being the fluffy potatoes they were born to be. Thanks Mum and Dad for bringing me constant cuppas in the last couple of months! And last but not least, Richard B Brookes, who I could always rely on to send me a great photo of a dog during the really hard moments.

# Credits

This work was made possible by funding from both the Natural Environment Research Council and the Met Office.

This research could also not have been completed without the use of the MON-SooN supercomputing system - a collaborative facility supplied under the Joint Weather and Climate Research Programme, a strategic partnership between the Met Office and the Natural Environment Research Council.

Many thanks to Dr Lindsay Bennett, Dr Jeffrey French and Dr David Leon for allowing the use of their data collected during COPE. Thanks as well to the Met Office Cardington for providing the COPE radiosonde data used widely throughout this work.

# Abstract

# Abbreviations

# Contents

# Chapter 1

## Introduction



## Chapter 2

# Literature Review

# Chapter 3

## Methodology

## Chapter 4

# Using Homogeneous Surface Fluxes to Produce a Convective Cloud Population in MONC

## Chapter 5

# Convective Boundary Layer Controls on the Initiation and Development of Non-Precipitating Shallow Cumulus Clouds

## Chapter 6

# Gravity Wave Controls on the Initiation and Development of Non-Precipitating Shallow Cumulus Clouds

# Chapter 7

## Discussion and Future Work

# Appendices

# Appendix A



# Appendix B

# Appendix C

# Appendix D

# Appendix E

# Appendix F

# Appendix G

# List of Figures

# List of Tables