

Report on visit to NCAR funded by RMetS Rupert Ford Travel Award

Visit dates: 26th-30th August 2024

The financial support granted to me by the society through the Rupert Ford travel fund was awarded to support a research visit to the Climate & Global Dynamics (CGD) group at NSF-NCAR (National Center for Atmospheric Research), Boulder, Colorado. At NCAR my visit was sponsored by Dr Jon Petch, the CGD group leader.

The invitation to visit the CGD group came following discussions with Jon developing a joint research grant application under the shared NERC-NSF funding scheme programme. The grant topic would relate to diagnosing the upscale impacts of convection on the large-scale atmospheric circulation in the latest generation of global convection-permitting climate models. Such questions are now tractable to scientific study due to the advent of exascale computing resources which have permitted the completion of multi-year simulations which explicitly resolve convective dynamics. Unfortunately, due to administrative technicalities we were unable to pursue the application with NSF-NCAR as a funded partner – the grant development therefore formed the basis of a NERC Pushing the Frontiers grant submitted July 2024, and a visit to the group in Boulder prior to my participation in the Convection Permitting Climate Modelling VIII conference at Colorado State University, Fort Collins.

During my week at NCAR, I was provided desk space in the CGD Mesa lab building. My time primarily comprised in-person unstructured scientific discussions with many members of the CGD and Mesoscale & Microscale Meteorology (MMM) groups. These primarily focussed on discovering the research interests of scientists in these groups, sharing my own personal work, and identifying mutual areas of interest which may be developed in future. My visit also coincided with those of Jun-Ichi Yano (CNRS) and Dan Lunt (Bristol), with whom I also shared work and ideas, while I was also very fortunate to be able to briefly visit the Tropical Meteorology group at the NOAA campus (National Oceanic and Atmospheric Administration) in Boulder and discuss my research with another world-leading group.

An especially important outcome of my visit was bridging the gap between the climate communities in the USA and UK. I was surprised at the segmentation of climate and weather modelling in the USA, and the disparate plethora of multiple modelling endeavours which even local practitioners struggled to keep up to date with. Meanwhile US colleagues were impressed by present CP modelling capabilities under development by the Met Office, and prior key projects such as the CP4A multi-year present and future climate simulations covering the African continent. It became rapidly apparent that there is a significant partition in the body of literature familiar to US and European atmospheric scientists working on convection – I was unaware of key literature from US groups, while many seminal findings from UK and European groups were not known at NCAR. This was a great surprise to both sides. The contacts and learning established through my travel award will continue to slowly better integrate our research communities.

A highlight of my visit was the opportunity to present my personal research in a formal joint CGD-MMM seminar. This one-hour talk was given in person at the MMM Foothills lab on Thursday 29th August, at the invitation of Dr Hugh Morrison. The seminar was recorded and remains available at https://www.youtube.com/watch?v=6v0r_smwPaY. In my talk I presented two strands of research conducted through my postdoctoral role on the NERC grant “Land Impacts on Mesoscale Convective Systems” (LMCS). I discussed the influence of vertical wind shear on MCS rainfall in CP simulations (published in *Geophysical Research Letters* the next month, <https://doi.org/10.1029/2024GL110119>); and the role of convective cold pools in MCS dynamics over the West African Sahel. Both topics were of great interest

to the groups at NCAR, which host world-leading experts in MCSs, their interaction with wind shear, cold pool dynamics, and CP modelling. My talk was received very positively and followed by questions and discussion. I am extremely grateful to the Society for enabling me to present my work to such a major international group – moreover, this activity has proven to be a highlight activity of the wider LMCS project.

At the time of my visit, I was beginning the process of writing up the cold pools work I presented into a research article. This article came to be influenced substantially by multiple conversations I had during my time at NCAR with Dr Mitch Moncrieff. My study had already been greatly influenced by Mitch's papers, in particular his 1988 work with Andrew Crook where they showed that MCSs can be maintained and propagate through gravity wave dynamics, rather than a cold pool density current, in the presence of large-scale background convergent flow. I was able to show this criteria in a sensitivity experiment where MCS cold pools were suppressed by turning off rainfall evaporation in the MetUM microphysics scheme. Discussing this work with Mitch was a fantastic opportunity, and he prompted me to pursue some new lines of investigation to further probe the mechanisms of storms in the absence of cold pools. The conversations and advice directly led to an entirely new figure demonstrating that Sahelian MCSs without cold pools still show the upper and midlevel atmospheric flow structure shown in other papers by Mitch to be fundamental to maintaining an MCS. This figure was introduced into my paper draft; in this manner, my discussions with Mitch during my visit directly contributed towards the development of a research article which I have since submitted to the Society's Quarterly Journal. The article is presently in review but is available as a preprint

(<https://doi.org/10.22541/essoar.173161634.46945036/v1>) – the Figure in question is Fig. 10. Both Mitch's contribution, and the financial support from the Society which enabled it, are acknowledged in the paper.

In summary, my visit to Boulder was an immensely productive week which provided me a superb opportunity to share my research with world-leading scientists, directly contributed towards a research article, and expanded my scientific network beyond the UK and European atmospheric dynamics communities. As an Early Career Researcher this final point is especially invaluable to me, and I continue to build on connections made during my time at NCAR. I will be contributing towards a second stage of the international MCSMIP tracking intercomparison in part facilitated by Dr Julia Kukulies, and in April 2025 will be hosting Dr Erin Dougherty for a reciprocal visit to Leeds – both Julia and Erin are NCAR postdocs with common interests to myself, and whom I hope to collaborate with further.

Finally, I would like to take the opportunity to express my sincere thanks to the Society for the financial support that made this visit possible. It has been a highlight of my postdoctoral career, and provided a unique opportunity to build independent research links in the USA. I would also like to particularly thank Jon Petch for sponsoring my visit; Dr Rich Neale for organising my schedule and desk in addition to fruitful discussions; Dr Brandon Wolding for enabling my visit to NOAA; Mitch Moncrieff for conversations that developed my concurrent research; and the many, many other scientists I learned from and shared my work with during my week! I will update the Society once the cold paper discussed here is published as a peer-reviewed article, and can only convey my gratitude for this opportunity once again.



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