# School of Mathematics and Statistics
## Faculty of Science, Technology, Engineering and Mathematics

## 2024 PhD Projects

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| **Project title** | Analysing Clouds |
| **Principal supervisor** | Michael Wilkinson |
| **Second supervisor** | Marc Pradas |
| **Discipline** | Applied mathematics |
| **Research area/keywords** | meteorology, fractals, turbulence, phase separation |
| **Suitable for** | Either full time or part time applicants |

**Project background and description**

Clouds play a central role in determining weather and climate, but many aspects are poorly understood. In particular, there is no satisfactory theory for the rapid onset of rainfall from clouds that are do not contain ice crystals. The project will address two aspects of this problem. The first concerns the mechanism for microscopic water droplets to achieve sufficient size to undergo runaway growth. Attempts to explain this by collisional mechanisms have not been successful [1]. Non-collisional mechanisms, involving transfer of water from one droplet to another by evaporation and condensation of water vapour, are a promising alternative approach [2]. Analysing these mechanisms depends upon understanding the supersaturation field of water vapour, how droplets move through this field and sample it [3]. The second aspect concerns the growth of microscopic water droplets to form raindrops. After droplets reach a critical size, they grow by sweeping up a vast number of smaller droplets in their path (about one million microscopic droplets are required to make a typical rain droplet). The first few collisions have a very low probability (typically one collision per hour), and it is necessary to understand how a sufficient number of droplets can undergo runaway growth. Recently there has been substantial progress understanding this problem, by applying 'large deviation theory' [4,5]. The project will also extend this work to build a model for the onset of rain showers.

**Background reading/references**


1 *Collisional Aggregation due to Turbulence*, A. Pumir and M. Wilkinson, *Ann. Rev. Cond. Matter Phys.*, **7**, 141-70, (2016).

2 *A Test-Tube Model for Rainfall*, M. Wilkinson, *Europhys. Lett.*, **106**, 40001, (2014).

3 *Convective Ripening and Initiation of Rainfall*, M. Wilkinson, *Europhys. Lett.*, **108**, 49001, (2014).

4 *Large Deviation Analysis of Rapid Onset of Rain Showers*, M. Wilkinson, *Phys. Rev. Lett.*, **116**, 018501, (2016).

5 *Quantifying the Lucky Droplet Model for Rainfall*, M. Wilkinson, *J. Stat. Phys.*, **190**:37, (2023).