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A convective rain cell database based upon high-resolution radar images: unravelling convection patterns

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This work introduces a bottom-up approach to convective storm analysis and forecasting. It comprises a regional rain cell database and an analytics platform whereby radar-based rain cell data are stored and associated rain cell 'properties' and traces are extracted and made available for analysis.
In the initial development of the database, individual convective rain cells and their traces have been extracted from the Met Office (Nimrod) radar archive for the period 2004-2016 over a 500 $\times$ 500 km2 area centred at the Birmingham city, UK. The cells and traces were identified using a new object-based convective storm cell tracking algorithm developed by Muñoz et al. (2017). Incorporating an optical flow-based rain-field tracking and a multi-threshold object identification techniques, this new algorithm enables the accurate isolation and tracking of convective rain cells from high-resolution radar reflectivity data. In addition, the algorithm can handle the merging and splitting processes of rain cells, thus making the identified cells and traces more accurate and detailed than other storm tracking algorithms.
The extracted rain cells and traces have been stored using TimescaleDB (http://www.timescale.com/), which is an open-source database optimised for fast and complex queries. This database combines the advantage of being a full SQL (Structured Query Language) relational database, while scaling in ways previously reserved for NoSQL databases. Therefore, the properties of cells and traces can be efficiently queried using standard SQL command.
This database is the starting point of a web-based platform which will include data analytics modules and RESTful web services to enable the querying of data and rain cell properties via HTTP calls. Users can easily reconstruct convective storm events or the complete lifetime of individual rain cells over a specific period. In addition, this platform will allow users to develop other data analytics modules and applications to support the understanding and forecasting of convection processes.