A MULTI-MODEL AIR QUALITY SYSTEM FOR HEALTH RESEARCH

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Summary
The Multi-model Air Quality System for Health Research (MAQS-Health) is a coupled air quality modelling system spanning national to urban street scales, accounting for physical and chemical processes at all relevant temporal and spatial scales. The system links a wide range of regional meteorology and chemical transport models to a newly developed road-source dispersion model, ADMS-Local (Seaton *et al.*, 2022) derived from the quasi-Gaussian ADMS-Urban local air dispersion model currently used worldwide for city-scale air quality modelling studies for regulatory, research and policy purposes. The technical implementation and scientific performance of MAQS-Health has been evaluated through system applications for Northern Ireland, Scotland, Southwest England and the West Midlands; selected results are presented here.

Introduction
Air quality in urban areas has complex temporal and spatial variability due to influences on many scales, from long-range transport of regional pollution to individual road emissions in street canyons. Access to street-scale pollutant concentration data is important for health research, as exposure levels differ considerably between roadside and urban background locations for some pollutants. Regional photochemical models are used to predict neighbourhood scale air quality, but do not represent the fine scale (metres) variations in concentrations close to a road sources; conversely, local models capture small-scale dispersion and chemistry processes close to individual sources, but do not account for longer-term transport and chemistry processes affecting pollutant emissions from further afield. Coupling regional and local models creates a computationally efficient system for calculating pollutant concentrations at high spatial resolution; a significant technical issue is the avoidance of double-counting the contribution of local emissions.

Methodology and Results
The MAQS-Health concept of coupling a local model to a regional AQ model is based on a separation of time-scales to which each model is applied. A gridded regional model is used to represent the longer range pollutant transport and chemistry, whereas a local model is used to capture the short timescale dispersion in the immediate vicinity of the source. The 'mixing time' required for local emissions to become uniformly mixed over the scale of the regional model grid is used as the threshold between these local and regional calculations.

MAQS-Health is an off-line system, meaning that regional models are run separately from the local modelling, allowing archived regional model data to be used as input. Consistent emissions and meteorological data are used in both component models. Each regional model grid cell included in the nesting domain is treated separately within MAQS-Health in order to ensure that the corresponding regional meteorological and concentration data are used in the calculations; a road source buffer zone ensures a smooth transition across cell boundaries. This approach also allows the use of spatial parallelisation to optimise run times. To avoid double counting, the local model is executed in two modes for each grid cell: one with explicit emissions, the other with gridded emissions matching that of the regional model. The difference between these two results is added to the regional model concentrations to get the final system results. Additional complexities, including the treatment of background concentrations for pollutants strongly influenced by NO_x chemistry, are addressed within the system. MAQS-Health has been tested by a number of groups covering different regions of the UK; evaluation results from CERC's Model Evaluation Toolkit and air pollution maps for Northern Ireland (Fig.1) and Scotland are presented.

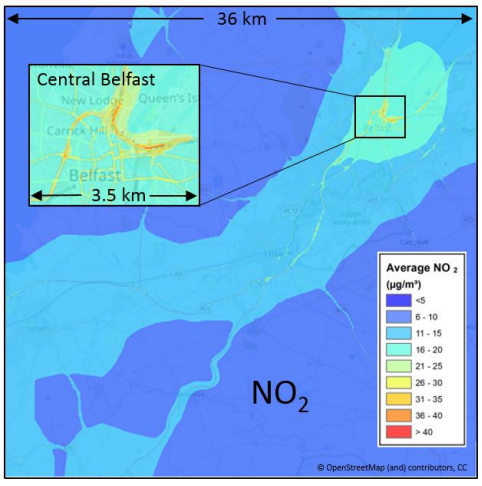

Fig.1 Portion of the Northern Ireland domain: WRF-Chem coupled with ADMS-Local

Conclusions
MAQS-Health is an efficient system for coupling regional and local models producing concentration output at high spatial and temporal resolution for use in health research; key atmospheric processes are accounted for at each modelled scale.

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References
Seaton M *et al.* 2022. A Multi-Model Air Quality System for Health Research: road model development and evaluation. Journal of Environmental Modelling and Software. *At review.*