A COMPARISON OF DISPERSION MODEL MET PRE-PROCESSING WITH URBAN FLUX MEASUREMENTS FROM BIRMINGHAM U.K.

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Dispersion models require aspects of the meteorology which are not routinely measured; the process of estimating quantities such as stability from synoptic data is 'meteorological pre-processing'. This work aims to improve the accuracy of dispersion modelling in urban areas by testing the performance of meteorological pre-processing with urban measurements. The Monin-Obukhov length L is a quantitative metric of stability. It requires two quantities not routinely measured by national meteorological networks: the friction velocity u_* and the flux of sensible heat H. By day, a typical model approach is to estimate incoming solar radiation from solar elevation and cloud cover. Then parametrizations of the radiation and surface energy budgets lead to an estimate of sensible heat flux H. Friction velocity u_* is found iteratively using the wind speed and roughness length by solving for the surface layer wind profile. At night the energy and radiative balances are more subtle, simple physically based parametrizations are harder to find, so more empirical approaches are usually adopted. After Venkatram (1980) and Holtslag and van Ulden (1982), the surface layer temperature scale may be estimated empirically, then H, u_* and L obtained by iteratively solving for the surface layer wind profile.

Three urban experiments have been conducted in Birmingham, U.K., as in Ellis and Middleton (2000a, b, c). Rooney (2001) found the roughness length $z_0 \approx 0.5 - 2.0$ m, fairly typical of values used in dispersion models for cities, and analysed the effects of wind direction, according to fetch and land-use type. Instruments were operated on 15 m, 30 m, 45 m masts for 4-week periods in 1998, 1999 and 2000 at a factory site within the city. Synoptic observations were taken from the Coleshill station outside the city. During the 2000 campaign, a sonic anemometer was also placed on a 15 m mast beside the Coleshill station, to measure sensible heat flux, friction velocity and Monin Obukhov stability simultaneously at both sites. In addition to the expected change in wind speed associated with increased surface roughness, a clear difference in heat flux at the two sites was observed. This paper uses the Birmingham data sets to study the performance of met pre-processing in the ADMS and AERMOD dispersion models. The models use fairly similar pre-processing schemes (Carruthers et al., 1994; Cimorelli et al. 1998). Uncertainties in the radiation arising from cloud cover are estimated. Pre-processor values of H, u_* and L are tested in rural and urban conditions. An urban heat store scheme in the Boxurb model (Middleton, 1998), delaying the onset of stable conditions on summer evenings and avoiding overprediction, is also evaluated. The Birmingham data present an opportunity to test many of these ideas in an urban setting. The paper concludes by a discussion of the effects of the urban sensible heat flux on stability diagnosis during pre-processing for dispersion modelling.

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