Refining an inverse dispersion method for sources on undulating terrain

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It is common practice to estimate ground-air gas fluxes (Q) from agricultural sources by inverse dispersion, placing detectors upwind and downwind from the source to determine mean gas concentration ($\bar{c}$). Often however, topography compromises an assumption that is (normally) inherent to the inverse dispersion methodology, namely that wind statistics in the atmospheric surface layer are "undisturbed" (i.e. horizontally-homogeneous). We analysed a trace gas dispersion experiment with multiple fixed point sources on gently undulating terrain, to investigate the performance of inverse dispersion using a dispersion model (WindTrax) that encodes a Lagrangian stochastic trajectory model giving wind paths from sources to detectors. Results indicate that the effects of this moderate terrain on the $\bar{c}$–Q relationship can be adequately modeled by postulating an undisturbed Monin- Obukhov flow in a terrain following height coordinate, thus permitting easy extension of a well proven method to conditions that, à priori, had been considered unsuitable. We also used the measurements to study the influence (on the accuracy of retrieved Q) of discretionary elements of inverse dispersion procedure. These sensitivity studies addressed optimal placement of detectors relative to the source(s); data rejection criteria, such as threshhold values for the friction velocity and the Obhukhov length; and exclusion of mean wind directions that confound the "upwind/downwind" concentration differences. We also investigated the impact of alternative spatial representations of the source, supposing one had but partial information in that regard.