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Identifying urban signatures in MOPITT CO data

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Thermal infra-red nadir instruments have been shown to be capable of varying degrees of vertical profile information, dependent on the species being studied. However, it has been more difficult to demonstrate differentation of the lowermost troposphere using these instruments. It has instead been argued conventionally that the information tends to be more responsive to mixing ratio enhancements in the atmosphere from 850 mb and higher layers, although there is increasing evidence to the contrary. In the present study, it is demonstrated that signatures of urban enhancements can be identified in carbon monoxide (CO) data with good confidence given good diagnostics of the retrieval process, simulations of atmosphere enhancements and a methodology which relies on the natural variability of retrieval sensitivity to different layers in the atmosphere.

The platform for this study is provided by CO vertical profile information retrieved operationally from observations by Measurements of Pollution in the Troposphere (MOPITT) instrument which has provided nearly a decade of data. Previous studies have shown that MOPITT often has sensitivity to the lowermost atmosphere during daytime measurements, particularly when thermal contrast is high (e.g. Deeter et al, 2007). Clerbaux et al, 2008, have also demonstrated that some urban enhancements, associated with particular cities, could be identified in averages of seven years of the surface retrieval level in MOPITT data. However, it has been difficult to develop methodologies which more regularly diagnose and detect urban enhancements in MOPITT data.

In the present study we show that a much improved performance is possible by utilising the very differing sensitivity of MOPITT daytime and nighttime retrievals, biasing towards data with higher degrees of freedom for signal, and by accounting for differing a priori information. We find that the most sensitive differentiators for the lowermost atmosphere are the difference between the 700 mb daytime and nighttime monthly averages for V3 data, and between 850 mb and 700 mb monthly averages for V4 data. The method has been validated by simulation of averaging kernels applied to enhanced layer profiles for Indian cities and by assessment of typical TOMCAT profiles. Application of the results to one year of averaged daytime minus nighttime data for 2007 reveals many examples of enhanced CO concentrations in the lowermost troposphere asociated with the locations of nearly 100 urban areas. The results of the study represent a significant step forward in understanding the utility of thermal infra-red species data for investigations of the lowermost troposphere.

References

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