Dispersion Modelling in the Western Cape using the Model Ready Data Sets

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1 Introduction

Results from air pollution dispersion modelling that was conducted as part of a health risk assessment in the Western Cape is presented in this paper. Modelling was conducted using the Calpuff dispersion model and utilised the meteorological model ready data sets available from the Western Cape Government Department of Environmental Affairs and Development Planning.

2 Aims and Objectives

The following questions are answered in this study:

- Does the use of a regional domain produce higher concentrations due to simulation of "recirculation"?
- Do the smaller, non-scheduled sources warrant use in a dispersion model for air quality applications?

3 Methodology

3.1 Model Domains

We run the Calpuff dispersion model (Scire *et al*. 2000) for scheduled and non-scheduled emitters in the Western Cape. Two model domains are used; a regional domain with a 2km (270 x 325km) resolution and a smaller local domain covering the city of Cape Town with a 300m resolution (50 x 50km).

3.2 Sources Modelled

APPA industrial sources were modelled in the City of Cape Town domain and the same sources were modelled in the regional domain. This will help identify whether average concentrations are higher in the regional domain due to a longer life time of puffs and, therefore, the chance for recirculation.

Non-scheduled sources were modelled in the 300m City of Cape Town domain (hereafter referred to as local domain) to quantify the contribution of these numerous smaller sources to the atmosphere. These sources were not modelled in the regional domain because they have short stacks and are expected to have an effect on immediate surroundings and not on a regional scale.

4 Preliminary Results

4.1 Predominant Wind Direction

Cape Town experiences two predominant wind directions, namely the South-Easter and North-Westerly flow (Figure 1). Wind flow shifts between these two directions during the day, thus allowing for events where emissions from a source are blown away from the source at one time of the day and blown back later in the day.

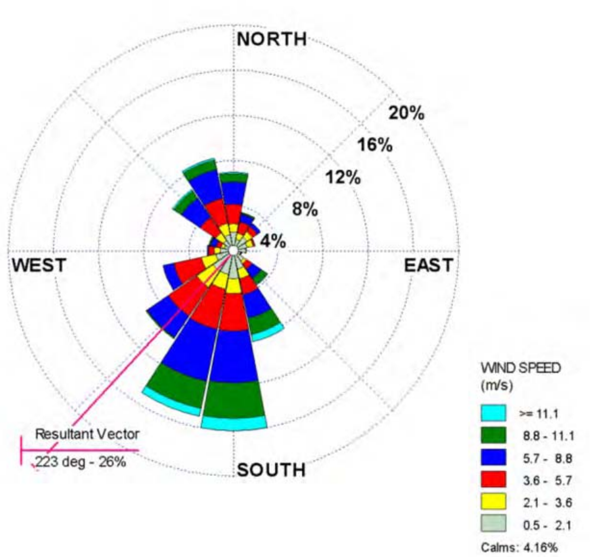

Figure 1. Annual (2010) windrose at Cape Town International Airport.

4.2 Scheduled Sources

Annual average concentration of SO_2 from scheduled sources was low and ranged from 0.5 to 18ug/m^3. In general, results from the local domain (Figure 2) produced similar magnitude and spatial distribution of annual concentrations of SO_2 than results from the regional domain (Figure 3). This suggests that the smaller 50x50km domain adequately captures any return flow and is not bias to under prediction caused by puffs exiting the model domain.

Neither domain demonstrated a bias in simulating higher concentrations when considering maximum 1 hour averaged concentrations. Instead, this varied on a source by source basis. In general, the local domain produced higher 1 hour concentrations for high emitters, and thus, overall, when all emitters are considered together, produced higher maximum 1 hour concentrations.

4.3 Non-scheduled Sources

Annual average concentration of SO_2 from small industries was in the same range as scheduled sources. However, as expected, the geographic extent of concentrations above 5ug/m^3 is much smaller (Figure 4).

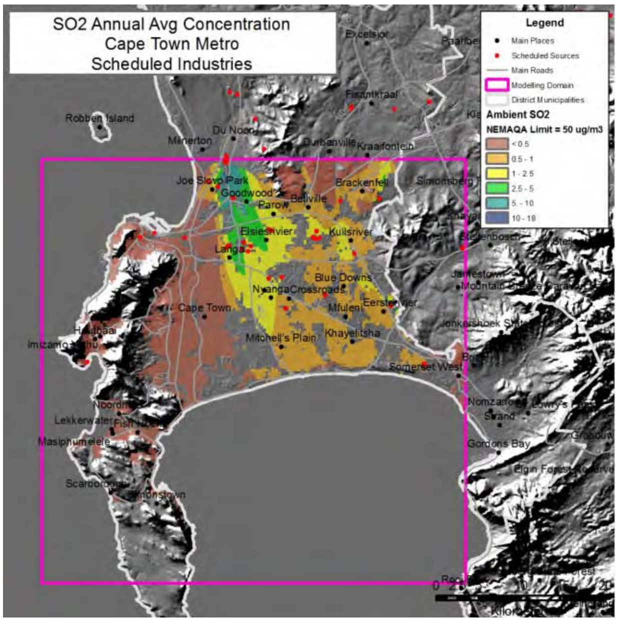

Figure 2. Annual SO_2 concentrations from scheduled sources in the local domain.

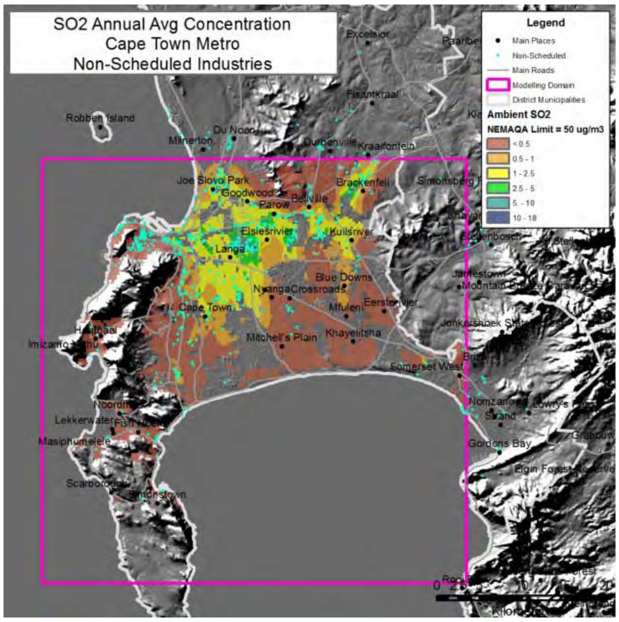

Figure 4. Annual SO_2 concentrations from non-scheduled sources in the local domain.

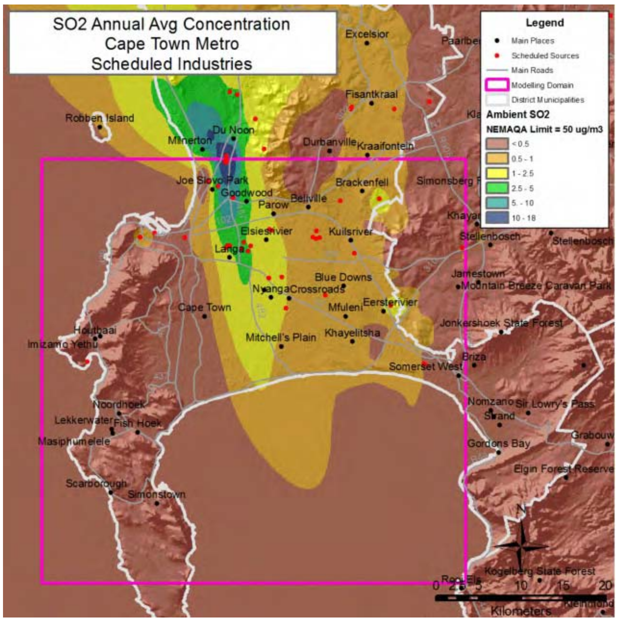

Figure 3. Annual SO_2 concentrations from scheduled sources in the regional domain.

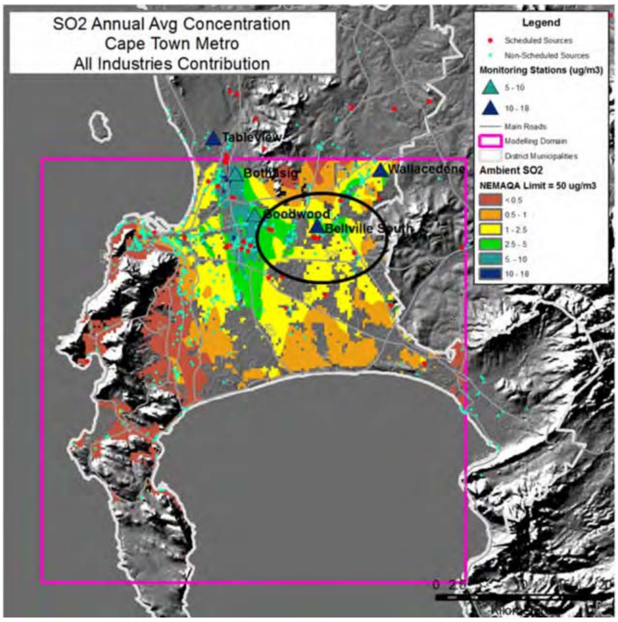

Figure 5. Total annual SO_2 concentrations from scheduled and non-scheduled sources in the local domain.

The contribution of small industries to the annual average SO_2 concentration is particularly high (above 50%), for the Southern suburbs and extending to Muizenberg (Figure 6). However, concentrations are very low in these areas and can be considered negligible. Of much more interest is the area around Belville South (black circle in Figure 5 and Figure 6) where annual concentrations are higher (5) and small industries contribute 50% or more in some places (6). This suggests that small industries can be a substantial contributor to air quality, although concentrations are low.

Figure 6 on next page.

5 Conclusions

Modelling dispersion using smaller, non-regional domains produced similar results to regional domains. This suggests that the local domains adequately captured any return flow.

Small industries produce low annual concentrations (between 1 and 2.5ug/m^3). However, small industries contribute over 50% of the annual concentration for some areas when combined with scheduled sources.

6 Acknowledgments

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7 References

Scire J., Strimaitis, D., and Yamartino, R, 2000, CALPUFF Dispersion Model, *Earth Tech, Inc.,* U.S.A.

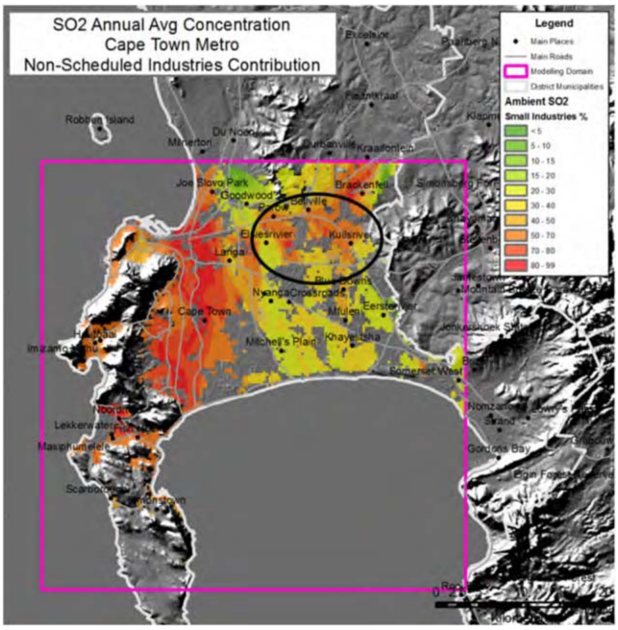

Figure 6. Percent contribution of small industries to annual SO_2 concentrations combined with scheduled sources.