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The integration of measured, modelled and remotely sensed air quality data and its' impacts on the Highveld.

Bhugwandin, Kubeshnie Naicker

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ABSTRACT

Although a vast number of air quality investigations have been conducted on the Mpumalanga Highveld previously, there has been limited attempt to integrate available datasets from the different methods of air quality monitoring (satellite, in-situ and ground-based observations) and modelling. This study compares modelled, satellite and measured data to determine the most accurate estimate of ground level sulphur dioxide (SO_2) and nitrogen oxide (NO_x) concentrations.

The main value of the project comes from the 'improvement' of modelled concentration fields using measurements. Measurements only provide information on air quality at isolated places (for example monitoring stations) or at isolated times (aircraft measurements and satellite observations). Dispersion models predict concentrations continually over a wide area. However, models have inherent inaccuracies based on the assumptions made in developing the model and the variability in the input parameters supplied. These can be accounted for or are part of the inherent variability of the model results. This study assists in the refinement of modelled outputs as well as the verification of satellite data using ground-based measured data as a point of reference.

In the wake of increasing governance on air pollution, industry has been compelled to account for their impacts on the environment. This study aids industry by proposing a method to quantify their impacts on the environment and possibly on human health. Three datasets from 2003 (modelled, measured and satellite) were integrated using a geographic information system in order to analyse and interrogate the data and produce an integrated set of data, maps of potentially sensitive ecosystems and maps of potential exposure to poor air quality of sensitive population groupings.

The results of the study have shown that although the concentration value for the NO_2

tropospheric column is greater than the values observed on the ground there is a good correlation between measured observations and SCIAMACHY retrievals. The sample size was too small to indicate a statistically significant bias.

The results from the validation of the CALPUFF model indicate with respect to SO_2 predictions that the model is only reliable for 62% of the time within the United States Environmental Protection Agency's model performance guideline of acceptance i.e. predictions within a factor of 2, and for NO_2 the predictions are reliable for only 50% of the time. There is also no constant value by which the model under or over predicts. The cumulative distribution function graphs illustrate that the CALPUFF model predicts the highest values from the bulk of the distribution rather that the tail of the distribution where the extremes lie. This could possibly account for the large variance between measured and modelled outputs.

The results of identifying areas of potential harm from SO_2 emissions reveal that hotspots for high to very high risk to human health occur around all power stations. Generally the category of high risk around power stations seems to be located in areas with population agglomerations between 0-1 000 per km^2 and 2001- 5000 per km^2.

Several high risk areas for potential harm to ecosystems from SO_2 emissions can be seen on the Highveld with a large spatial extent around Kendal, Matla and Kriel power station. Approximately 871 wetlands fall within the high risk areas. The vegetation risk map indicates a high risk to several grassland and bushveld types. Model results for this study indicate no potential risk to human health from emissions of NO and subsequent conversion to NO_2 in the atmosphere.