

Chapter 5

Project evaluation and future perspectives

5.1 Project evaluation

In this section, the success of the study presented in this thesis is reviewed in relation to the objectives presented in **Chapter 1**. A critical evaluation of the outcome of this study will not only highlight the success of the study and the contribution it has made to the better understanding of VOCs in South Africa, but will also indicate possible key areas that need to be addressed in future research.

Objective I: Conduct a comprehensive literature survey to establish the importance of atmospheric VOC compounds and to assess the current state of knowledge on atmospheric VOCs for South Africa.

The literature survey revealed that some VOCs and their reaction products pose a risk to public and occupational health. VOCs play an important role in the global carbon budget and radiation balance, regional oxidant balance, as well as in the distribution of O₃ and other reactive gases. Notwithstanding the importance of atmospheric VOCs, very little has been published in the peer-reviewed scientific literature on atmospheric VOCs in South Africa.

Objective II: Measure a comprehensive set of anthropogenic and biogenic VOCs at a site with high atmospheric variability in the North West Province (South Africa), i.e. Welgegund measurement station, for at least a full seasonal cycle.

This objective was accomplished successfully. Anthropogenic and biogenic VOCs were measured for at least a full seasonal cycle (9 February 2011 to 4 February 2012). A total of 40 VOCs were quantified in samples collected at the Welgegund measurement station. These species included 13 aromatic hydrocarbons and seven alkanes usually associated with anthropogenic emissions, as well as 20 BVOCs. According to the knowledge of the author, this is one of the most comprehensive datasets of atmospheric VOCs measured in South Africa. Previous studies mostly focused either on BTEX or biogenic species in isolation.

Objective III: Determine the temporal and other possible trends of the above-mentioned VOCs at this measurement site.

In order to determine the temporal and other possible trends of the above-mentioned VOCs at the Welgegund measurement site, samples were collected for two hours during day time and night time for two days per week for a year. However, the results indicated no statistically significant differences between daytime and night-time anthropogenic VOCs concentrations. Furthermore, no distinct seasonal trend was observed for anthropogenic VOCs, which was surprising, since it was expected that these species would peak in winter due to the trapping of pollutants and recirculating meteorological conditions. Distinct differences for some of the BVOCs species were observed between daytime and night-time concentrations. Furthermore, certain BVOCs exhibited distinct seasonal patterns, i.e. higher values in summer and lower values in winter.

Objective IV: Explain the observed trends by investigating possible sources, interspecies correlations and ratios, as well as correlations with other high resolution ancillary data measured at Welgegund, e.g. meteorological data and trace gas concentrations.

Since no distinct seasonal cycles could be identified for the measured anthropogenic VOCs, the possible influence of the origin of air masses on the concentration of these species was explored. These results indicated that air masses that passed over Area I (Mpumalanga Highveld, the Vaal Triangle and the Johannesburg-Pretoria conurbation) had higher anthropogenic VOC concentrations than air masses that passed over Area II (western and eastern Bushveld Igneous Complex and an area over which the air masses typically followed an anti-cyclonic movement pattern) and the Regional Background. The observed BVOC seasonal trends were explained by correlating BVOC concentrations to meteorological parameters measured at Welgegund. Furthermore, in an effort to determine the transport of BVOCs from the vegetation surrounding the site, pollution roses for isoprene, MT, SQT and MBO were compiled. The isoprene pollution rose showed a dominance of sources from the north-west to the north-east, as well as the south-east. These directions correlated to areas where pockets of the savannah biome are located within the grassland biome in which Welgegund is situated.

Objective V: Compare the measured VOC concentrations to published VOC data from previous measurements conducted in South Africa and internationally.

The anthropogenic and biogenic VOC levels observed in this study were somewhat lower than concentrations reported in other studies conducted nationally and internationally. The difference in VOC concentrations measured at Welgegund suggests that the difference in regional climate, geographic location, as well as the influence of industrial and vehicle emission strongly affect the VOC concentrations measured at the site. Long-range transport and transformation that occur during transport result in relatively low, but fluctuating concentrations of anthropogenic VOCs advected over Welgegund. BVOCs, which have relatively short atmospheric lifetimes, are influenced by local biogenic activity. The BVOC data presented in this study is the most comprehensive dataset measured for the Dry Highveld Grassland Biome.

5.2 Future perspectives

Recommendations with regard to possible future studies include:

- A long-term measurement campaign, spanning over several years, might provide additional insight into possible seasonal VOC cycles and inter-annual differences.
- Although continuous online measurements are more expensive, these measurements will provide more insight into diurnal variations of VOCs and will enable the reporting of peak concentrations.
- A vegetation survey of the area surrounding Welgegund would aid in explaining the observed BVOC cycles. Such a survey is currently being conducted.
- Although VOC levels were correlated with certain ancillary data, the measured VOC concentrations must also be related to other ancillary data, e.g. new particle formation and chemical composition of PM₁ particles.