An investigation of high ozone episodes in the City of Johannesburg

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Contents

Why were high ozone episodes investigated in Johannesburg ?

- City of Johannesburg
  - second largest city in Africa

- Near-surface ozone can have deleterious health effects
  - a greater emphasis on the need for appropriate data to support the implementation of the AQA
  - database for air quality in the city spans over many years

- The aim of this study was to access and use the ambient air quality monitoring data from the SAAQIS to identify:
  - possible high ozone episodes in the City of Johannesburg
  - the key drivers of these episodes.

High ozone episodes

- Monitored data for ozone and its precursor gases were obtained from the SAAQIS
- Data cleaning procedure was used to create usable datasets of ozone for the period of 2004 – 2011
  - data quality issues and lack of precursor data
- Focussed on identifying pollution episodes for further investigation using additional information on:
  - long distance transport of air masses (HYSPLIT)
  - prevailing meteorological conditions
    - solar radiation
    - temperature
    - rainfall

Criteria used to select episodes

- A set of selection criteria were applied to the ozone dataset to select high ozone events

- These criteria included:
  - exceedances of the 8-hour running average
  - concentrations within the upper percentiles (95^{th}, 75^{th}, 50^{th}) of the 8-hour concentrations
  - exclusion of episodes occurring at one station
  - minimum of 70% data coverage for days before and after
  - the fourth criterion also applied to the datasets of the ozone precursor gases

Ozone trends in trends in the City of Johannesburg

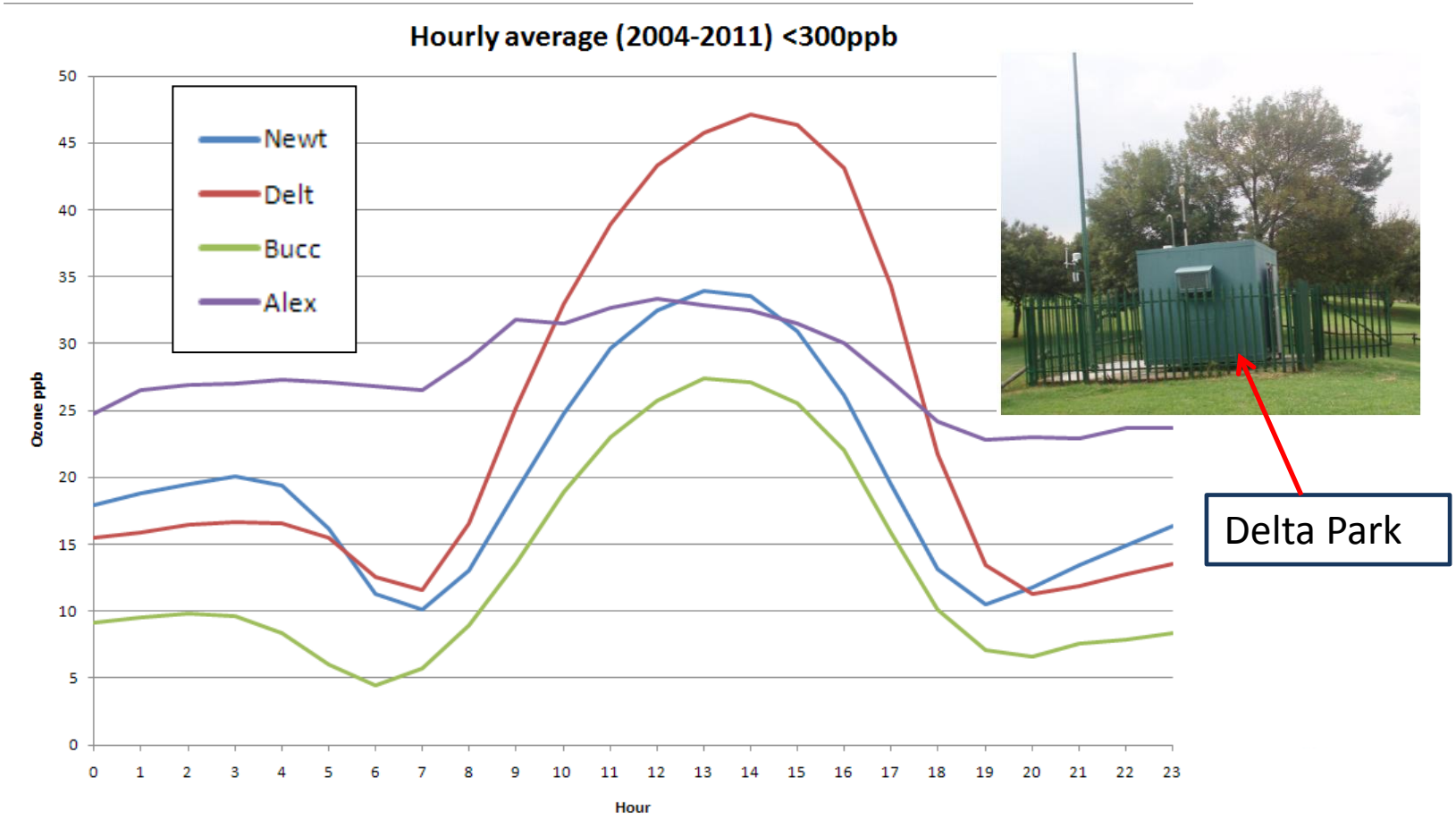

Figure 1: Delta Park station had unusually high ozone concentrations compared to other stations.

Case studies of pollution episodes

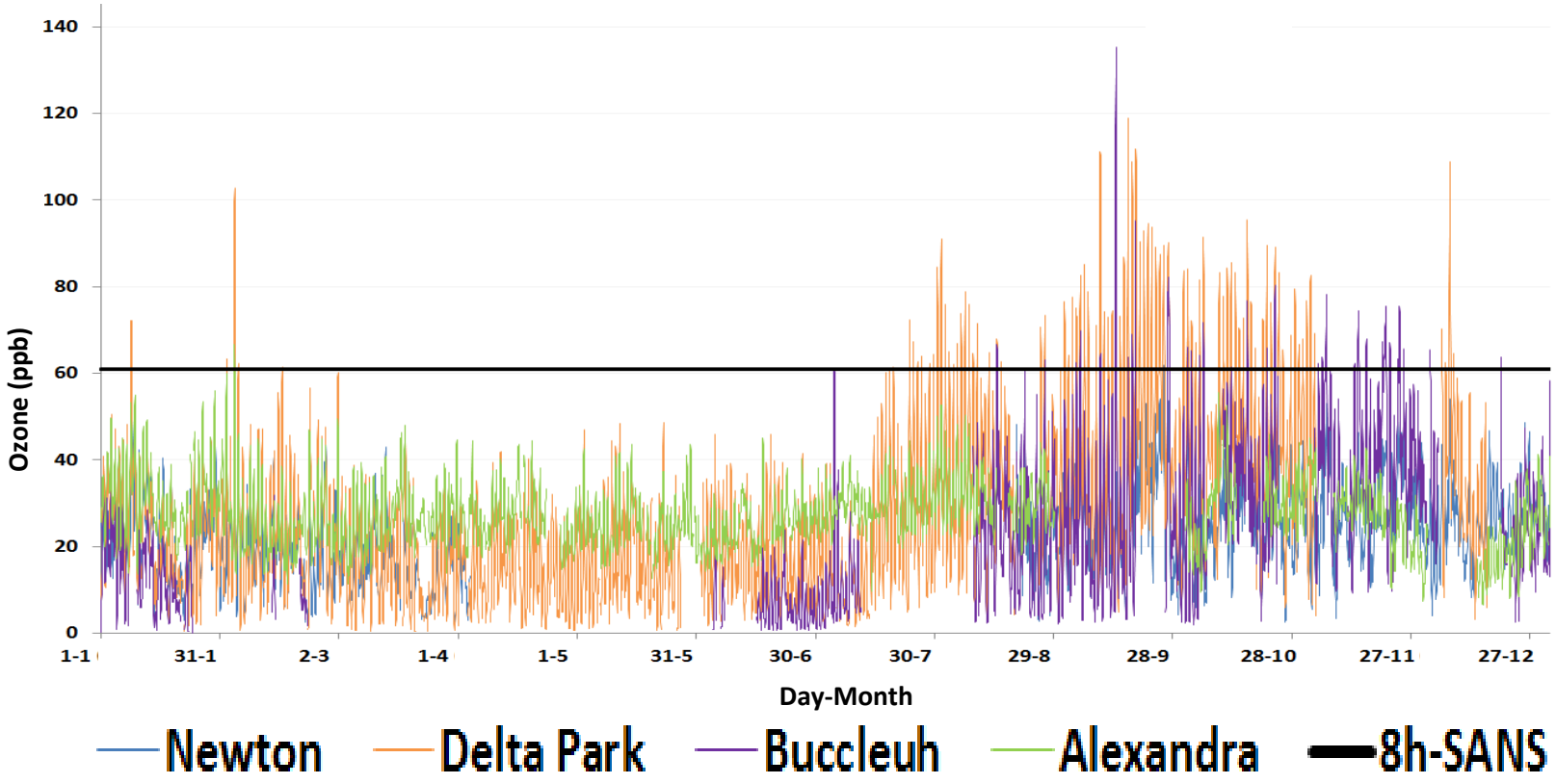

Figure 2: The bulk of these episodes occurred in the summer (DJF) and spring (SON) months in 2005

Case studies of pollution episodes

- 3 February 2005
  - did not occur in a typical ozone season i.e. spring.

- 16 September 2005
  - highest exceedance as compared to other days with exceedances in spring
  - high numbers of exceedances observed during the spring season as compared to the summer

- Episodes isolated considering the two days before and after the occurrence of the episodes

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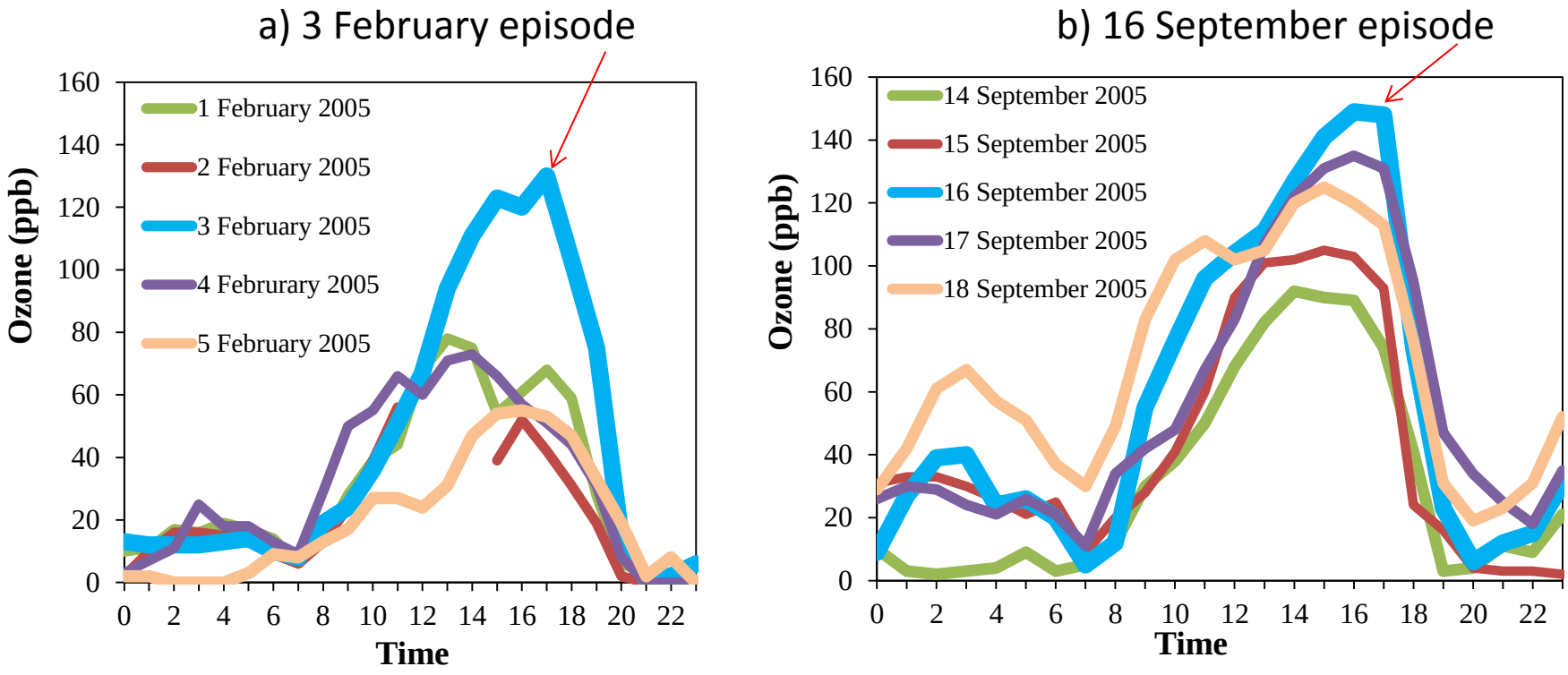

Figure 3 : Ozone peaks occurred at different times when considering the two days on either side of the occurrence, with a) the 3 February 2005 and b) the 16 September 2005

Case studies of pollution episodes

- Meteorological conditions on 3 February and 16 September 2005
  - there were neither clouds nor rain recorded according to the historical data from OR Tambo International Airport
  - the vertical profile of modelled temperature showed no inversions on the days of these episodes
  - conditions represented atmospheric instability which were favourable to the dispersion of pollutants

- Even though there was elevated ozone levels on these days, precursor concentrations (particularly for 3rd Feb) does not indicate localized ozone formation

Case studies of pollution episodes

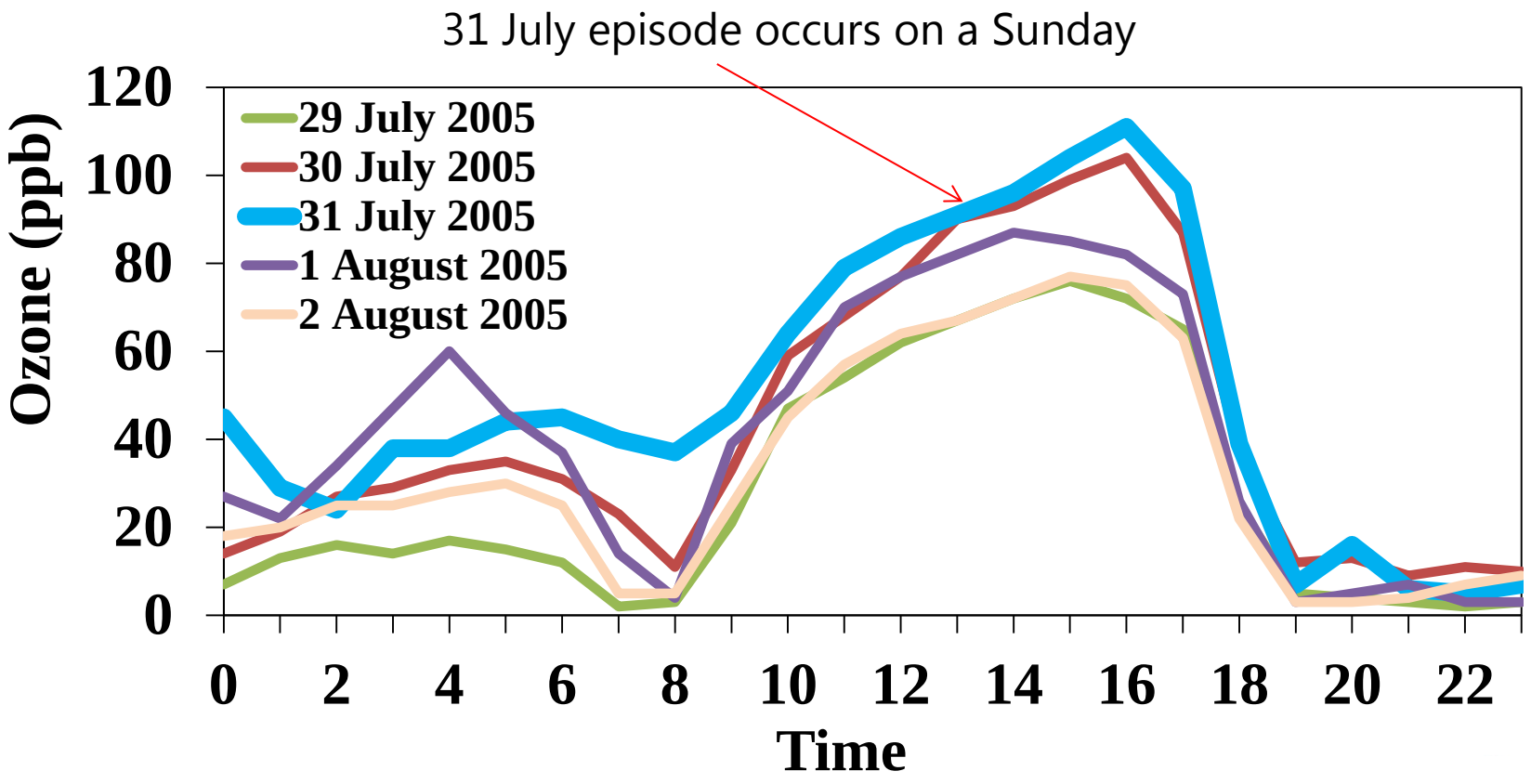

Figure 7: The episode occurring during the period during 28 July to 2 August, which shows the highest peak in 8 hour ozone on 31 August

Case studies of pollution episodes

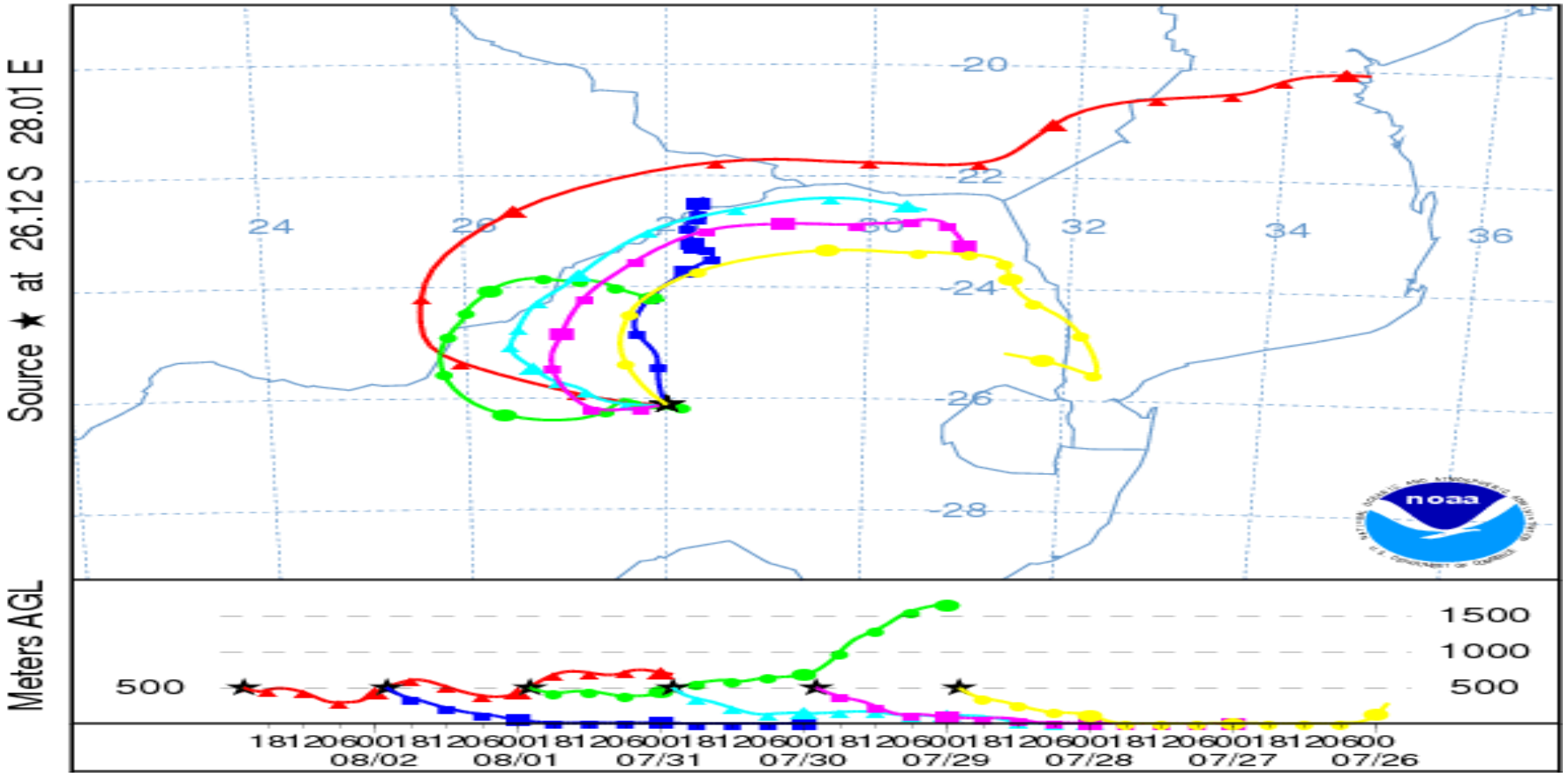

Figure 8 : The HSYPLIT back trajectories were used to investigate if this peak could have been influenced by the transport of pollution air masses to the region

Case studies of pollution episodes

- The episode on the 31 July 2005 was unique compared to the episodes on the 3 February and 16 September

- It may be suggested that the episode on the 31 July 2005 was caused by two factors
  - the 'weekend ozone effect'
  - transport of precursor from distance sources with regional anti-cyclonic circulation
    - precursor concentrations are low

Recommendations

- However, further research is needed to investigate the possibility of the ‘weekend effect’.

- This will involve developing an improved understanding of whether:
  - A reduction in NO_x emissions on weekends reduces the titration of ozone
  - A weekend change in the timing of NO_x emissions allows for more efficient production of ozone
  - Less precursors or pollution allows for more sunlight and thus more efficient photochemical production of ozone

Implications

- The influence of long-range transport and the ‘weekend effect’ on near-surface ozone levels has important implications for the City of Johannesburg.

- Other cities, internationally, have demonstrated that although efforts have been made to remediate near-surface ozone issues, there is evidence that while local emissions of ozone have been successfully reduced, there has no drastic decline of near-surface ozone levels over the past 10 years

Summary and Conclusion

- The high ozone events at the Delta Park station are of interest for further study
- There is a possibility that the peaks observed during the high episodes in spring and summer were formed as a result of transported reacted precursors
- Future research on the characterisation of the NO_x/VOC's relationship is needed to understand the 'weekend effect'
- Measurement of VOC and oxidation products around Delta Park will aid immensely in this characterization and allow for effective air quality management

Acknowledgements

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Thank you

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