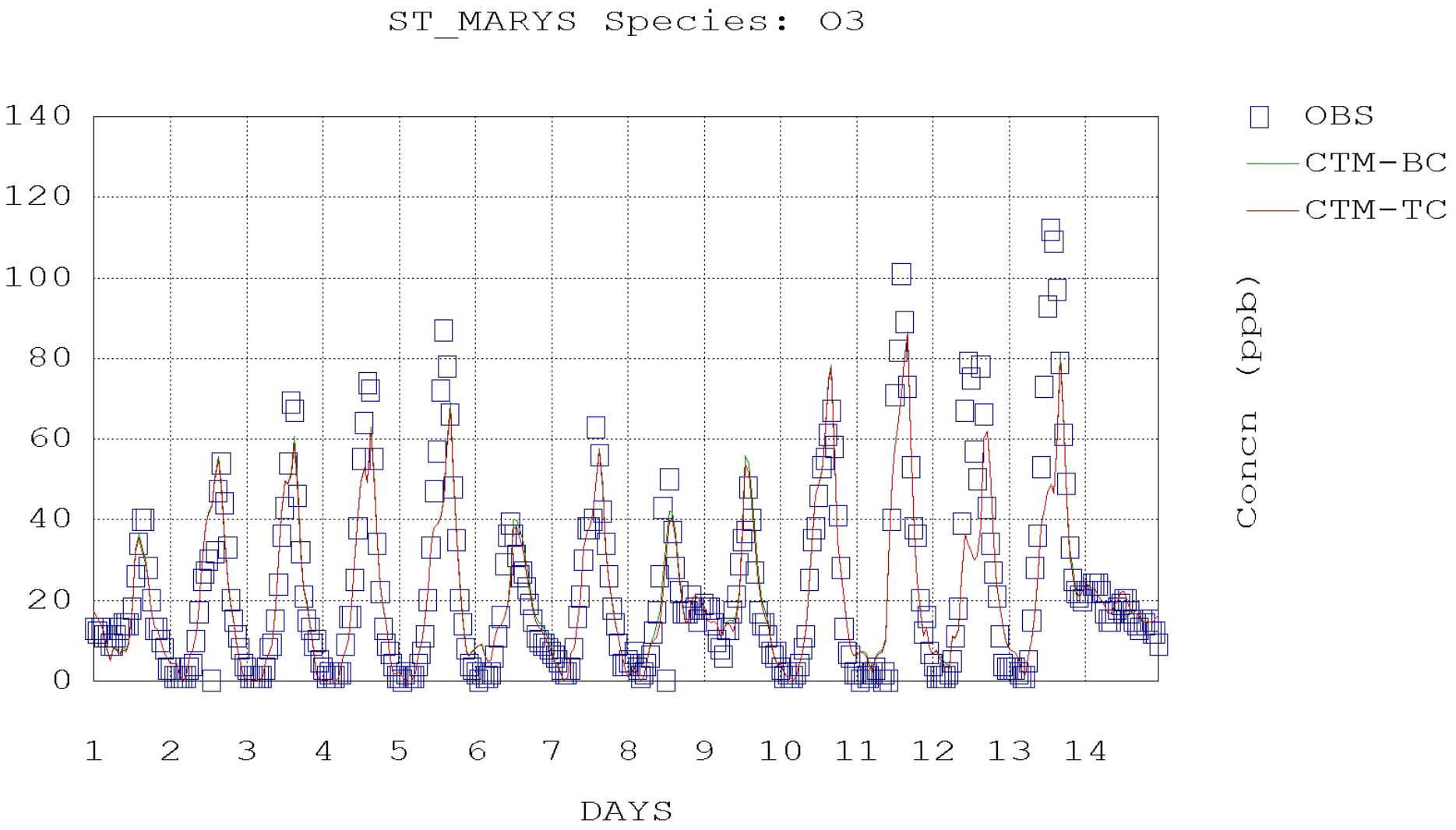
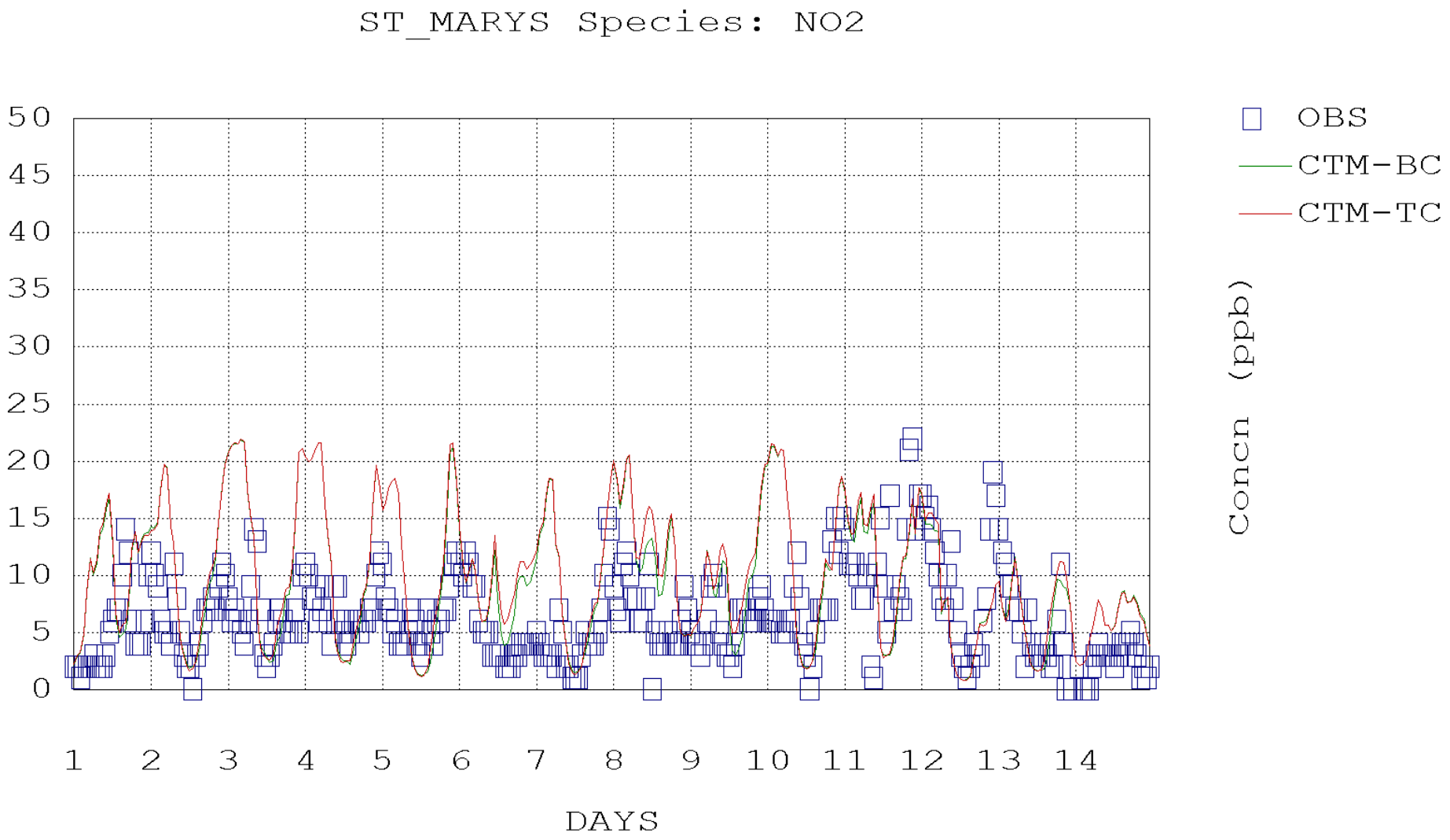
Appendix D TIME SERIES OF O_3, NO_2 AND NO_X FOR MODEL PERIOD

NB: Day 1 of the modelling period corresponds to 27 January 2009




ST_MARYS Species: NO2
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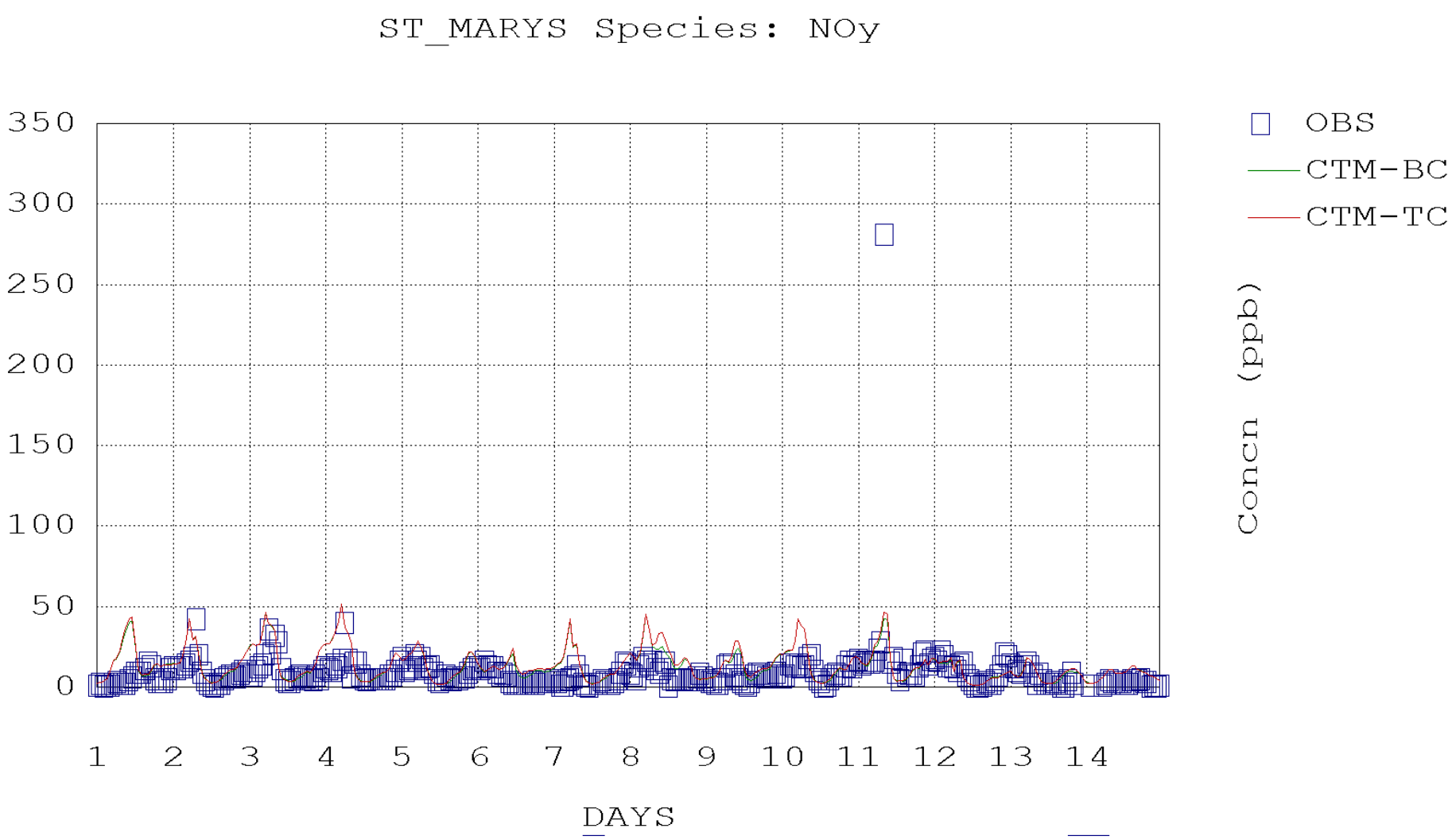
45
40
35
30
25
20
15
10
5
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
DAYS
Concn (ppb)
OBS
CTM-BC
CTM-TC


ST_MARYS Species: NOy
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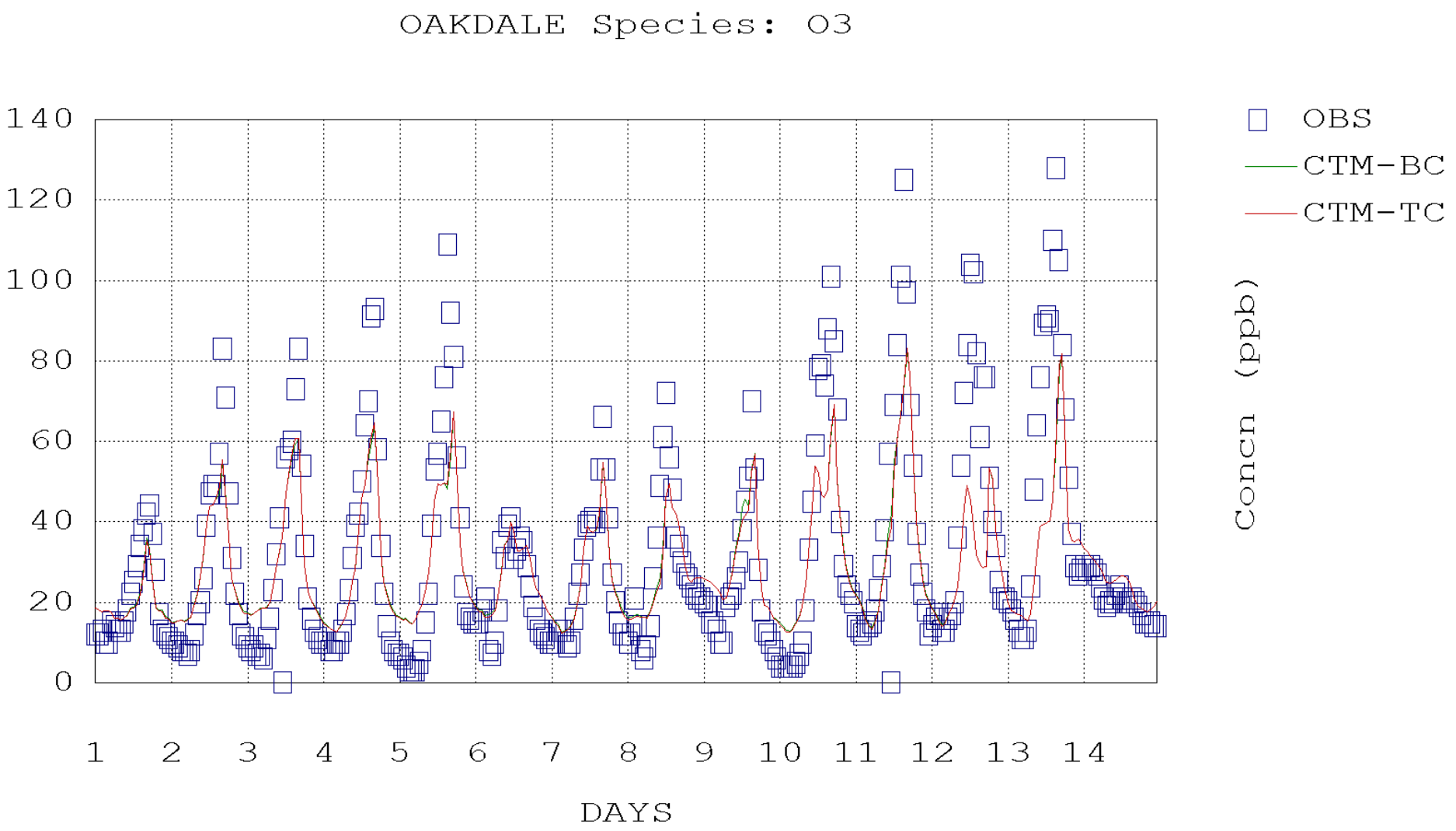
300
250
200
150
100
50
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
DAYS
OBS
CTM-BC
CTM-TC
Concn (ppb)


OAKDALE Species: O3
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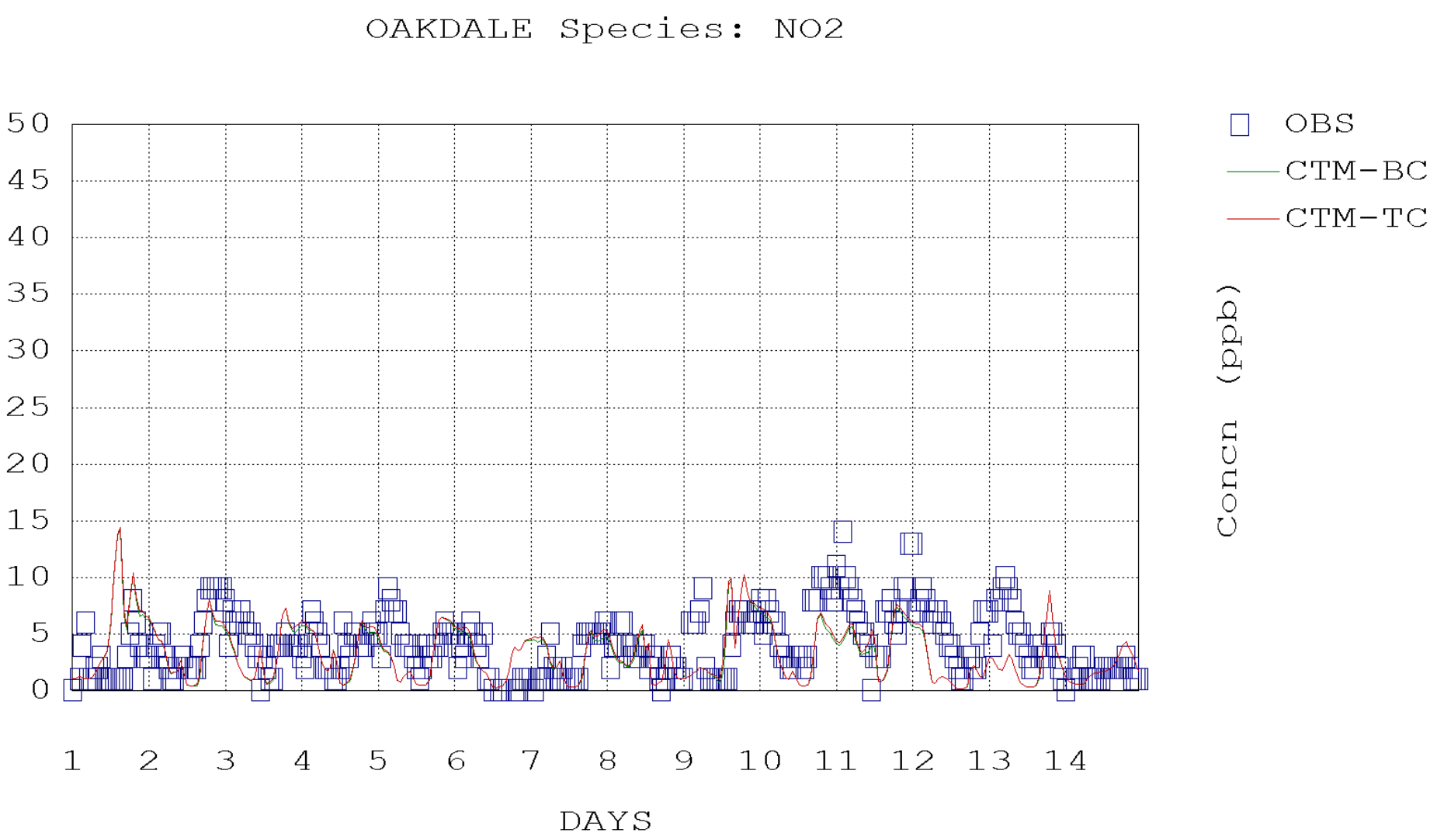
120
100
80
60
40
20
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
DAYS
Concn (ppb)
OBS
CTM-BC
CTM-TC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35
30
25
20
15
10
5
0
1
2
3
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6
7
8
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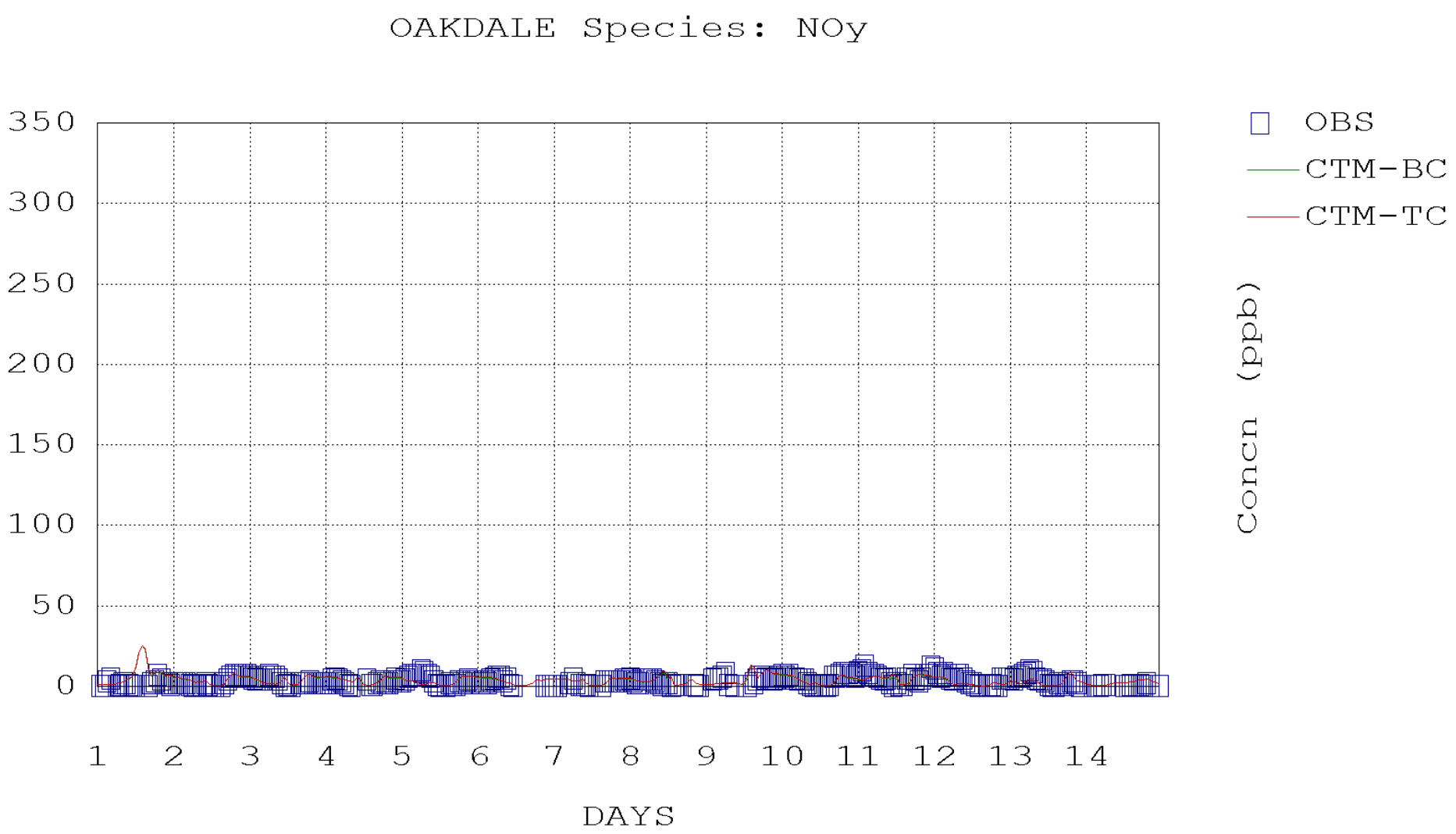
12
13
14
DAYS
OBS
CTM-BC
CTM-TC
Concn (ppb)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300
250
200
150
100
50
0
1
2
3
4
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6
7
8
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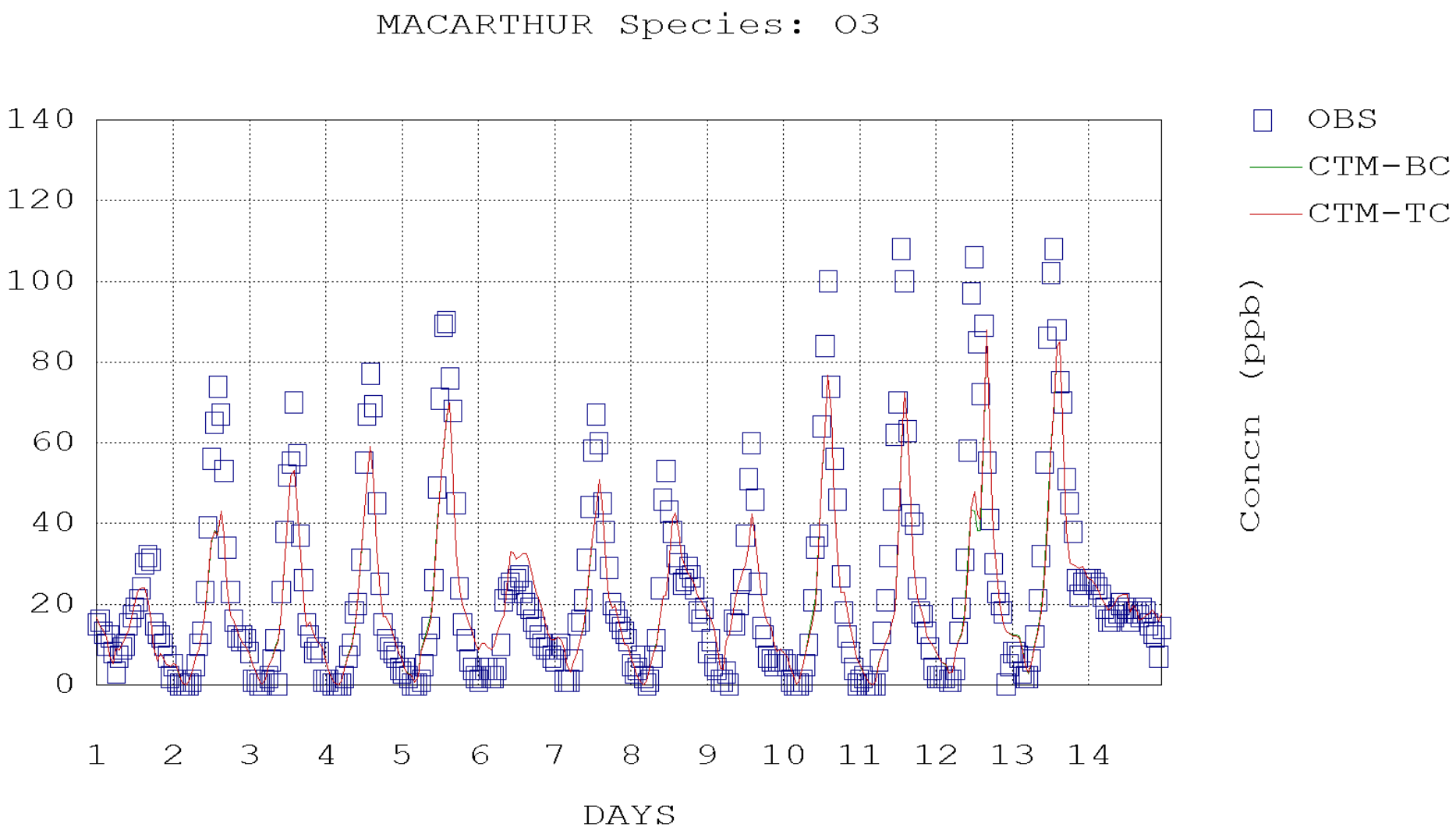
DAYS
Concn (ppb)
OBS
CTM-BC
CTM-TC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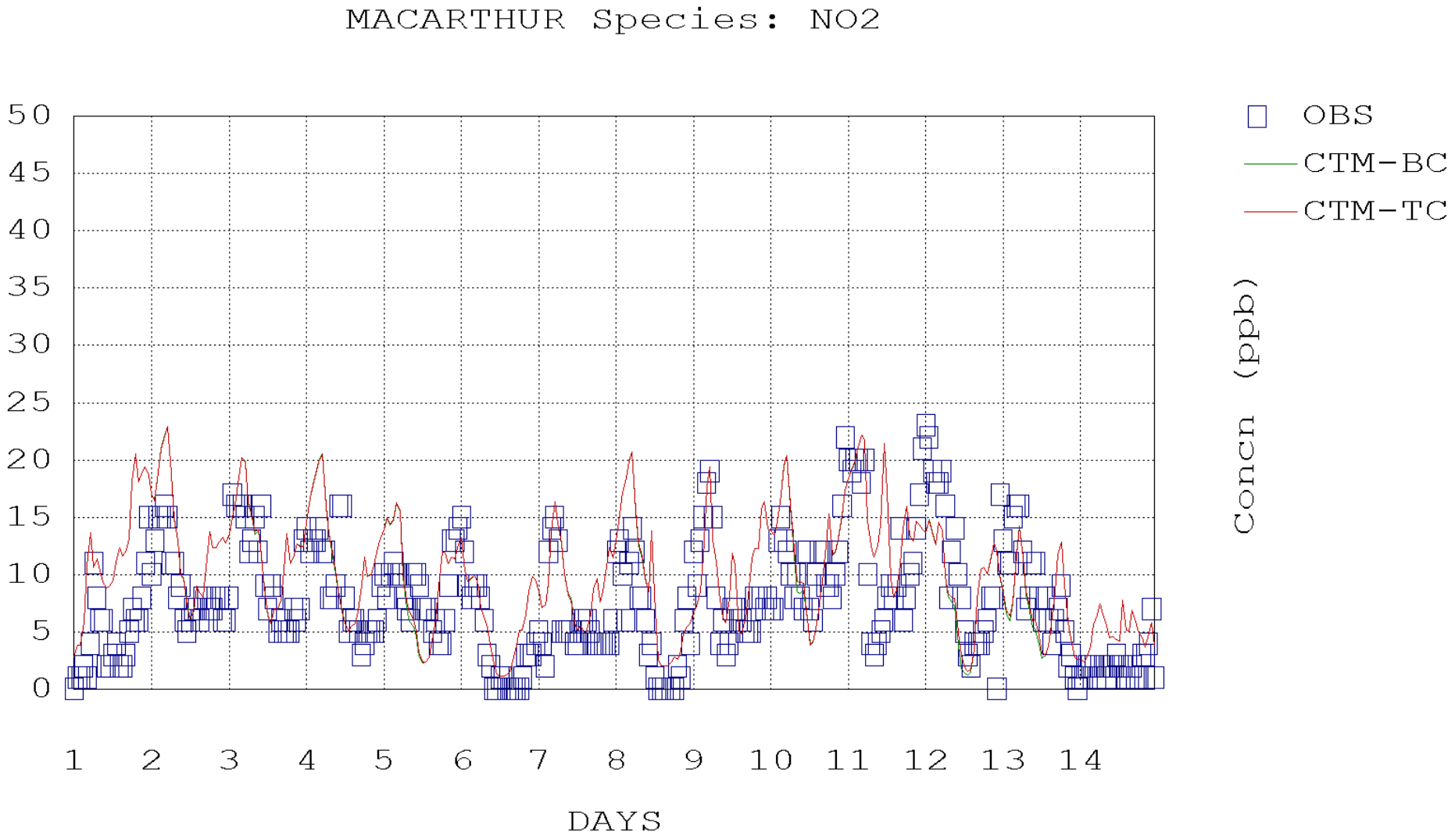
120
100
80
60
40
20
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
DAYS
Concn (ppb)
OBS
CTM-BC
CTM-TC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35
30
25
20
15
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13
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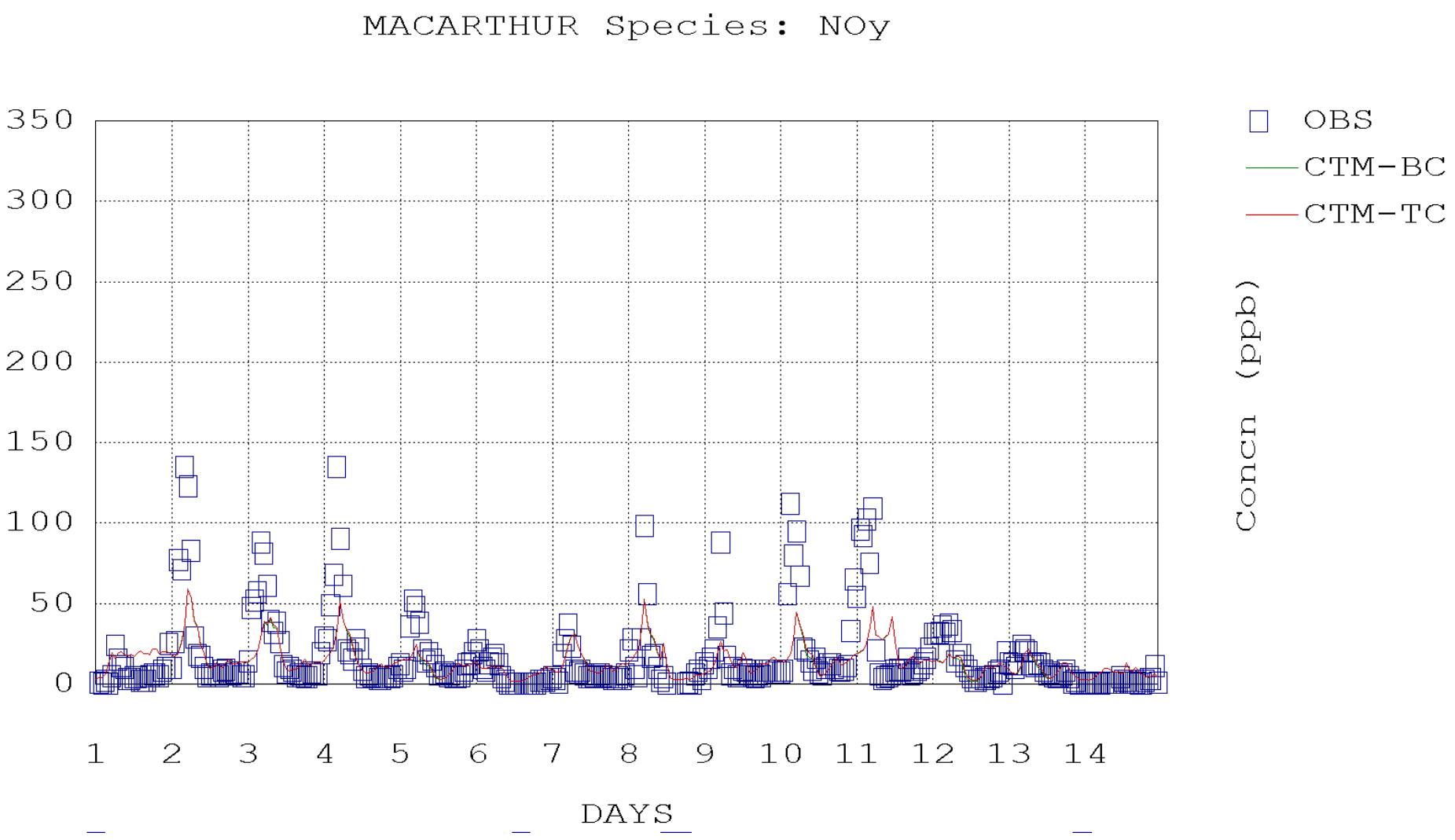
DAYS
Concn (ppb)
OBS
CTM-BC
CTM-TC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300
250
200
150
100
50
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1
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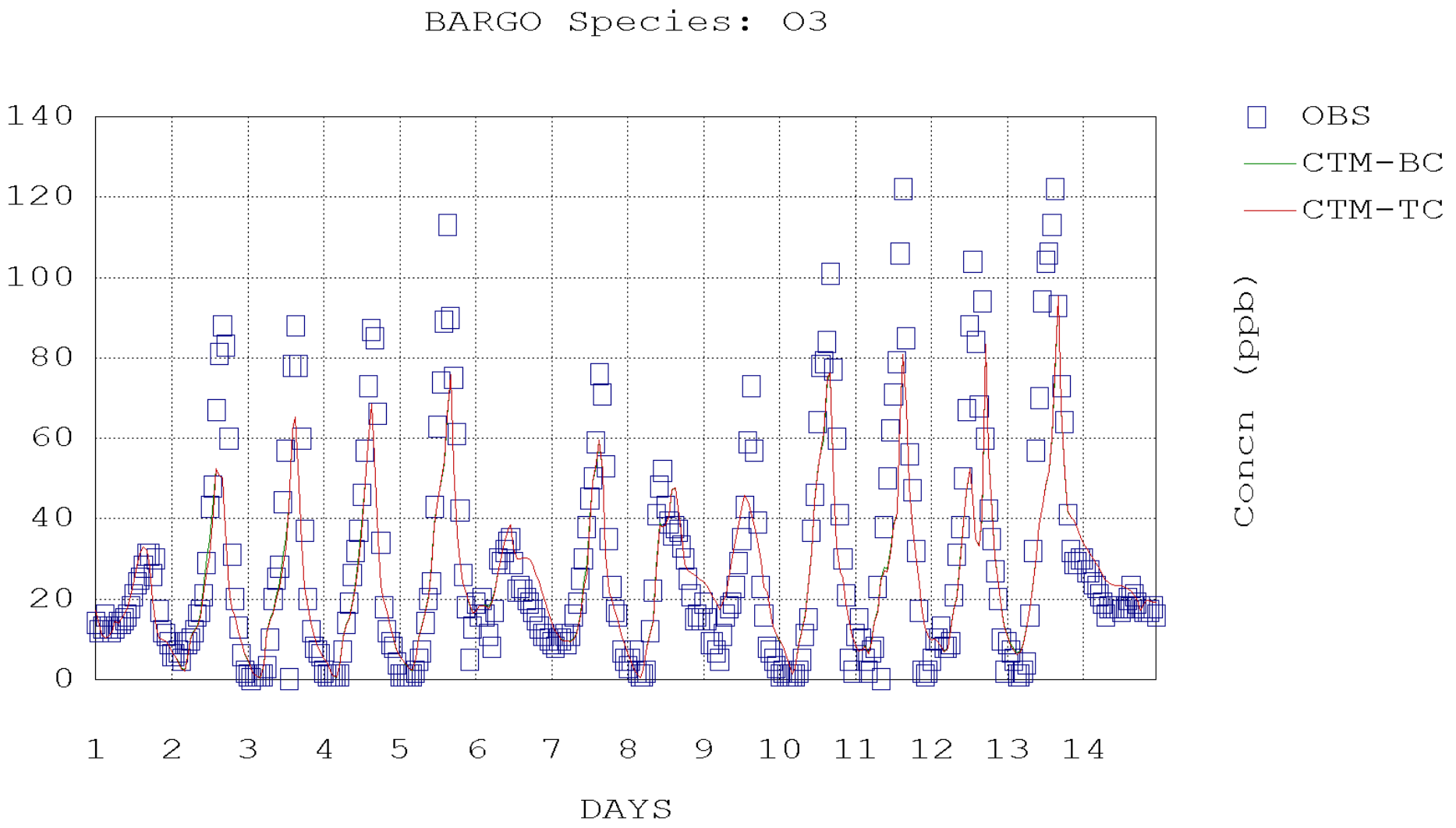
12
13
14
DAYS
OBS
CTM-BC
CTM-TC
Concn (ppb)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80
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1
2
3
4
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8
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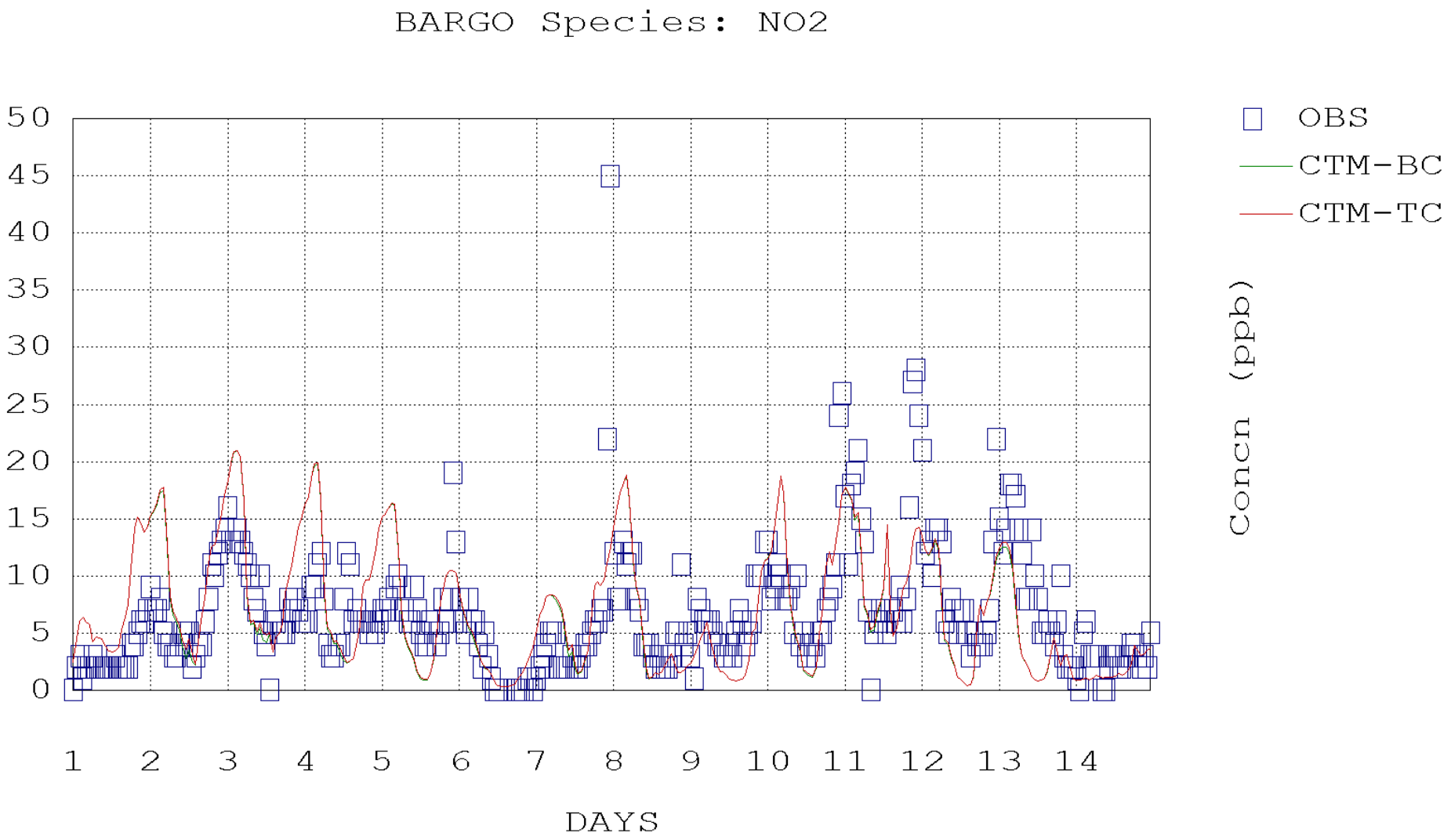
10
11
12
13
14
DAYS
Concn (ppb)
OBS
CTM-BC
CTM-TC


BARGO Species: NO2
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0
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2
3
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6
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8
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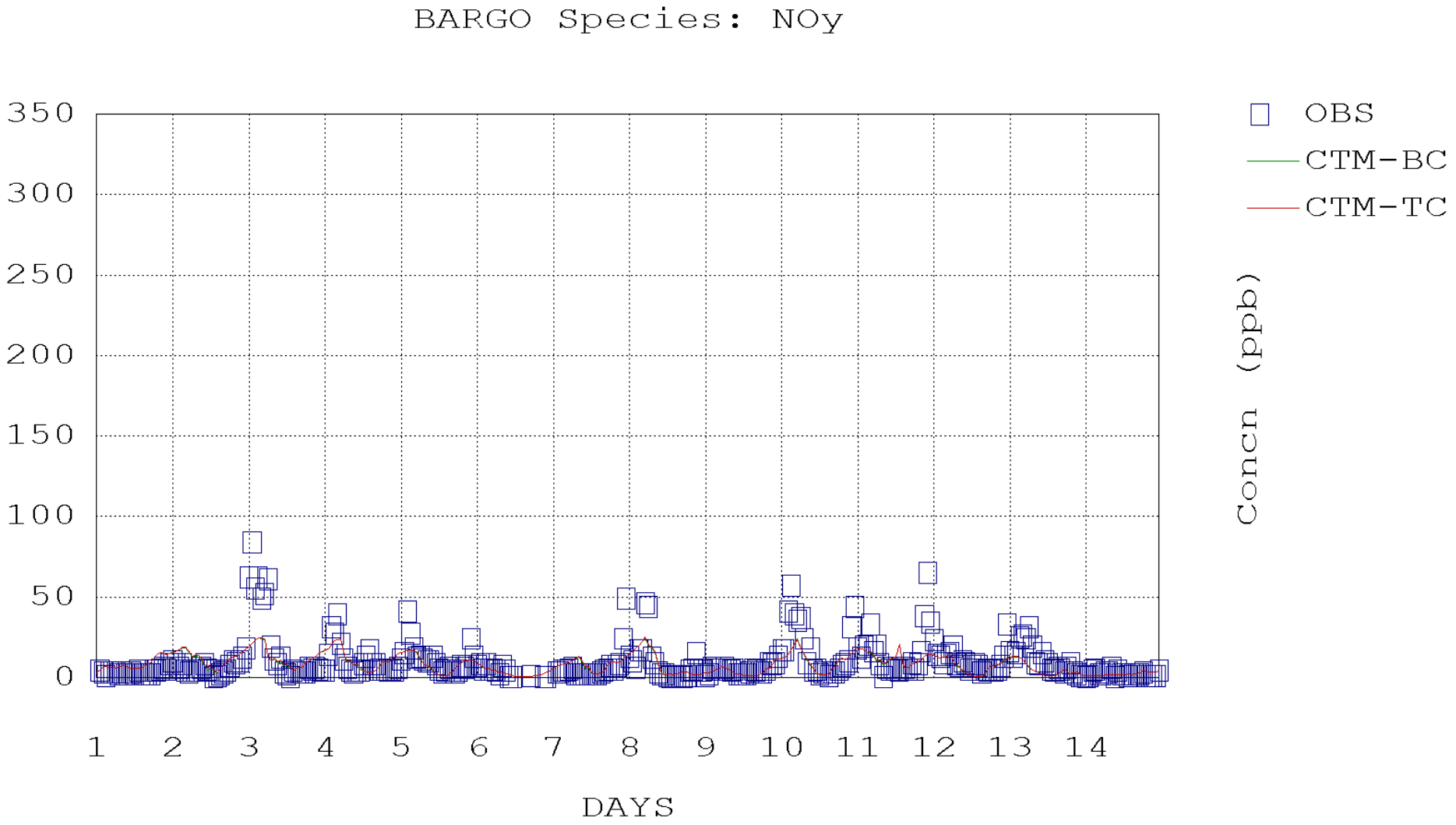
12
13
14
DAYS
Concn (ppb)
OBS
CTM-BC
CTM-TC


BARGO Species: NOy
350
300
250
200
150
100
50
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1
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4
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6
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8
9
10
11
12
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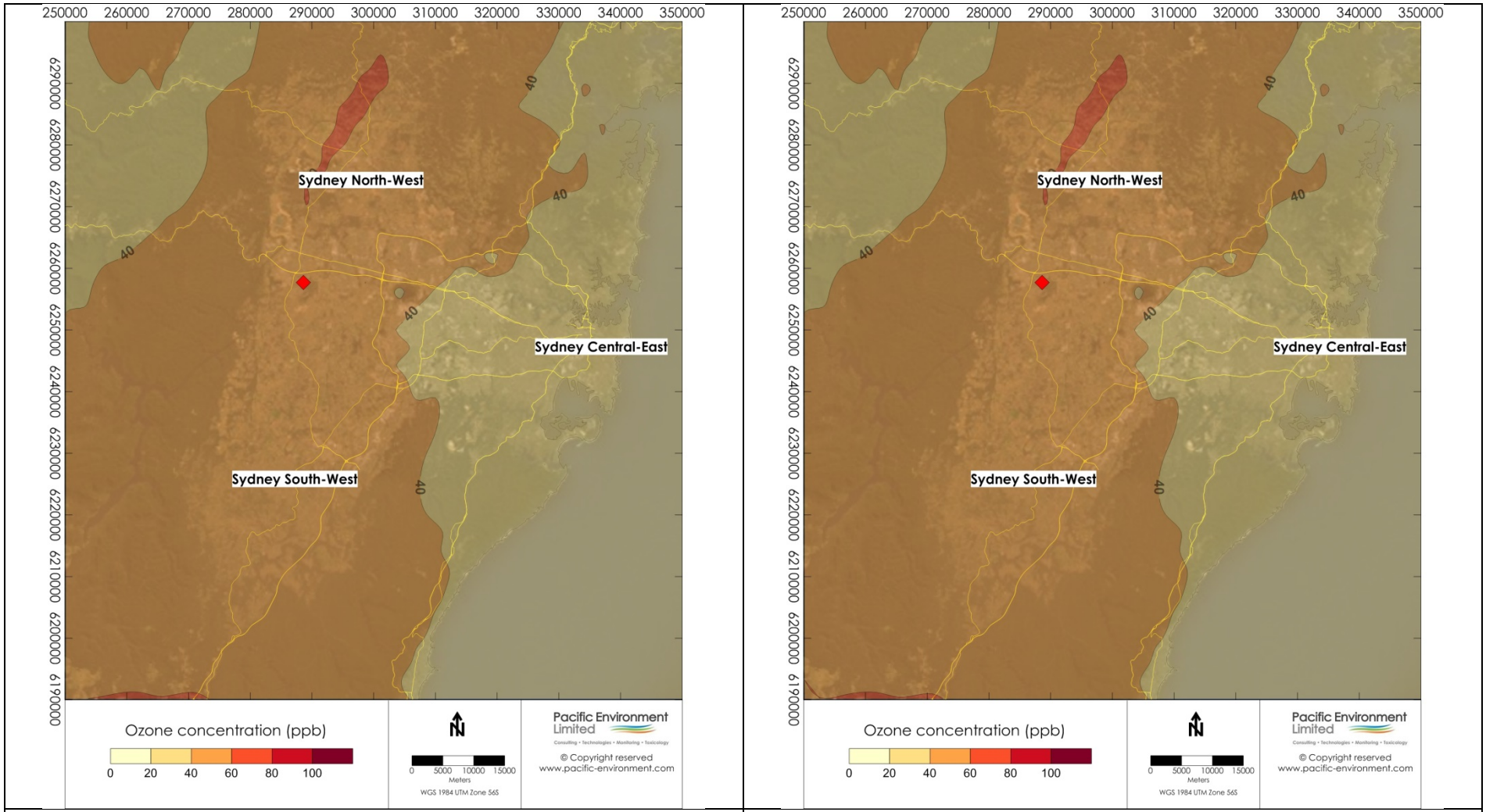
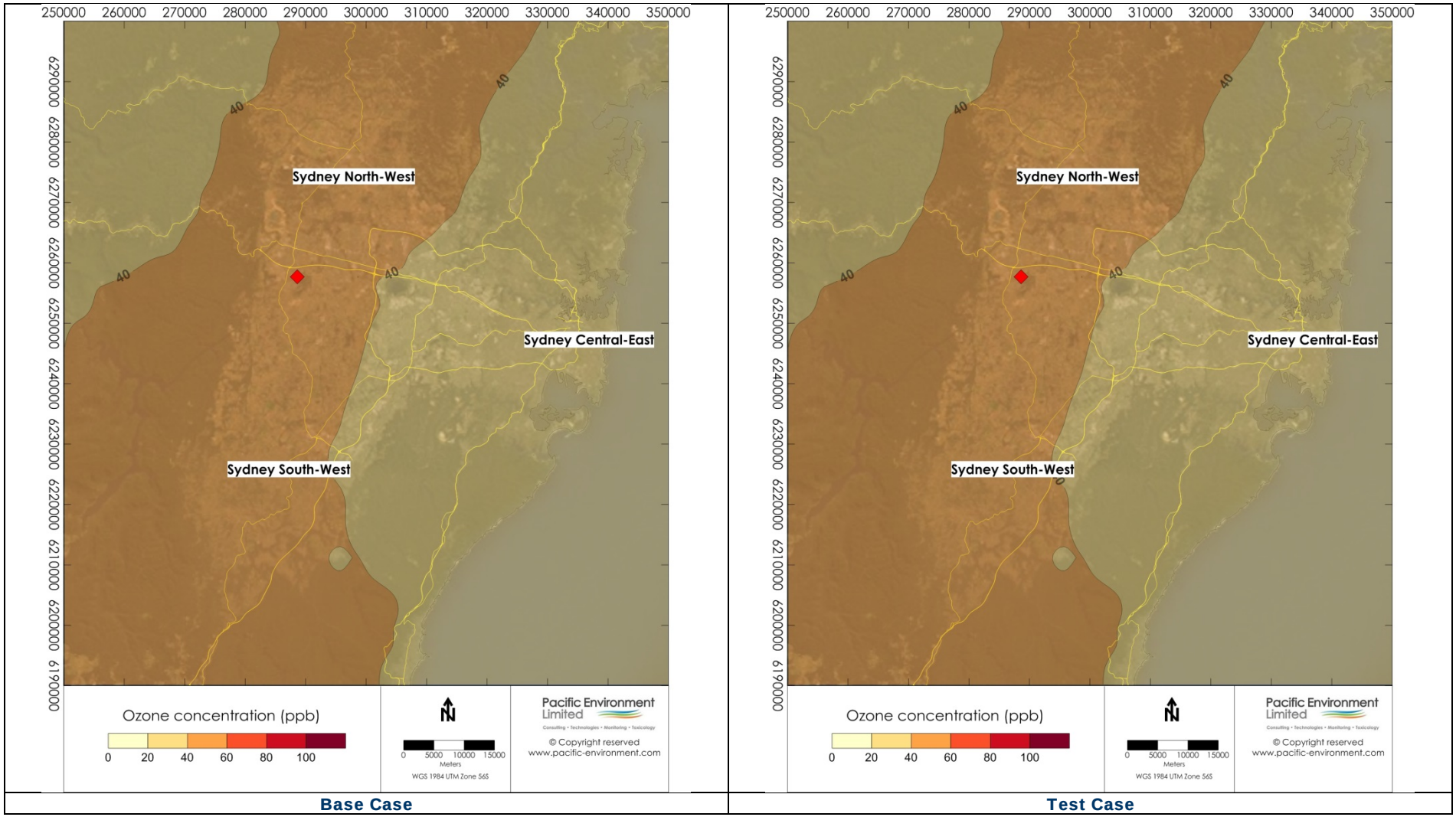
14
DAYS
Concn (ppb)
OBS
CTM-BC
CTM-TC

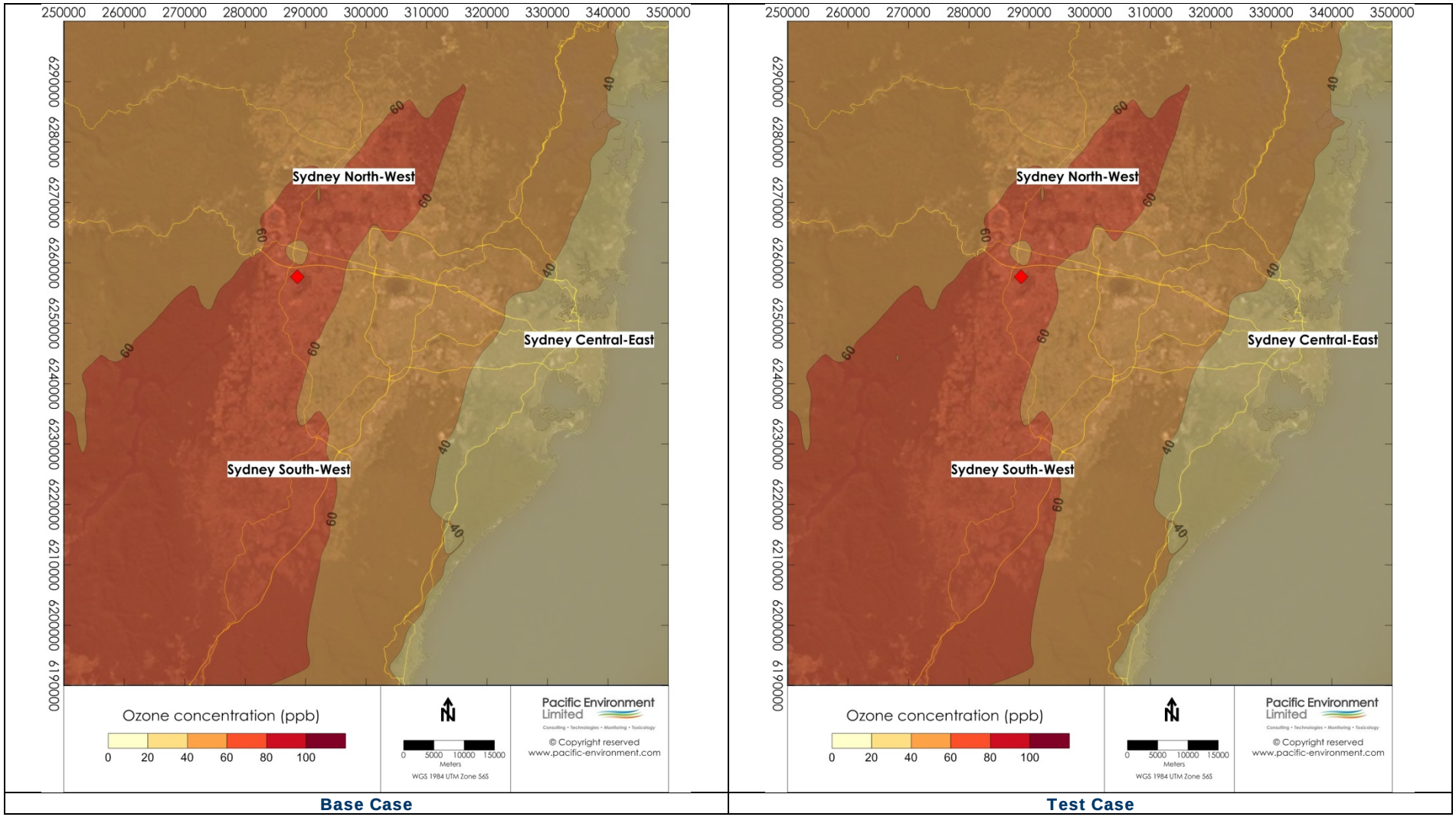
Appendix E INVESTIGATION DAY CONTOUR PLOTS – MAXIMUM OZONE CONCENTRATION



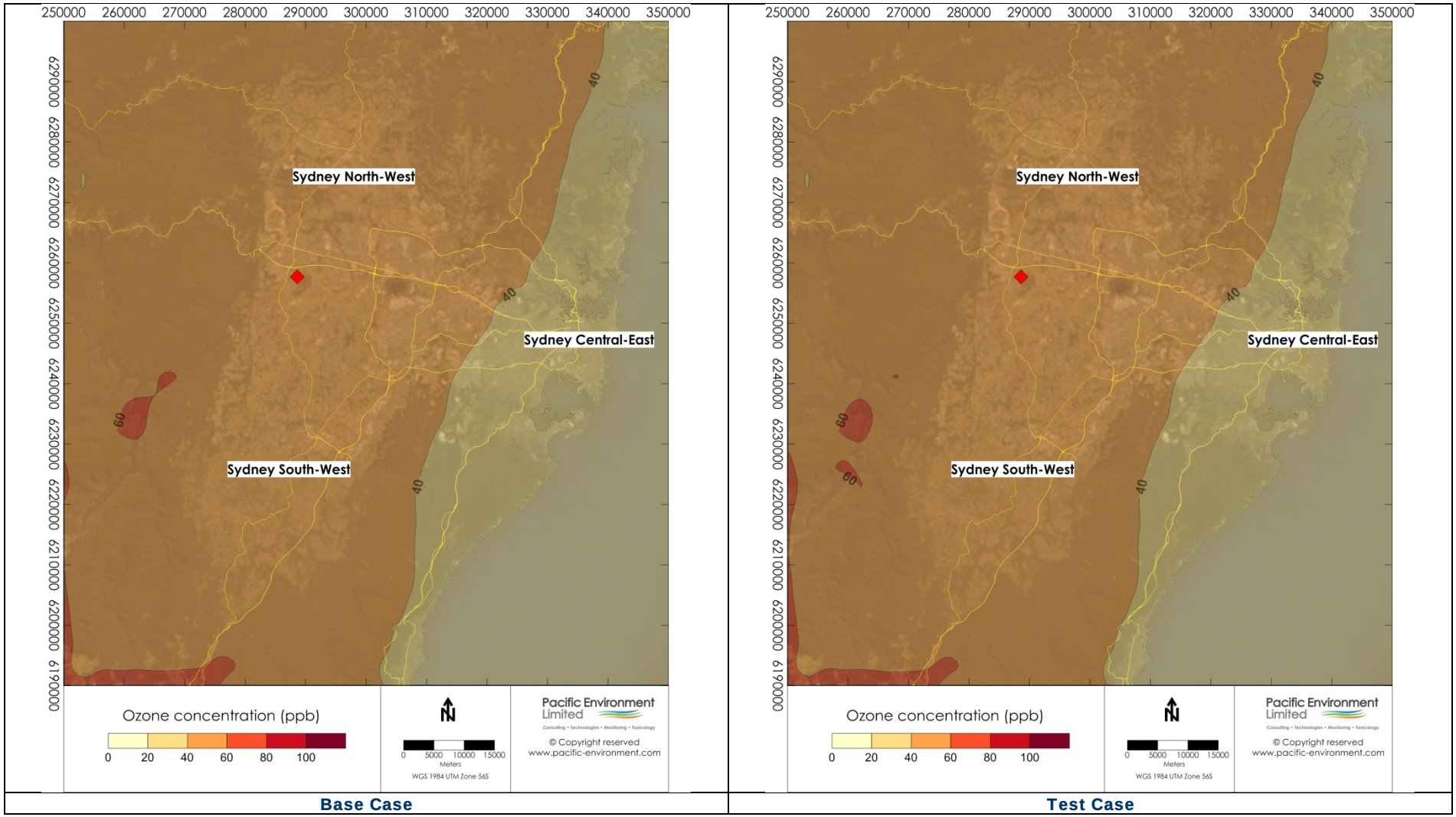
E.1.1 Maximum 1-hour O_3 concentration on 28/01/2009 for Base Case and Test Case



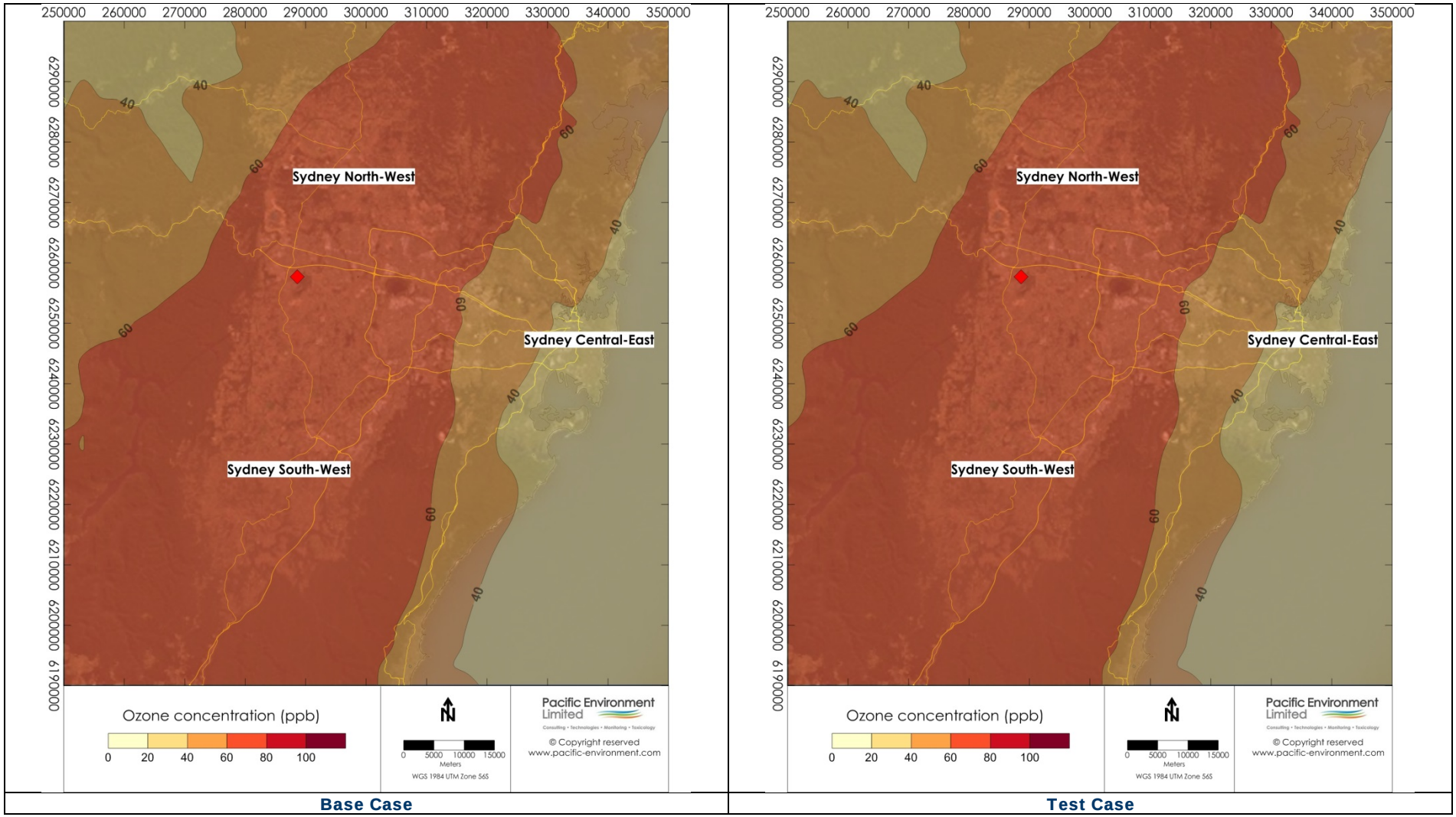
E.1.2 Maximum 4-hour O_3 concentration on 28/01/2009 for Base Case and Test Case



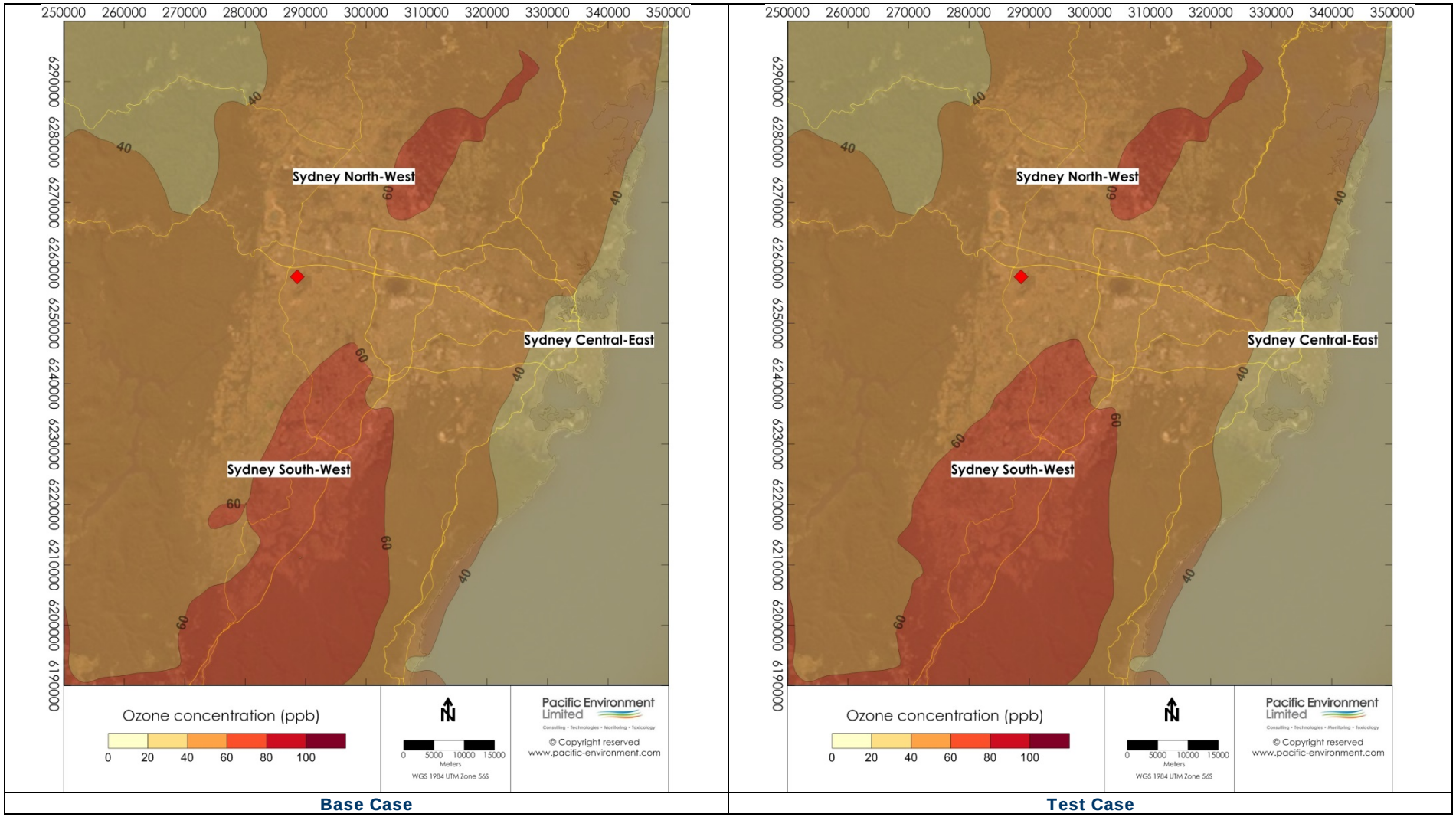
E.1.3 Maximum 1-hour O_3 concentration on 30/01/2009 for Base Case and Test Case



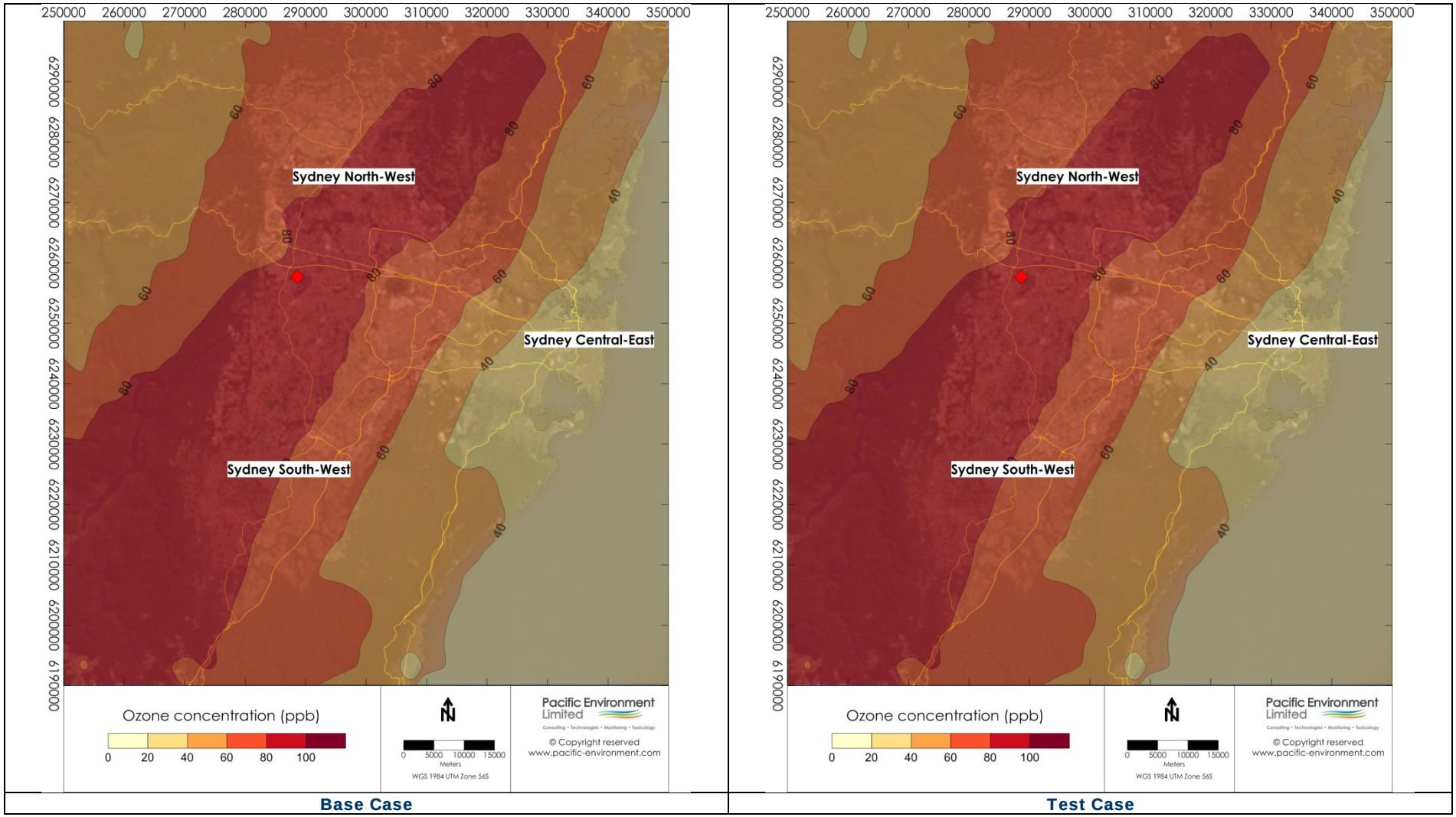
E.1.4 Maximum 4-hour O_3 concentration on 30/01/2009 for Base Case and Test Case



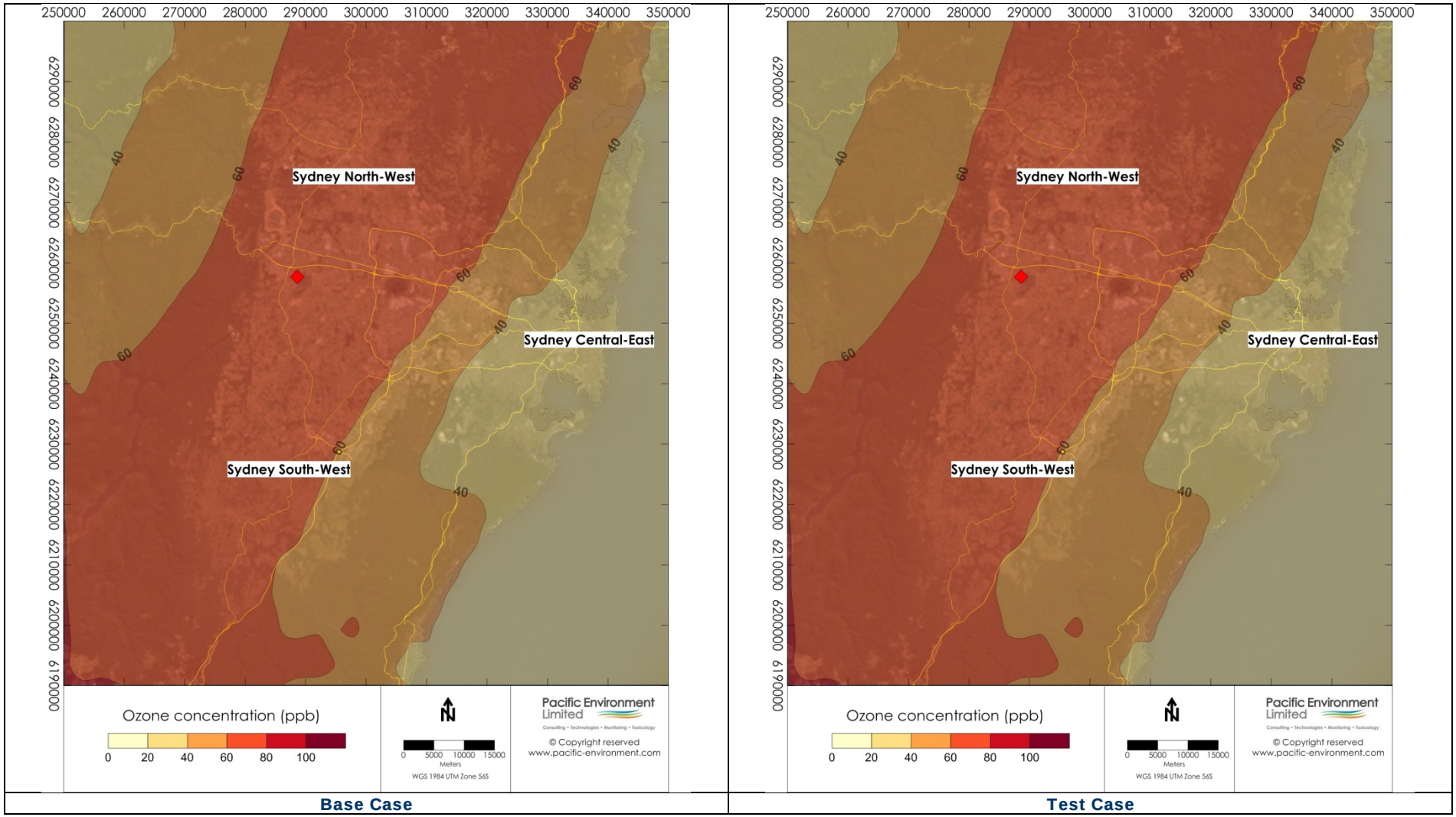
E.1.5 Maximum 1-hour O_3 concentration on 31/01/2009 for Base Case and Test Case



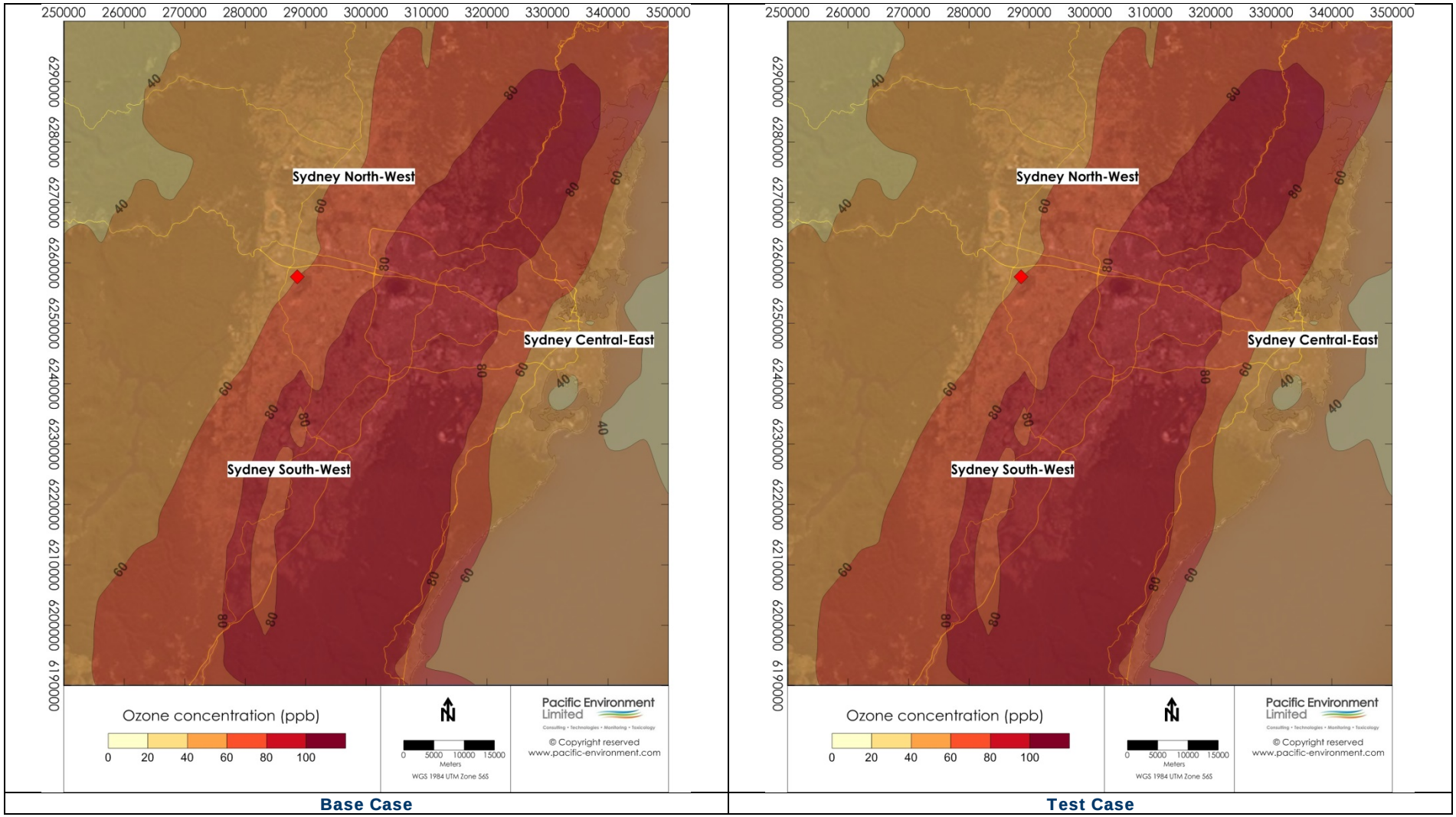
E.1.6 Maximum 4-hour O_3 concentration on 31/01/2009 for Base Case and Test Case



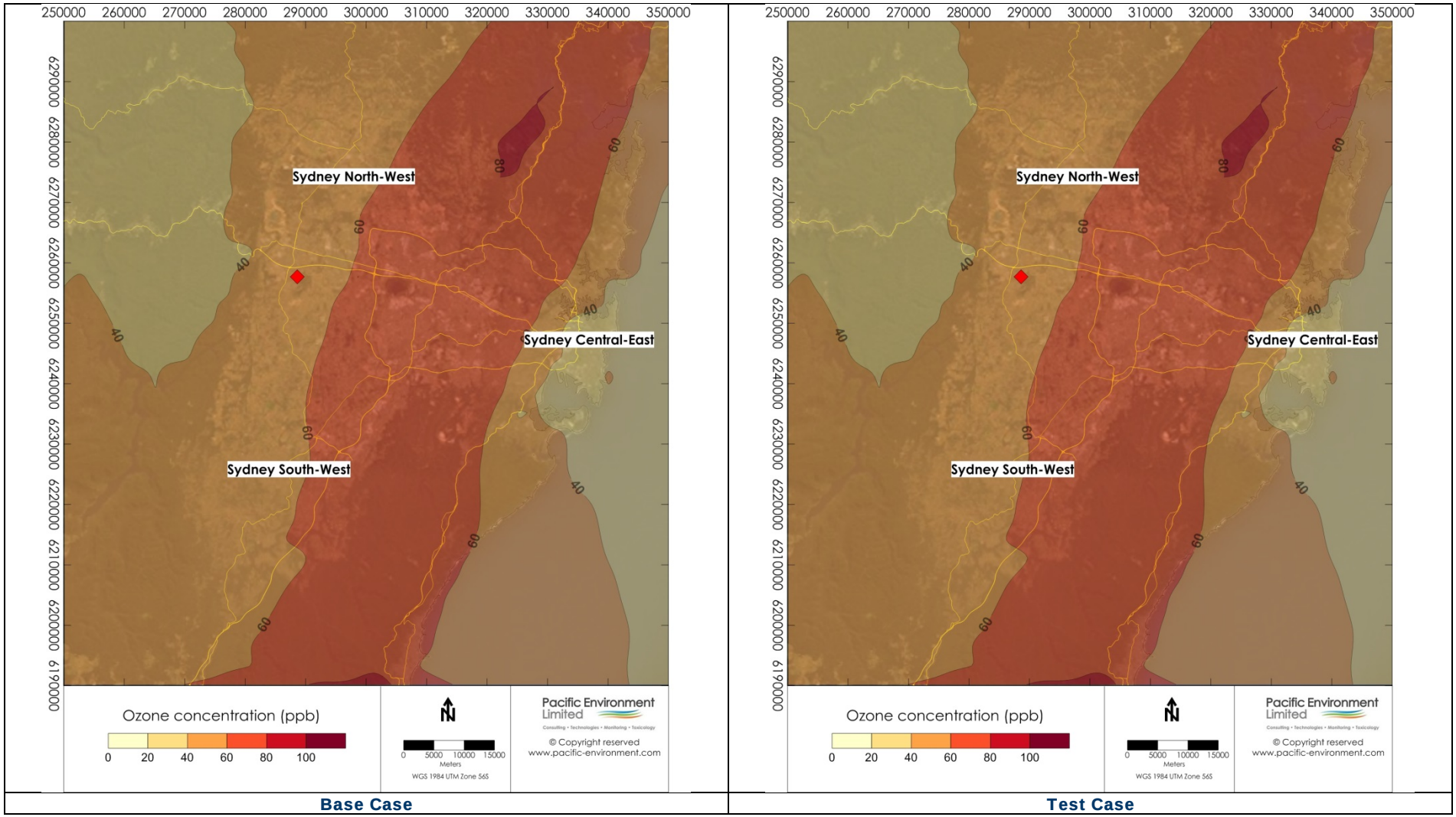
E.1.7 Maximum 1-hour O_3 concentration on 06/02/2009 for Base Case and Test Case



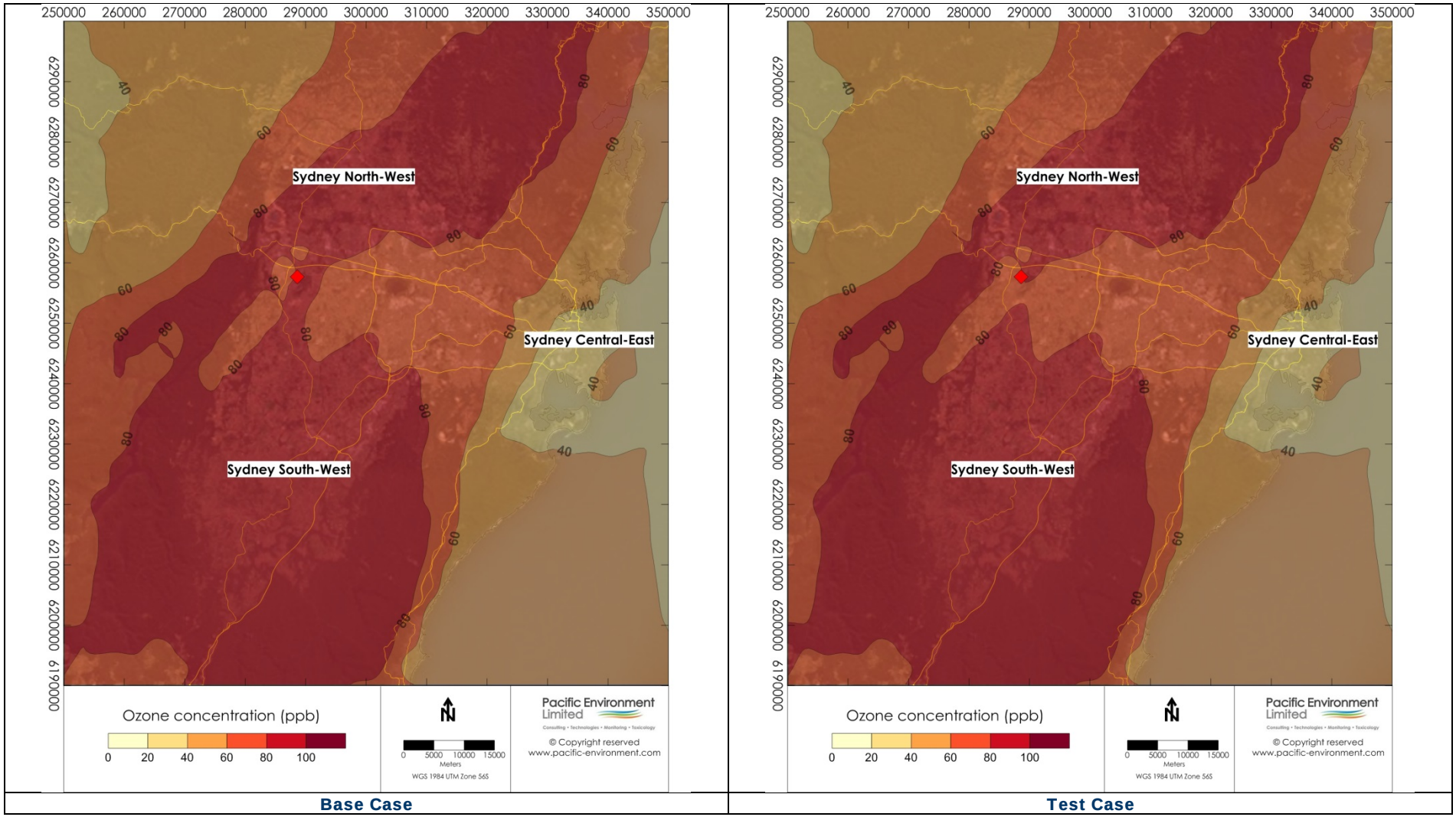
E.1.8 Maximum 4-hour O_3 concentration on 06/02/2009 for Base Case and Test Case



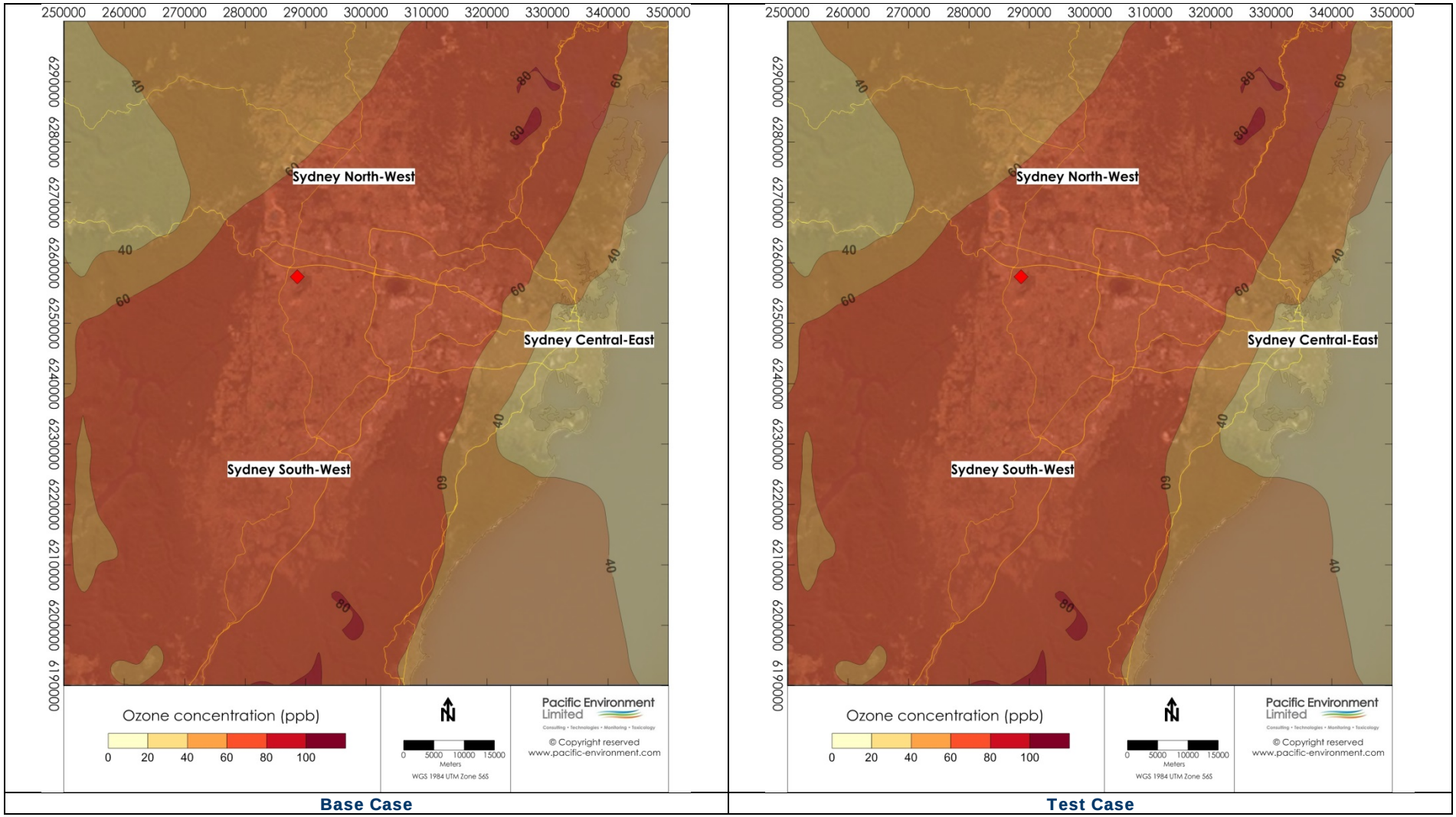
E.1.9 Maximum 1-hour O_3 concentration on 07/02/2009 for Base Case and Test Case



E.1.10 Maximum 4-hour O_3 concentration on 07/02/2009 for Base Case and Test Case



E.1.11 Maximum 1-hour O_3 concentration on 08/02/2009 for Base Case and Test Case



E.1.12 Maximum 4-hour O_3 concentration on 08/02/2009 for Base Case and Test Case

Appendix F: CSIRO PEER REVIEW COMMENTS

OCEAN AND ATMOSPHERIC FLAGSHIP
www.csiro.au

107–121 Station St., Aspendale VIC 3195
Private Bag No 1, Aspendale VIC, 3195, Australia
T (03) 9239 4647 • **ABN** 41 687 119 230

10th April 2015

Damon Roddis
Principal/General Manager (NSW)
Pacific Environment
Level 1, 146 Arthur Street,
North Sydney, NSW 2060

Dear Damon

This letter is to confirm that, on behalf of CSIRO, I was engaged to provide expert advice to Pacific Environment with respect to photochemical modelling being undertaken by your team to assess the influence of emissions of oxides of nitrogen from the proposed The Next Generation (TNG) Energy from Waste (Efw) facility to be sited at Eastern Creek.

This expert advice/peer review process commenced at the beginning of February 2015, and since that time, I provided feedback on two draft assessment documents (and on comments tabled by EPA with respect to the first document); attended phone meetings with members of your team; OEH and NSW EPA, provided chemical transport modelling software (and ancillary software), provided advice on model installation; worked with your team on the configuration of the modelling system for the GMR, and have undertaken an assessment and analysis of model performance.

Following this process of review and feedback, I believe that Pacific Environment deployed a photochemical modelling system and analysis techniques which may currently be considered state-of-the art for the GMR. Even so, there were challenges in applying the system to a series of photochemical smog events for which data suitable for the diagnostic evaluation of the modelling system were not available. This was compounded by the uncertainty associated with using the 2008 GMR emissions inventory which is new and relatively untested in chemical transport modelling studies at this point in time. Although the modelling system generally under predicted the observed peak 1-h ozone concentrations, the magnitude of the under prediction was considered acceptable, particularly given that the model was able to reproduce key features of the ozone time series, including the presence of single and double peaks at the inland monitoring stations.

Your team are to be commended for working quickly and efficiently throughout this project to address the issues which were identified from the first assessment document, thus resulting in a more robust set of simulations which were then available for the final assessment.

Additional details regarding the peer review process, including comments with respect to model performance and uncertainty are contained in the attachment.

Regards

Martin Cope
Principal Research Scientist
martin.cope@csiro.au
(03) 9239 4647

Attachment

Initial Recommendations

Following a review of the initial modelling which was undertaken in 2014 (together with feedback from the EPA), it was concluded that the model generally performed well with respect to the simulation of ozone (although the observed peak concentrations were under predicted).

However a number of extensions to the original work were recommended including an investigation of model performance with respect to NO_2; the use of an additional low resolution model domain (27 km grid spacing) in order to reduce sensitivity to uncertainties in boundary concentrations; more selective use of near surface wind observations for nudging and for TAPM meteorological performance characterisation; the use of scatter plots to analyse the calculated change in ozone concentration due to emissions of NO_x from the proposed facility.

Over prediction of NO_2

A review of observed and modelled NO_2 concentrations showed that there were some situations in which severe over prediction occurred. Generally these occurred when the NO_x was also over predicted and the NO_2:NO_x ratio corresponded to fresh vehicular emissions mixed with background ozone titrated to NO_2 in the presence of excess NO. This has been seen previously in work undertaken in the GMR by CSIRO and collaborators and results from poor characterisation of urban mixing processes as the urban boundary layer transitions from stable/neutral to unstable and vehicular emissions of NO_x increase rapidly as the morning commuter cycle begins.

Under these conditions, small timing errors in either the boundary layer growth or commencement of the morning traffic peak can lead to large errors in the simulated NO_x (and NO_2) concentrations. This issue is currently treated in TAPM–CTM (and similar modelling systems) by prescribing an initial region over which surface-based emissions are mixed rapidly. Use of this methodology by Pacific Environment required the installation of a later version of TAPM–CTM plus the application of a pre-processor step to change the format of the EPA emission files into an alternative format usable by the updated TAPM–CTM code. Adoption of this technique reduced the degree of over prediction of NO_2 to an acceptable degree.

Under prediction of O_3

Although the temporal behaviour of the 1-h observed ozone is often well predicted (including the presence of double peaks; plateau followed by peak; single peak) observed peak ozone concentrations are generally under predicted by up to 40% by the chemical transport modelling.

Accurate simulation of the observed temporal behaviour is a necessary condition for good model performance as it indicates that the meteorological modelling (TAPM) has been able to reproduce key processes which have led to the observed ozone behaviour. For example, the presence of a single ozone peak late in the day can usually be related to the presence of a deep relatively unpolluted boundary layer prior to the transport of ozone precursors and ozone within the sea breeze. The presence of a double peak can be related to photochemical smog development within a relatively low and slow growing boundary layer prior to dilution through boundary layer growth and then the transport of a second polluted air mass within the sea breeze (the second peak). There are also additional mechanisms which operate in the GMR which can lead to multi-peak ozone distributions, including the presence of an aged air mass (whether anthropogenic or smoke) in Western Sydney prior to the onset of the sea breeze.

Guidance as to the significance of the model under prediction in this assessment with respect to other studies can be taken from Morris et al. (2005) who quantifies model performance according to the following criteria. Thus the model performance for the current study is average but acceptable.

Average	Good	Excellent
|fraction bias| ≤ 60% and fractional error ≤ 75%	|fraction bias| ≤ 30% and fractional error ≤ 50%	|fraction bias| ≤ 15% and fractional error ≤ 35%

Under prediction of the peak ozone concentrations can be caused by many factors including over prediction of the boundary layer height; under prediction of biogenic VOC emissions from vegetation; uncertainties in the anthropogenic emissions inventory (the 2008 inventory has only recently been released and is relatively untested); omission of significant sources (i.e. ozone and ozone precursors in smoke plumes); uncertainty in the treatment of atmospheric chemistry.

Identification of the causes of the under prediction is difficult to achieve without access to detailed diagnostic data- generally only collected during purpose-designed field studies (e.g. see http://tinyurl.com/mzvpydw; http://tinyurl.com/n6nqzrv). Until such data are used to undertake a diagnostic evaluation of the photochemical modelling system when coupled with the NSW EPA 2008 inventory, it will be challenging to resolve the under prediction issue. It is considered that such a detailed evaluation does not fall within the bounds of the current project, but rather should be led out of OEH as part of the development of a recommended and comprehensively verified suite of simulated photochemical smog events which are linked to the EPA tiered photochemical smog impact assessment procedure.

With respect to the assessment of the TNG EfW, the under prediction of the peak ozone concentrations adds to the uncertainty of the calculated TNG EfW influence on peak ozone (and hence the magnitude of the ozone change), however is unlikely to change the sign of the ozone response. This is because the influence of the plant's NO_x emissions will generally robustly lead to titration and ozone reduction in the near field, and through the geographical location of the facility in the west of Sydney, to some increase in ozone concentration for situations when the NO_x emissions interact with an aged photochemical smog plume transported inland from coastal urban regions.

References

Morris, R., McNally, D., Tesche, T., Tonnesen, G., Boylan, J., and Brewer, P. (2005). Preliminary evaluation of community multiscale air quality model for 2002 over the southeastern United States. J.Air and Waste Manafe. Assoc, 55, 1694-1708.