atmosphere

Supplementary Materials:

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1. Correlation of MLH, PBLH with Air Pollutants (O_3, PM_{10}, $PM_{2.5}$, NO_2 and NO_x) and Meteorological Variables (Temperature, Relative Humidity)

1.1. Period 12 to 19 February 2021 (Austral Summer)

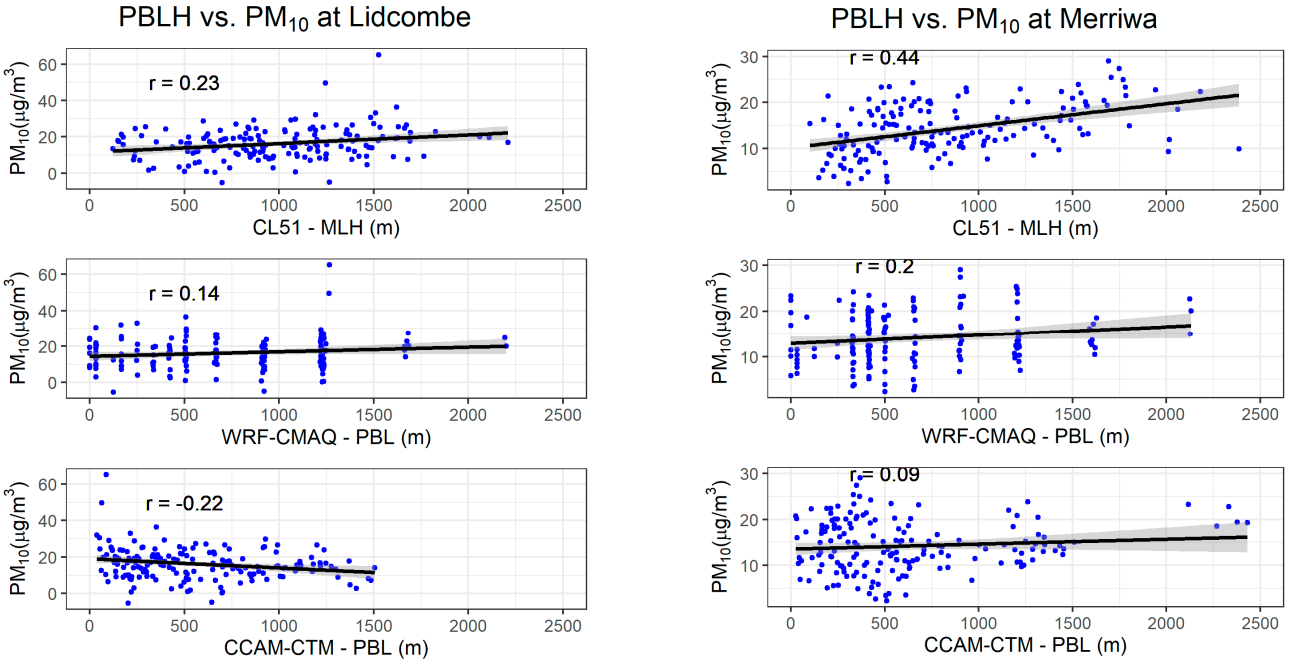
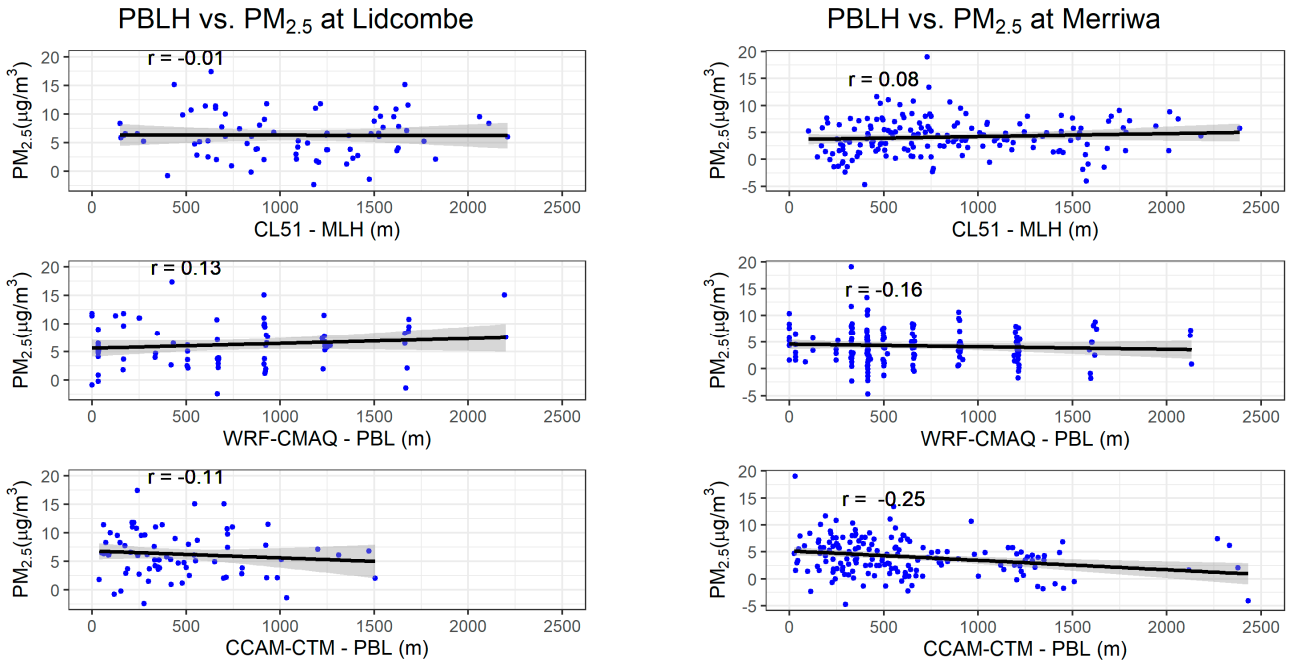
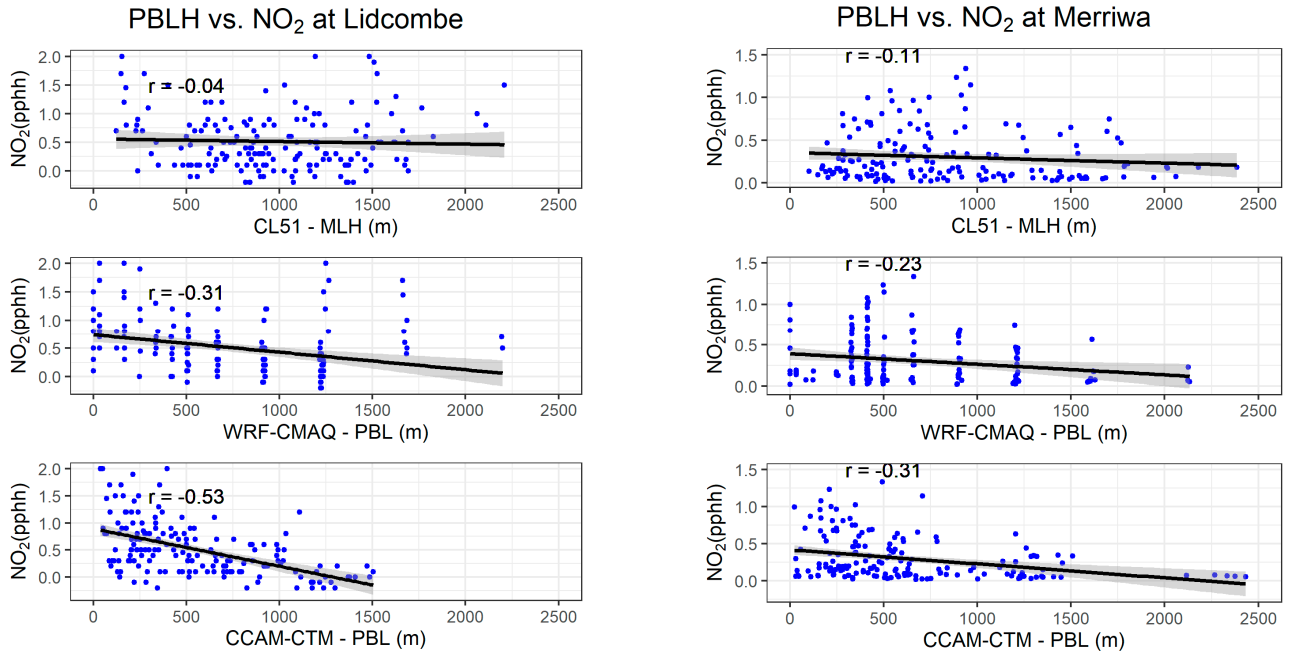


Figure S1. Scattered plots of PM_{10} concentration versus PBLHs(PBLH, planetary boundary layer height) as measured from CL51 ceilometer, predicted by WRF and by CCAM at (**a**) Lidcombe and (**b**) Merriwa for the period 12 February to 19 February 2021. The regression lines with 95% confidence band are in black colors. Positive correlation is stronger at Merriwa rural site as compared to that at Lidcombe urban site. Dust from inland NSW could play a role at Merriwa site while fine particle $PM_{2.5}$ has no correlation with PBLH at both sites (figure S2 below).



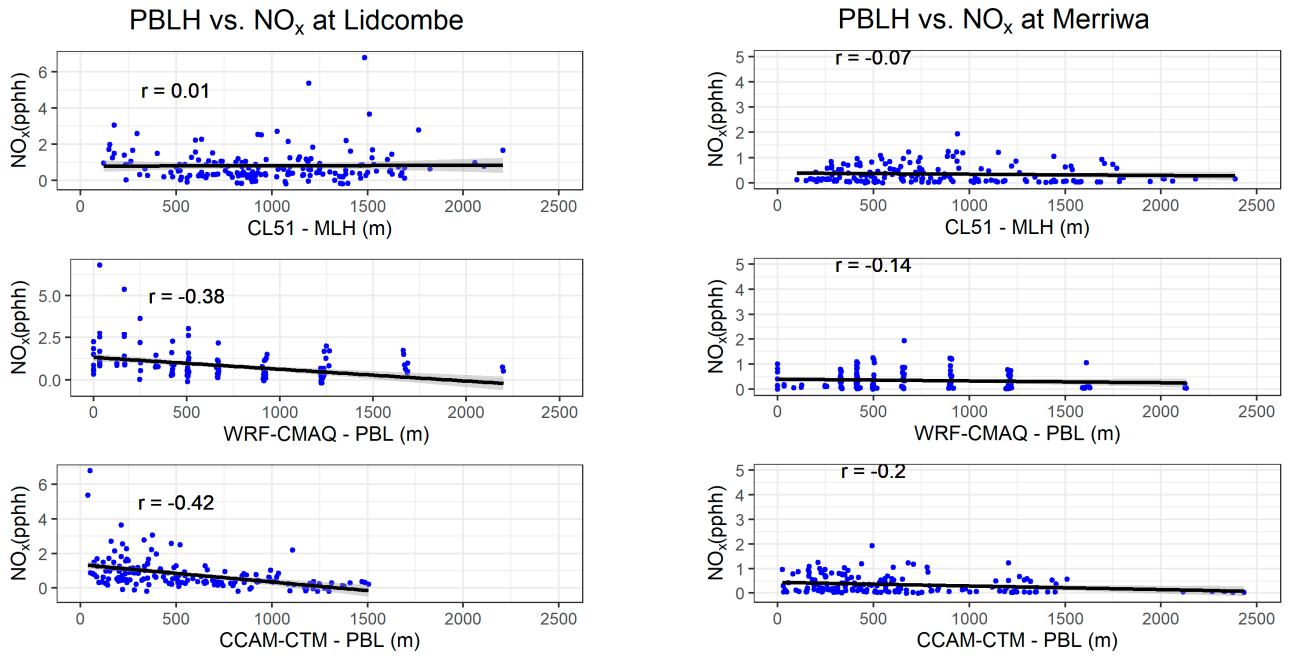
(**a**) (**b**)

Figure S2. Scattered plots of $PM_{2.5}$ concentration versus PBLHs as measured from CL51 ceilometer, predicted by WRF and by CCAM at (**a**) Lidcombe and (**b**) Merriwa for the period 12 February to 19 February 2021. The regression lines with 95% confidence band are in black colors. No correlation between PBLH and $PM_{2.5}$ at Lidcombe and Merriwa sites.



(**a**) (**b**)

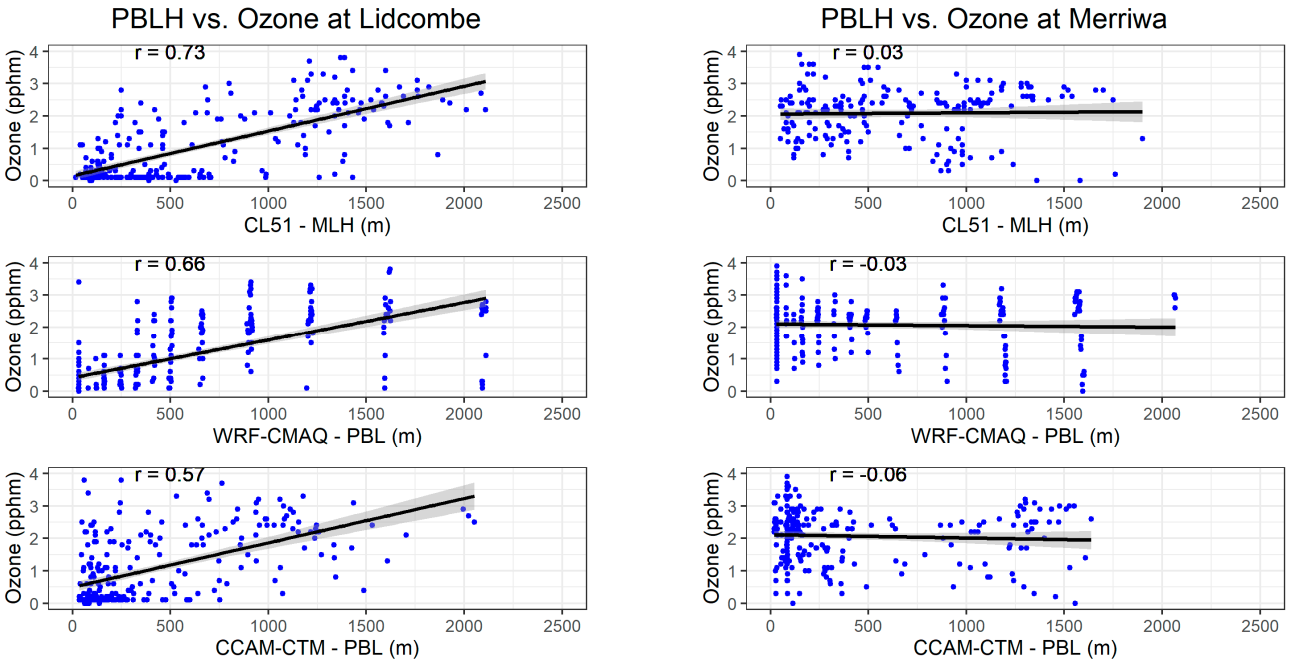
Figure S3. Scattered plots of NO_2 concentration versus PBLHs as measured from CL51 ceilometer, predicted by WRF and by CCAM at (**a**) Lidcombe and (**b**) Merriwa for the period 12 February to 19 February 2021. The regression lines with 95% confidence band are in black colors.



(**a**) (**b**)

Figure S4. Scattered plots of NO_x concentration versus PBLHs as measured from CL51 ceilometer, predicted by WRF and by CCAM at (**a**) Lidcombe and (**b**) Merriwa for the period 12 February to 19 February 2021. The regression lines with 95% confidence band are in black colors. There is no correlation between NO_x and PBLH at Lidcombe and Merriwa but both WRF-CMAQ and CCAM-CTM predicted negative correlation.

1.2. Period 17 April 2021 to 2 May 2021 (Austral Autumn)



(**a**) (**b**)

Figure S5. Scattered plots of measured ozone versus PBLH as measured by CL51 ceilometer and predicted by WRF-CMAQ and CCAM-CTM at (**a**) Lidcombe and (**b**) Merriwa for the period 17 April to 2 May 2021. The regression lines with 95% confidence band are in black colors. Positive correlation of PBLH and ozone is higher at Lidcombe urban site compared to that at Merriwa rural site which practically has no correlation. This is probably due to higher photochemical reaction due to increase in precursors (NOx and VOC) in urban area.

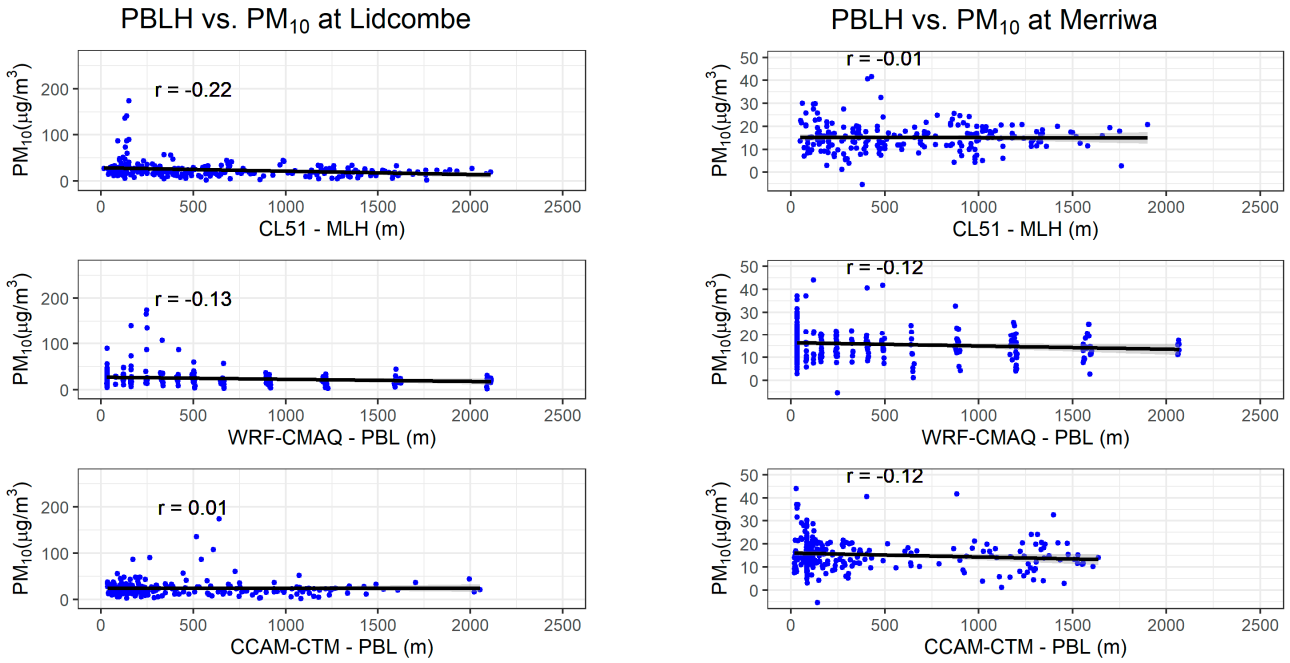


Figure S6. Scattered plots of PM_{10} concentration versus PBLHs as measured from CL51 ceilometer, predicted by WRF and by CCAM at (**a**) Lidcombe and (**b**) Merriwa for the period 17 April to 2 May 2021. The regression lines with 95% confidence band are in black colors. Correlation is low at both Lidcombe urban site and Merriwa rural site.

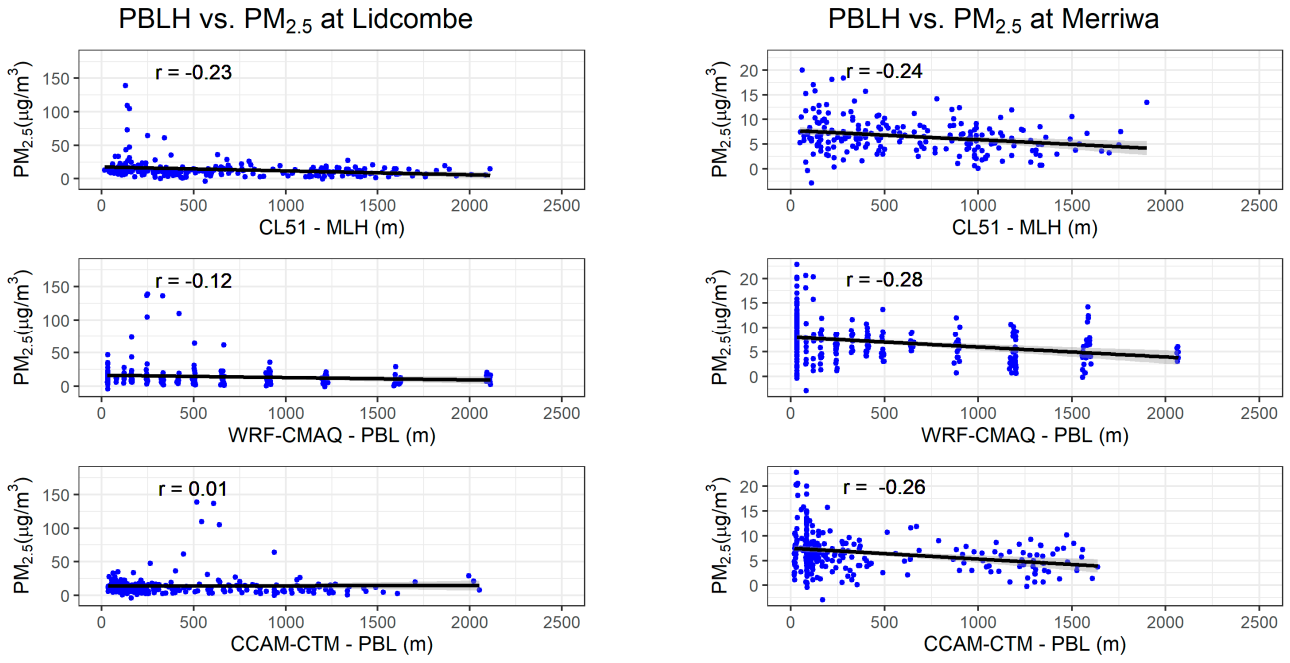


Figure S7. Scattered plots of $PM_{2.5}$ concentration versus PBLHs as measured from CL51 ceilometer, predicted by WRF and by CCAM at (**a**) Lidcombe and (**b**) Merriwa for the period 17 April to 2 May 2021. The regression lines with 95% confidence band are in black colors.

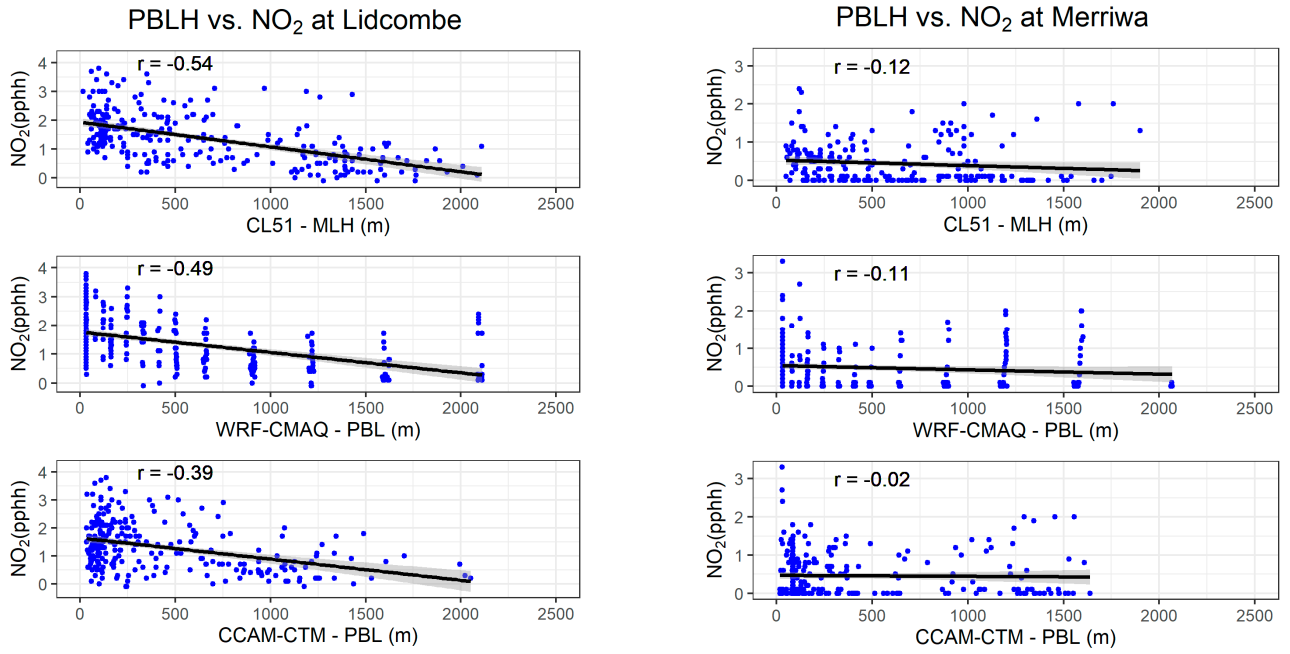


Figure S8. Scattered plots of NO_2 concentration versus PBLHs as measured from CL51 ceilometer, predicted by WRF and by CCAM at (**a**) Lidcombe and (**b**) Merriwa for the period 17 April to 2 May 2021. The regression lines with 95% confidence band are in black colors. Negative correlation of PBLH and NO_2 is stronger at Lidcombe compared to that at Merriwa.

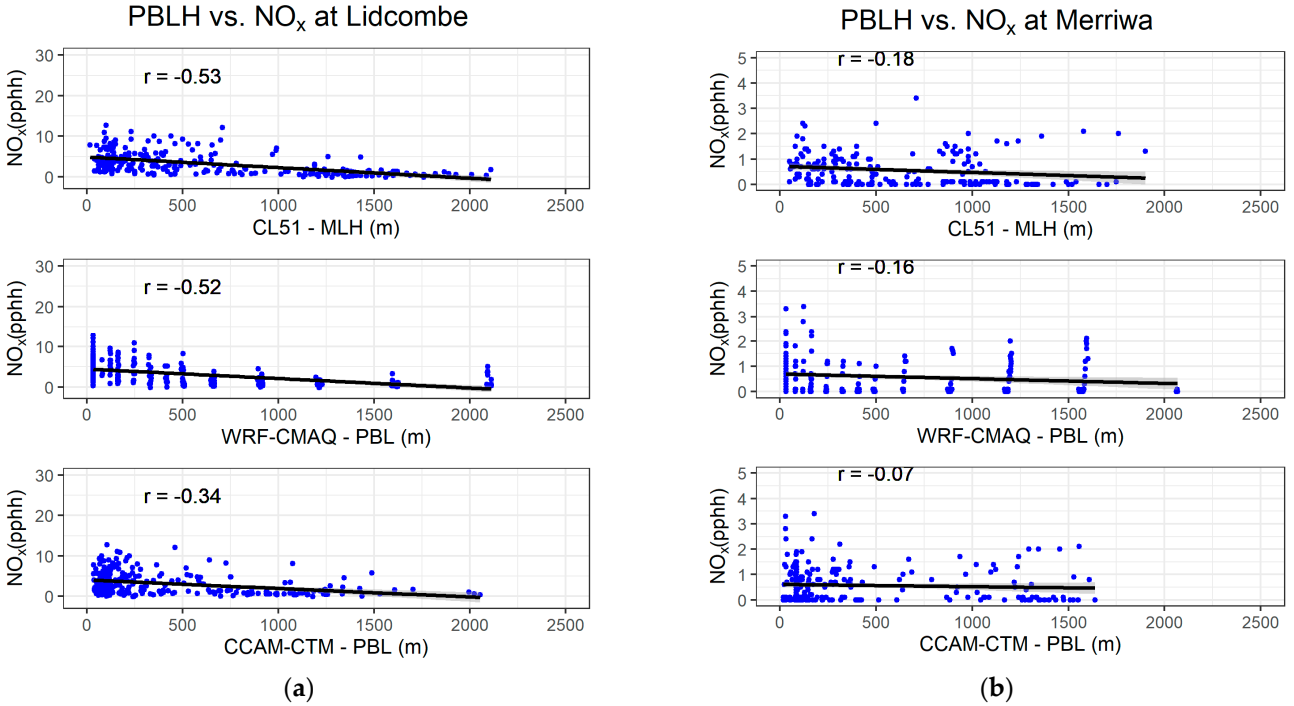


Figure S9. Scattered plots of NO_x concentration versus PBLHs as measured from CL51 ceilometer, predicted by WRF and by CCAM at (**a**) Lidcombe and (**b**) Merriwa for the period 17 April to 2 May 2021. The regression lines with 95% confidence band are in black colors. Negative correlation of PBLH and NO_x concentration is stronger at urban Lidcombe site than that at Merriwa and NO_x concentration is also much higher. This negative correlation is mirrored that of ozone and PBLH positive correlation. Photochemical reaction plays an important role in NO_x, O_3 and PBLH relations.

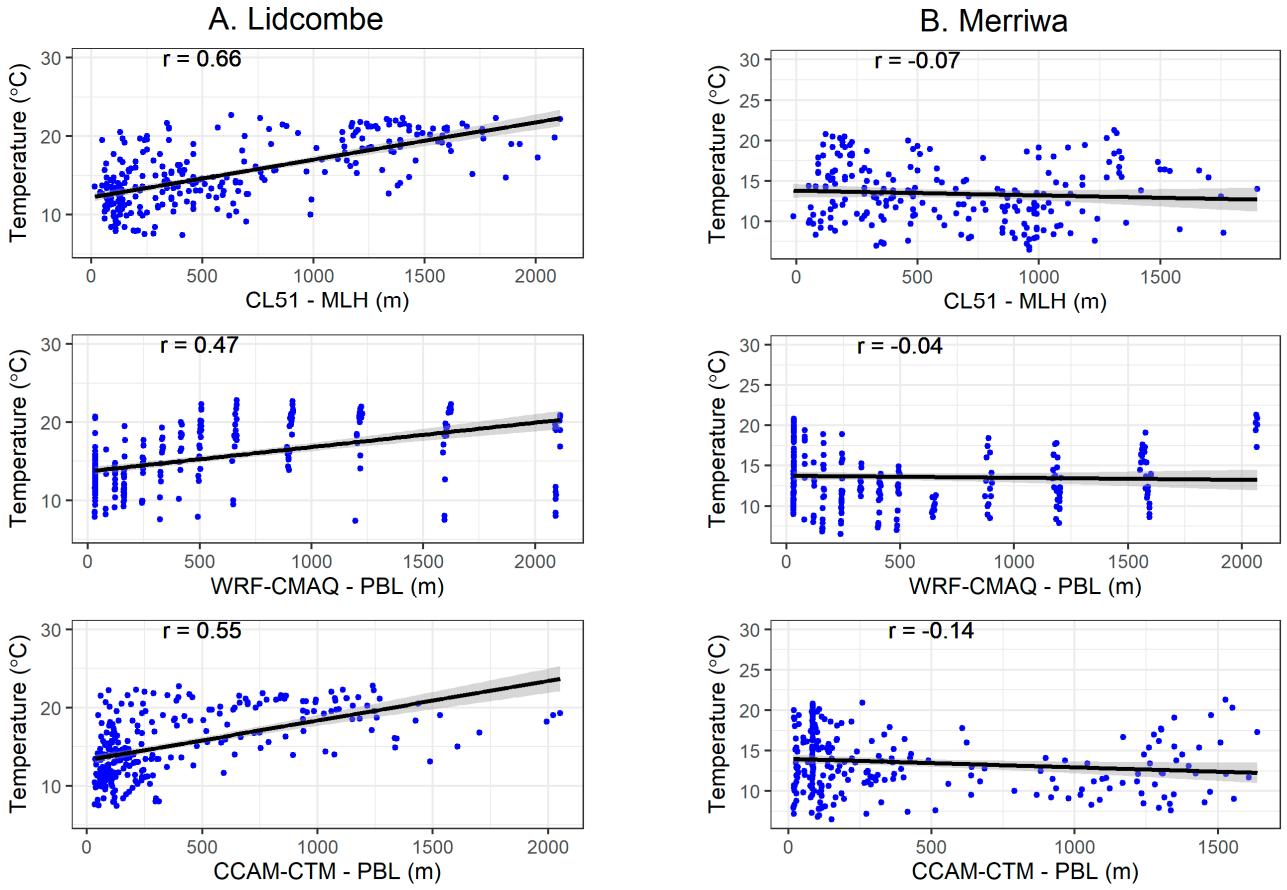


Figure S10. Scattered plots of temperature versus CL51 MLH as measured at (**a**) Lidcombe and (**b**) Merriwa and predicted PBLH from WRF-CMAQ and CCAM-CTM from 17 April to 2 May 2021. The regression lines with 95% confidence band are in black colors.

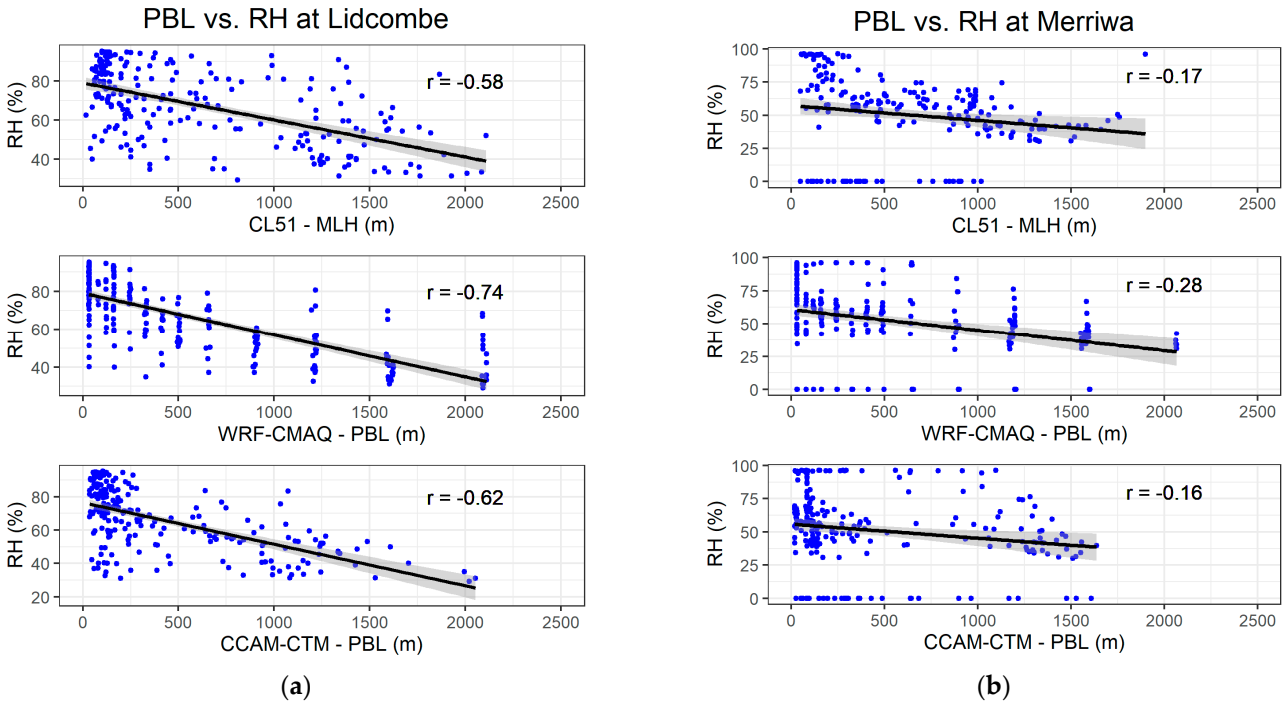
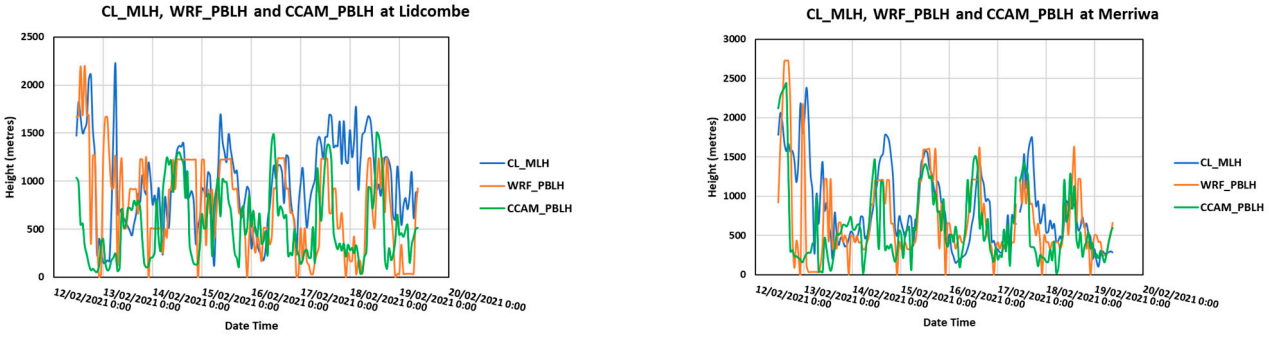


Figure S11. Scattered plots of relative humidity versus CL51 MLH as measured at (**a**) Lidcombe and (**b**) Merriwa and predicted PBLH from WRF-CMAQ and CCAM-CTM from 17 April to 2 May 2021. The regression lines with 95% confidence band are in black colors.

2. Time Series of CL51 Ceilometer MLH, Predicted PBLH from WRF and CCAM Models

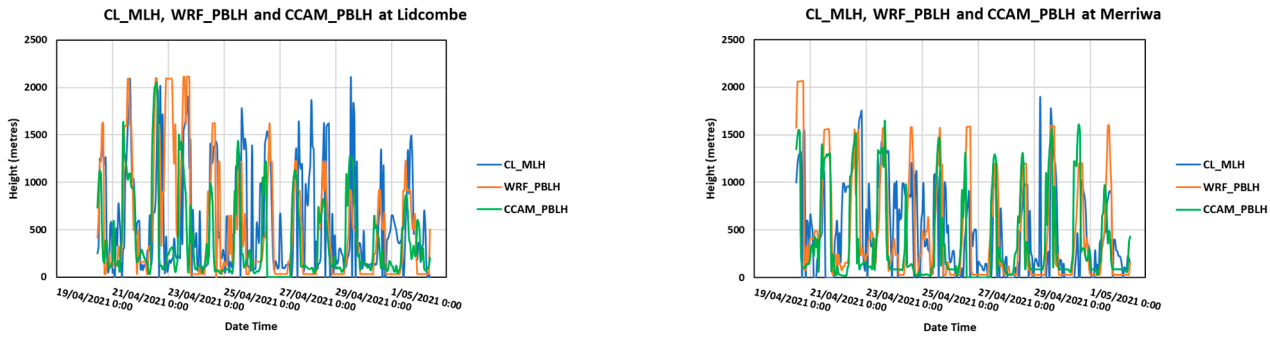
2.1. Period 12 to 19 February 2021 (Austral Summer)



(**a**) (**b**)

Figure S12. Time series of hourly mixing level height (MLH) as measured by CL51 ceilometer, predicted PBLH from WRF (WRF_PBLH) and CCAM (CCAM_PBLH) at (**a**)Lidcombe and (**b**)Merriwa for the period 12 to 19 February 2021.

2.2. Period 17 April 2021 to 2 May 2021 (Austral Autumn)



(**a**) (**b**)

Figure S13. Time series of hourly mixing level height (MLH) as measured by CL51 ceilometer, predicted PBLH from WRF (WRF_PBLH) and CCAM (CCAM_PBLH) at (**a**) Lidcombe and (**b**) Merriwa for the period 17 April to 2 May 2021.