General comment

This study explores the diurnal variation of total NO_2 columns and surface NO_2 concentrations using GCHP model simulations with independent NO_2 measurements from DISCOVER-AQ campaign and Pandonia Global Network. Two corrections are applied on PGN/Pandora total NO_2 columns to better represent the dependence of NO_2 cross section on the temperature, and different local solar time along the PGN/Pandora line-of-sight. Besides, the authors also test the influences of horizontal resolution and planetary boundary layer height (PBLH) modification on the model performance against aircraft and ground-based observations. It is demonstrated that compared with the other two sensitivity runs, fine scale (~12km) modelled NO_2 columns with PBLH modification show smaller bias to independent measurements and better agreement in terms of NO_2 diurnal variation. Based on model simulations, the authors find that NO_2 columns below 500m show much stronger diurnal variation that that of total columns, which is dampened by residual columns above with much weaker variability.

The findings of this study are important for understanding the relationship between NO_2 columns and surface concentrations, and I recommend it to be published after addressing following issues.

Specific comments

Line 39: what is “connected layers”?

Line 200-203: please re-write this sentence and explain the meaning of each term in this equation.

Line 241: what do you mean by “left panel” and in which figure?

Line 254-255: why the simulated effective temperature is lowest in the early afternoon?

Line 258-260: please explain the scientific meaning of “0.2” and “(294-220)” in the equation.

Line 289: it seems that PBLH modification has larger impact on simulated NO_2 columns in the morning and evening than midday. What is the reason for this?

Line 292: in Figure 4 and 5, both corrected PGN/Pandora NO_2 columns and aircraft partial NO_2 columns present a distinct increase in early morning, which is also found in GEMS NO_2 observations. However, this feature is not reproduced in modelled NO_2 columns even though NO_x emissions have a morning peak around 9:00 a.m. local time. What is the explanation for this discrepancy?

Technical comments

Line 31-35: please simplify this sentence.

Line 36: change “column” to “columns”.

Line 70: please expand the abbreviation “KORUS-AQ” when it appears for the first time.

Line 85: please expand the abbreviation “CTMs” when it appears for the first time.

Line 97-102: please combine these two sentences to make it less redundant.

Line 108: please expand the abbreviation “CONUS” when it appears for the first time.

Line 136-137: please re-write this sentence.

Line 143: please keep consistent expression of longitude (sign) in Tables A1 and A2.

Line 198: change “identifies” to “identified”.

Line 315: change “3.3” to “3.4”.

Line 340: change “3.4” to “3.5”.

Line 355: change “3.5” to “3.6”.

Line 397: remove the comma.