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Interactive comment on "Diurnal variations of BrONO$_2$ observed by MIPAS-B at mid-latitudes and in the Arctic" *by* Gerald Wetzel et al.

Gerald Wetzel et al.

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Response to Referee #2:

First of all we thank the referee for the effort to carefully reading the manuscript and for all comments.

General comments:

1. The comparisons between measured and modelled BrONO2 mixing ratios are discussed in a too qualitative way and therefore it is very difficult for the reader to have a quantitative view about the level of agreement (or discrepancy) between MIPAS-B and EMAC. To improve this, I suggest to add in the manuscript 2D colorplots of EMAC minus MIPAS-B BrONO2 VMR relative differences for the three balloon flights and for

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[Discussion paper]

both smoothed and unsmoothed model profiles. Those plots would also help to better characterize and discuss the impact of the smoothing of model profiles by MIPAS-B averaging kernels on the comparison results (see e.g. page 9, lines 255-261).

As proposed by the referee we added the corresponding 2D plots to the manuscript and modified the text accordingly.

2. As Anonymous Referee 1, I strongly recommend to discuss the pros and cons of using nighttime BrONO2 for estimating Bry, instead of daytime BrO.

We included a new section 3.3 where we discuss all the issues concerning the estimation of Bry.

Specific comments:

1. Page 6, lines 169-171: The authors should briefly describe here how the vertical resolution of the MIPAS-B BrONO2 observations is estimated (FWHM of the averaging kernel matrix). I think that showing typical averaging kernels could be also useful to see in which altitude range the maximum sensitivity of the MIPAS-B BrONO2 measurements is located.

The altitude resolution was calculated from the full width at half maximum (FWHM) of the rows of the averaging kernel matrix. This is written in the text now. The altitude resolution is shown in the right column of Figures 4 and 5. The maximum sensitivity is located in the altitude region near the measured tangent altitudes (as typical for limb sounding).

2. Page 8, lines 223-227: It is stated that the sensitivity study of Kreycy et al. (2013) about the BrONO2 photolysis rate is not relevant here because it was conducted for mid-latitude conditions. If this is true for the two Kiruna flights, this is not the case for the third flight, which was launched from Timmins ($49°$N, Canada), i.e. at mid-latitude. For the latter, I would suggest to also perform model simulations using the Kreycy et al. BrONO2 photolysis rate and see how it impacts (1) the MIPAS-B versus model

comparison, and (2) the Bry estimate.

There was a mistake in the manuscript. The Kreycy et al. (2013) flight was performed at the beginning of September 2009 not at mid-latitudes but from Kiruna (Sweden). Anyhow, we tested the 1.7*J/k ratio recommended by Kreycy et al. by using a 1-D photochemical stacked box model for the situation of our September 2014 flight. The photolysis rate of BrONO2 will then be enhanced and the production rate of BrONO2 will be reduced. As expected, this leads to lower BrONO2 during day towards higher BrO amounts. Hence, the Kreycy et al. recommendation further degrades the agreement between model simulations and our measurements since daytime BrONO2 values are already lower in the model (compared to the measurement) using the standard JPL kinetics. Thus, in our case, we should rather scale the J/k ratio with a factor < 1 (and not > 1 as stated by Kreycy et al.) to get a better daytime agreement between measurement and simulation. Hence, concerning the EMAC calculations, we stick on the JPL data. It is important to emphasize, that during night, the BrONO2 VMR does not change significantly (< 0.1 pptv) when varying the J/k ratio in the altitude region where the BrONO2/Bry ratio is high (> 0.90) such that our estimation of Bry from measured nighttime BrONO2 is not influenced by the outcome of the Kreycy et al. study. These conclusions are also valid for the situation during the March 2011 flight. We added some sentences in Section 3.2 to explain these issues in the manuscript.