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Interactive comment on “Satellite observations of long range transport of a large BrO cloud in the Arctic” by M. Begoin et al.

Anonymous Referee #1

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The manuscript compares GOME2 satellite observations of Arctic tropospheric BrO enhancements to transport predictions based on passive tracer studies using the FLEXPART model and source region predictions based on Potential Frost Flower (PFF) maps. Qualitatively good agreement is found between the FLEXPART tropospheric BrO column predictions and the GOME2 observations, suggesting that long-range transport of BrO from remote regions may contribute to local BrO enhancements and subsequent ozone depletion events (ODEs). Given the short lifetime of BrO in the troposphere, the fact that FLEXPART passive BrO tracer predictions agree with GOME2 BrO observations leads the authors to conclude that BrO must be rapidly recycled within the advected air mass. Significant PFF levels were predicted nearly 5 days prior to the observed BrO enhancements, implying that Frost Flowers must have a lifetime of at least 5 days to be a potential source of the observed BrO enhancements.

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I find the authors arguments regarding BrO recycling during long-range transport within the Arctic boundary layer to be rather unconvincing. The editor's comments regarding some quantification of the sources and sinks of BrO along the FLEXPART trajectories would help. However, it seems quite likely to this reviewer that a much simpler argument could account for the qualitative agreement between the FLEXPART passive tracer predictions and the observed BrO. Namely, that the large-scale BrO observed by GOME-2 during the study period is in the upper troposphere/lower stratosphere and not within the Arctic boundary layer as assumed by the authors. I have two reasons to suspect this:

1) The GOME-2 tropospheric BrO retrievals used in the study are constructed by removing a constant (4.5×10^{13} molec/cm²) stratospheric contribution during a period of significant dynamical variability in the lower stratosphere. This is likely to introduce significant errors in the inferred "tropospheric" BrO column. 2) The GOME-2 BrO retrievals used in the study were not cloud-cleared; consequently much of the BrO enhancements must be above the clouds, not in the Arctic boundary layer.

Regions of strong cyclonic motion (low pressure) associated with the analyzed transport event will have significant mid-tropospheric cloudiness and lower tropopause heights. The mid-tropospheric cloudiness will obscure boundary layer BrO while the low tropopause heights will lead to incorporation of stratospheric BrO in what the authors assume is "tropospheric" BrO column. Figure 1 illustrates this point for March 26, 2007, which is the day used to initialize the FLEXPART BrO trajectories used in this study. The figure shows GOME2 BrO from figure 2 in the M. Begoin et al manuscript, MODIS Cloud Optical Depth produced using the Giovanni online data system, developed and maintained by the NASA GES DISC, and OMI total column ozone imagery obtained from <ftp://toms.gsfc.nasa.gov/pub/omi/images/> on 26 March 2007.

The GOME-2 BrO enhancements are found within the Arctic polar vortex (the region with lower OMI total column ozone amounts) and are associated with high MODIS cloud optical thickness. This pattern is consistent with lower stratospheric BrO en-

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hancements associated with stratospheric ozone loss processes. Assuming that the observed BrO is within the Arctic boundary layer is not justified based on the MODIS cloud fields, which would obscure low level BrO enhancements. I suspect that FLEXPART trajectories initialized in the upper troposphere would show similar qualitative agreement with the GOME-2 BrO observations, particularly if the cyclone responsible for the transport is occluded. I recommend that the authors conduct FLEXPART BrO tracer simulations initialized in the upper troposphere to test this possibility.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 20407, 2009.

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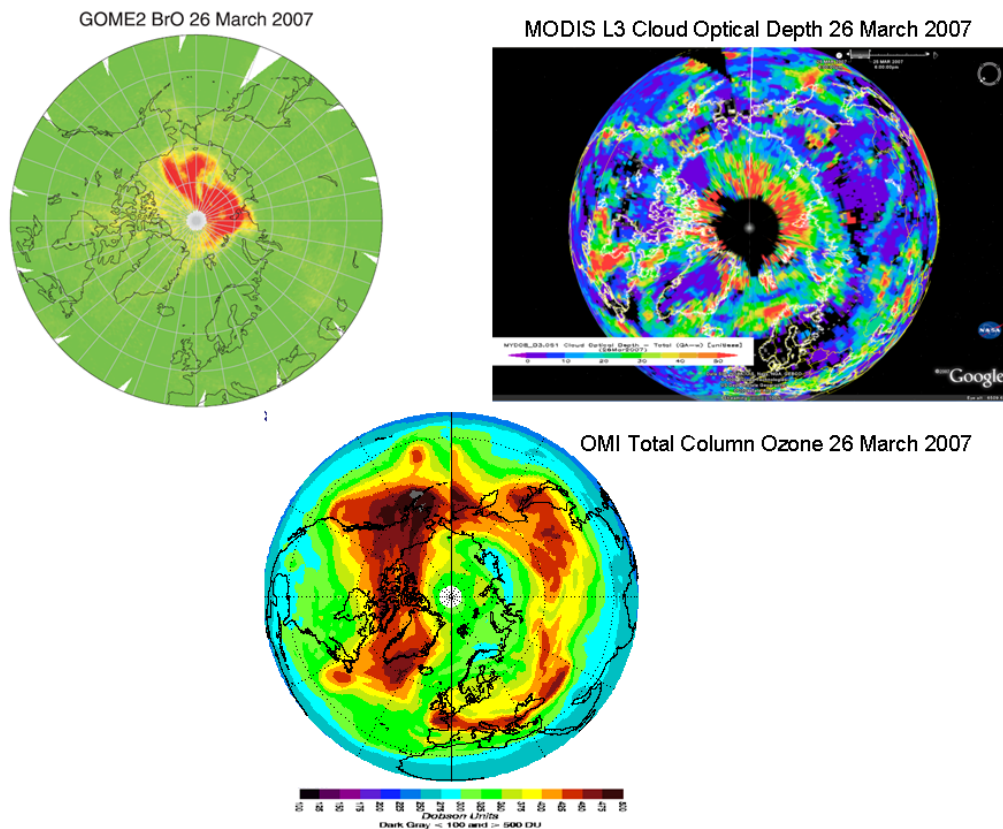
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Fig. 1. GOME2 BrO (upper left), MODIS Cloud Optical Depth (upper right), and OMI total column ozone (lower middle) on 26 March 2007.