General comments

This paper is easy to read, except where details of the instrument are given (see specific comments below). The introduction is quite good. I was impressed that the antenna field-of-view was considered in the instrument modelling and that pointing biases were reduced by ~300 m by using features of the atmospheric radiance profiles.

My overall impression is that the measurements are not very sensitive to BrO and that a lot of what is shown as measurements actually comes from the *a priori.* I see in Fig. 5 that BrO leads to a brightness signal of 0.2 K and the noise level after averaging all day is ~0.15 K. Given this, I suspect the small error bar on BrO mixing ratio of ~12% (2 ppt /16 ppt) is largely determined by the retrieval approach (optimal estimation) and the *a priori* covariance matrix and this needs to be admitted if it is the case.

To address this reader's impression, I suggest the authors provide:

1) an illustration of *a priori* BrO vertical profile (e.g. into Fig. 6) and, if available, a reference for its source.
2) the covariance matrix of the *a priori*
3) the SLS measurement response as a function of height. I strongly recommend the use of "open" circles for the SLS BrO points with measurement response < 0.67 in Figures 7-9.

Another related point is that there cannot be much sensitivity to BrO at 40 km for SLS because this altitude is not viewed tangentially. I suggest profiles extend no higher than 36 or 38 km.

I wonder about certain sources of systematic error with the day-night subtraction that may not have impacted the BrO profile from this balloon flight (fortunately) but are still weaknesses with the method. Firstly, the day/night BrO differencing as applied to Aura/MLS data relies on a cancellation of random errors that is possible due to the large number of days and nights included in mean values (2-3 months). Sources of cancelling error may include:

1) air mass changes that affect BrO abundance directly (although this is minor since the BrO almost disappears at night)
2) air mass changes that affect interfering species such as O_3

With a balloon flight that only covers one night, there can be no cancellation of random errors due to air mass changes, simply a positive or negative bias depending on whether ozone mixing ratio was higher and lower relative to its daytime value. I suggest the authors conduct two sensitivity studies relating to ozone interference. Furthermore, if ozone is a strong absorber especially at low altitudes, even if there is no day/night ozone difference, assuming an ozone profile that is biased uniformly by 5-10% (a reasonable ozone guess) may lead to BrO retrieval errors because ozone can change the transmittance of the BrO and ozone emissions along the line-of-sight. Perhaps the ozone lines are too weak since they are due to a minor isotopologue in one case and a hot band in another case. Also, I was unable to find some indentified transitions using the JPL catalog (http://spec.jpl.nasa.gov/ftp/pub/catalog/catform.html) used by the authors. I found the $OO^{17}O$ lines, only the HO_2 lines forming the more distant feature (650426.8 MHz), and could not find the O_3 ($\nu_{1,3}$) line. Please confirm that this adjacent 'hot' O_3 feature is correctly attributed. Also, SMILES sees no such feature (Kikuchi et al., 2010). The BrO multiplet has been specified sufficiently in the text.

Sensitivity study #1: perturb $OO^{17}O$ by 10% (throughout the whole profile) or some percentage that seems reasonable between night and the following day and look for spectral signatures near the two ozone features neighbouring BrO in the day-night differential spectra and quantify the impact on retrieved BrO. Note that the viewed air mass can change with changing viewing azimuth angle, even though the balloon is drifting according to the local circulation, especially when one considers that tangent points can be >500 km away. If the viewing azimuth angle is controlled, this should be mentioned and this study could be skipped.

Sensitivity study #2: perturb the stratospheric temperature uniformly by ~3 K (approximate day/night difference) and look at the residual ozone features in the day-night differential spectra and biases in retrieved BrO. This study is also relevant for MLS.

Section 5 was the weakest section. The source of the assumed ozone profile should be specified. The last term of right hand side of Eq. 5 should be something like [Δy-KΔx]. The authors should be more clear regarding the quantity **y** in practical terms. Is it the day-night differential spectra? Is **y** boxcar-smoothed or is this smoothing used only to make Fig. 5 more appealing.

Specific comments

Section 1 - SLS acronym should be defined at first occurrence.

P28894L9 - "…equator…" -> "…equator crossing time…"

P28895L6 - Please state whether daytime observations were collected on 22 September.

P28895L24 - Output IF seems to extend to only 7 GHz in Fig. 3.

P28896L3 – "…FPGA…" -> "…field-programmable gated array (FPGA)…"

P28896L11 "deep and steep skirts" – non-specialist does not know why this is of value.

P28896L8 – This statement is difficult to evaluate since 'advanced' is qualitative. I suggest it is removed.

P28896 (bottom) – "Limb-sky difference radiance…" -> "Limb – sky radiance difference…"

Eq. 3 – rewrite left-hand side as P_{limb} - P_{sky}

Section 6- The number of daytime and nighttime limb scans or the duration of a limb scan should be stated (probably in Section 2). It seems that hundreds of limb scans are required to reduce the random measurement noise from e.g. 3 K to 0.15 K (noise level in Fig. 5). On a related note, why is the spectral resolution degraded to 750 kHz from the native resolution of 375 kHz in Fig. 5?

P28900L20 – "…the altitude range…" -> "… the tangent altitude range…"

P2890026 – "…near equivalent strength lines…" -> "…lines of nearly equivalent strength…"

Section 7.1 If the number of limb scans during this balloon flight is small (which I doubt, see above), then there may be an issue with the average TH within a 2 km TH bin not matching the center TH of the bin.

P28901L5 – the atmospheric range of signals appears to be ~180 K, at least for the tangent heights shown in Fig. 3.

P28901L17 – until what hour of the morning?

P28903L2 – "…to the model…" -> "…to the modelled BrO…".

P28903L11 – "…estimate of the…" -> "…estimate the…"

P28906L11 – "…2007a…" -> "…2007b…" check other Kovalenko *et al.* [2007a] citations as well.

P28907L8 – Why not take the September mean of the 30-40°N band for OSIRIS or at least something that only includes mid-latitudes? I think OSIRIS might have lower Br_y than SLS at high N_2O because of this. Why does the Figure 13 legend have "OSIRIS 2005"? The authors should specify in the text and in the caption that the OSIRIS average is for September 2005.

P28907L13 – "…from (Wamsley et al., 1998)… -> "…from Wamsley et al. (1998)…

P28912L16 – omit "28 UNIV CHICAGO PRESS Part 1"

P28912L26 – "…Ieee.." -> "…IEEE…"

P28912L27 – omit "61 IEEE-INST … INC,"

P28912L9 – page run missing.

Figure 3 caption - "LO" -> "local oscillator". Also, add "flight-averaged" before "spectra". Also, in Figs. 3-5 : "…frequency in as…" -> "…frequency as…"

Figure 4 – "Daytime…" -> "Daytime-average…"

Figure 6 – What are the "open" circles for SLS? If it is for diurnal correction to MLS local time, please state.

Figure 14 – "Kovalenko(2007)" -> "Kovalenko (2007b)". The references are missing for the Sinnhuber et al. papers, Theys et al. (2007), Schofield et al. (2004), and Salawitch et al. (2010). The "SLS Sept 2007" row should be removed unless the work is published in a peer-reviewed journal. If it is, provide the reference.