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Atmospheric Measurement Techniques Discussions
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Interactive comment on "Seven years of IASI ozone retrievals from FORLI: validation with independent total column and vertical profile measurements" *by* A. Boynard et al.

Anonymous Referee #2

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The manuscript "Seven years of IASI ozone retrievals from FORLI: validation with independent total column and vertical profile measurements" by Boynard et al. presents a validation study for IASI-A/IASI-B total and profile ozone retrievals with FORLI algorithm. This manuscript fits to the scope of the problems discussed in the AMT. The manuscript is mostly well written with good quality figures and tables. However, there are several caveats in the analysis and interpretation of presented results that have to be addressed by authors before recommending this manuscript for publication in the AMT. Please, see my comments below.

In the manuscript (Sec. 2.2, page 5) authors describe the sensitivity of IASI to atmospheric ozone. According to this, the leading factor that affects IASI's sensitivity is

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a thermal contrast. Results, shown on Fig. 2, demonstrate that total DOFS increases from 2.69 with thermal contrast of 1K to 4.06 with contrast of 26K. This makes me wonder why authors didn't include any figure that shows ozone differences (IASI-GOME, IASI-sonde) as a function of thermal contrast. This seems like a logical way to validate IASI retrievals. Instead of considering all latitude bands and seasons, it would be better to focus on time periods and regions where IASI measurements have the most information. I also would advice authors to include a table or figure that shows mean values of thermal contrast for different latitude zones and seasons. This will help readers to better understand and interpret shown results.

Results presented on Figure 1 and the corresponding discussion in the text are misleading on my opinion. By looking at this pictures and reading the text one might get a false impression that IASI retrievals reasonably represent a seasonal ozone depletion over Antarctica. But careful examination of results presented in sections 3-5 and on Figures 3-7 reveals that IASI retrievals have significant problems over Antarctica. Specifically, in section 4.1 authors demonstrated that largest differences between IASI and GOME-2 total ozone were observed over Antarctica (up to 30%) with the seasonal amplitude about 20% (see figure 7). Careful consideration of figure 6 (right column) shows that there is a clear gradient in IASI-GOME-2 differences between land and ocean surfaces. This gradient especially apparent in austral summer months (fig. 6, top right). Most likely this is related to the specific IASI instrumental/retrieval features (low brightness temperature ???). Largest disagreement between two IASI sensors are also found over Antarctica (Fig.4-5), which, perhaps, tell us that the retrieval algorithm is not robust over Antarctica (?). My point here is that with the current version of IASI ozone retrievals it is not possible to accurately estimate the Antarctic ozone loss (difference between winter O3 amount and min O3) and the size of the ozone hole because of large biases that strongly vary with the season and Earth's surface properties. Therefore, I think this figure (Figure 1) misleads readers and should be removed from the manuscript or should be moved into the section 4.1 and critical analysis of shown results must be provided.

Specific comments:

Page 4, l.29-32: It is mentioned later in the manuscript (in section 5) that a priori information used in FORLI does not depend on latitude. However, this is not described in this section. Does the a priori depend on a season? Considering a poor IASI sensitivity to the middle stratospheric ozone (shown on Figure 2), I would assume that having reasonable a priori constraints, which vary with latitude and month, will improve retrieved profile and total ozone. Please, explain in this section the reason for choosing latitude independent a priori constrains.

Page 4-5, l. 33: It is stated here that due to a large volume of measured data by IASI, O3 retrievals are performed only for cloud clear or almost clear scenes. It remains unclear if IASI ozone retrievals are sensitive to clouds, and avoiding cloud contaminated scenes helps reduce errors, or retrievals are not possible in presence of clouds. This should be explained here.

Figure 2, and corresponding discussion on page 5, l. 15-27: First it is not clear why authors decided to divide the altitude range on 4 different partial columns. After careful examination of AKs shown on Figure 2, I cannot agree with the authors' statement that three independent layers can be retrieved in cases of medium and high thermal contrast. Specifically, right plot on Figure 2 shows AKs in case of high thermal contrast, and AK for layer 300-150 hPa (red curve) peaks at the nominated layer, but has long tails below and above with almost $\sim$50% of information laying outside of the layer. I would hesitate to call considered layers "independent". Another prominent feature that authors didn't describe in the text is a very broad AK for the stratospheric ozone layer (25-3 hPa) without a clear peak and with a tail in the troposphere.

Page 7, l. 33. Authors emphasize that one of the benefits of IASI is its ability to provide O3 measurements in the winter season. However, this point is not clear to the reviewer, because IASI's sensitivity depends on thermal contrast, which I assume is very low during polar winter season. Do you think these winter time ozone retrievals

will be reliable for the scientific applications?

Page 12, l. 12-17. Higher correlation for the layer surface-300hPa was found in the tropics. Authors explain this by the fact that IASI retrievals are more sensitive to tropospheric ozone in tropics because of higher surface temperature. At the same time in section 2.2 (page 5) the thermal contrast was defined as "a difference of temperature between the ground and the atmospheric layer just above it". I assume that in the tropics the difference between surface temperature and boundary atmospheric layer temperature should be fairly small, meaning low IASI sensitivity. Please, clarify that.

Section 5. In this section IASI partial ozone columns for four atmospheric layers are compared with ground-based sonde measurements. Authors heavily based their conclusions on the analysis of correlations. But interpretation of high correlations as a good agreement between two time series could be misleading in some cases. I would prefer that authors show the time series of IASI partial ozone columns along with sonde values at least for several locations to support their conclusions.

Page 8, l. 15. Please, explain the effect of temperature profiles used in FORLI on ozone profile retrievals. This might be not obvious for readers. This could be done here or in section 2.2.

Page 12, l. 25-27. Authors emphasize a good agreement between IASI A and IASI B instruments. But I think this is expected considering results presented in Section 3. There is no need to repeat this again.

Page 12, l. 27-29. It is not clear what authors describe here. It says that "largest bias and lowest correlation are found in summer". Is this statement about a bias between two IASI sensors? Is it for total column or specific layer? Can you, please, clarify that.

Page 12, l. 29. Considering that IASI is more sensitive to the lower stratosphere and troposphere, I don't understand why authors mentioned here a diurnal ozone cycle, which usually is observed at altitude above 3 hPa - above the top boundary of IASI

retrievals. Please, explain that.

Page 12, l. 30-33. It is stated that "the summer O3 values will change more in 50 min than in winter and hence the difference is more pronounced in summer than in winter." First of all, please, clarify whether you mean total ozone or tropospheric ozone. I would expect that total ozone varies more in winter months when dynamical processes are stronger. If you aware about some studies that can support your statement, please, add references. Secondly, it seems to me that this discussion of IASI-A and IASI-B comparisons is not relevant to validation against sondes. It might be better to move it in section 3.

Figure 13. Typically, ozone concentration is shown on a linear scale rather than log scale. One of the important characteristic of the successful ozone profile retrieval is a representation of the ozone peak and changes in ozone vertical gradients. Showing ozone concentration as log values makes it impossible to see these features. Please, make X-scale linear on these plots. Since IASI profiles go up to 3 hPa, please, extend the vertical scale to 3 hPa and show IASI's ozone profiles (even though you will not have sonde data at those altitudes). This will show how well IASI retrievals capture the ozone peak.

Page 15, conclusions, #1: Please, indicate here that larger differences between two IASI sensors are observed over Antarctica with biases more than -10% in some seasons in the lower stratosphere.

Page 15, conclusions, #3: Authors consider correlations as a measure of the successful agreement between sonde and IASI partial ozone columns. I will not agree with this conclusion, until authors show the time series to support their conclusions (see my comment above). Another comment here is that authors support their conclusions by saying that IASI sensitivity to tropospheric ozone is larger in the tropics due to higher surface temperature. My impression from section 2.2 is that thermal contrast (difference between surface and boundary atmospheric layer temperatures) is the leading

factor that define IASI sensitivity, not just surface temperature. Please, explain that.

Page 16, l. 3-5: What do you mean here by rough vertical sampling of 1 km? I assume IASI's vertical resolution is several kilometers in this altitude range versus ∼100 m for sondes. It is not clear how fine vertical sampling can change a coarse IASI's vertical resolution.

Minor/technical comments:

-Page 4, l. 29 and l. 31: a symbol for the a priori covariance matrix is not readable (I can't see it in my pdf version);

-Page 7, l. 29: Please, add "Antarctic O3 hole" to "...except for the O3 hole season...";

-Page 8, l. 10-11. I agree with the statement about a "larger seasonal change in transport at high latitudes", but I doubt that "the seasonal cycle of photochemical activity" is "more pronounced" at high latitudes. Do you mean photochemical production in the troposphere or stratosphere? Please, add references on related studies.

-Page 12, l. 20. Should be "and positively biased""

-Page 13, l. 11-12. Please, introduce coefficients n1, n2, n3.

-Page 13, l. 27-28. I would suggest to change "upper stratosphere" to "middle stratosphere", because most of the atmospheric ozone is concentrated between 20 and 35 km.

-Page 14, l. 8-9. It seems that "18%" and "13%" will be more accurate estimates based on results shown on fig. 18.

-Page 14, l22-25. I would suggest to replace "no improvements" with "no significant changes".

-Page 15, l. 31. I would suggest to spell out "LUT" in the conclusions.

-Page 16, l. 2: It is not clear from the context what "a smaller bias" means here. Please,

consider to re-phrase this part.

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