### **General considerations:**

During the review of our manuscript, we found that a general paper regarding IASI-NG, aimed at introducing and presenting the IASI-NG mission, was in preparation. We then decided to slightly modify some details of our paper to avoid confusion and to be in line with that paper. Here are in details the modifications:

1) We changed the title from: "Potential of the future thermal infrared space-borne sensor IASI-NG to monitor lower tropospheric ozone" to: "Analysis of the potential of one possible instrumental configuration of the next generation of IASI instruments to monitor lower tropospheric ozone"

2) We define IASI-NG/IRS2 (also called IASI/2 in our revised manuscript) the possible configuration of IASI-NG used in our study. Indeed, while our work is based on an instrumental configuration of IASI-NG which is generally considered as one probable setup (and which is the basis of most Phase A studies of IASI-NG), with this remark we want to stress that the final set-up is still not officially decided.

3) Consequently, in all figures "IASI-NG" is changed to "IASI/2".

We think that these modifications do not substantially change the target and scopes of our study. These modifications have been accepted by the PIs of the IASI-NG mission.

### Anonymous Referee #1

This paper gives a detailed comparison of the performance of retrieving lower tropospheric ozone from TIR measurements between IASI and the future IASI-NG (to be launched in the 2020 timeframe on EPS-SG satellite) instrument and evaluates IASING's potential of to improve the monitoring of lower tropospheric ozone at various spatiotemporal scales. IASI-NG will have better spectral resolution and measurement noise both by a factor of 2 than IASI measurements. This study uses MOCAGE CTM data as truth and use a pseudo-observation simulator that includes the use of KOPRA RTM to simulate IASI and IASI-NG TIR measurements and a Tikhonov-Phillips regularization based inversion algorithm to perform the retrievals. The results show that IASI-NG will significantly improve the LT ozone retrievals with better vertical resolution and reduced retrieval errors especially for low thermal contrast scenarios, better resolving LT features at various spatiotemporal scales including those relevant to the AQ. This paper is well suitable for publication on AMT. It is generally well written and organized. However, the abstract could be reduced by removing a lot of background materials, a few references are missing in the introduction, some figures could be improved and the English writing could be improved. Overall, I recommend this paper to be published on AMT after addressing the following specific and technical comments.

Thanks for the kind words.

#### **Specific comments**

**1.** I agree with Reviewer 2, there is too much background material that belongs to introduction.

Please refer to: *Reviewer 2, comment 1* 

## 2. P7027, L10, it is not clear about what might cause the reduction of several months in life expectation? Do you mean some events or episodes?

We changed the sentence to: "An average reduction of up to several months in life expectation in European urban areas, due to exposure to higher levels of pollutants like ozone or particulate matter, has been hypothesized..."

3. P7027, L 17, it is better to refer to those direct retrievals from UV spectra including Munro et al., 1998 and Liu et al., 2005. To include retrievals using residualbased approaches, you should also include Fishman et al. (1990), i.e., the earliest derivation of tropospheric ozone column and change "UV backscattered spectra" to "backscattered UV radiances" since TOMS does not measure the spectra but at a few channels.

4. P7028, L 21, also include Natraj et al., 2012, Landgraf and Hasekamp (2007) 5. P7028, L 22, add reference (Fu et al., 2012)

The references have been added and the text changed.

6. P7030, L1, change "Another option is that..." to "Another objective is to determine if its added value is limited to..."

The text has been changed.

# 7. P7032, L16, Do you mean "surface-6 km" for LT? If so, you can add "(surface-6 km)" after "error in the LT". In L21, add "in LT ozone column" after "the estimated error" as error at individual layers could be much larger.

We changed the sentences: "...the method is here optimized for LT ozone observations using IASI..." to "...the method is here optimized for LT (surface-6 km) ozone observations using IASI..." and "...the estimated error is about..." to "...the estimated error in LT ozone column is about...".

# 8. I suggest changing "TOC surface-6 km" to "surface-6 km TOC" or "TOC from surface to 6 km" or some abbreviation like "s6TOC", and making similar changes to "TOC surface-12 km"

All occurrences of "TOC surface-6 km" were changed to "surface-6 km TOC"

## 9. Have averaging kernels been applied for results in section 4.1 (Figs. 5, 6, Table 1)? Please make it clear.

No, in section 4.1 we compared the pseudo-observations with raw (no AK convolution) MOCAGE pseudo-reality. To make it clearer we added the sentence "...to the reference MOCAGE pseudo-reality, based on several statistical parameters. Please note that the pseudo-reality used in this analysis is not convolved with the AKs."

## 10. Figs. 7 8 (especially Fig. 8) are too small some of the figure captions cannot be read clearly.

The caption of figure 7 has now bigger characters and figure 8 has been split into two

figures.

#### 11. Fig. 12, since smoothed MOCAGE is very similar to the IASI-NG pseudoobservations, it is better to show IASI pseudo-observations instead in the second column in comparison with the IASI-NG pseudo observations.

The figure has been modified according reviewer's suggestion.

#### **Technical comments**

Most of the technical comments have been taken into account. Here in the following some points that need attention.

## **1.** P7026, L26, change "values of nearly 3.0 km" to "reaching nearly 3 km above surface"

It is not "3 km above surface", it is just 3 km tout-court

### 2. P7042, L17, change "follow" to "follows" as "series" is a singular

"Series" is invariable. In this sentence we used it as plural, as we talk about more than one time series.

### Anonymous Referee #2

This paper describes a feasibility study, where the superiority of IASI-NG versus IASI is demonstrated by retrievals based on simulated measurements. This topic fits well into AMT. The scientific content seems sound to me but there are a lot of presentation issues.

**1.** Abstract: About a third of the abstract is general background which belongs in the introduction of the paper but not in the abstract.

The abstract is now considerably shorter and concise.

2. Intro: Indeed a good motivation for the study with a large number of references. Also a lot of references to pre-existing work in the field of satellite remote sensing. Well done! I am not a specialist in this area but if instruments like GOME GOME-II, SCIAMACHY or OME also have contributed to this research field, this deserves to be mentioned.

Indeed they are mentioned (see also specific comment 3 of Reviewer 1)

#### Some minor comments:

Most of the technical comments have been taken into account. Here in the following some points that need attention.

**1.** p7028 l10 "topical task" not sure if this expression is correct in this context. Please check.

We changed to "topical issue"

# 2. p7019 I23 "added value" to me means improvement of something existing, which exists in parallel. I am not sure if its application to a future replacement (where the initial thing no longer exists) is appropriate.

Here we consider "added value" as an improvement of one future instrument with respect of a corresponding present instrument. Such a use of "added value", with this meaning, is often found in the literature of, e.g., OSSEs. So, we decided to leave it through the text.

# 3. p7031 l1-2: I am sure you have not reduced the grid of MOCAGE but you have resampled its output on a finer grid for the radiative transfer calculation. If so, please reword accordingly.

The sentence has been changed to: "MOCAGE uses 47 hybrid vertical levels, from surface to about 35 km, with a fine vertical grid, from about 200 m into the lower troposphere to about 1 km into the stratosphere. The outputs of MOCAGE have been resampled to the smaller vertical resolution required by the subsequent radiative transfer calculation, 1 km into the troposphere and lower stratosphere, and 2 to 5 km at higher altitudes."

4. p7031 I14/15: "The two instruments ... are defined by their technical specification" Not sure what this sentence is supposed to tell me. Do you intend to say "Radiative transfer calculations for generation of pseudo-measurements have been performed according to the instrument specifications of IASI and IASI-NG, in terms of spectral resolution, line-shape, field of view and NESR"?

Exactly. The set-up is then described in the following lines (p7031 l15/29).

5. p7031 l21/22: What are "observations"? I.e. what is the thing actually counted? Is "observation" equivalent to "nadir spectrum"? This question might sound silly, but in Rodgers retrieval theory applied to spectra an observation is a single spectral gridpoint. Thus I recommend to be clearer here.

We have substituted "nadir spectra" for "observations".

#### 6. p7031 l24: Has "SSI" been defined before?

Yes (p7029 l17)

7. p7032 I10: I suppose you use the Tikhonov implementation using the squared first order finite differences matrix, which minimizes differences between values at adjacent profile gridpoints. The Tikhonov family contains a lot of variants, including a scheme involving a diagonal regularization matrix, which is similar to optimal estimation withoput consideration of covariances, and higher order schemes. Please state explicitly what you use. Some further information is needed: On which altitude grid are the retrievals performed (this grid is not necessarily the same as that on which the radiative transfer calculatione are performed). Which other variables are retrieved besides the ozone profile. What about surface emissivity, surface temperature, etc?

The inversion algorithm used in this work is the same as in Eremenko et al., 2008. So, we

didn't give a detailed description of the algorithm, instead we say (p7033 I4-6): "For more details, please refer to the comprehensive description of the LISA algorithm in (Eremenko et al., 2008; Dufour et al., 2010). " In any case, for the sake of clarity, we have added the sentence "...IASI measurements (Eremenko et al., 2008). The constraint matrix is a combination of the identity matrix, and the first and the second derivative operator, with coefficients depending on the altitude. The constraint matrix ... "

8. p7033 l24: Eq 1 in the given form is valid only if (a) the a priori is a climatological priori information, and if S\_a is a real climatological covariance. Be careful (a) not to use any ad hoc a priori (e.g. altitude constant profile) and not to use any Tikhonov type regularization matrix instead of the true S\_a to evaluate the smoothing error. For the retrieval settings chosen here, Eq. 1 is correct, but the statement on bottom 7033/7034 sounds a little over-generalizing to me.

Please refer to our reply to comment 9/10

9. p7034 I3 The smoothing error depends on the S\_a, so it is essential to report how S\_a has been built. Further, the smoothing depends on the grid on which it is evaluated. For the same instrument and the same altitude resolution you get two different smoothing errors if you evaluate them on two different altitude grids! So the grid has to be reported, and it has to be checked that in any comparison of smoothing errors (and in consequence in all comparisons of total errors) all involved smoothing errors have been evaluated on the SAME altitude grid. Otherwise such intercomparison is meaningless.

10. p7034 I28: Have Eremenko and Dufour evaluated their smoothing errors on the same grid? If not, don't use the smoothing error and report only the quadratic sum of noise and parameter error, and report the altitude resolution or DGFs separately, but don't use the smoothing error.

We have always used the same altitude grid (1 km resolution), which is the same used by Eremenko and Dufour. We have also added the following sentence to give more details on S\_a: "S\_a is obtained with the climatology of McPeters et al. (2007) for mid-latitude summer conditions, as done by Eremenko et al. (2008). "

# 11. p7035 l12: as acronym for averaging kernel in the text, AvK is acceptable, but why is it in italic bold face? As a mathematic symbol, bold face A is appropriate (see above).

In the revised version of our paper we have used AK as the acronym for "Averaging Kernel".

## **12.** Fig 4: "Mean values and standard deviations are also reported." Where? In this figure?

We have changed the sentence to "Mean values and standard deviations are also reported in the upper right corners (mean/std)."

### **13.** Fig 8: The figures are too small. Split on 2 pages.

Figure 8 has been split on two pages.