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Interactive comment

Interactive comment on "Decrease in tropospheric O_3 levels of the Northern Hemisphere observed by IASI" *by* Catherine Wespes et al.

Anonymous Referee #1

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This paper describes an analysis of variations in tropospheric ozone as observed in the IASI-FORLI product between 2008 and 2017. This work represents a continuation of previous analysis of the existing IASI-FORLI ozone dataset, which has, as the authors point out, been already extensively characterized in other works. Building on earlier work, the authors use a multivariate regression approach to distinguish linear trends from other sources of variability in tropospheric ozone. and identify the timespan of measurements required to identify statistically significant trends. The timespans differ for different regions and seasons due to differences in the level of natural variability. The authors conclude that significant negative trends can be detected in summer Northern Hemisphere mid-high latitudes. The analysis of the IASI-FORLI dataset is valid and the work is novel. However, there are a number of issues with the manuscript

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Discussion paper

that ought to be addressed before final publication.

Major comments

The authors have performed a careful statistical analysis of a particular dataset. However, the manuscript does not discuss potential issues associated with the dataset that was used. The authors cite a number of papers that deal with characterization and validation of the IASI-FORLI dataset, but do not discuss any of the potential issues with the dataset that these works may have raised. Of particular relevance for this work on trends is the previous work by Boynard et al. [2016] (a paper on which all authors in this work were involved and cited in this work in the list of papers that deal with characterization of the IASI-FORLI dataset) that has shown that the IASI-FORLI dataset may have its own issues in terms of drifts with time. Figure 15 in Boynard et al. [2016] shows comparisons of IASI-FORLI with sondes over time. The figure appears to show a distinct negative drift in the IASI-FORLI surface-300 hPa ozone compared to sondes over the 2008-2015 time period. This is highly relevant to the results reported in this work, but was not discussed.

Also, in considering trends from the IASI-FORLI ozone dataset, the influence of clouds on sampling ought to at least be mentioned somewhere. If I understand correctly, the IASI-FORLI retrievals are only performed for relatively clear-sky cases. We might expect there to be changes in cloudiness over time, and this could potentially impact trend estimates for thermal-IR ozone.

There is no substantive discussion of how the trends from this analysis of IASI-FORLI data compare with those reported from radiosondes or from other satellite datasets. The authors do have some discussion in the introduction about difficulties and limitations associated with previous trend studies, and some rather vague, qualitative statements in Section 4.1 about how the trends determined from this work are consistent with findings in the literature However, there is some implication here, from this paragraph in the introduction, and from the lack of specific discussion of results from other studies in the conclusions, that the trends reported here from this IASI-FORLI analysis provide definitive and absolute answers. I felt that there ought to be some more discussion of these results in the context of the recent Gaudel et al. paper associated with the Tropospheric Ozone Assessment Report. (This paper, for which the authors of this work were also involved as co-authors, had previously been available for public comment and is currently in review for Elementa.) I appreciate that a reconciliation of the differences in the trends from different satellite datasets reported in the Gaudel et al. TOAR paper is outside the scope of this manuscript, and I appreciate that the Gaudel et al. paper used a linear regression approach rather than the more rigorous multivariate approach advocated for in this work. Nonetheless, I feel strongly that the point that there are discrepancies between trends from different datasets included in Gaudel et al. ought to be raised more prominently in this manuscript.

The authors raise some interesting speculative points about attribution of trends in tropospheric ozone, but since no rigorous attempts at attribution were made in this work, some care is needed with the language associated with these statements. Specific examples are provided in the minor comments below.

The discussion of attribution of trends (Section 4) is largely limited to changes in emissions. Why is this? What about long-term variations in stratosphere-tropopshere exchange and the influence on tropospheric ozone? I see that Section 4.1 mentions interannual variability in stratosphere-troposphere exchange in the discussion of trends in IASI-FORLI tropospheric ozone in the SH tropical region, but I did not understand why this was not mentioned in the context of other regions. Presumably this could also be an important factor in mid-latitudes? (e.g. as per Verstraeten et al., 2015)?

Minor comments

In general, the paper would benefit from editing by an English language service. There are small eccentricities in grammar throughout the paper. They are so numerous that I have not attempted to list issues of grammar in the minor corrections below. However, in most cases, these are not an impediment to understanding.

The authors have chosen to describe the quantity of interest (tropospheric column from ground to 300 hPa) as tropospheric ozone columns (TOCs) in this work. In the previous Wespes et al. [2016] companion paper, the authors had referred to this ground-300hPa quantity as middle-low troposphere (MLT) ozone. The Gaudel et al. TOAR-Climate paper states that the IASI-FORLI TCO used in that study relies on the WMO definition of the daily tropopause height. It seems confusing to refer to the ground-300 hPa values as TOCs.

Abstract, line 23-24: “This finding supports the reported decrease of O3 precursor emissions in recent years”. It would be more appropriate to say that the finding “is consistent with”, rather than “supports”.

Line 76-77: What is menat by “trend characteristics”? Consider an alternative choice of wording?

Lines 103-104: “These profiles are characterized by a good vertical sensitivity to the troposphere and the stratosphere”. I am not sure exactly what the authors mean here. Please consider an alternative choice of wording.

Figure 2: What is the difference between gray areas and crosses in Figure 2? This is not clear from either the manuscript text or the figure caption. Also, the crosses in Figure 2 are almost impossible to see. The crosses are also tough to see in Figure 5, but are a bit more visible in that figure, possibly because of the lighter colour scale. Please find a way to make the crosses more visible.

Lines 216-224: This is difficult to follow, possibly because the authors are trying to make a general statement that covers all eventualities. I was not sure what the main point of this paragraph should be.

Lines 246-251: I think the wording of this statement is too strong, given the scope of this study. I was also surprised that this section does not mention stratosphere-troposphere exchange.

Lines 272-281: I found the idea that the annual and summer trends for 2008-2016 are “amplified” relative to the trends for 2008-2013 hard to reconcile with the language about “leveling off”. Can the authors please revise this paragraph for clarity?

Line 433 (and also line 523): I do not think it makes sense to talk about “air masses” in the context of seasonal means. Consider changing “air masses” to “outflow regions”?

Lines 471-482: I found this paragraph difficult to follow. China is not the only place where ozone precursor emissions have been decreasing in recent years. Perhaps it would be better just to say that the pollution outflow from Eastern Asia shows a stronger positive O3-CO relationship than the outflow from either the Eastern US or Europe and leave it at that? It does not seem that there is enough information here to make definitive statements about attribution.

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