Review of “Decrease in tropospheric O3 levels of the Northern Hemisphere observed by IASI” by C. Wespes, D. Hurtmans, C. Clerbaux, A. Boynard, and P.-F. Coheur

This is an interesting analysis of tropospheric ozone trends derived from nine years of IASI nadir IR retrievals. The authors are experts in both IR retrieval and the data analysis methods used for the study. The emphasis of the paper is detection of negative trends in IASI tropospheric ozone, primarily in the latitude range 40N-70N. To evaluate this submitted paper, a first thing I did was go to the TOAR climate which is in review circulation in 2017. For reference purposes, the latest drafts of TOAR-Climate chapters can be downloaded from http://www.igacproject.org/activities/TOAR/OpenComments.

There are major differences between IASI trends (both for this submitted paper and in the TOAR) aand trends measured from other independent sources of tropospheric ozone. The reported negative trends for IASI tropospheric column ozone do not appear to be reproduced by other data sources of tropospheric ozone. This paper does not compare IASI trends with several key studies on trends and also does not compare IASI trends directly in this paper with trends derived from other independent data.

The current paper will require major analysis/changes by the authors – they should compare with other studies on tropospheric ozone trends and reconcile differences. Comparisons of IASI trends with trends from either ECC sondes and/or aircraft measurements are also not present in this paper. Both sondes and aircraft data from MOZAIC+IAGOS are public domain / open access and can be compared directly with the IASI trends.

A recent paper by Petetin et al. (2016) examined the long record of MOZAIC+IAGOS aircraft tropospheric ozone for 1994-2012 and did not measure negative trends in any season. Here is a paper that describes the MOZAIC and IAGOS ozone instruments and also shows that the two time series can be joined for trend studies:

Instrumentation on commercial aircraft for monitoring the atmospheric composition on a global scale: the IAGOS system, technical overview of ozone and carbon monoxide measurements, Philippe Nédélec, Romain Blot, Damien Boulanger, Gilles Athier, Jean-Marc Cousin, Benoit Gautron, Andreas Petzold, Andreas Volz-Thomas & Valérie Thouret, Tellus B: Chemical and Physical Meteorology Vol. 68 , Iss. s1,2016
http://www.tandfonline.com/doi/abs/10.3402/tellusb.v67.27791@zelb20.2016.68.issue-s1

Near-daily MOZAIC+IAGOS ozone profiles are available above Frankfurt since 1994. These profiles extend from the surface to 12 km and cover the full depth of the troposphere at the latitude of Frankfurt. There is no drift in the observations as these instruments are routinely calibrated. Tropospheric ozone data from Frankfurt is of high data quality and high sampling frequency, and is ideal for evaluating satellite tropospheric ozone products.

Monthly mean profiles on pressure surfaces can be easily provided by Herve Petetin. He can also limit the analysis to the portions of profiles measured below the tropopause.

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The following paper shows no tropospheric ozone trend at Frankfurt for 1994-2012 in any season, except for winter where ozone has actually increased. The TOAR-Climate provides an update and gets similar results.

Petetin, H., V. Thouret, A. Fontaine, B. Sauvage, G. Athier, R. Blot, D. Boulanger, J.-M. Cousin, and P. Nédélec (2016), Characterizing tropospheric ozone and CO around Frankfurt between 1994–2012 based on MOZAIC-IAGOS aircraft measurements, Atmos. Chem. Phys., 16, 15147-15163, doi:10.5194/acp-16-15147-2016. https://www.atmos-chem-phys.net/16/15147/2016/

The following paper demonstrates that many profiles are available at Frankfurt during the morning, around the time of the IASI overpass:

Petetin, H., et al. (2016), Diurnal cycle of ozone throughout the troposphere over Frankfurt as measured by MOZAIC-IAGOS commercial aircraft, *Elem. Sci. Anth., 4:129*, DOI: http://doi.org/10.12952/journal.elementa.000129/.

In addition, the following paper in ACPD shows evidence that UT ozone has actually increased across the NH mid-latitudes from 1995 to 2013:

Cohen, Y., et al. (2017), Climatology and long-term evolution of ozone and carbon monoxide in the UTLS at northern mid-latitudes, as seen by IAGOS from 1995 to 2013, ACPD, https://www.atmos-chem-phys-discuss.net/acp-2017-778/acp-2017-778.pdf/.

In your paper you also mention negative trends in the SH from IASI that are hard to explain. You reference an ACPD paper (Zeng et al., now published in ACP, 2017) that combined ozonesondes with a Chemistry-Climate Model for evaluating ozone trends for Lauder, New Zealand during 1987-2014. The Zeng et al. study found evidence of negative trends for 9-12 km column ozone, but no trends in upper tropospheric ozone (6-9 km) and distinctly positive trends for the lower troposphere (0-6 km). For most of the mid-latitude troposphere (i.e., 0-9 km) the trends that they measure for Lauder actually appear as positive rather than negative. It is also not certain how much their 9-12 km layer ozone is impacted by decadal decreases in lower stratospheric ozone.

Shown below is a comparison that includes ozonesondes, Umkehr, and FTIR ozone at Lauder (this figure appears in the supplement to TOAR-Climate). While IASI-FORLI shows a strong ozone decrease at this location, the sondes, FTIR, and Umkehr data show no trends since 2000. There seem to be substantial discrepancies in IASI trends in not just the NH but also in the SH as well that the authors will need to reconcile.

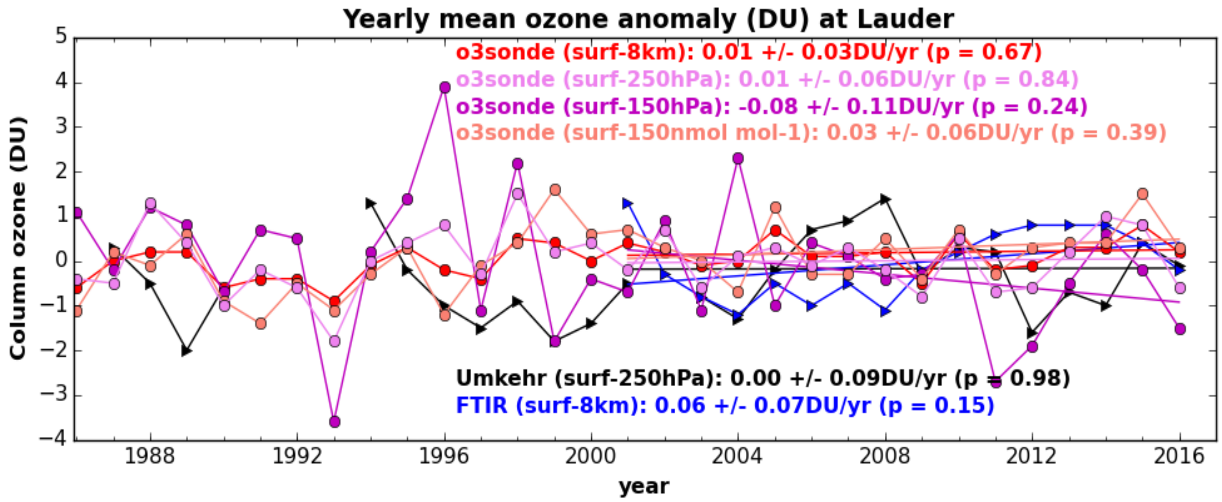

Figure S4.2.3. Comparison of annual ozone anomalies (tropospheric ozone columns in Dobson units) as measured by FTIR, Umkehr and ozonsondes above Lauder, New Zealand. Ozone columns extend from the surface to 8 km, 250 hPa or to the 150 nmol mol^{-1} ozone isosurface, as labeled in the figure. Trends in this figure are based on least-squares linear regression and reported with 95% confidence intervals and p-values.