Anonymous Referee #3

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In this study, Nedoluha et al. investigate ozone anomalies in a 22 year record of ground-based microwave measurements at Lauder, New Zealand. The ground-based observations are augmented by satellite observations that provide a global perspective. Long-term ground-based observations are extremely important to provide a reference for the long-term evolution of the middle atmosphere under the influence of ozone recovery and a changing climate. Understanding how dynamical variations affect trace gases, and in particular ozone, is essential for interpreting long-term observations. The present study is a well written case study, analyzing an important data set. While there is some overlap with the earlier study of Nedoluha et al. (2015), the focus of the present study is sufficiently different and provides enough independent evidence to justify publication as an individual paper. I recommend publication in Atmos. Chem. Phys. after consideration of the following, mostly minor, comments.

General comments:

As presented here, there is some disconnect between the shorter-lived O3 anomaly in June 2001 and the longer-lived anomaly in 2009-2013. E.g., how does the 2009-2013 anomaly behave in terms of tracer equivalent latitude? Can the event in 2001 help to better understand the longer-lived anomaly in 2009-2013?

While it is true that both of these anomalies involve dynamical variations that affect constituents at 45S, the June 2001 anomaly is for a given longitude (near Lauder), while the 2009-2013 anomaly is observed in a zonal average. In the zonal average, the TrEL value for June 2001 is not particularly unusual (seventh highest in 35 years).

Can you relate (directly or indirectly) the ozone anomaly at Lauder to the reported reversal in HCl columns at Northern Hemisphere mid-latitudes (Mahieu et al., Nature, 2014)? Maybe even if these anomalies are not related you may want to consider referring to Mahieu et al. in the introduction and/or in discussion of the N2O trends seen in Fig. 9b.

Yes, good point. We have added the text: “While the beginning and endding dates are slightly different, Fig. 10 is qualitatively consistent with the conclusion in Mahieu et al. (2014) that the air in the SH mid-latitude lower stratosphere is younger in 2010/2011 than in 2005/2006, while the opposite is true in the NH. “

The ozone increase from MOPI1 measurements between _2005 and _2013 (Fig. 6) are much larger than what is seen in the MLS measurements. Is this because MLS in Fig. 6 is a zonal mean from 40-50S? How does this compare for coincident data, i.e. as in Fig. 5, but with annual averages? In general I would have expected that the lower (vertical) resoluition MOPI data would show smaller anomalies.

While it is not as clearly apparent in Figure 5 (now Figure 6), the ~4% relative change between MLS and MOPI which is clear in Figure 6 (now Figure 7) and occurs primarily from the beginning of the MLS time series until ~2007 is actually present in Figure 5 (Fig. 6) as well. We have added text in 3.2 pointing out this change. It does not appear to be related to differences in vertical resolution.

Specific comments:

p. 5242, l. 5: Abstract: “We will study” -> “We study”

done

p. 5242, l. 9: Why 35 yr period and not the 22yrs of measurements discussed here?

Since MERRA was available back to 1979 (as we now indicate in the abstract as well as later on in the text) we thought it would be best to do the calculation for the entire MERRA period.

p.5242, l.9: better indicate “most equatorward” rather than just “highest”

done

p. 5242, l.15: “This latitude band”: I suggest giving the latitude of Lauder already in line 3.

done

p.5244, l.17: “Each MOPI instrument: : :”: I feel that some introduction is needed here on the different MOPI instruments. More importantly: Is MOPI1 a single instrument, which has been used continuously throughout the 22yr record? Were there any significant modifications of MOPI1 within this period?

We now mention at the start of Section 2 that there is a MOPI2 instrument at Mauna Loa, and that the MOPI1 instrument is essentially unchanged except for repairs since 1992.

p. 5246, l.3: any ideas why the MOPI1 vertical resolution is coarser than MOPI2 at Mauna Loa? Is this an instrument effect (different signal-to-noise) or due to differences in tropospheric opacity? Not essential here but would be nice to know.

Yes, tropospheric opacity is the biggest reason for the difference. Lauder is 370m AMSL and the Mauna Loa site is 3400m AMSL.

p.5248, l.19: You mean O3 latitudinal gradient in a climatological sense?

Yes, and we have added the word “climatological”.