

## ***Interactive comment on “Hemispheric asymmetry in stratospheric NO<sub>2</sub> trends” by Margarita Yela et al.***

### **Anonymous Referee #2**

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This paper presents sound analysis of four data series that, in keeping with NDACC requirements, have measured stratospheric species to the best available standards over decades. The literature is well surveyed, and the analysis techniques follow established practice, but in doing so the paper does not add much new insight. The results are at odds with cited previous studies, and that should be discussed further.

My main criticism is that, starting with the title, the representativeness of the sites seems to be exaggerated; one site in the Canary Islands serves as a proxy for the northern hemisphere, while three sites in Tierra del Fuego, the Antarctic Peninsula, and the southern Weddell Sea purportedly represent the southern hemisphere. It would be better to acknowledge the respective limitations, especially as the NDACC as a whole gives much wider (if still irregular) coverage. Both latitudinal and longitudinal gradients

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may be present, as implicit for Antarctic vortex displacement toward South America, but also cited as a feature of Gruzdev's 23-station analysis in 2009 ("Trends were found to be mostly positive in the middle and low latitudes of the SH and mostly negative in the European sector of the middle latitudes of the NH" - both different from this study).

It may also be that the difference depends heavily on the analysis period. The Izaña residuals in Fig 2 to 2008, as comparable to a 2009 analysis, show no upward trend, and the Ushuaia and Marambio data to the same time show indistinct trends.

On the subject of time periods, the authors should perhaps also mention why their paper in mid 2017 only includes data to the end of 2014. My guess is that it represents a lengthy period of trying different analyses in what is routinely a frustrating attempt to tease meaning from such datasets, but it would still be better for the 25 years of NDACC special issue to use the 24 years of data from Izaña and 23 from the others.

Specific points:

lines 41-43: The technique of zenith-sky DOAS was pioneered by Noxon, and the first regular monitoring was at Lauder, continuous from 1980, and later from Scott Base.

line 106: "... degradation ... at a rate of 4.33%/year." Confidence limits on this figure are relevant to the inferred trends.

line 147: The second beta terms should be subscripted  $2k$ , not  $2k-1$ .

line 154: "... since the start of measurements, in months". The scaling of  $t$  by  $2\pi/12$  in the trigonometric terms of the equation means that  $t$  must be expressed in months.

line 156: "annual, semi-annual, and four-monthly waves". A quarterly term would have  $k=4$ .

line 160: " $\alpha > 0.1$ " is less conventional than  $p > 0.1$  to express significance level.

line 178: "in the first few years of the time series, strongly affected by Pinatubo, which would otherwise bias the trend" would make it clearer that the bias was a genuine

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geophysical effect rather than a measurement or statistical artefact.

line 197: "negative trend (Schwarzkopf and Ramaswamy, 2006)", rather than "i.e." Alternatively, "e.g." might have been meant here.

line 244: "large nitrate aerosols load injected following Pinatubo's eruption". Pinatubo injected 20 Mt of sulphur dioxide, which was oxidised to sulphate aerosol over a few weeks. There was no large injection of nitrate aerosols by Pinatubo, or following it.

line 247: "quarterly" is "four-monthly".

line 265: "negative decadal trend of  $-5.9 \pm 1.5\%$ " would be clearer, without any risk of tautology.

lines 303-306: "The negative trend in the SH increases ... At Ushuaia, the negative trend is reduced to values close to the annual minimum (-7%), whereas in Marambio, the trend increases with respect to previous months". Talking of minima, and reductions, in negative trends is unnecessarily ambiguous. While the reader can perhaps correctly assume a reduction in the absolute value of a negative trend is meant, it is better to choose different words: "The downward trends in the SH become more negative further south ... At Ushuaia, the trend is less negative ..."

line 340: "The MIPAS data have been combined with the DOAS averaging kernels ...", or "converted", rather than "corrected".

line 348: Fig 10, lower panel, does not show similar seasonalities; that would require a monthly plot like Fig 8.

line 351: "MIPAS decadal trend of  $+3.0 \pm 0.4\%$ " appears as  $5.0 \pm 3.5$  in Table 5. Please check all such figures.

line 364: "... evidence that N<sub>2</sub>O oxidation is not the cause ..." Please clarify. Is that argument that N<sub>2</sub>O is sufficiently well mixed that any change would expect both hemispheres the same?

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line 369: "Negative trends were found in the lower stratosphere ..."

line 391: "... change of sign between hemispheres in the stratospheric trend" would be better, except for comments above about whether the four sites really represent their respective hemispheres.

In Table 5, please check the calculation of the "T statistic" (usually "t statistic") as the values appear to be at odds with the trends and their standard errors.

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